# aquaculture NEWS 35

May 2009 ISSN 1357-1117


Published by the
INSTITUTE OF AQUACULTURE
University of Stirling
Stirling FK9 4LA
Scotland UK

UNIVERSITY OF STIRLING

# INSTITUTE OF AQUACULTURE

## Want to develop your career as an aquaculture professional?

*Immerse yourself in one of our exciting range of taught programmes:*

MSc /PG Diploma/ PG Certificate in:

- Sustainable Aquaculture
- Aquaculture Business Management
- Aquaculture and Development
- Aquaculture and the Environment
- Aquaculture Nutrition
- Aquaculture Systems
- Aquatic Pathobiology
- Aquatic Veterinary Studies
- Aquatic Animal Health (PG Cert, distance learning)

*or, develop your career through our specialised short courses for the aquaculture industry in subjects including:*

- Business Management
- Economics and Marketing
- Disease and Health Management
- Environment
- Genetics and Reproduction
- Nutrition

Further details about these courses can be found on our training website: **http://www.aqua.stir.ac.uk/training**

*Contact:* The Departmental Secretary, Institute of Aquaculture, Tel. + 44 (0)1786 467874, Fax. + 44 (0)1786 472133 • E-mail: aquaculture@stir.ac.uk

Research postgraduates are an absolutely vital part of the Institute's activities. We have trained very large numbers of research students who have carried out world-class research over a wide range of aquaculture-related topics. Many of them have gone on to follow outstanding research careers around the world.

It is therefore particularly appropriate that this issue of Aquaculture News is devoted to our current research students. The Research Student Conference held within the Institute last autumn was a tremendous success, allowing students to present their research to a wide audience drawn from academia, research organisations and industry. You will be able to see details of some of the prize winning presentations in these pages. Special thanks are due to Andy Shinn and Richard Corner for their tremendous efforts in making the conference successful.

We hope to have a big intake of new research students over the next 3 years for a series of studentships funded by the sale of Institute properties in Bridge of Allan. Our staff have obtained very significant matching funding from external sources for these studentships. In addition further studentships have been obtained from industry and as part of collaborative agreements with Fisheries Research Services, Aberdeen, and the Moredun Institute. These new studentships will maintain the dynamic research environment of the Institute and strengthen the relevance of our work to aquaculture worldwide.

This will be my last Director's column for Aquaculture News as my term of office is now about to finish. It has been hugely rewarding to lead the Institute over the past 13 years and to see it maintain its position as a world-leading centre in the field. The new Director will be Professor Brian Austin, who will be known to many of our readers, and I wish him well as he leads the Institute through the challenging times ahead.

PROFESSOR RANDOLPH RICHARDS, DIRECTOR


| | |
|---|---|
| EDITOR: | Anton Immink |
| SCIENTIFIC ADVISOR: | Dr Rod Wootten |
| LAYOUT: | Original Design: Graphics and Print Services, University of Stirling |
| FRONT COVER: | Oral presenters from the First Institute of Aquaculture Conference. Image courtesy of Denny Conway. |
| BACK COVER: | Juvenile turbot at Ardtoe Marine Laboratory. Image courtesy of Hervé Migaud. |

All correspondence, including copy requests, should be sent to Anton Immink, e-mail a.j.immink@stir.ac.uk


## Contents


**Research showcase**
- Our first PhD Research Conference 2

**Randolph Richards CBE** 2

**Soothing that Ich** 3

**Balancing copper** 3

**Cod copepod** 4

**Vibriosis vaccine** 5

**Quality cod eggs** 6

**SARF success** 7

**Aquaculture in Sierra Leone** 8

***Gyrodactylus* infection routes** 8

**Our new Director** 9

**PhD conference pix** 9

**Recent visitors** 9

**Aquaculture in practice**
**- MSc sector tour** 10


### Future e-Aquaculture News

Aquaculture News is becoming an electronic publication. We will be publishing short electronic editions on a quarterly basis. We would like to keep our e-mailing list up to date and, of course, welcome new subscribers. We continue to welcome short articles from readers and would be grateful if you could circulate this copy to anyone you feel would find it interesting. Aquaculture News will remain free of charge.

To join the mailing list or update your e-contacts, please e-mail Anton on a.j.immink@stir.ac.uk

# Research Showcase – Our First PhD Research Conference

## Richard Corner and Andrew Shinn

It is funny how small conversations over coffee can result in something magnificent and worthwhile. So say the conference organisers Richard Corner and Andrew Shinn. The thought, by a number of staff, to do a small internal meeting with some students presenting their research to peers and staff, ended up as a full blown international conference. Attended by over 240 people; academics, students, industry representatives, government officials and overseas visitors; they were all in Stirling to listen, to appreciate and to understand the huge diversity of PhD research carried out at the Institute. The result: an exhilarating and exciting conference enjoyed by all who attended.

