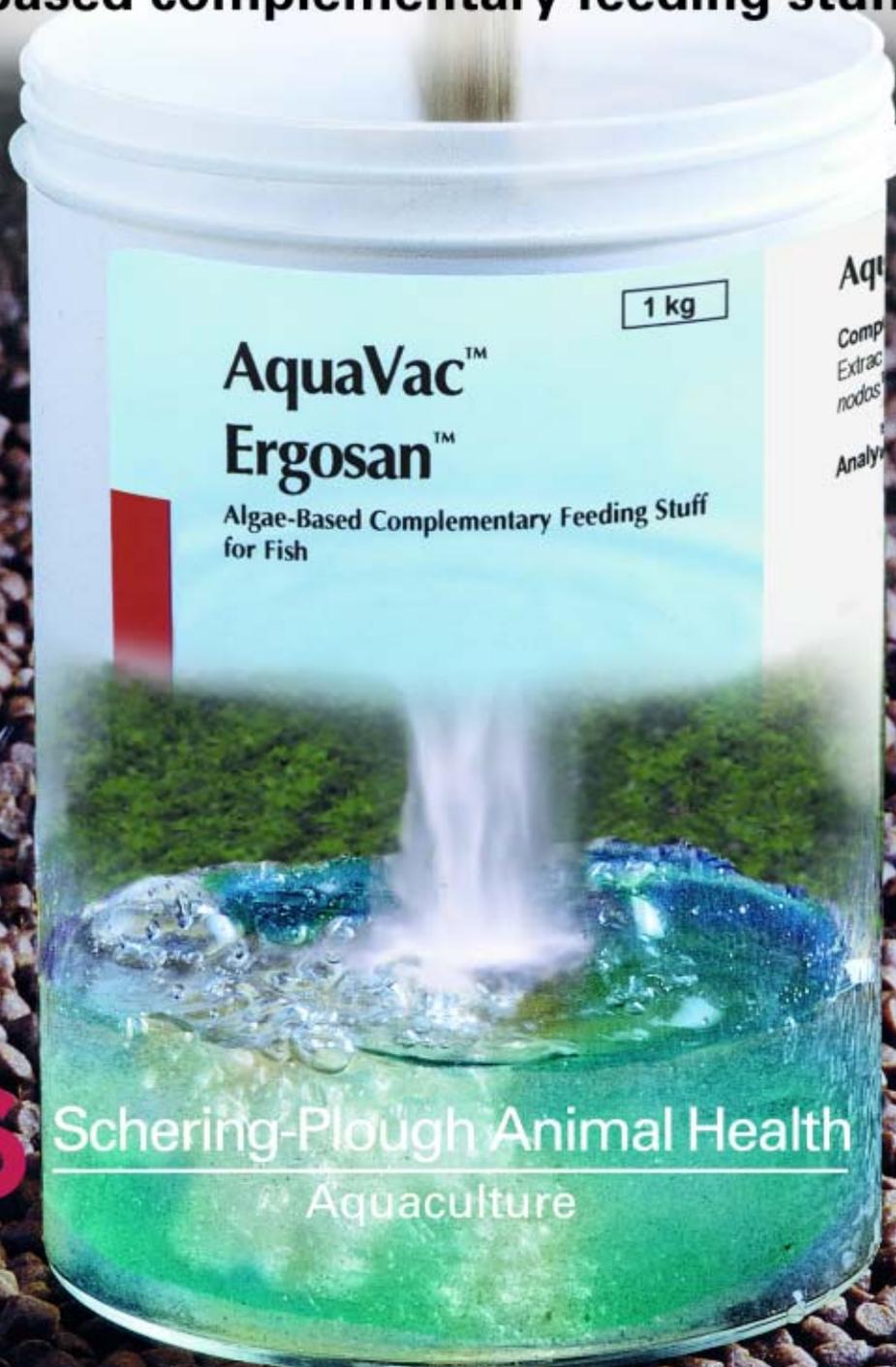


## Back to Nature

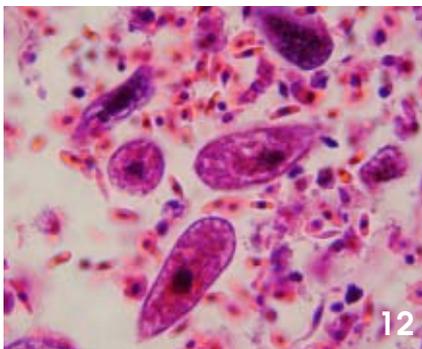
Algae based complementary feeding stuff for fish



Schering-Plough Animal Health  
Aquaculture

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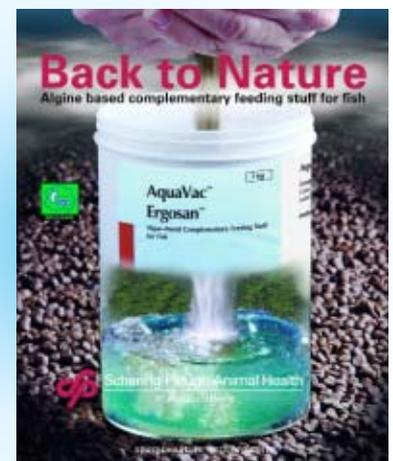
The effects of Aquavac™ Ergosan™ on juvenile Chinook salmon

## FROM THE COVER

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# THE EUROPEAN COMMISSION DIRECTIVE ON FISH AND SHELLFISH HEALTH – A WELCOME DEVELOPMENT?

DR SCOTT PEDDIE, EDITORIAL DIRECTOR

As many of you will no doubt be aware, the Commission of the European Union has recently published its proposals for a Council Directive on the health requirements for cultured aquatic animals and on the prevention and control of certain diseases [COM 2005 362].

The purpose of the proposal is to update and consolidate animal health rules in relation to trade in aquaculture products, including disease prevention and control.

By supplanting EU Directives 91/67 EEC, 93/53 EEC and 95/70 EEC, the commission hopes to streamline legislation and, by doing so, increase the competitiveness of European aquaculture. It will also bring the EU into line with international standards laid down by the OIE and WTO, among others.

Many have shared a sentiment that the existing legislation, developed over two decades ago, was reaching the end of its useful shelf life. Not only has the EU expanded in the intervening years to include new member states, but also the scope of aquaculture practice has increased markedly to incorporate a plethora of new species and farming techniques.

The commission should therefore be commended for taking

the changing dynamics of the industry and the environment in which it operates by addressing the legislative framework that underpins it.

The proposed legislative changes look attractive on paper. Granting greater flexibility to facilitate local and regional approaches to disease control and eradication makes good sense. So too does the requirement of member states to formulate emerging and exotic disease eradication contingency plans.

A positive development is that the proposal includes provision for compensation via the European Fisheries Fund for farms subjected to compulsory stock culling measures carried out as part of a disease eradication plan. In the eyes of many, bringing aquatic animal health legislation into line with that in existence for terrestrial animal health is overdue.

Simplifying and consolidating complex animal health legislation is not always an easy task. That the European Commission has made a good start in the aquaculture arena is a welcome development. ■



## CORRECTION

In the first issue of *Aquaculture Health International*, the quoted losses for rock oyster caused by QX diseases should have read, "In New South Wales Australia, *Martelia sydneyi* (or QX disease) is the single most important pathogen, causing 90 percent prevalence in rock oyster which has a production value of US\$30 million". Thanks to Melba Reantaso and Eva-Maria Bernoth for pointing this out.



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# DIAGNOSTIC LABORATORY SERIES

SERIES EDITORS: DR DAVE GROMAN AND DR FRANCK BERTHE  
(ATLANTIC VETERINARY COLLEGE AT THE UNIVERSITY OF PRINCE EDWARD ISLAND, CANADA)

A variety of service, research and teaching laboratories exist worldwide which support the aquaculture industry. These laboratories often offer disease screening and diagnostic services, with various levels of testing and quality assurance. In addition, some laboratories may not engage in pro-active international marketing. As a result, many aquaculture companies and their fish health service providers are not always aware of the range of laboratory resources available in the global marketplace.

This series of laboratory articles will provide *Aquaculture Health International* readers with a guide to diagnostic laboratories which offer regional, national or global "routine - fee for service" veterinary diagnostic services to finfish, mollusc and crustacean producers and their veterinary service providers.

In addition, the articles will focus on affiliations that these diagnostic laboratories may have with universities, government agencies and institutes linked to aquatic health training or research. The articles will seek input from each laboratory as to their strategic goals and operational philosophy.

This objective services review, in combination with subjective input on management philosophy, will provide readers with a

balanced description of the laboratory, and will ultimately help aquaculture veterinary professionals to make informed decisions on selecting appropriate diagnostic service laboratories, aquatic health training and research programmes.

To accomplish this, we will provide a formative review of the services provided by each laboratory, with the approval and assistance of the company, programme or laboratory management. To this end, we have developed an aquatic health diagnostic services evaluation checklist which will detail information on the type and scope of services offered:

- quality assurance programmes
- referral options
- reporting methods
- client base, and
- the cost of testing.

We will strive to capture a thorough description of the diagnostic component of the laboratory, with a capsulated summary of services provided. If a laboratory prefers not to participate in the series, we will only provide a description based on published information, public advertising or government documentation.

## FEATURED DIAGNOSTIC LABORATORY: ADL Diagnostic Chile Ltda. (Chile)

AUTHOR: DR PATRICIO BUSTOS (ADL DIAGNOSTIC CHILE LTDA, CHILE)

In 2000, ADL Diagnostic Chile Ltda (ADL) began to offer commercial clinical and diagnostic veterinary services to the salmon and trout producers located on Chiloé Island, the primary aquaculture region in southern Chile.

The company was founded by aquaculture veterinarian Dr Patricio Bustos, the general manager of ADL and his wife, Valeria Vallejos, who is chief administrator.

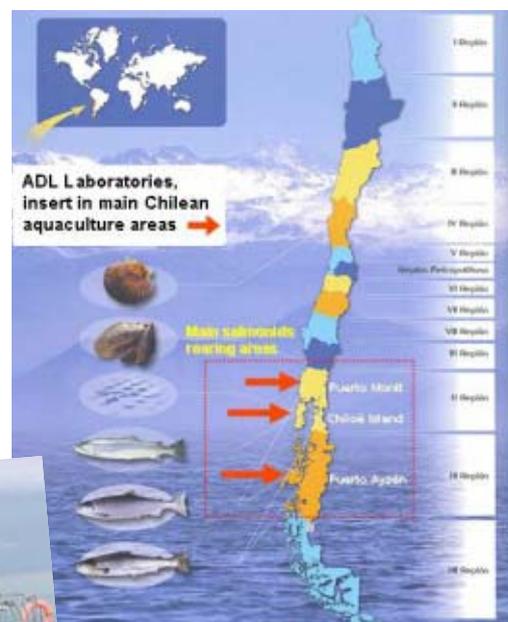
For Dr Bustos, the formation of ADL was the culmination of over 17 years of aquatic health work in Chile. The company began with five staff and a basic diagnostic laboratory that has developed into a nationally competitive fish health company. This occurred in a slow, progressive manner, with new staff, services, technology and expanded facilities being incorporated to meet the challenges of a very demanding and sophisticated aquaculture industry.

During the past two years ADL has expanded its services and opened offices and laboratories in Puerto Montt (Xth region) and Puerto Aysén (XIth region), in addition to the original laboratory in Castro on Chiloé Island.

An important milestone for ADL is the construction of a new 700m<sup>2</sup> headquarters and state-of-the-art laboratory complex in the city of Puerto Montt with an expected completion date of December 2005. This will be one of the more modern private diagnosis laboratories in the country, with quality procedures based on international standards. ADL currently employs a multi-disciplinary team of 32, comprising veterinarians, medical technologists, biochemists, biologists, microbiologists, aquaculture engineers, technical personnel and assistants, in addition to administrative and financial staff.

RIGHT:  
THE LOCATION  
OF ADL'S  
LABORATORIES

BELOW:  
AN ADL FISH  
VETERINARIAN  
IN THE FIELD



### SERVICES PROVIDED

ADL's services are essentially dedicated to aquatic health. They include diagnosis of the causative agent or etiology of mortality, together with programmes for preventing or controlling aquatic diseases. The company promotes the use of high-quality diagnostic and analytical

testing, as well as technological innovation to provide concrete actions and efficient solutions to clients' needs.

The ADL team of professionals is constantly upgrading their skills and knowledge in the aquatic health field. The primary business goals of ADL include research into enzootic and emerging



A VIRTUAL VIEW OF ADL'S NEW LABORATORY COMPLEX

aquatic diseases, and the development of new diagnostic techniques utilising new cell lines coming from locally reared fish. The company also provides training opportunities for veterinarians in aquatic health sciences, with students and veterinarians participating from as far away as Brazil.

ADL offers nine primary services to the aquaculture industry in Chile:

### CLINICAL AND TECHNICAL VETERINARY FIELD SERVICES

This ADL service is provided by veterinarians working on farms as part of a specified fish health programme. This field veterinary team is one of most experienced in the Chilean salmon industry and operates mainly in the VIII, IX, X and XI regions of the country.

#### Aquatic health diagnostic services evaluation checklist

This table summarises the level and diversity of aquatic diagnostic testing provided, as well as information on methods of pathogen or agent confirmation, laboratory quality assurance, referral services, reporting options, client base and cost of testing. (See key below.)

CATEGORY	CLINICAL VISITS	WATER QUALITY	PHYCOLOGY	NECROPSY	CLINICAL CHEMISTRY	HAEMATATOLOGY	CYTOLOGY	HISTOPATHOLOGY	ELECTRON MICROSCOPY	BACTERIOLOGY	MYCOLOGY	VIROLOGY	PARASITOLOGY	TOXICOLOGY	SEROLOGY	ENDOCRINOLOGY
Finfish	A	NA	S	F	NA	S	S	F	NA	F	S	S	S	S	S	S
Molluscs	NA	NA	S	S	NA	NA	NA	NA	NA	F	NA	NA	NA	NA	NA	NA
Crustaceans	NA	NA	S	S	NA	NA	NA	NA	NA	F	S	NA	NA	NA	NA	NA
Pathogen ID			M				M	M	M,C,I	M,C,I,G	M,C,G	M,C,I,G	M,C,I,G	AC	I	AC
Quality assurance			IN	IN, ISO*	IN	IN	IN	IN	IN	IN	IN	IN, ISO*	IN	IN	IN, ISO*	IN
Referral		A	A		A			A	A	A(G)	A(G)	A(G)	A(G)	A	A	A
Reporting	PE	PE	PE	PE	PE	PE	PE	PE	PE	PE	PE	PE	PE	PE	PE	PE
Client base	N	N	N	N	N	N	N	N,R	N	N	N	N	N	N	N	N
Cost (\$)	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$

#### KEY

Scope of testing

Full testing available = F

Selective testing = S

Pathogen/agent ID

By morphology = M

By culture = C

By immunology/serology = I

By genomic / molecular = G

By analytical chemistry = AC

Quality assurance scheme

Internal quality control = IN

External quality assurance/ring testing = EX

Certification = ISO

Referral testing

Available = A

Not available = NA

Reporting options

By post = P

By fax = F

By email = E

By website = W

Client base

Regional = R

National = N

International = I

Cost of services

Full cost recovery = \$

Partial subsidy = P\$

Full subsidy = F

\*ISO = Refers to viral analysis carried out in accordance with governmental regulations. Where this is the case, necropsy, serology and virology must be certified by ISO rules. Only related to List 1 Viruses according Chilean rules (IHN, VHS, OMS, EHN), or where there are clinical signs of ISA. The regulations stipulate that every commercial rearing centre for fish, molluscs or crustaceans is subject to multiple virology (cell line) checks per year.



### VETERINARIAN DIAGNOSTIC INTERPRETATION AND CONSULTATION

This ADL service provides veterinary support and interpretation of laboratory results, facilitating the provision of clear advice to field veterinarians and clients on the significance of the diagnostic findings.

### DIAGNOSTIC LABORATORY SERVICES

These services encompass a wide range of diagnostic laboratory testing, including bacteriology, mycology, parasitology, virology, molecular biology (RT-PCR), immuno-diagnostic tests (serology), descriptive histopathology and haematology.

ADL offers referral options for a wide range of alternative testing,

such as electron microscopy (TEM), radiology and genetic sequencing, among others.

### RESEARCH AND DEVELOPMENT SERVICES

Proactive research is enormously important to the ADL team, as it reinforces strong strategic alliances with other national biotechnological companies, universities and overseas institutions. Historically ADL-sponsored studies have examined the epidemiology of relevant pathogenic agents affecting the Chilean salmon industry. These include *Piscirickettsia salmonis*, IPNV, *Vibrio ordalii*, *Listonella anguillarum*, *Photobacterium damsela*, *Flavobacterium psychrophilum*, *Streptococcus phocae* and diverse Ulcerative Vibrios, as well as some systemic fungus causing septicaemia, *Loma* and other microsporidians.

The ADL team has also addressed other studies examining health management and production techniques, for example severe gill damage in harvested products, skeletal deformity, fish stock movement, evaluation of health using immunostimulants and disinfectants, natural anti-stress dietary supplements and alternative anti-*Saprolegnia* therapeutants.

### STATISTICAL AND FISH HEALTH MANAGEMENT AND PRODUCTION SERVICES

ADL processes and analyses the production records and health information of clients, incorporating relevant epidemiological information, in order to provide clients with constructive options for preventing and controlling disease.

### BROODSTOCK SCREENING PROGRAMME

This programme is directed at detecting and certifying diseases that can be transmitted vertically via infected broodstock, providing clients with disease profiles of the progeny with respect to IPN, BKD and SRS. Broodstock certification programmes are obligatory in Chile for IPNV and *Renibacterium salmoninarum* (BKD). Some studies are being carried out in other diseases with probed vertical transmission in order to know its behavior and impact in progeny.

### FISH HEALTH SURVEILLANCE PROGRAMMES

In accordance with Chilean government regulations, all fish-rearing facilities must submit to bi-annual specific List-1 viral pathogen screening for IHNV, OMV, EHN and VHSV. ADL provides this programme to clients based on procedures outlined in the national code (NCh NT-10), in collaboration with Office International des Epizooties (OIE) reference laboratories.

### BAY OR ZONE HEALTH MANAGEMENT PLANS

Integrated bay or zone health management plans help companies to minimise sanitary problems, improve productivity and reduce environmental impacts. ADL assists associations and groups of companies which occupy the same body of water to develop workable health management programmes.

One such example is the Quellon Group located on Chiloe Island, which comprises five companies operating 34 marine farming sites. To better assist groups of companies, ADL has streamlined its zone management services into three divisions:

- the Centre of Health Information (CIS)
- the Centre of Environmental Information (CIA), and
- the Centre of Productive Information (CIP).

These centres provide active epidemiological updates to zone management groups, focusing on risks analysis, early warning of emerging diseases, planning, and monitoring of disease control programmes.



AQUATIC  
DIAGNOSTIC  
SERVICES

D

Atlantic Veterinary College




### Services

<ul style="list-style-type: none"> <li>• Bacteriology</li> <li>• Clinical Chemistry</li> <li>• Hematology</li> <li>• Endocrinology</li> <li>• Necropsy</li> <li>• Histopathology</li> <li>• Electron Microscopy</li> <li>• Virology</li> </ul>	<ul style="list-style-type: none"> <li>• Parasitology</li> <li>• Toxicology</li> <li>• Analytical Services</li> <li>• Health Inspections</li> <li>• Diagnostic Consultation</li> <li>• Antisera Production</li> </ul>
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University of Prince Edward Island

## QUALITY CONTROL (ISO 17025) CONSULTATIONS

ADL operates a quality assurance system based on the Norm ISO 17025, as part of the national authorities (INN). This QA programme is operated to assure the aquaculture industry and ADL clients that protocols and data produced by ADL laboratories are rigorously documented.

## COLLABORATIONS AND LINKAGES

ADL staff members participate in an array of local, regional and national technical committees:

- Technical Fish Health Committee of INTESAL (belonging to The Chilean Salmon Industry Association)
- Branch of Veterinary Medicine linked to Aquaculture (MEVEA)
- Working-Table Group for Health Management of the Chilean Salmon Industry (PTI Programme, INTESAL), and the
- IPNV Sub-Committee for INTESAL.

In addition, ADL has developed links with specialists at national research institutions and overseas agencies, including:

- Centre for Biotechnology, University of Chile (Chile) - genetic identification of pathogen agents
- BiosChile Ing Genetics (Chile) - projects relating to new diagnostic techniques in broodfish screening
- Intervet Norbio (Chile - Norway) - *Vibrio ordalii* Project
- Veterquímica SA (Chile) - *Listonella anguillarum* Project
- Centre for Fish Diseases Research at Oregon State University (OSU) - Myxosporidian and Microsporidian work
- US Geological Survey - Western Fisheries Research Centre (USA) - IPNV and other viruses
- Delta Research and Extension Centre (USA) - RLO (new rickettsial species) and *Piscirickettsia salmonis* research
- Aquatic Diagnostic Services at Atlantic Veterinary College (UPEI) (Canada) - in diverse disease diagnosis and histopathological consultancy
- Marine Laboratory (Scotland) - Jaundice Syndrome and its relationship with (or not) ISAV
- Department of Industries, Water and Environment (DPIWE) (Australia) - Jellyfish, and
- VESO Vikan (Norway) - IPNV.

## INTEGRATED SERVICES AND THE FUTURE AT ADL

The general trend in the Chilean aquaculture industry is to seek companies that provide integral services for disease diagnostics, product traceability, toxicological analysis and environmental monitoring. To cater for this demand, ADL established a strategic alliance in mid-2005 with BSI-Inspectorate, a multinational analytical company with over 70 laboratories located in more than 120 countries.

The focus of BSI is to reduce commercial risk related to products exported to markets in Europe, Asia and the United States by providing HPLC-based toxicological analysis of food products. In addition to chemical analysis, BSI offers product traceability, inspection and training programmes.

In the environmental area, ADL has agreed to collaborate with GEEAA, a company dedicated to studies and environmental analyses, and with strong links to the salmon industry and activities tied to aquaculture.

In short, ADL sought through this alliance and agreement to strengthen, extend and promote participation of markets, under the option of offering an integral service to their clients, with the experience, specialisation, knowledge and exclusive dedication to its respective areas of competition.

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# FOCUS: FISH HEALTH MANAGEMENT EVENT IN POLAND



PARTICIPANTS TAKING NOTES  
DURING THE FISH HEALTH  
MANAGEMENT COURSE

A fish health workshop was held in mid-June under the auspices of the EU Aqua Innovation Network in Nowa Wies' Leborska, Poland. The workshop was presented by CSN INTRAN's pharmaceutical partner, Schering Plough Animal Health (Aquaculture). The Danish feed company Aller-Aqua was also involved as sponsors of the event.

More than 70 industry representatives from Poland attended, including fish farmers, veterinarians and local industry press. Prof Patrick Smith and Dr Chris Gould of Schering Plough Animal Health's Global Aquaculture Unit gave a series of lectures and talks to promote health management within the trout farming sector.

More than 70 industry representatives from Poland attended, including fish farmers, veterinarians and local industry press

The first day concentrated on the major diseases for which vaccines were available. Detailed presentations were then given on how to apply these vaccines to achieve the best performance possible.

The second day concentrated on vaccination strategies to give protection throughout the life cycle of the fish, with particular reference to newly developed oral vaccines that allow a prime and booster vaccination strategy to be employed. The workshop concluded with a 30 minute DVD demonstrating the practical aspects of fish vaccination.

See [www.aquainnovation.net](http://www.aquainnovation.net)

## EUROPE: NEWSLETTERS ON LINE

Since the last issue of *Aquaculture Health International* was published, DIPnet (Disease Interactions and Pathogen exchange between farmed and wild aquatic animal populations - a European network) has updated its website.

See [www.dipnet.info](http://www.dipnet.info) for the newsletter archives.

Additional newsletters include:

**Newsletter 25** - Prevalence of infectious salmon anaemia virus in wild salmonids in western Norway.

**Newsletter 24** - Molecular detection of crayfish plague in Norway.

**Newsletter 23** - Virulence specificity of *Vibrio nigripulchritudo*, a pathogen for farmed shrimp in New Caledonia.

**Newsletter 22** - Risk on local fish populations and ecosystems posed by the use of imported feed fish by the tuna farming industry in the Mediterranean.

**Newsletter 21** - Geographical distribution of oyster herpes virus.

## UK: VACCINE WINS ANOTHER FIRST

Schering Plough Animal Health's dedicated Aquaculture Business Unit has received approval of its vaccine to protect rainbow trout from enteric red mouth disease, or yersiniosis, through the European Union's Mutual Recognition Procedure.

The Aquavac<sup>TM</sup> ERM vaccine is said to be the first fish vaccine to be approved under the procedure. It was the first experimental fish vaccine developed in the late 1970s and was also the first fish vaccine to be licensed in Europe.

Aquavac ERM will now become available in Austria, Czech Republic, Greece, Spain, Norway, Poland, Portugal, Slovakia and Slovenia. It is already available in the United Kingdom, France, Ireland, Denmark, Italy and Germany.