The Institute of Aquaculture PhD Research Conference took place on the 29th October 2008, and was a day to celebrate the diversity of research students' work. The day itself was the culmination of weeks of hard (and stressful so they tell us) preparatory work by our students. All who attended had a tremendous day of oral and poster presentations, with a lunch and wine reception thrown in.

Early in the preparations some vigorous activity secured financial support from a range of sponsors to whom we are grateful; Intervet Schering Plough Animal Health, EWOS, Novartis, Lighthouse Caledonia, Scottish Aquaculture Research Forum, Scottish Salmon Producers Association, Wiley-Blackwell publishers and Thistle Scientific. Intervet Schering Plough, and especially Professor Patrick Smith, receive our special thanks for providing the all important prize funds.

The conference aims were simple. It provided a formal opportunity for students to share their research with peers, academics and industry; a forum to share and discuss the diversity of research at the Institute and the opportunity to widen the students' appreciation of the wider aquaculture-related community. What transpired was a day of high quality talks on subjects as diverse as fish stock management, disease, nutrition, complex particle tracking models, and the fish markets of Sierra Leone. Our directors, Professor Randolph Richards and Dr Rodney Wootten put it simply "*Research students are a vitally important part of the Institute of Aquaculture. Our research students are a large and very international group and we value them not only for their research, but also for the vibrant atmosphere they help to create*". The international nature of our student body was illustrated through the nationality of the presenters, 11 talks by 11 individuals representing 10 countries, from Africa, Asia, Europe and the Middle East.

The conference was opened by Professor Richards. This was followed by two oral presentation sessions before lunch, one session after lunch, a poster session and wine reception in the late afternoon. The day culminated in a prize giving ceremony to award the best and runner-up oral presenters and posters. The diversity of research presented, gave the two prize selection committees* much to talk about and after hearty discussion and some disagreement, they were in the end unanimous in their decisions. The best presentation was awarded to Matteo Minghetti for his investigation of the expression of copper transport genes in sea bream and for her poster on white spot disease Sara Picon-Camacho received the poster prize. You will be able to read about their work and the work of the runners up in this issue of Aquaculture News.

We received many plaudits and congratulations after this event, and encouragement to continue this into the future. The real stars of the 2008 conference were the PhD students who contributed so magnificently to the event.

*We would like to acknowledge the sterling contribution of our prize committees.
Assessing talks were:

- Dr John Webster (Scottish Salmon Producers Organisation)
- Prof. Ruth Zadoc (Moredun Institute)
- Dr Jim Treasurer (Viking Seafarms)

Assessing posters were:

- Dr Alistair Duguid (Scottish Environment Protection Agency)
- Dr Katherine Reibeg (University of Stirling)
- Bob Bowden (Pisces Engineering)

# Randolph Richards CBE

## Honours for our current Director

Professor Randolph Richards, Director of the Institute of Aquaculture, received a CBE in the Queen's Birthday Honours. The award was bestowed in recognition of his services to veterinary science.

Professor Richards has played a major role in the aquaculture industry in Scotland, being veterinary adviser to key aquaculture industry associations, an active member of a number of joint government/industry working groups and contributing to the development of industry codes of practice – the Scottish Framework for Sustainable Aquaculture and the Scottish Aquaculture Bill.

He has played a central role in the development of the Institute of Aquaculture, which in turn has made a major contribution to the economy of Scotland and greatly enhanced Scotland's reputation throughout the world. The award is a fitting recognition of a lifetime contribution to Scottish intellectual effort in support of its economy.

Professor Richards has also been honoured with the FEAP (Federation of European Aquaculture Producers) Award for Excellence in European Aquaculture. Presented at the FEAP AGM in the Faroes (May 2009), the award is represented by a silver statue of Poseidon.

# Soothing that Ich

## Sara Picon

The focus of my PhD is the management and control of the ciliate protozoan parasite *Ichthyophthirius multifiliis* Fouquet, 1876 commonly known as "white spot" or "Ich". This freshwater parasite can live in a wide range of temperatures and is not host specific, but can infect all freshwater fish.

The parasite sits under its host's epidermis and causes mortality when large numbers of the mature trophont stage exit the fish causing damage to the integrity of the epithelium resulting in osmoregulatory and respiratory dysfunction. Over 60% of UK trout farms suffer problems from the parasite and at present there are few measures that can be taken to control infections.

The poster I presented at the Institute of Aquaculture PhD Research Conference assessed the efficacy of a continuous, low dose delivery of Compound-X, a novel chemotherapeutant, on the infection dynamics of *I. multifiliis* in small scale raceways. The trial set out to establish the efficacy of Compound-X, when used at doses ranging from 1mg/l to 5mg/l, in reducing the number of *I. multifiliis* stages infecting and subsequently establishing on juvenile rainbow trout held in small flow-through tank systems (see Figure 1).