The successful completion of the MRP allowed Schering Plough Animal Health to request marketing authorisations across member states of Europe for Aquavac ERM, says Richard Braley of SPAH's regulatory department.

It would be based upon the marketing authorisation held in the reference state, which for this vaccine is the United Kingdom. "The success of this process reflects the work put in by the whole of SPAH's aquaculture team over many years for this product. The team will be making every effort to approve further vaccines through the MRP," Braley said.

See [www.spaquaculture.com](http://www.spaquaculture.com) or contact the marketing manager of Global Aquaculture, Chris Haacke, at [chris.haacke@spcorp.com](mailto:chris.haacke@spcorp.com).

## UK: IMPORTANT ADVANCE IN COMBATING WHITE SPOT

A joint research programme has led to the development of a patented mechanical system that removes the threat of white spot (*Ichthyophthirius multifiliis*), one of the major threats and causes of mortality to worldwide aquaculture.

The programme is funded jointly by the British Trout Association and DEFRA between the Institute of Aquaculture, Stirling and Pisces Engineering Ltd.

Commercial field trials held on a race way system were said to have yielded dramatic results. Similar results were expected for further trials in lined ponds and tanks.

The primary device in the system is a special suction head connected to a pump. The bottom is vacuumed, removing unwanted cysts, rather than being brushed or cleaned. The vacuum design ensures that even very small fry are not drawn in or damaged, while there is sufficient suction and mechanical action to remove the cysts and other debris.

An additional benefit is that the vacuum is also very effective at removing uneaten feed and faeces, resulting in improved water

quality and probable other environmental and pathogenic benefits to the fish.

A secondary and equally necessary device used in the trial was to line the concrete race ways with a special low-adhesion polymer sheeting. This eliminated the problems of cyst adhesion and the potential for cysts to settle and develop in the cracks and pores of the rough surface.

The team says it expects the system to have far-reaching benefits for other pathogenic and environmental problems in aquaculture. The labour time required to use the device is offset against the time that would normally be taken up by removing dead fish and treating infected stock. In addition there is less stress on the fish and no need to starve them before administering the treatments.

The system is said to represent a positive move towards more environmentally sound solutions, as it eliminates the need for formalin or other chemical treatments.

See [www.pisces-aqua.co.uk](http://www.pisces-aqua.co.uk).

## INDIA: RAPID DETECTION OF WHITE SPOT VIRUS

Indian scientists have developed a simple test to detect white spot virus in shrimp.

The monoclonal antibody-based immunodot test requires only five steps to complete, and the results are available in 10 minutes. The immunodot has a higher sensitivity than the one-step PCR, and can detect WSV five hours earlier.

The testing procedure is said to be very simple and requires no specialist training or equipment, and is therefore ideal for farming staff to use on-site. Moreover, it is substantially cheaper than the PCR-based method. For example, in India the total cost per sample is estimated to be US\$1.50 to \$2, compared with about \$13 for the PCR test.

The kit was developed with funding support from the Department of Biotechnology, New Delhi, and was evaluated in hatcheries and grow-out farms over a two-year period.

Possible uses of the rapid field level detection kit include:

- use by farmers to confirm the presence of WSV infection, and enable a decision to be made as to whether or not to initiate an emergency harvest
- routine screening and testing of stock
- rapid screening of broodstock at landing centres where time is critical, and
- screening shrimp seed in hatcheries.

## FORTHCOMING Conferences and Meetings

### Vllth International Congress on the Biology of Fish

St John's, Newfoundland, Canada. July 18-22, 2006

Planned symposia for this fish biology conference include disease and host response, fish welfare, and linking fish biology to improved performance in finfish aquaculture.

See [www.mun.ca/biology/icbf7/index.html](http://www.mun.ca/biology/icbf7/index.html)

### XII International Symposium on Fish Nutrition and Feeding

Biarritz, France. May 28-June 1, 2006

A session on nutrition, immune response and health is planned as part of the overall programme during this symposium.

See [www.st-pee.inra.fr/btz06](http://www.st-pee.inra.fr/btz06)

## EUROPE: EC PROPOSES NEW AQUACULTURE HEALTH RULES

The European Commission has recently proposed new EU legislation on the health of farmed fish and shellfish (molluscs) and the control of certain diseases in the aquaculture sector.

The legislation aims to simplify and upgrade existing legislation in order to improve aquaculture health across Europe. It also aims to improve the safe trade in aquaculture animals and products, and boost the competitiveness of this important sector for the EU.

A central aspect of the proposal is a shift in focus to preventing disease occurrence at each point in the production chain, rather than dealing with it only when an outbreak occurs.

“Having healthy animals is fundamental to Europe’s aquaculture sector, which generates millions of euros annually,” said the Commissioner for Health and Consumer Protection Disease, Markos Kyprianou.

“Outbreaks undermine consumers’ confidence in the safety and wholesomeness of farmed fish and shellfish. They can also devastate the stocks of farms affected by them. Prevention is the best cure, and that is what our legislation aims at.”

The proposed directive responds to the need to update current animal health legislation for aquatic animals, taking into account the developments in aquaculture, as well as international experience and scientific knowledge. A major focus of the proposal is on preventing disease by applying better controls throughout the production chain.

This approach should reduce the economic losses caused by diseases and restrictions on trade. Measures are also laid down to protect disease-free farms from the introduction of pathogens and to prevent exotic diseases from entering the EU.

Flexibility is given so that local or regional approaches can be taken to prevent and contain diseases, while member states will be responsible for ensuring proper implementation and controls. The proposed directive states that national authorities should also draw up control and eradication programmes and contingency plans for outbreaks of emerging or exotic diseases.

In cases where compulsory measures to eradicate exotic diseases, such as culling stock, need to be taken, or where member states implement programmes to eradicate non-exotic diseases, the proposal foresees that the European Fisheries Fund should provide compensation.

A key objective of the proposal is to simplify and modernise existing legislation and procedures on aquatic animal health. The directive would bring the rules for placing aquaculture animals and products on the market in line with the standards of the world organisation for animal health (OIE).

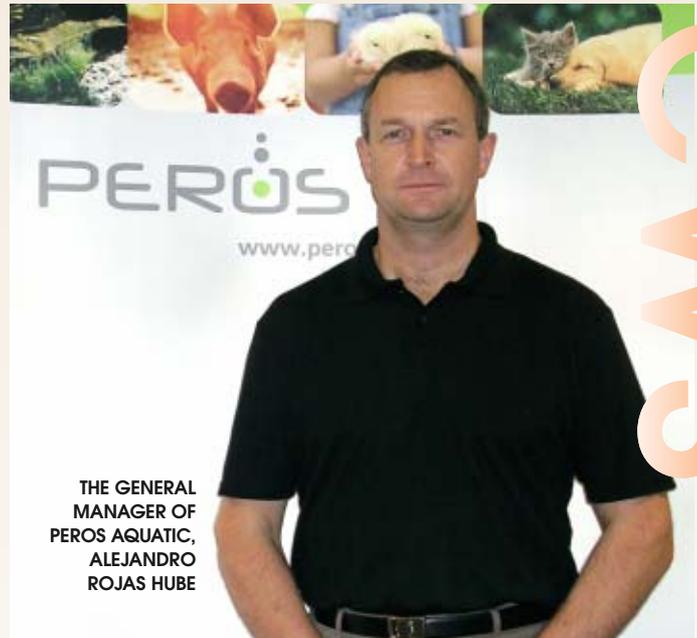
It aims to improve intra-Community trade, while also making it easier for third world countries to trade with the EU by providing harmonised rules on aquaculture.

See [www.europa.eu.int/eur-ex/lex/LexUriServ/site/en/com/2005/com2005\\_0362en01.pdf](http://www.europa.eu.int/eur-ex/lex/LexUriServ/site/en/com/2005/com2005_0362en01.pdf)

## CHILE: NEW BIOTECHNOLOGY COMPANY ANNOUNCED

The Canadian company PerOs Systems Technologies has established a worldwide aquaculture division, PerOs Aquatic Limitada. This new Chilean biotechnology company uses PerOs’ patented Oralject™ technology to address major health concerns in the aquaculture market.

Oralject is said to permit the oral delivery of a variety of therapeutic molecules, including antigens, peptides and nutraceuticals. It can be combined with these prescribed bioactive compounds and administered at virtually any stage of a fish’s growth cycle. PerOs says its unique drug delivery technology will allow it to offer unprecedented protection to fish crops. Unlike injectable drug delivery methods, the technology allows fish to be



THE GENERAL  
MANAGER OF  
PEROS AQUATIC,  
ALEJANDRO  
ROJAS HUBE

protected in any field situation.

The company says it will introduce a range of new Oralject technology over the next few years, and Chile will be the first country to have access to these solutions.

“PerOs Aquatic will represent an important economic value to Chile,” said the chief executive of PerOs, Jean-Simon Venne. “The establishment of PerOs Aquatic in Chile will not only impact the Chilean aquaculture industry, but also generate applications of the technology that will be exported around the world,” he said.

Alejandro Rojas Hube, a veterinarian, has been appointed the general manager of PerOs. He has more than 17 years’ experience in aquaculture, including production, health, environment and traceability.

“Rojas’ expertise in salmon aquaculture is a very good addition to our international team,” said Denis Bernier, the president of PerOs. “I am convinced we’ve chosen the best person to lead our aquatic division.”

PerOs Aquatic’s veterinary specialists will work directly with Chilean fish producers to evaluate health problems encountered at their installations. They will also help develop customised treatments that take advantage of the flexibility of the company’s Oralject technology.

Based on these cooperative ventures, PerOs Aquatic says it will continue to develop and manufacture Oralject applications that will impact on the aquaculture industry throughout the world.

## AUSTRALIA: NEW DISEASE FIELD GUIDE

The latest edition of Aquatic Animal Diseases Significant to Australia: Identification Field Guide is now available.

It is designed as a practical reference tool for identifying serious aquatic animal diseases, and is geared towards a wide audience of professionals involved in the aquaculture industry, as well as wild and recreational fisheries.

A CD-ROM can be ordered by emailing [aah@daff.gov.au](mailto:aah@daff.gov.au) or downloaded from [www.disease-watch.com/documents/CD/index/index.htm](http://www.disease-watch.com/documents/CD/index/index.htm)

## EUROPE: PROGRESS REPORT PUBLISHED

The Permanent Advisory Network for Diseases in Aquaculture, known as Panda, has released its progress report online for downloading. The update contains sections on risk analysis, epidemiology, diagnostic methods, environmentally safe control strategies, training and project management.

See [www.europanda.net/publications/PANDAUupdateOct05v2.pdf](http://www.europanda.net/publications/PANDAUupdateOct05v2.pdf)

# REPORT: PROBIOTICS IN TROUT FEED

BY MR VINCENT USACHE AND SYLVIE ROQUEFEUIL-DEDIEU  
(LALLEMAND ANIMAL NUTRITION, FRANCE)

Earlier this year Lallemand Animal Nutrition announced the completion of a two-year research programme on the benefits of probiotics in aquaculture. The programme is a joint collaboration between INRA, the French Agronomic Research Institute, Ifremer, the French Research Institute for the Exploitation of the Sea, the French Agency for Food Safety, and several private companies (Lallemand, Viviers de France, Aquanord and Biomar).

Co-funded by OFIMER (French Interprofessional Syndicate of Sea Products and Aquaculture) and CIPA (Interprofessionnal Committee of Aquaculture Products), the objective of the programme was to evaluate the impact of probiotics on the improvement of productivity, quality and safety in rainbow trout and sea bass.

More than 30 people representing every level of the sector (scientists, official authorities, independent veterinarians, feed producers, fish farmers, representatives of the fish processing industry, professional syndicates and journalists), gathered at Institut Pasteur on March 2 to hear the results of the study.

The event, placed under the auspices of Louis Pasteur, the father of microbiology, was dedicated to the impact of probiotics in fish farming, and was also an opportunity for open discussions and debates between all participants in the industry about the promises and realities of probiotics in aquaculture. The results presented highlighted the benefits of probiotics in aquaculture, particularly in terms of flesh quality and disease prevention.

The programme presented involved studies in both experimental and production conditions for rainbow trout, the main freshwater fish produced in Europe, and sea bass. Two types of probiotics were tested: live yeast *Saccharomyces boulardii* (Levucell SB®) and a lactic acid-producing bacteria, *Pediococcus acidilactici* (Bactocell®), either alone, or in combination.

The part of the study dedicated to the influence of probiotics on the immune response, conducted by the team of Dr Claire Quentel at the AFSSA, gave very promising results. In experimental conditions, trout challenged with *Yersinia ruckeri*, a common and recurring pathogen in the aquaculture industry, were extremely resistant to the infection after four months treatment with probiotics.

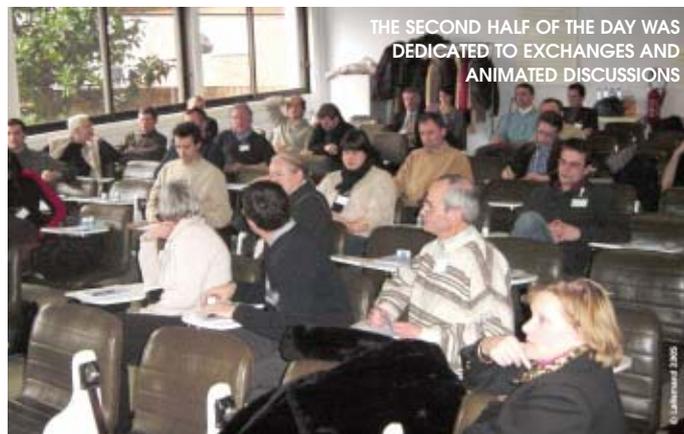
Levucell SB gave the best protection, even when high doses of pathogens were used: 5-6 percent of the trout died in the Levucell SB group compared with an 80-90 percent mortality rate in the untreated group.

Moreover, in the probiotic group, the rate of healthy carriers of *Yersinia* also decreased from 80 percent (control group) to 15 percent (Levucell group), demonstrating that probiotics act as a prophylactic agent. Bactocell also conferred significant protection against infection, with a 15-25 percent mortality rate.

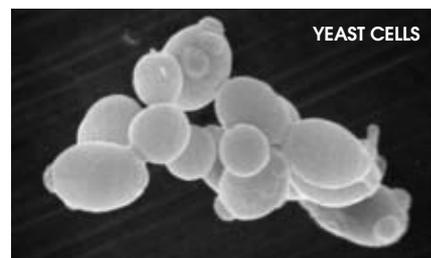
In terms of zootechnical parameters, probiotic administration resulted in significantly enhanced lipid content and in trout muscle and increased colouration when this was sub-optimal. Peri-



VINCENT  
USACHE OF  
LALLEMAND  
ADDRESSES THE  
CONFERENCE



THE SECOND HALF OF THE DAY WAS  
DEDICATED TO EXCHANGES AND  
ANIMATED DISCUSSIONS



YEAST CELLS

visceral fat levels were unchanged therefore carcass grade was unaffected. The occurrence of vertebra compression was also reduced with both probiotics. These observations allowed J Aubin from INRA, which is responsible for the programme, to conclude that: "Probiotics showed no negative impact on fish quality and productivity, and could enhance flesh quality parameters when these were not optimum. So far, we can conclude to a compensating action of probiotics."

The interaction of the probiotics with the digestive tract and its endogenous microflora was also extensively studied. It was shown that both probiotics survive and transit well in the trout digestive tract and, in the case of Levucell SB, the probiotic is even shown to adhere to the mucosa and influence the microbial balance.

In the case of growing sea bass, Levucell SB didn't survive in the intestine of the fish, although the survival of Levucell SB has already been demonstrated in the gut of marine fish larvae. This may explain the lack of effect observed in sea bass after metamorphosis. Dr Gatesoupe, from a joint INRA-Ifremer team, concluded on his part of the work: "The environmental variability and some parameters difficult to control, such as water quality, are inherent issues in aquaculture."

"We've shown in this study that fish intestinal microbiota is extremely variable in time and between breeding sites for a given species, and this is why I think that probiotics, with their ability to regulate microbiota and intestinal mucosa, may contribute to healthy and controlled breeding without any detrimental impact on the environment. However, it is essential to test such treatments in representative panels of fish farms before recommending their practical application."

"It is the President of the European Probiotics Association, Bruno Rochet, who concluded the seminar with those words: "The programme presented here is the result of a close collaboration between research and industry, and we've shown today that this kind of initiative is extremely positive and can benefit each industry sector." He added: "The results presented today are very promising and, while not sufficient to draw definitive conclusions on the use of probiotics in aquaculture, they encourage us to pursue in this direction. I can tell you today that further studies are already on their way."

More information is available upon request from Sylvie Roquefeuil-Dedieu ([sroquefeuil-dedieu@lallemand.com](mailto:sroquefeuil-dedieu@lallemand.com)).

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# FINFISH: DISEASES OF KINGFISH (*SERIOLA LALANDI*) IN AUSTRALASIA

BY DR BEN DIGGLES (DIGSFISH SERVICES PTY LTD) AND KATE HUTSON (UNIVERSITY OF ADELAIDE)

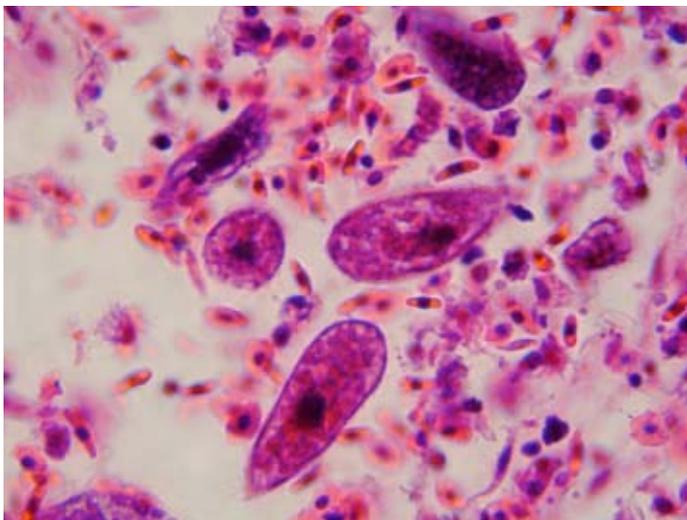


FIGURE 1: HISTOPATHOLOGY OF SCUTICOCILATE INFECTION IN THE SPLEEN OF A NEW ZEALAND KINGFISH

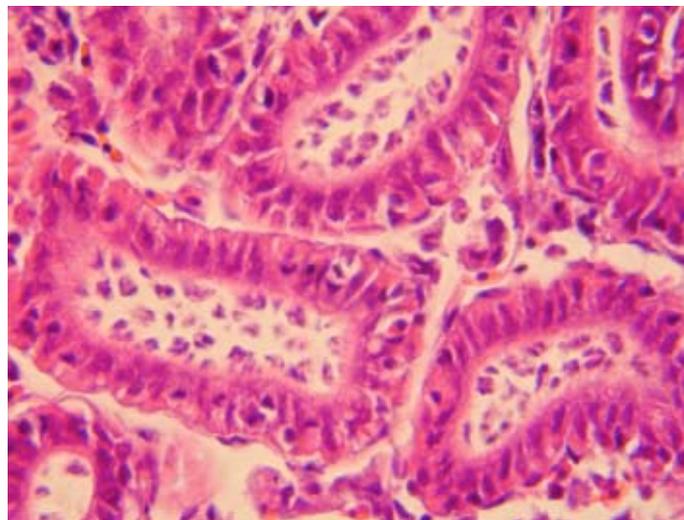


FIGURE 2: HISTOPATHOLOGY OF A RENAL MYXOSPOREAN INFECTION IN A NEW ZEALAND KINGFISH. NUMEROUS DEVELOPMENTAL STAGES ARE EVIDENT IN THE LUMEN OF RENAL TUBULES

The intensive culture of any new fish species leads to a rapid increase in the knowledge of their disease agents. There is no better example in the southern hemisphere than the culture of yellowtail kingfish (*Seriola lalandi*).

In the northern hemisphere, the closely related Japanese yellowtail (*Seriola quinqueradiata*) has been cultured for over 50 years, and there is a vast amount of information on the various diseases that affect these fish in culture.

In contrast, until recently the parasites and diseases of kingfish in Australia and New Zealand were not well described. However, the emergence of kingfish aquaculture in both countries over the past decade has seen a rapid increase in the knowledge of their parasite fauna and other disease agents that infect *Seriola* species in these regions.

Unlike farmed *Seriola quinqueradiata* that are stocked from the wild and already harbour a variety of disease agents, kingfish fingerlings in Australia and New Zealand are sourced from broodstock spawned in land-based hatcheries. Consequently, in comparison with the situation in Japan, there is probably an increased likelihood of infection of larvae and juveniles by vertically transmitted disease agents harboured by broodstock.

On the other hand, juvenile fish are usually not exposed to protozoan or metazoan parasites until they are stocked into sea cages.

Certainly wild fish are believed to be the primary reservoir of parasitic infection for kingfish cultured in sea cages. Surveys of wild kingfish in both countries have found that parasites are common in wild populations.

The natural occurrence of wild kingfish in locations where cultured fish are farmed in sea cages therefore provides ample opportunities for transfer of disease agents to farmed populations. However, conditions associated with culture, such as increased stocking densities, stress, suboptimal nutrition and reduced water quality can contribute to increased prevalence and intensity of parasites in farmed fish.

Indeed, parasites that are normally considered benign, or for

which pathology is unknown in wild host populations, can be problematic in culture. Recent research into the parasite assemblages of wild and farmed *Seriola* species in Australia and New Zealand has revealed several viral, bacterial and parasitic disease agents.

This report has been produced to provide a brief update of the current knowledge of the disease status of cultured kingfish in Australasia. Nineteen different parasites and disease agents have been recorded to date in this part of the world, and are listed in Table 1.

## VIRUSES

RNA of a betanodavirus with genetic affinities to an isolate originally described from Australian bass (*Macquaria novemaculeata*) has been detected using a PCR probe in broodstock kingfish in Port Stephens on the eastern coast of Australia.

This virus has not been associated with clinical disease in kingfish in Australia and is yet to be cultured from kingfish in cell lines. Nor has the original isolate from Australian bass been fully characterised. PCR testing of hatchery-reared juvenile kingfish in Australia for this virus gave equivocal results. To date, viral RNA has not been detected in either broodstock or cultured juvenile kingfish from New Zealand, despite some testing by PCR.

## BACTERIA

Epitheliocystis is a bacterial disease observed in farmed and wild kingfish in Australia and New Zealand; the causative agent is thought to be *Chlamydia*-like organisms. The primary source of infection has not been determined, but is probably wild fish.

Vibriosis is a bacterial disease of fry and juveniles that has been observed in cultured juvenile kingfish in New Zealand, particularly in fish held under conditions of poor water quality, or after handling or transfer of kingfish into sea cages.

## PROTOZOA

A systemic scuticociliate infection has been recorded in cultured juvenile kingfish in New Zealand. Histopathology of affected fish revealed large numbers of ciliates in the tissues surrounding the brain (Figure 1) under the skin, in muscle, the circulatory system and other internal organs.

In wet preparations the ciliates were pyriform shaped and had uniform ciliature with a prominent posterior contractile vacuole, features consistent with infection by scuticociliates of the genera *Uronema*, *Miamiensis* or *Philasterides*. Determination of the specific identity of these opportunistic parasites awaits further study.

## MYXOZOA

Preliminary identifications indicate that the myxozoans *Ceratomyxa seriola* and *C buri* infect the gall bladder of wild and farmed fish in Australia. These two species have also been detected in cultured *Seriola quinqueradiata* in Japan.

It is thought that these parasites may be associated with green liver syndrome in farmed fish by causing inflammation, and blocking the normal flow of bile to the gall bladder.

A renal myxosporean infection observed in cultured juvenile kingfish in New Zealand has been associated with mortalities. Large numbers of developmental stages are evident in the lumen of renal tubules of affected fish (Figure 2).

Preliminary identifications suggest that this parasite has affinities with the genus *Myxidium* sp, and additional studies are being undertaken to determine its identity.