The effect of Compound-X on the colonisation success of new infections entering the system (i.e. infective theronts entering a system via the inflow) was investigated by administering 2mg/l Compound-X at the time of infection and for the first three days following infection. The effects of Compound-X on the trophonts (the parasitic stage of the parasite), as they mature and exit the fish, the tomonts (the exiting stage) as they settle and encyst, and the theronts (the infective stage) before they infect the fish was assessed through treatment (1mg/l, 2mg/l-start/end & 5mg/l) at 10-36 days post-infection.

The trial found that a nominal dose of 2mg/l Compound-X significantly reduced the number of theronts surviving in the water column at the time of initial parasite challenge by 35-48%. Similarly, nominal doses of 2mg/l and 5mg/l during the second wave of infection gave further significant reductions in the number of parasites establishing by 46-83%, while nominal doses during the third wave gave further significant reductions of between 83-97%. For example, there were an average of 881.6 ± 1088.1 parasites on each control fish after the third wave of infection while those fish that had been continuously exposed to 5mg/l Compound-X had only 22.9 ± 19.4 parasites per fish i.e. 97.4% lower.

I thoroughly enjoyed the PhD conference not only because it was an opportunity to learn about the diversity of research being conducted by the Institute's army of students, but also to talk and exchange ideas with some of the industry's leading lights over a glass of wine. In particular, I would like to thank the British Trout Association, the Scottish Aquaculture Research Fund and Scottish Quality Salmon for some great chat and for their support in what we are trying to achieve.

**Figure 1**. Sara and her experimental system that was specifically designed for the current study

# Balancing copper

## Matteo Minghetti

My work at the Institute of Aquaculture began in 2003 when I came to study the toxic effects of copper and cadmium in fish through the European Union-funded Large-Scale Facility Programme. The results achieved during this six month project enabled me to obtain a scholarship from the Italian government (*Ministero Politiche Agricole*) and start a PhD on the homeostasis of copper in sea bream (*Sparus aurata*) under the supervision of Prof. Stephen George and Dr. Michael Leaver.

Copper is an essential metal. Like vitamins, essential metals are required for normal growth and development of all living organisms. Copper is utilized as a cofactor by many enzymes that catalyze redox reactions used in fundamental metabolic processes such as respiration, free radial detoxification, connective tissue formation, blood clotting and many others. However, because of its redox properties copper can generate reactive oxygen species that are highly cytotoxic. Therefore organisms are faced with the challenge of acquiring sufficient copper for cellular requirements, while avoiding accumulation that could lead to cellular toxicity. Consequently this necessity has led organisms to evolve dedicated systems to uptake, deliver to specific intracellular targets and excrete copper. The importance of these systems is demonstrated by some human genetic diseases (Menkes and Wilson disease) in which genes for copper transporting proteins are defective. The recent availability of fish whole genome sequences has enabled me to characterise these and other copper homeostasis genes for the first time in a fish species of commercial importance, sea bream.

The knowledge of copper transporters at the molecular level is of critical importance to understand the requirement for, and toxicity of this metal to living organisms including

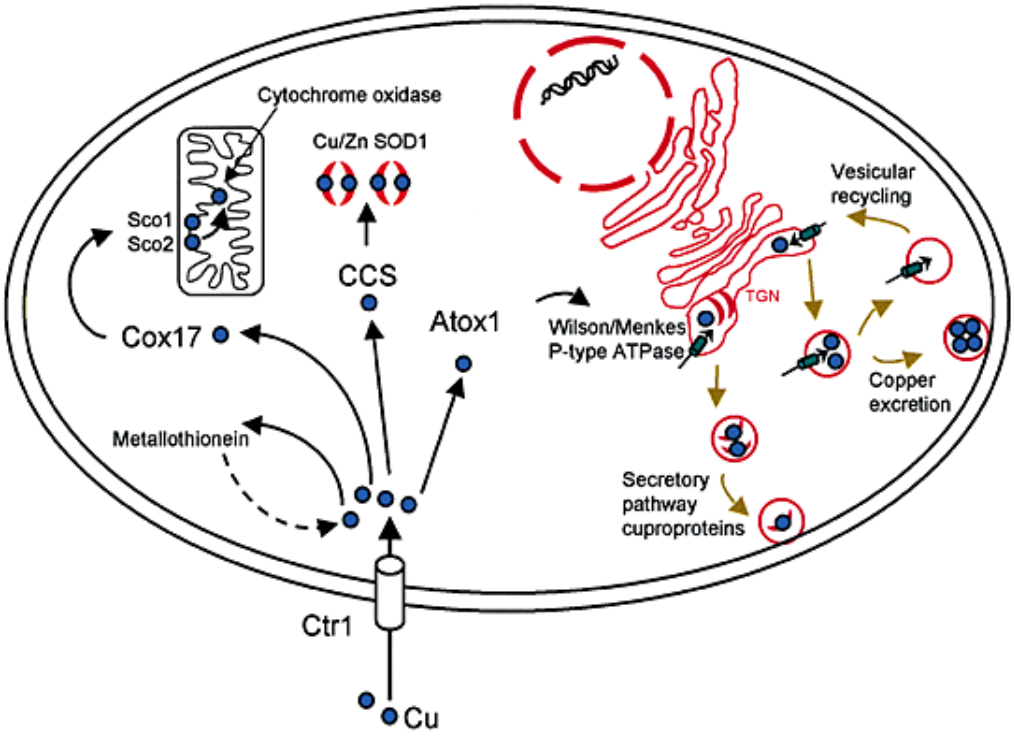
fish. Fish require copper and other trace elements for their normal development, growth and reproduction. Therefore in aquaculture these elements are supplemented in their feed. With the vast expansion of the aquaculture business, the input of copper in the environment threatens local ecosystems.