Wild kingfish in warmer waters off the eastern coast of Australia are known to be infected by *Unicapsula seriola* and *Kudoa* sp that cause myoliquefaction of the muscle tissue ("milky flesh"). However, to date there are no documented reports of these parasites in Australasian kingfish aquaculture. ▶



FIGURE 3 (ABOVE): PALE GILLS OF AN ANAEMIC KINGFISH HEAVILY INFECTED BY THE MONOGENEAN *ZEUXAPTA SERIOLAE*

FIGURE 4 (BELOW): HISTOPATHOLOGICAL SECTION THROUGH THE LIVER OF A NEW ZEALAND KINGFISH, SHOWING THE PRESENCE OF AN ADULT BLOOD FLUKE

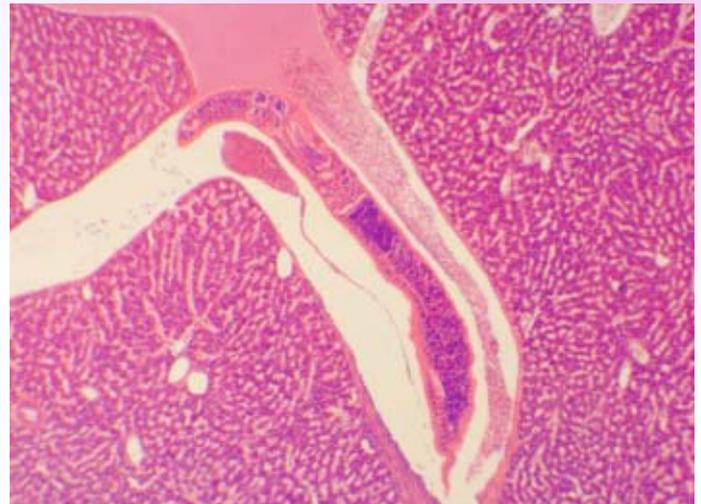
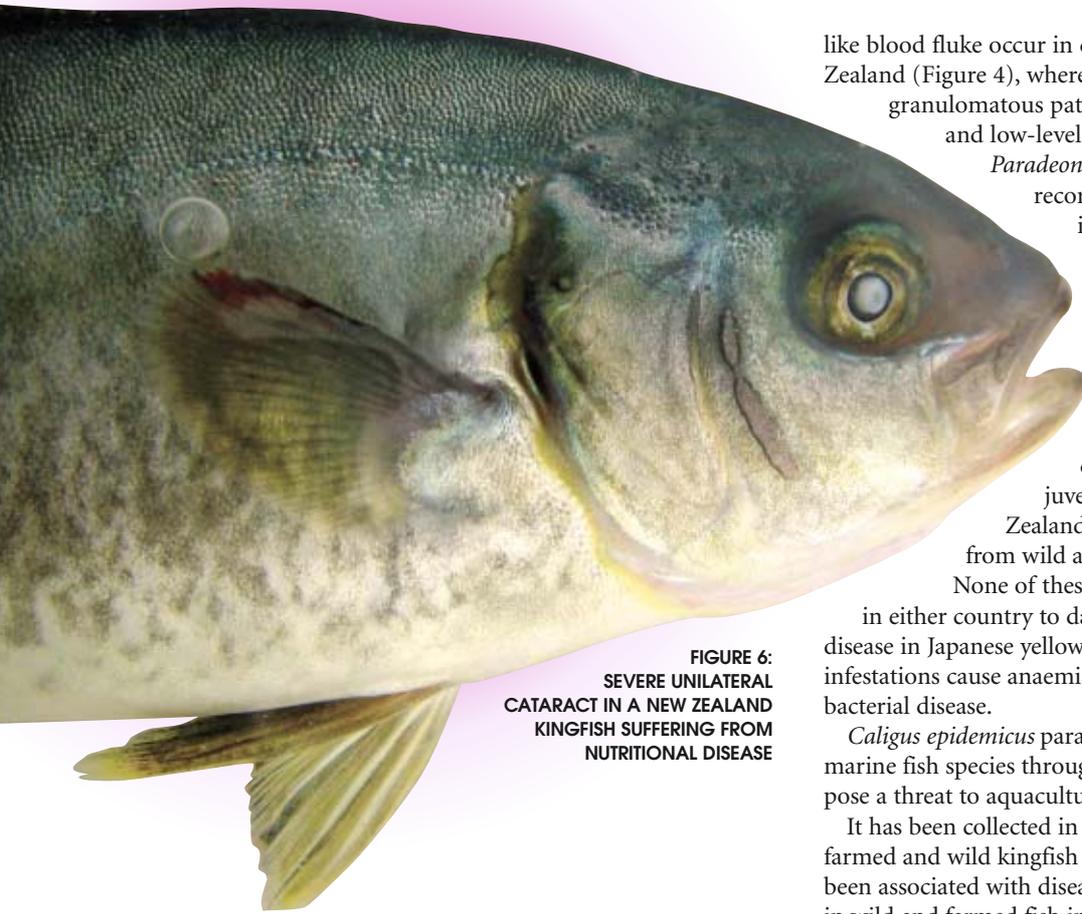


TABLE 1. Disease agents recorded from cultured kingfish in Australia and New Zealand

	SITE OF INFECTION	AUSTRALIA	NEW ZEALAND
<b>VIRUS</b>			
Nodavirus	Brain, retina	Broodstock (suspected in juveniles)	
<b>BACTERIA</b>			
Epitheliocystis	Gills	Juveniles	Juveniles
Vibriosis	Fins, body		Juveniles, broodstock
<b>PROTOZOA</b>			
Scuticociliate infection	Brain, internal organs		Juveniles
<b>MYXOZOA</b>			
<i>Myxidium</i> sp	Kidney, urinary bladder		Juveniles (preliminary id)
<i>Ceratomyxa seriola</i>	Gall bladder	Juveniles (preliminary id)	
<i>Ceratomyxa buri</i>	Gall bladder	Juveniles (preliminary id)	
<b>METAZOA</b>			
<b>Monogenea</b>			
<i>Benedenia seriola</i>	Body surface	Juveniles, broodstock	Juveniles, broodstock
<i>Zeuxapta seriola</i>	Gills	Juveniles, broodstock	Juveniles, broodstock
<i>Paramicrocotyloides reticularis</i>	Gills		Broodstock
<b>Digenea</b>			
Blood fluke ( <i>Paradeontacylix</i> sp)	Heart, brain, internal organs		Juveniles
<b>Crustacea</b>			
<i>Caligus epidemicus</i>	Body surface	Juveniles	
<i>Caligus lalandei</i>	Body surface		Juveniles, broodstock
<i>Caligus spinosus</i> (syn. <i>C aesopus</i> )	Body surface	Juveniles	Juveniles, broodstock
<i>Caligus</i> sp	Body surface	Juveniles	
<i>Naricolax</i> sp	Nasal cavity	Juveniles	
<i>Neobrachiella</i> sp	Gills		Broodstock
<i>Lernanthropus</i> sp	Gills		Broodstock
<b>NON-INFECTIOUS DISEASES</b>			
Nutritional cataract	Eye		Juveniles

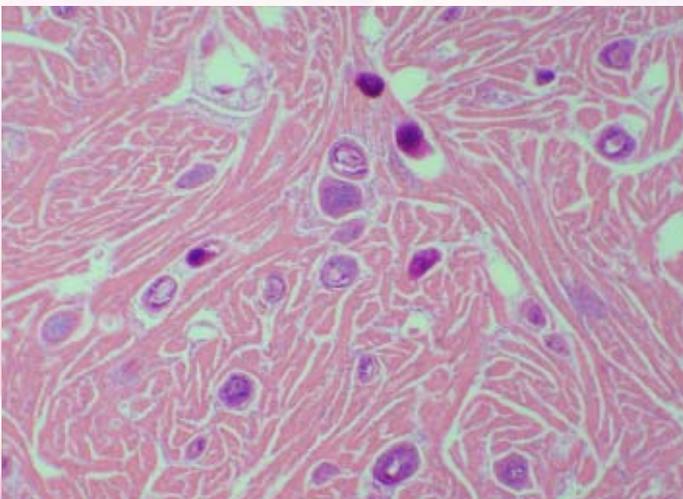


**FIGURE 6:**  
SEVERE UNILATERAL  
CATARACT IN A NEW ZEALAND  
KINGFISH SUFFERING FROM  
NUTRITIONAL DISEASE

## METAZOA

**Monogeneans:** The gill fluke *Zeuxapta seriolae* (Figure 3) and skin fluke *Benedenia seriolae* are important pathogens of cultured *Seriola* spp, and have been responsible for considerable losses in *Seriola* aquaculture in Australia, New Zealand, Japan and the Mediterranean. *Paramicrocotyloides reticularis* is present in wild kingfish in New Zealand and the eastern coast of Australia, and has been recorded in broodstock kingfish in New Zealand. This parasite has not been detected in southern Australian waters on wild kingfish from Victoria or South Australia, which may explain its apparent absence from South Australian kingfish farms.

**Digeneans:** Blood flukes of the genus *Paradeontacylix* spp are considered to be serious pathogens for sea cage-cultured amberjacks (*S. dumerili*) in Japan, the Pacific, the United States and the Mediterranean. Systemic infections of a *Paradeontacylix*-



**FIGURE 5:** Large numbers of granulomas in the heart of a New Zealand kingfish infected by blood flukes. The granulomas surround eggs and miracidia trapped in the heart muscle

like blood fluke occur in cultured juvenile kingfish in New Zealand (Figure 4), where they have been associated with granulomatous pathology in the heart (Figure 5) and gills, and low-level mortalities. The blood fluke *Paradeontacylix sanguinicoloides* was recently recorded for the first time from wild kingfish in Australia, but these parasites have not been detected in farmed Australian kingfish to date.

## CRUSTACEANS

*Caligus spinosus* and *C. lalandi* have been recorded from the gills and body surfaces respectively of wild-caught broodstock kingfish, as well as juveniles ongrown in sea cages in New Zealand. *Caligus spinosus* has also been recorded from wild and farmed kingfish in Australia.

None of these copepods have caused serious problems in either country to date. In Japan, *C. spinosus* causes gill disease in Japanese yellowtail (*Seriola quinqueradiata*). Serious infestations cause anaemia, appetite suppression and secondary bacterial disease.

*Caligus epidemicus* parasitises a number of wild and cultured marine fish species throughout Asia. The parasite is believed to pose a threat to aquaculture because of its low host specificity.

It has been collected in low numbers from the body surfaces of farmed and wild kingfish in South Australia, but to date it has not been associated with disease. A *Naricolax* sp has also been detected in wild and farmed fish in Australia.

This is the first time this genus has been recorded from a Carangid host, and as the name indicates, *Naricolax* spp live in the nasal cavity. Representatives of the genera *Neobrachiella* and *Lernanthropus* have been reported on the gills of broodstock kingfish in New Zealand and wild fish on the eastern coast of Australia.

These latter two species remain firmly attached to the gill surface, and do not appear to rapidly increase in numbers or cause any significant disease in confined fish.

## NON-INFECTIOUS DISEASES

### Nutritional cataracts

Several episodes of nutritional cataract have been observed in cultured juvenile kingfish in New Zealand. Cataracts appear most problematic when the fish are growing at rapid rates, and at these times fish fed nutritionally inadequate diets can show either moderate to severe unilateral (Figure 6) or bilateral cataracts. Blinded fish have difficulty feeding and do not thrive, and in severely affected fish the condition appears to be irreversible. This problem has usually been resolved by changing feed suppliers and/or reviewing feed storage conditions.

## FURTHER READING

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# FOCUS: THE MARINE HARVEST TRIALS UNIT IN SCOTLAND

JOHN MACPHEE (MARINE HARVEST SCOTLAND LTD, UK)

The Marine Harvest Trials Unit (TU) at Lochailort has been providing fish farmers and scientists alike with invaluable data over the past two decades.

The Trials Unit is managed within the Development and Technical Services Department of Marine Harvest Scotland (MHS) based in Lochailort.

Located approximately 45 minutes drive west of Fort William, the facility is easily accessible all year round. A full range of services is offered, from short tank trials to larger-scale longer field trials in the purpose-built Field Trial Unit.

The main MHS laboratory and two large feed trial facilities, situated within what is known collectively as the Lochailort Unit, offer a range of internal and external services to the industry.

The TU at Lochailort has a proven track record of being able to carry out internal and external scientific trials in the spirit of good laboratory practice.

## FACILITIES AND SERVICES

The facilities on offer are diverse, and include:

- 18 x 1m (250 litre) disease trial tanks
- 4 x 1.5m (1000 litre) disease trial tanks
- 8 x 2m diameter holding tanks
- 10 x 1.5m marine re-circulation holding tanks
- 22 x 4m diameter holding/feeding tanks, and
- 1 x Field Trial Unit consisting of 5m cages replicating normal production conditions.

The recent range of disease work includes studies on infectious pancreatic necrosis, salmon pancreas disease virus, *Aeromonas salmonicida*, *Vibrio salmonicid*, *Lepeophtheirus salmonis*, *Moritella viscosa*, *Vibrio anguillarum*, *Saprolegnia parasitica*, *Yersini ruckeri*, *Piscirickettsia salmonis* and *Pasteurella skyensis*.

In this dynamic industry, Marine Harvest Scotland strives to lead the way in disease control methods and product development. MHS is the only aquaculture production company in Scotland to have its own Home Office licensed team dedicated to solving internal as well as external disease threats that arise.

Staffing the TU is a highly trained, motivated and dedicated team currently working on existing challenge models and developing new ones as the need arises.

A suite of in-house analytical services is available to back up fish husbandry and experimental work. Sampled fish are analysed for the full range of microbial pathogens to ensure that the correct causes of mortality are quickly identified. Flesh quality monitoring in salmonids for pigment and oil levels is carried out using a range of techniques ranging from the simple colour fan to the much more sophisticated Near Infra Red spectroscopy.