Fish and amphibian larvae represent unique models among vertebrates to study copper homeostasis as they can absorb copper by two routes, either via water through the gill or through the diet via the intestine. Under low dietary copper conditions, fish are able to uptake copper from the water thus avoiding copper deficiency. On the other hand, in copper polluted aquatic environments, copper accumulates in their tissues. Chronic copper toxicity results in reduced growth rates and reduces survival of early life stages, whereas acute copper toxicity results in inhibition of sodium and potassium osmoregulation, which in turn leads to fish death.

The systems responsible for dietary copper absorption are not known and thus the dynamics of copper absorption and its interaction with other essential metals (e.g. zinc and iron) are not understood. This gap in knowledge means that aquaculture diets may not be supplemented with the optimal ratios of these metals, and a greater understanding of copper and metal homeostasis generally might allow a reduction in dietary and thus environmental inputs.

In my study sea bream were exposed to copper *via* diet or *via* water and the results showed a distinct molecular response to waterborne or dietborne copper exposure. The patterns of expression of copper homeostasis genes under these two exposure routes suggests mechanisms for the observation that fish are much more sensitive and vulnerable to copper dissolved in the water compared to diet. Ultimately this knowledge will be utilized to control the balance between the risk of environmental damage and the requirement to provide farmed fish with essential nutrients.

**Copper trafficking and incorporation into copper-proteins**



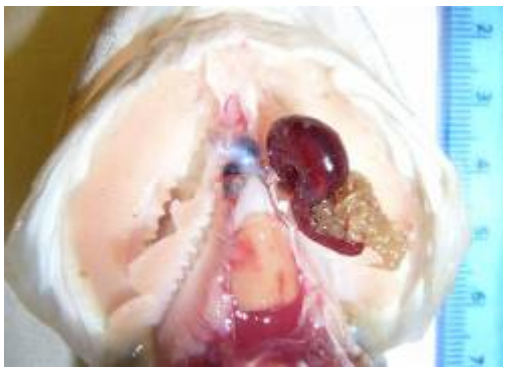

# Cod copepod

## Sarah Barker

The relatively recent development of commercial cod farming has led to increased research into the diseases affecting cod, and their immune system. *Lernaeocera branchialis* is a common parasite of wild cod and other gadoids in the North Sea and North Atlantic Ocean. The females have a complex life cycle with an intermediate and a definitive host, the latter usually being cod, haddock or whiting, which is infected by the fertilised female.

Post-attachment the female undergoes extensive metamorphosis with the development of "antlers" which anchor the parasite in the ventral aorta or *bulbus arteriosus* of the gadoid's heart, where the parasite feeds on the host's blood. The detrimental effects of this activity upon the host have been well documented and include reduced growth rate, reduced condition factor, anaemia, and sometimes mortality when multiple parasites are present.

These negative impacts on cod, particularly juveniles, by *L. branchialis* have the potential to adversely affect cod aquaculture in the future. This PhD project therefore, investigated the immune response of cultured-cod during infection and the mechanisms by which the parasite modulates the hosts' immune system. Many arthropod parasites, such as ticks and salmon lice, have been previously documented to produce pharmacologically active secretions, aiding host invasion, parasite feeding and preventing the host immune response from working effectively



*Lernaeocera branchialis* anchored in ventral aorta of wild infected haddock from the North Sea

against the parasite, all resulting in improved survival of the parasite.

Therefore, the effects of the secretory/excretory products (SEPs) of this parasite on the immune response of hatchery reared cod, and the location of secretory glands associated with the oral region of the parasite were investigated, and the results presented at the Institute of Aquaculture conference.

The SEPs from fully metamorphosed female *L. branchialis* had a number of detrimental effects on the host immune response including suppression of the production of cytotoxic hydrogen peroxide during the respiratory burst of phagocytic leukocytes, suppression of the production of macrophage activating factor by leukocytes with a priming effect on phagocyte function, and suppression of the chemo-attraction 'power' of zymosan activated cod serum, *i.e.* anaphylatoxin activity, on head kidney-derived leukocytes. The effects of the SEPs were dose-dependent and highlight the capacity of *L. branchialis* to suppress its host's innate immune response at the local feeding area. Further work is required to establish the mechanisms by which SEPs suppress these host immune parameters, and to identify which molecules produced by the parasite are responsible.