Through internal use of the TU, MHS is in the fortunate position of being able to assess and benchmark new and existing vaccines, chemo-therapeutants and in-feed supplements (licensed and unlicensed), thus aiding the internal decision-making process. Nevertheless, the facility is available to the rest of the industry, including pharmaceutical and fish farming companies.

Fish welfare is an integral part of the unit's remit. In January 2005, the MHS TU team organised and hosted the first Named Animal Care and Welfare Officers meeting for personnel involved in working with fish.



COLLECTING DATA FROM THE TRIALS UNIT AT LOCHAILORT



AN OVERVIEW OF THE TRIALS UNIT LAYOUT

This forum was designed for staff in the day-to-day husbandry departments of their institutions as a forum to learn and discuss best practice for the care of research animals. This was the first of its kind and was well attended by academic and research institutions from throughout Scotland.

More recently, as new and upcoming species have been identified as candidates for finfish culture, the TU has had to turn some of its focus towards species other than salmonids. The main research species continue to be salmonids, but halibut, cod and haddock have all been studied in the last few years.

The new challenge procedures developed within the TU for vibriosis in cod and haddock have proven to be very successful over the past 18 months. This can be attributed to a combination of novel development work and the driving force of the increasing value and production in the new species market.

Disease control within the aquaculture industry is still as important and serious an issue today as it has ever been. In the TU, MHS is proud to say that its work over the past years in conjunction with pharmaceutical industry colleagues has been instrumental in developing a number of key products commonly used on fish farms around the world.

The Trials Unit conducts external work with the highest degree of professionalism and confidentiality and is happy to provide further information as requested.

**For further information and all enquiries, please contact John MacPhee (Trials and Challenge Unit Manager) at [John.MacPhee@Marineharvest.com](mailto:John.MacPhee@Marineharvest.com), or Tony Laidler (Lochailort Unit Manager), [Tony.Laidler@Marineharvest.com](mailto:Tony.Laidler@Marineharvest.com).**

# DISEASE PREVENTION FOCUS: FARM-LEVEL BIOSECURITY AND WHITE SPOT DISEASE OF SHRIMP



DRS CV MOHAN, FLAVIO CORSIN AND ARUN PADIYAR  
(NETWORK OF AQUACULTURE CENTRES IN ASIA-PACIFIC, THAILAND)

This article introduces the concept of biosecurity, briefly discusses farm level biosecurity issues with respect to managing white spot disease, and offers approaches to promote the adoption of biosecurity concepts by small-scale farmers.

## INTRODUCTION

Shrimp aquaculture contributes to global food security and provides economic, social and nutritional security to stakeholders. However, threats to the sustainability of this sector come from environmental, aquatic animal health and food safety issues.

Shrimp diseases caused by dangerous viral pathogens (eg white spot syndrome virus, the yellow head virus and the Taura syndrome virus) are the greatest bottlenecks to sustainable shrimp farming in many parts of the world.

It is widely believed that these three most economically significant viral pathogens have been introduced to many countries through the careless introduction of live shrimp stocks.

White spot disease (WSD) is a pandemic disease of crustaceans.

Since its first appearance in China and Japan in 1993 the disease has spread rapidly to other Asian countries and to the Americas. In Asia, first yellow head virus (YHV) from 1992 and later the white spot syndrome virus (WSSV) from 1993 caused continuing direct losses of approximately US\$1 billion per year to the native cultured shrimp industry (Briggs et al, 2004). Implementing scientific health management strategies, incorporating principles of biosecurity at the pond, farm, national and regional levels is increasingly becoming crucial for ensuring successful and sustainable shrimp aquaculture.

Biosecurity is a new term for an old concept. There is no single definition for biosecurity, however it can be defined as a set of standard scientific measures adopted to exclude pathogens from



WATER FILTRATION BY TWIN BAG FILTERS IN INDIA

culture environment and host and, more broadly, to limit pathogen establishment and spread.

Some concepts vital for biosecurity are identifying pathogen entry routes, quarantine and screening of hosts introduced into the system, disinfection at defined critical control points, restricted access, and identification of risk factors that favour pathogen establishment and spread.

A biosecure system could therefore be based on specific pathogen-free stocks, including enclosed, reduced water-exchange/increased water-reuse culture systems, biosecure management practices and cooperative, industry-wide disease control strategies.

Most likely all farmers want to operate a biosecure system. However, the extent to which the principles of biosecurity can be applied strongly depend on the type of culture system. Biosecurity may be easy to adopt and implement in land-based systems which are under cover and in closed aquaculture systems.

On the other hand, applying the principles of biosecurity in small-scale, extensive, open farming systems may be difficult. Open farming systems with regular water exchange and with little, if any, control over pathogens or carriers entering the pond, still contribute to the major share of shrimp produced in Asia.

## CONCEPT OF CAUSE FOR DISEASE

A disease will occur only when there is a sufficient cause. Especially in the case of infectious disease, a component of the sufficient cause is the presence of the pathogen, which is necessary for the disease to occur (necessary cause).

Unless the necessary cause is also sufficient for causing the disease, the presence of the pathogen alone will not cause the disease. Several component causes (risk factors) along with the necessary cause are needed for the disease to occur (Thrusfield 1986).

By using epidemiological approaches, it is possible to identify pond/farm level component causes (risk factors) for disease outbreaks. Intervention strategies can then be developed to minimise or eliminate such risk factors and reduce the risk of disease outbreaks. Epidemiological approaches for identifying pond level risk factors for shrimp disease outbreaks (eg white spot disease) are becoming increasingly popular in the development of aquatic animal disease prevention and management strategies. (Corsin et al 2001, 2002a. MPEDA/NACA 2003).

Dangerous viral pathogens often cause serious disease outbreaks and crop losses in shrimp farming. The principles of biosecurity are normally considered only for dangerous pathogens that are highly virulent, infectious, untreatable, vertically transmitted, have a diverse host range and threaten the very survival of the industry (Lotz 1997).

All of the crustacean diseases listed by the OIE (OIE 2003) fall into this category. The principles of biosecurity should be considered to keep these pathogens not only out of the culture environment but also out of the country and the region.

For example, Australia has successfully kept many pathogens out of the country by adhering to strict principles of biosecurity, quarantine and health certification. Once the dangerous pathogens enter and become established (endemic), it becomes practically impossible to keep them out of the culture system, especially in open farming systems.

Therefore, the prevention of diseases caused by dangerous pathogens calls for adherence to strict biosecurity protocols at all levels. As biosecurity principles primarily target pathogen exclusion from the culture environment and host, knowledge about the pathogen, its carriers and routes of entry are vital. Biosecurity principles can be best applied to well-studied pathogens. However, general principles can also be applied to less known pathogens.



## BIOSECURITY PRINCIPLES FOR PREVENTING PATHOGEN ENTRY

Possible pathogen carriers include infected hosts (eg seeds, broodstock, vectors, intermediate hosts, reservoir hosts), non-host biological carriers (eg birds, dogs, insects, other predators, human beings) and fomites (eg water, vehicles, buckets, shoes, nets or clothing). Pathogen carriers could enter the culture system through waterborne, airborne and overland transport routes.

Waterborne transport may include contaminated water (eg pond effluents or processing plant effluents) and natural hosts in water. Airborne transport (eg migratory birds, insects, wind) of pathogens is a concern in open farming systems without cover. Overland transport (eg human beings, animals, vehicles or farm equipment) is often the most common route of introducing the pathogen to the culture system.

Several generic approaches are available to prevent the entry of pathogens and their carriers to the pond and the farm (Clifford 1999). Pathogens entering through the waterborne route can be minimised through:

- site selection to avoid contaminated sources
- water use reduction
- closed systems
- water treatment
- screens and filters at water intake points
- the use of disinfectants
- reservoirs, and
- switching over to ground water and subsurface wells.

Risks from airborne route can be reduced by:

- siting the farm away from other farms and aquaculture waste dumps
- placing covers over the ponds
- indoor rearing
- bird deterrence programmes, and
- controlling insects.

Pathogens gaining access overland can be prevented by

- screening hosts used for culture
- restricting visits and access by installing perimeter fencing
- adopting strict sanitary measures for visitors, farm staff (foot dips, hand hygiene, protective clothing) and vehicles (wheel dips)
- restricting the movement of farm tools and equipment (nets, buckets, aerators, etc), and
- restricting the movement of cultured organisms between ponds and farms.

Implementing strict biosecurity measures at the farm level can be very expensive and may not be feasible in open farming systems. Identifying and quantifying relative risks associated with different pathogen carriers and routes of entry through epidemiological studies would help to target resources to the main risks, in order to make biosecurity measures cost-effective at the farm level. Biosecurity measures will be adopted at the farm level only if they are shown to be effective in preventing the occurrence of the disease and at the same time cost-effective for the farmer. ▶

## FARM-LEVEL BIOSECURITY AND WHITE SPOT DISEASE OF SHRIMP



VIETNAMESE FARMERS BEING TRAINED IN SEED QUALITY ASSESSMENT

### FARM LEVEL BIOSECURITY AND WSSV

Biosecurity principles for excluding WSSV from shrimp culture systems has been the topic of many reviews (Lotz 1997, Clifford 1999). Shrimp farmers around the globe hit by WSSV are looking for answers to the following questions:

- Is it possible to prevent the entry of WSSV into the pond?
- If the virus enters the pond, is it possible to prevent a WSD outbreak?
- If an outbreak of white spot disease occurs, is it possible to contain its spread?

Corsin and collaborators have reviewed these issues (2002a). They will be presented here with an emphasis on how improving biosecurity can limit the impact of WSD.

### PREVENTING THE ENTRY OF WSSV

In cultured shrimp WSSV is encountered in post-larvae (Withyachumnarnkul 1999, Thakur et al 2002), shrimp during various stages of grow-out (Lo et al 1998, Tsai et al 1999), in sick and dead shrimp (Mohan et al 2002a) and in harvested shrimp (Turnbull et al 2002). WSSV is also encountered in several species of wild crustaceans and other carriers outside the pond, and also inside the pond both before and after pond preparation (Lo et al 1996, Flegel and AldaySanz 1998, Maeda et al 1998).

The current practices followed in most shrimp farming countries aimed at keeping WSSV out of the pond/farm involve various approaches:

- pond preparation to eliminate pathogens and their carriers
- water treatment in reservoirs to inactivate the free virus and kill virus carriers
- water filtration using fine filters to keep carriers out
- closed systems to avoid contamination from source water

- reduced water exchange to minimise the entry from source water, and
- changing the water source (eg ground water, farming in fresh water).

Limited strategies are in place to prevent overland transport. Crab fencing is common in some countries. Perimeter fencing, foot dips, wheel dips and disinfection programmes are rarely seen in Asian aquaculture facilities.

When it comes to aquaculture inputs, a lot of attention is being paid to screening the PL using highly sensitive screening methods like PCR. Stocking of screened seed has become a common feature in many countries of the region. Pelleted feed is also known to contain WSSV DNA (Corsin et al 2002b), although most likely feed is not infectious (Pongmaneerat et al 2001).

The available evidence suggests that it is possible to minimise the entry of WSSV to the pond/farm, if not totally prevent it. Many of these approaches have been shown to be useful in reducing the risks of WSD outbreaks. Of all the measures, avoiding stocking PL with high viral load and high prevalence appears to be very encouraging (Withyachumnarnkul 1999, Peng et al 2001) in high-density culture systems.

However, the association between WSSV infection in stocked PL and WSD outbreaks in the pond has not always been consistent (Corsin et al 2002a, Turnbull et al 2002), but it is beyond the scope of this article to discuss the reasons for these inconsistencies. WSD still occurs and contributes to major production losses in many countries of the region.

### PREVENTING THE PRECIPITATION OF WSSV INFECTION

Successful crops have been taken in the presence of WSSV (Lo et al 1998, Tsai et al 1999) and, at least in some farming systems, the majority of ponds harvest WSSV-positive shrimp.

Some of the possible reasons include

- low viral load and low prevalence in PL
- reduced contact ratio and transmission (related eg to stocking density)
- reduced stress (eg better water quality, quality feed, clean pond bottom)
- better surveillance, and
- early diagnosis and informed decision-making.

These considerations point to the fact that it is possible to prevent WSD outbreaks despite the presence of the pathogen (Corsin et al 2002a).

Why individual latently infected shrimp become clinically sick and die and what triggers this is not clear, though several theories have been put forward (Peng et al 1998, Vidal et al 2001).

However, once sick and dead shrimp appear in the pond, progression to an WSD outbreak appears to be quick (Turnbull et al 2002). Transmission probably occurs through the ingestion of dead shrimp. In fact, there is increasing evidence to suggest that the ingestion of sick and dead shrimp is the major mode of WSSV transmission between shrimp in a pond (Wu et al 2001, Lotz and Soto 2002) during an outbreak.