Secretory glands were located in the infective and the fully metamorphosed stages associated with the oral region, one pair termed the anterior gland complex, and the other pair extending either side of the oral cone termed the circum-oral glands. They were found to produce multi-component secretions of which protein was concluded to be a major element due to the abundance of protein-manufacturing rough endoplasmic reticulum, and these glands also increased in size post-metamorphosis. It is hoped that the 'mapping' of these glandular structures will aid future studies regarding the production sites and secretion kinetics of parasite-derived molecules during the infection process.

These studies together with the investigation of the immune response to infection in this PhD have shed more light on the interactions between this host and parasite, which with further research could lead to the development of targeted control measures. Such measures could include vaccine development against SEPs important in the modulation of the host's immune response or the use of immuno-stimulants to counteract the host immuno-suppression.

Sarah Barker is currently writing up her PhD thesis. Sponsorship was given by the Fisheries Society of the British Isles with supervision from Dr J. Bron, Dr K. Thompson, and Prof. I. Bricknell (FRS Marine Laboratory, Aberdeen / University of Maine, U.S.A.).

# Vibriosis vaccine

## Remi Gratacap

Remi M. L. Gratacap recently completed his PhD in the Aquatic Vaccine Unit, under the supervision of Dr Kim Thompson, Prof. Alexandra Adams and Prof. Ian Bricknell. The title of his thesis was: Characterisation of *Vibrio anguillarum* for the development of a vaccine in cod (*Gadus morhua*); sponsored by SeaFish Industry Authority and Intervet-Schering-Plough.

Cod aquaculture is expanding as a result of over-exploitation of many of the wild stocks for human consumption and the high commercial demand for this species. Successful culture of any new fish species depends on two main issues; what to feed them?; and how to protect them against diseases? With Atlantic cod (*Gadus morhua*), the nutrition requirement has been extensively investigated and the industry seems happy with the food conversion ratio and the quality of the flesh resulting from commercial cod diets. Regarding disease, however, there are still a number of problems to overcome. Luckily, cod do not seem to be affected by the salmon lice (*Lepeophtheirus salmonis)*, but are susceptible by another "old friend" of salmon, the bacterium *Vibrio anguillarum,* responsible for causing vibriosis. This disease hit the salmon farming industry very early on in its development, and much effort was given to designing an effective vaccine for salmon based on formalin-killed bacteria. Commercial vaccines now available are extremely effective at protecting salmon from vibriosis.

However, with the onset of cod aquaculture, it was quickly realised that *V. anguillarum* also affected this species, and kills them, and that the commercial vaccines used for salmonids do not appear to fully protect cod against the disease.

This project, the aim of which was to develop an effective vaccine to protect cod against vibriosis, took place at the Institute of Aquaculture, Machrihanish Environmental Research laboratory on the west coast of Scotland and the FRS Marine Laboratory in Aberdeen. A number of different approaches were used to achieve this, including; (i) classification of a collection of *V. anguillarum* isolates recovered mostly from marine fish, based on their serotype, (ii) use of a variety of *in vitro* assays to examine the innate immune response of cod to *V. anguillarum* isolates; this was carried out to examine the pathogenicity of the isolates and to establish which isolates produced a good immune response by the host i.e. selection of isolates which resulted in the greatest phagocytosis by cod macrophages and neutrophils, thus possibly improving antigen presentation and potentially increasing protection elicited by the vaccine and (iii) formulation of a vaccine for cod and testing its efficacy.

The main achievements of this work included the discovery of a new sub-serotype for *V. anguillarum*. This new group, referred to as O2c, is not currently included in commercial vaccines for Atlantic cod and may explain why outbreaks of vibriosis are still occurring in commercially vaccinated cod. A number of *in vitro* assays, based on flow cytometry, were used as a novel method to select the best isolates to include in the vaccine based on host/pathogen interactions. Together these results lead to the formulation of a vaccine which included isolates from all the serotypes affecting Atlantic cod, and which elicited the highest innate immune response in the fish. The results of the efficacy experiments suggest that the vaccine formulation used in this study looks very promising, although further work is required to fully assess its potential to protect Atlantic cod against vibriosis.

# Quality cod eggs

Jarin Sawanboonchun

with William J. Roy, Derek, A. Robertson and J. Gordon Bell

## Introduction

Catches from cod fisheries have been in serious decline for many years and there is now increased interest in cod farming. Around the world the amount of cod farmed has increased from 169 t in 2000 to 3812 t in 2004. The trend is to further increase production (FAO, 2006). Cod farms need good quality fish eggs and larvae all year round. One of the most important factors affecting egg quality is broodstock quality and their diet. Studies have shown that wild cod have higher levels of the carotenoid pigments, principally astaxanthin (Ax), compared to farmed cod (Salze *et al*. 2005). Findings from other species have shown that higher levels of Ax in the broodstock diet increases egg and larval quality. To date there are no reports of the effects of carotenoid supplementation on egg quality in cod. The aim of our experiment was to look at the effect of short-term supplementation of astaxanthin in broodstock diets on a number of egg quality parameters in farmed cod.

## Materials and methods

Two duplicate groups of broodstock were fed either a control diet with no added Ax or a supplemented diet containing 80 mg/kg, Ax as Carophyll pink®.
The broodstock were kept at Machrihanish Marine Environmental Research laboratory in four fibreglass 7m$^3$ tanks. Diets were fed for two months prior to the peak-spawning date and each group contained 34 or 35 males and 35 or 36 females. Egg quality was assessed using standard techniques to measure total egg production, floating egg production and fertilisation rate. Dropout (number of sinking, unfertilised eggs) was also measured. Samples of floating eggs (good quality and mainly fertilised eggs) were collected on 14 different dates for hatch rate determination and fertilisation rate. Ax content was measured in floating eggs collected from each tank on 11 different dates during the spawning period.

## Results

1) Short term supplementation of cod broodstock diets with Ax for a period of two months prior to peak spawning increased concentrations of Ax in the eggs, by around 3-fold, indicating efficient and rapid uptake (Figure 1).

2) Whilst fish fed the Ax supplemented diet produced fewer batches of eggs, the mean number per batch of eggs spawned/kg female was significantly higher (by 20%) (Figure 2).

3) The numbers of floating eggs and numbers of fertilised eggs per kg female in each batch were also significantly improved, by 37% and 47% respectively (Figure 2).

4) Figure 3 shows the visual comparison of egg colour between broodstock fed diets with and without the Ax supplement. Figure 4 shows cumulative egg production for control broodstock and broodstock fed Ax.

5) A correlation between the Ax content of the eggs and fertilisation success of individual batches was identified.