Early detection of sick and moribund shrimp, the use of rapid pond-side diagnostics and the safe disposal of dead shrimp might help to minimise the impact of the disease. Using scientifically validated case definitions and pond side predictors, farmers can make informed decisions regarding conducting emergency harvests or killing stock.

Such approaches prevent the pond from becoming a “pathogen farm” and a risk to other ponds. Clinical signs are often non-specific, and decisions based on clinical signs can often go wrong.

However, effective tools to predict WSD outbreaks have been developed (Turnbull et al 2002), and these can help staff make informed decisions and prevent the spread of the pathogen.

## LIMITING THE IMPACT OF WSD

In the case of WSD, treatment is certainly not an option. Quick response and damage control should be the only post-outbreak goals. Quick response will help prevent its spread to other ponds in the farm, other farms in the region or into the natural environment.

Once the outbreak occurs, the farm becomes a source of the pathogen. Isolating the farm, covering the ponds, avoiding movements onto and off the farm, removing affected hosts and disinfection programmes will help to contain the spread of the pathogen.

Cooperative efforts should include surveillance, early warning, coordinating harvest and water exchange schedules of contaminated ponds and processor cooperation to ensure that processing wastes are not threats to other ponds. In fact, a large percentage of shrimp harvest in WSD-affected areas is premature (emergency harvest) and the harvested shrimp will have heavy loads of the virus (Mohan et al 2002b, Turnbull et al 2002). Transporting and processing these shrimp could also pose a biosecurity threat.

## ADOPTION OF BIOSECURITY CONCEPTS

Lapses in farm-level biosecurity can be seen at every stage of the culture operation in many Asian countries, especially in low-input, extensive shrimp farming systems (Corsin et al 2001, Corsin et al 2002a).

These may include:

- improper pond preparation
- lack of water treatment
- stocking unscreened PL
- sharing farm equipment and labour between ponds
- unrestricted access, and
- absence of disinfection programmes.

Lapses in biosecurity following a WSD outbreak (eg the improper disposal of dead shrimp, release of contaminated pond effluents and the lack of post-outbreak considerations) could have major negative consequences to ponds and farms in the vicinity.

Building awareness and capacity of farmers on farm-level biosecurity concepts should be taken up as a priority. System-specific and cost-effective management practices (Bumps) incorporating principles of biosecurity should be developed, demonstrated and validated. There is considerable information in the region on better management practices for managing shrimp disease.

As a part of the Network of Aquaculture Centre's regional initiative to control aquatic animal diseases, ongoing collaborative projects in India and Vietnam are exploring and validating effective extension approaches to promote the widespread adoption of best management practices (BMPs) that include concepts of farm-level biosecurity.

The outcome from the work we conducted in India (Padiyar et al 2002, Padiyar et al 2003), with support from the MPEDA (India) and ACIAR (Australia) shows that it is possible to reduce the risks of crop losses from WSD, and improve the productivity and profitability of small-scale shrimp farms through disease control programmes.

This can be achieved by:

- providing access to science-based disease control principles
- providing technical support that enables farmers to adapt best management principles to their own circumstances
- promoting local self-help groups (aquaculture clubs) to facilitate cooperation and communicate best management practices to a wider group of farmers, and
- collectively addressing health management problems.

Our ongoing collaborative work with SUMA (DANIDA) in Vietnam has generated similar findings. BMPs which included concepts of biosecurity were disseminated to farmers in pilot communes. Farmers were encouraged to stock PL with better

## Lapses in farm-level biosecurity can be seen at every stage of the culture operation in many Asian countries

general health and testing WSSV-negative.

Areas where most of the ponds had stocked screened seed were less likely to experience WSD outbreaks. In addition, the spread of WSD between ponds was also controlled through chlorinating affected ponds. The farmers directly purchased chlorine for treating affected ponds, showing that at least in some areas farmers have realised the benefits associated with implementing biosecurity measures.

## CONCLUSION

The amount of farm-level biosecurity that can be applied to managing WSD will be determined by a combination of economics, and most importantly the risks associated with different routes of pathogen entry into the farms and its ponds.

Farm-level biosecurity programmes should be cost-effective, comprehensive and applied from the site selection stage through to harvest. Epidemiological concepts should be used to make informed decisions. In addition, strict post-outbreak considerations should be applied to prevent the spread of white spot syndrome virus.

The application of farm-level biosecurity measures in pilot sites in India and Vietnam contributed to reducing the risk of WSD outbreaks. To effectively promote adoption of biosecurity principles, it is essential to understand the socio-economic background and mindset of farmers. Extending this concept to a wider area, however, poses considerable challenges. A possible way forward should include collective approaches and facilitating farmer-to-farmer interaction through self-help groups and voluntary associations.

To be successful, this approach will have to be implemented within an institutional (government/private) framework that allows the implementation of best management practices on a wider area.

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## FARM-LEVEL BIOSECURITY AND WHITE SPOT DISEASE OF SHRIMP

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# FOCUS: AQUAFIN CRC AND SOUTHERN BLUEFIN TUNA HEALTH

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SPEAKERS FROM THE EAFP TUNA HEALTH WORKSHOP SESSION IN COPENHAGEN. FROM LEFT, BRIAN JONES, BARBARA NOWAK, NATHAN BOTT, IVONA MLADINEO, HAMISH AIKEN AND TAKUMA SUGAYA

The Cooperative Research Centre for Sustainable Aquaculture of Finfish (Aquafin CRC) was established in 2001 to address the research priorities of the Australian finfish culture industries.

During its seven-year life, Aquafin CRC is contributing to the growth and competitiveness of the aquaculture industry, developing effective research collaborations, providing education and training, and facilitating communication between industry sectors.

Aquafin CRC focuses on southern bluefin tuna, *Thunnus maccoyii*, (62 percent) and Atlantic salmon, *Salmo salar*, (32 percent) aquaculture. Snapper, mulloway, yellowtail kingfish and striped trumpeter are also being investigated as future commercial aquaculture species. The main objectives of the health programme are to reduce the economic impact of disease in farmed finfish, improve industry and government responsiveness to disease outbreaks, and to develop environmentally friendly approaches to disease management.

The programme consists of two sub-programmes - diagnostics and risk assessment, and management and control of amoebic gill disease in Atlantic salmon. Researchers in both sub-programmes collaborate and there is a flow of knowledge, technology and ideas between the two.

For example, research on the immune response in tuna is benefiting from these interactions. The total budget committed to agreed health programme projects during the life of Aquafin CRC is A\$6,172,600

## DIAGNOSTICS AND RISK ASSESSMENT PROJECTS

Three projects within the diagnostics and risk assessment sub-programme have already been completed. These include tuna health risk assessment, tuna cell line development, and the development of diagnostics for bacterial pathogens.

The continuing projects are on the effects of farming practices

on tuna health, and developing probes for detecting tuna pathogens in environmental samples. The health programme also addresses the needs of the aquaculture industry in training and human capital development.



THE SANGUINICOLID BLOOD FLUKE *CARDICOLA FORSTERI*

## TUNA HEALTH PROJECT

The current tuna health project investigates the effects of husbandry on southern bluefin tuna health. Southern bluefin tuna (SBT) are the most valuable species of cultured finfish in Australia, and the industry was worth over A\$300 million in 2003.

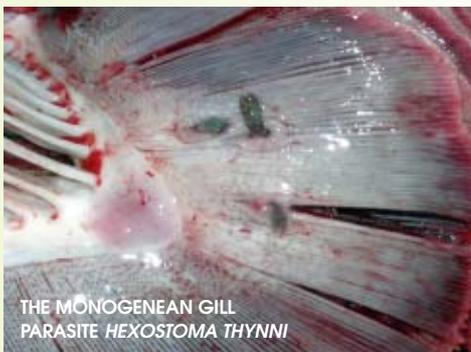
Virtually all fresh, chilled and frozen tuna is exported to Japan, where it is sold in sashimi markets. Unlike most other cultured fish, which are propagated artificially in hatcheries, schools of two to four-year-old wild tuna are caught by purse seine trawlers in the Great Australian Bight and towed to farm pontoons off Port Lincoln, South Australia, where they are fattened for between two and eight months.

Improved husbandry practices over the past decade (for example, lower stocking densities and towing speeds) have reduced mortalities to very low rates of around two percent per year.

Nevertheless, their health status is only now being studied. In particular, it is not known how much production value is lost due to diseases associated with infectious agents. One group of these agents, metazoan parasites on the gills, are frequently associated with disease in cultured fishes. Tuna are known to host a range of gill parasites, but their epidemiology has never been investigated.

The tuna health survey, a part of this project, started in 2003 (Deveney *et al* 2005). As parasites were identified as the main

## FOCUS: AQUAFIN AND SOUTHERN BLUEFIN TUNA HEALTH



THE MONOGENEAN GILL PARASITE *HEXOSTOMA THYNNI*



THE COPEPOD GILL PARASITE *EURYPHORUS BRACHYPTERUS*



THE COPEPOD *PSEUDOCYCNUS APPENDICULATUS*

health risk for SBT (Nowak 2004), the survey has focused on parasite loads in harvest fish and mortalities. Commercial and experimental samples are included in the survey.

So far 1543 harvest fish and 85 mortalities have been examined. The routine examination covers gill parasites, screening for sanguinicolid blood fluke *Cardicola forsteri* and, in most fish, examination of internal organs (except the kidney) for parasites.

The results are expressed as prevalence (percentage of fish affected) and intensity (average number of parasites in an infected fish). Targeted screening for *Uronema nigricans* or *Caligus elongatus* has been undertaken when these parasites were suspected to be an issue. This survey has not included examination of intestinal lumen and mucosa. Only a few gall bladders and bile samples were checked for coelozoic myxozoans. Other aspects of tuna health, such as histopathology, microbiology and immune response, are addressed by preliminary studies.

We collected quantitative data on metazoan parasite burdens over time in a series of monthly samples from a single cohort of tuna (from the same tow) in four pontoons on a commercial farm (n=10), during an experimental feed trial from March to August 2004.

Three species of gill parasites were recorded. These varied greatly in their prevalence and abundance. For two species there was no discernible trend in prevalence and intensity (*Hexostoma thynni*, *Hexastomidae*), a large, blood-feeding monogenean that was recently identified (Hayward et al submitted), and *Euryphorus brachypterus* (Gerstaecker, 1853) (*Euryphoridae*), a copepod.

There was, however, an overall gradual increase in intensity and prevalence for the third parasite species (the copepod *Pseudocycnus appendiculatus* Heller, 1865 [Pseudocycnidae]). These results contrast with other cultured species of finfish, in which there is usually a rapid increase in prevalence and intensity of gill parasites. This may be related to immuno-competence of the fish at capture, low stocking densities and short farming time, or a combination of all these factors.

A blood fluke, *Cardicola forsteri*, was identified as a moderate risk to SBT health, and an examination of the epidemiology of the fluke was recommended. We investigated the epidemiology of the blood fluke over one grow-out season in 2004 in Port Lincoln for a single cohort of the SBT. The SBT were sampled monthly after transfer from the tow to farm pontoons in March 2004. A total of 220 gills and hearts from the SBT were examined and flukes were collected. A range of adult fluke intensities (0-99) were observed within the ventricle of the SBT.

No statistical correlation between fluke intensity and condition was demonstrated. Intensities of flukes were observed to be very low initially. Within two months, the intensities increased rapidly, peaking in May with an average of 27 flukes per tuna (SE=3.91). Intensities then appeared to taper off.

A similar pattern was observed in the monthly prevalences, with a rapid increase and a peak in May (reaching 100 percent infection), followed by a decline. The rapid initial increase in fluke burdens may suggest that the *C forsteri* asexual stages aestivate in the intermediate host. The decline in both the percentage of fish infected and the intensity after the peak following the rapid increase may indicate a host immune response controlling the

infection. However, one negative effect is apparent, as white lesions commonly occur on the gills. This is presumed to be caused by the lodgement and hatching of the eggs of *C forsteri*.

The patterns of infection for each species of parasite were consistent in 2004 and 2005. One of the gill copepods, *Pseudocycnus appendiculatus*, showed a gradual increase in prevalence and mean intensity over the harvest season in both 2004 and 2005. The mean prevalence increased to a maximum of 67.5 percent in August 2004 and of 85 percent in July 2005.

However, the total number of this copepod on the gill was low, with a maximum mean of 10.35 in July 2005. The two other species of parasites on the gills - *Hexostoma thynni* and *Euryphorus brachypterus* - had relatively low numbers, and did not show marked changes in the percentage of SBT infected within the period of farming. Nor were there any obvious trends in the average numbers of worms over time.