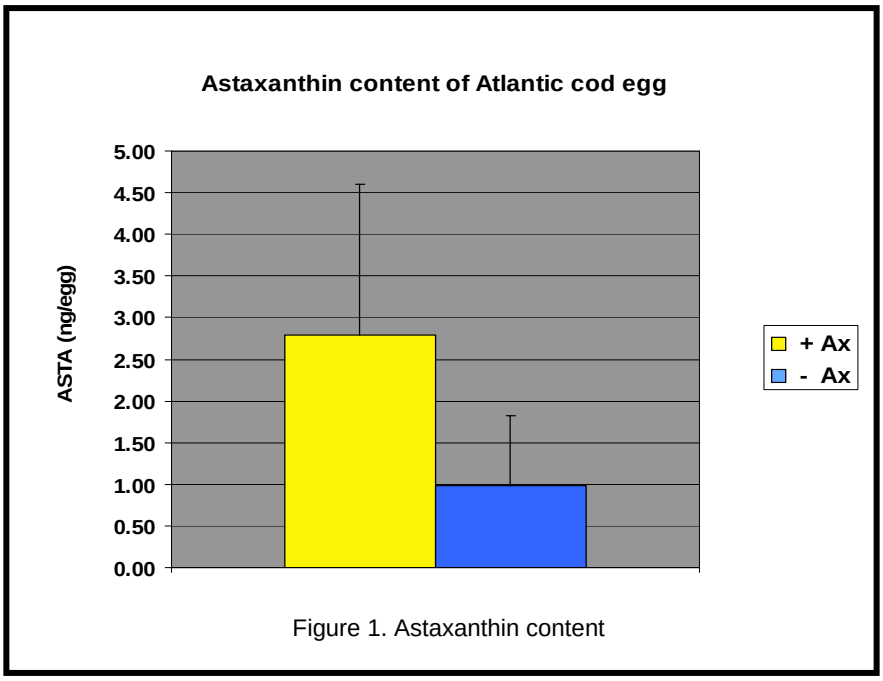



Figure 1. Astaxanthin content

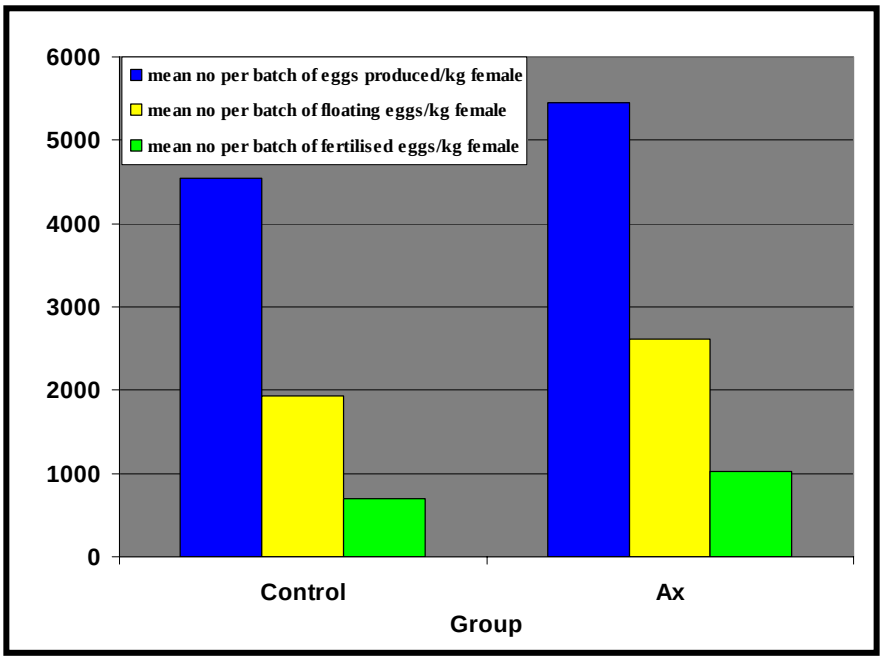



Figure 2. Egg production

## Conclusions

- Supplementing cod broodstock diets with Ax results in uptake and deposition of Ax into eggs.

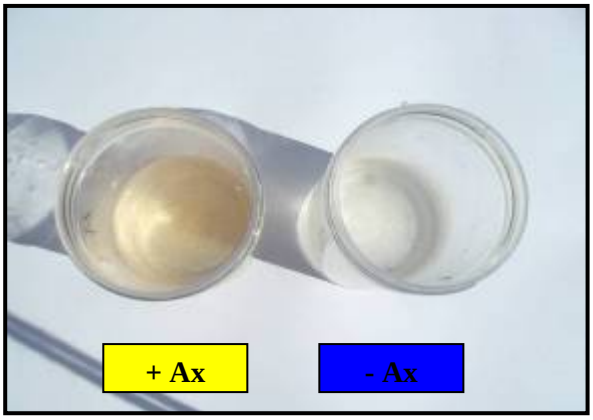



Figure 3. Colour differences between Ax supplemented (left) and unsupplemented eggs (right)

- Ax supplementation provides significant improvements in egg and larval quality, similar to those found in other marine fish species.

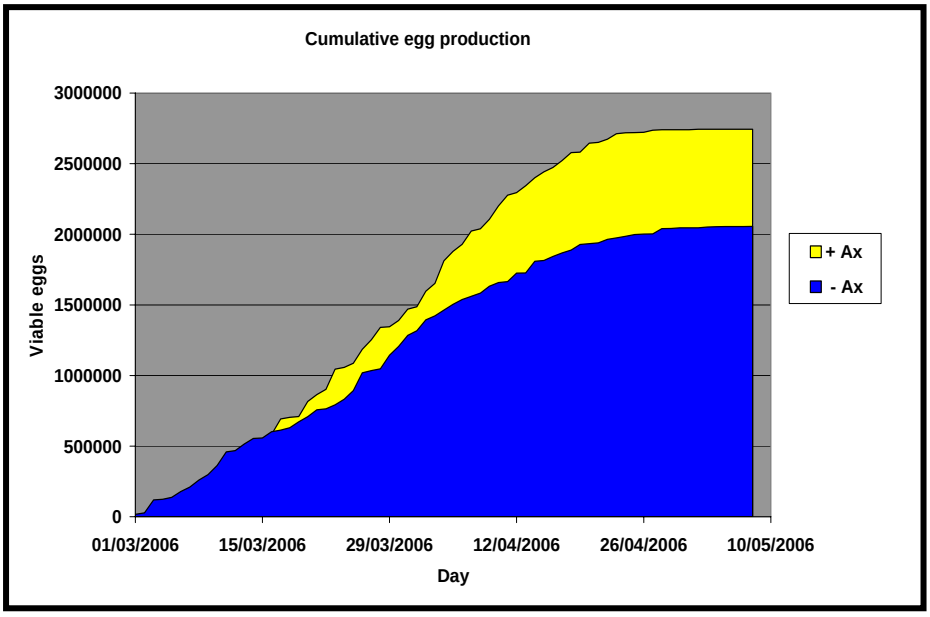



Figure 4. Cumulative egg production

- These results suggest that hatcheries should check the status of their cod broodstock with regard to dietary concentrations of Ax in the pre-spawning period to allow appropriate supplementation if required.

- If necessary, short term supplementation should be used to boost Ax prior to spawning. If the status of the broodstock is unknown, the hatchery should consider sending samples of eggs for analysis at the start of each spawning period.

- Records of egg quality in standard form (e.g. number of fertilised eggs per kg female) are necessary to allow effective comparisons between eggs from different broodstock populations.