Finally, the blood fluke *Cardicola forsteri* showed a markedly different pattern of infection. At the time of transfer into cages, infection rates were very low or zero, but quickly increased. By the end of the season, however, the infection rates had returned to lower levels.

So far, holding time is the only factor that affects parasite loads. Other factors, such as diet or vitamin supplements, did not have any effect on parasite loads. Parasite loads also did not affect the tuna's condition factor. We are currently investigating the potential causes of these temporal patterns.

None of these parasites was linked to any increased mortalities. *Uronema nigricans* infections were in the past linked to mortalities. However, improvements in husbandry and improved location of sites seemed to have eliminated this problem (Nowak, 2004).

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# THE EFFECTS OF AQUAVAC™ ERGOSAN™ ON GROWTH AND SURVIVAL IN JUVENILE CHINOOK SALMON

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 (Note: Preliminary research material published in the Research Feature section of *Aquaculture Health International* is not peer reviewed).

The major objective in aquaculture is to improve productivity by increasing survival and improving feed efficiency.

Successful improvements in these parameters ultimately lead to better economic performance.

In addition to improving overall performance, it is critical that the majority of the population achieves minimum standards. For example, salmon smolts need to achieve minimum size for transfer to sea, while shrimp prices are determined according to size category.

Such criteria will determine the viability of an operation, and controlling the parameters that influence these is critical for successful farming operations. Improved health status and feed performance go hand-in-hand to achieve the improvements required.

The use of immunomodulators/feed additives as an integral part of aquaculture management strategies has received increased attention in recent years from researchers and fish farmers alike. As a result, the aquaculture industry now uses a number of commercially available products worldwide.

This article reports on some work carried out in New Zealand to assess the impact of AquaVac™ Ergosan™ use on the performance of juvenile Chinook salmon, *Onchorynchus tshawytscha*.

## WHAT IS AQUAVAC™ ERGOSAN™ AND WHAT DOES IT DO?

AquaVac™ Ergosan™ is a complementary feedstuff comprised of dried seaweed and plant extracts from *Laminaria digitata* and *Ascophyllum nodosum*. The principal components are registered food additives: alginates and alginic acids.

Research has demonstrated that Ergosan can “switch on” key immune genes such as tumour necrosis factor alpha (TNF- $\alpha$ ) and Interleukin-1 beta (IL-1 $\beta$ ) when injected into rainbow trout (Peddie et al, 2002).

In-feed application is effective in reducing the incidence of rainbow trout fry syndrome (RTFS) and subsequent mortality rates (Anon, undated).

Moreover, work recently published from Italy has shown that enhanced levels of lysozyme complement and heat-shock-protein can be detected in sea bass fed with an Ergosan-supplemented diet (Bagni et al 2004).

## TRIAL DESIGN AND LOGISTICS

The trial was set up in the commercial production facility using six race ways containing between 110,000 and 148,000 fry in each. The race ways were randomly assigned as experimental or control groups. Ergosan was incorporated into a commercial fry diet at an inclusion rate of 0.5 percent, or 5kg per tonne of feed and fed at 2.1 percent per day. The Ergosan diet was fed for two 10-day periods in pulses, the first being from June 10 to 19, and the second from August 3 to 12, 2004. This reflects the expectation

that the effects of feeding Ergosan last for between 25 and 30 days. (Bagni et al 2004, Dr C Gould pers com).

Mortality and growth rates were recorded on a daily and weekly basis respectively, while routine fish health checks were carried out periodically. The grade of the fish was an important production parameter that was assessed at the end of the study.

The trial was divided into two phases, pre and post-split. The pre-split covered the time from first feeding the fry in the raceways with Ergosan to the time when they had outgrown the capacity of the original race ways and were split in order to reduce the stocking densities (June to July 2004).

The post-split was from after this time point until the final hatchery grade, or July to September 2004. Grading took place on September 13.

## PRE-SPLIT RESULTS

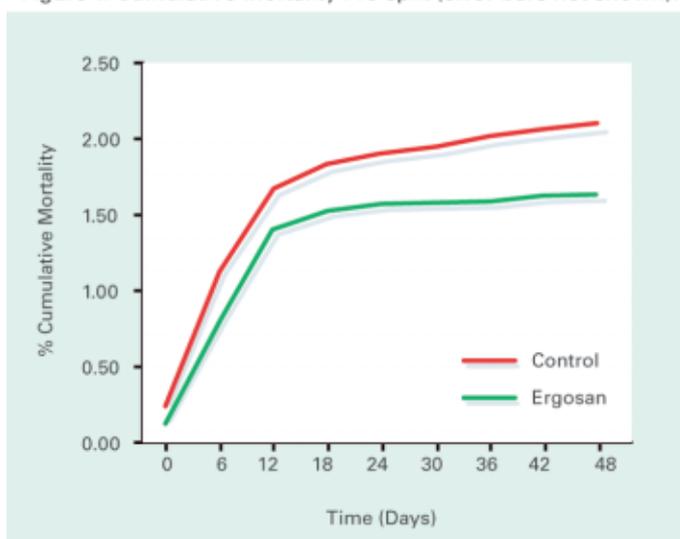
There was a significant effect of diet ( $p < 0.05$ ) and time ( $p < 0.001$ ) on cumulative mortality rate (by two-way ANOVA) (see Figure 1).

There was a significant effect of treatment over time ( $p < 0.001$ ) and diet ( $p < 0.05$ ) on average fish weight (by two-way ANOVA) (see Figure 2).

TABLE 1. The effect of AquaVac Ergosan on SGR and FCR Pre- and Post-Split

DIET	SGR (Mean)		FCR (Mean)	
	Pre-Split	Post-Split	Pre-Split	Post-Split
Ergosan	4.7	3.0	0.79	0.89
Control	4.5	3.1	0.90	0.98

Figure 1. Cumulative Mortality Pre-split (error bars not shown).



## THE EFFECTS OF AQUAVAC® ERGOSAN® IN JUVENILE CHINOOK SALMON

Figure 2: Average Fish Weight Over Time for the Pre-split Period (error bars not shown).

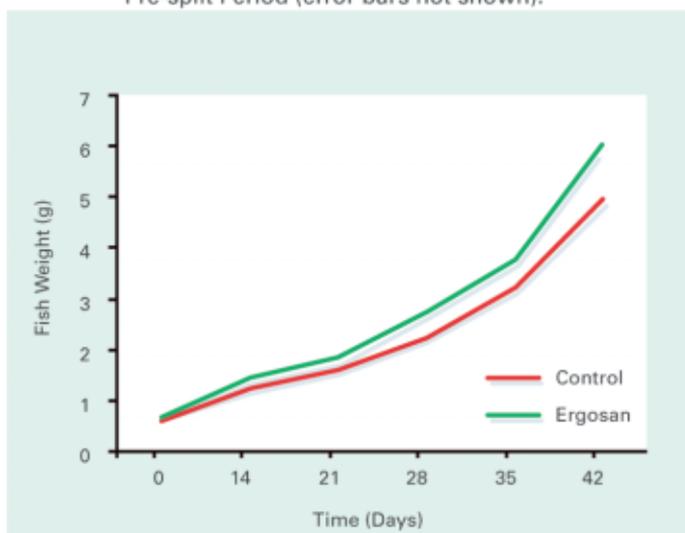


Figure 3: Cumulative Mortality Post-split (error bars not shown)

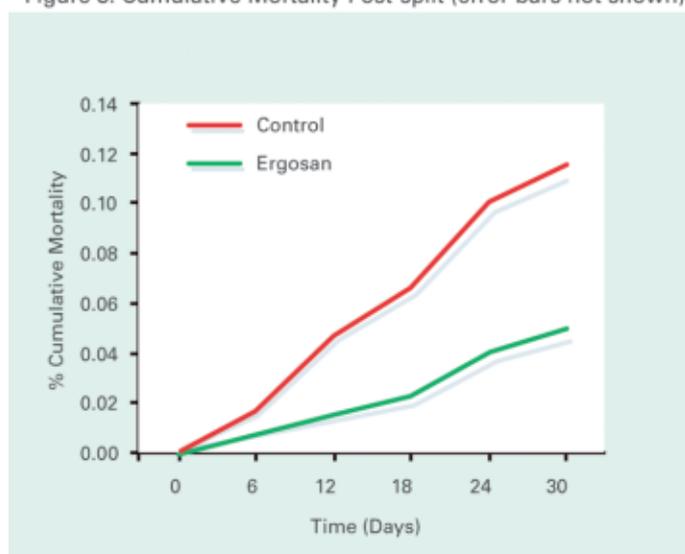


Figure 4: Average Fish Weight Over Time for the Post-split Period (error bars not shown).

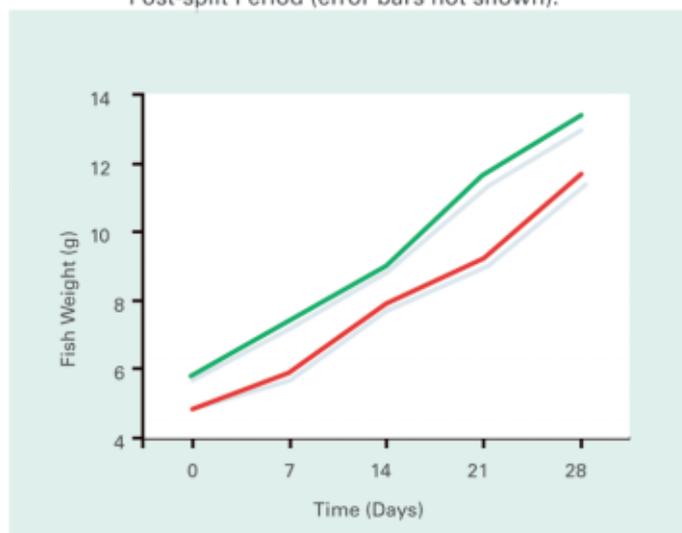
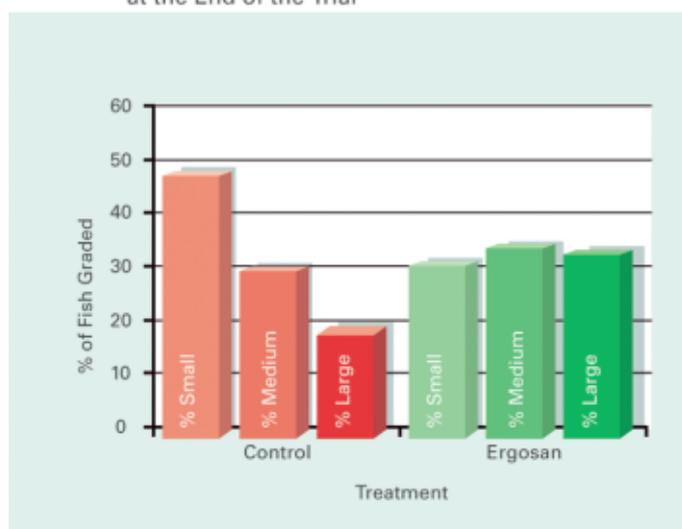


Figure 5. The Effect of AquaVac Ergosan on Grade-Mix at the End of the Trial



Although both SGR and FCR were more favourable in the Ergosan-treated groups, the difference was not statistically significant. (See Table 1 on previous page.)

## POST-SPLIT RESULTS

There was a significant effect of diet ( $p < 0.05$ ) and time ( $p < 0.001$ ) on cumulative mortality rate (by two-way ANOVA) (see Figure 3).

There was a significant effect of treatment over time ( $p < 0.001$ ) and treatment ( $p < 0.001$ ) on average fish weight (see Figure 4).

FCR was more favourable in the Ergosan-treated group, although this difference was not statistically significant. SGR was almost identical between groups (see Table 1).

## GRADING RESULTS

At the end of the trial, when the fish were graded, the group fed with AquaVac™ Ergosan™ yielded a higher proportion of “large” grade fish than the control group. Indeed, 69 percent were in the medium to large grade, with only 32 percent in the small grade (which were culled). In the control group, 49 percent of the fish were classed as small and were therefore culled (see Figure 5).

## IN CONCLUSION

- The results of this preliminary trial show that fish fed with AquaVac™ Ergosan™ had lower overall mortality rates than those fed on a normal production diet.
- No specific disease was recorded during the trial.

- The FCR and SGR were improved in the fish fed Ergosan. Although these differences were not statistically significant, the fish fed on the Ergosan diet were significantly larger than the controls.
- The grade of fish produced on the Ergosan diet was substantially improved compared to the controls, with 69 percent of fry reaching the critical size compared with only 51 percent in the control group.
- AquaVac™ Ergosan™ can play an important role in improving production efficiency in farmed Chinook salmon. See [www.spaquaculture.com](http://www.spaquaculture.com)

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