- Future studies should aim to determine the most efficient chemical forms of carotenoid supplement, the concentration of Ax and other carotenoids and the duration of supplementation required for optimal response. More information is also required on the role of environmental conditions, husbandry and behavioral interactions in relation to spawning of cod.

* This work has been published as

Sawanboonchun, J., Roy, W. J., Robertson, D. A., & Bell, J. G. 2008, The impact of dietary supplementation with astaxanthin on egg quality in Atlantic cod broodstock (*Gadus morhua*, L.), Aquaculture, vol. 283, no. 1-4, pp. 97-101.

**References:**

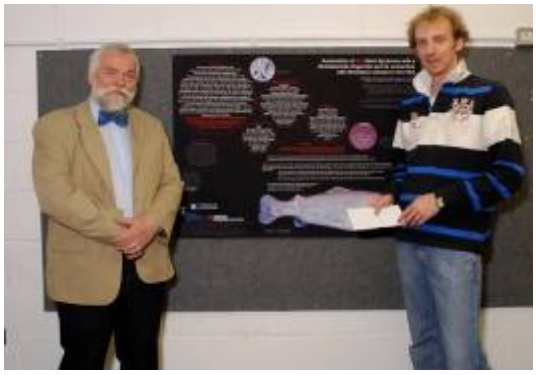
Salze, G., Tocher, D.R., Roy, W. and Robertson, D.A. (2005) Egg quality determinants in cod (*Gadus morhua* L.): Egg performance and lipids in eggs from farmed and wild broodstock. Aquaculture Research, *36*: 1488-1499.

FAO 2006, Fishery Statistical Collections http://www.fao.org/figis/servlet/static?dom=root&xml=tseries/index.xml (3rd July).

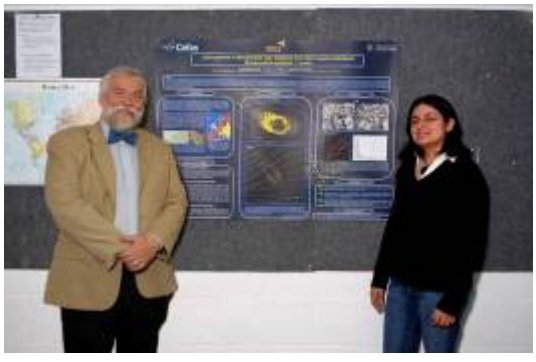
## SARF success

Two PhD students from the Institute of Aquaculture were successful with their posters at the recent Scottish Aquaculture Research Forum conference. Matthijs Metselaar and Mayra Grano Maldonado received recognition (and some money!) for posters that clearly explained their PhD research. Awards were presented by Professor Patrick Smith of Intervet Shering Plough.

Matt is investigating the **Association of Red Mark Syndrome with a Rickettsia-like organism and its connection with Strawberry Disease in the USA**. Red Mark Syndrome affects rainbow trout in the UK, but its cause is still unclear. However, it may have similar origins to Strawberry Disease observed in the USA.



Mayra is researching how parasite stages survive away from the host during her PhD entitled '**Lipid reserves in *Gyrodactylus* spp. migrating from their 3-spine stickleback (*Gasterosteus aculeatus* L.) hosts'.** She is assessing if these 'fat reserves' offer any indication of the ability of the parasite to survive.



# Aquaculture development in Sierra Leone

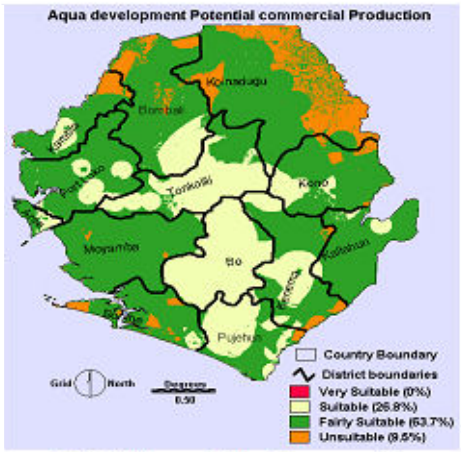
## Salieu Kabba Sankoh

with L.G. Ross and K. J. Rana

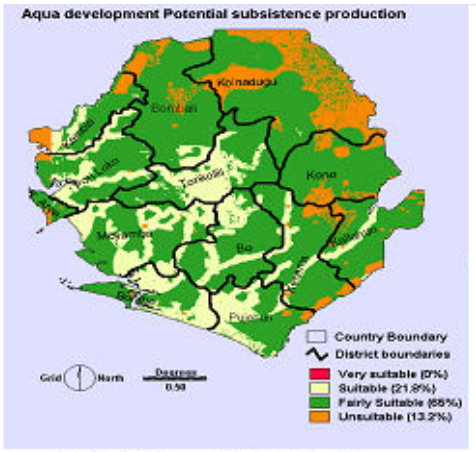
GIS models were developed using Landsat ETM+ and data on political, socio - economic (including fish market information) and natural resource factors. Traditional aquaculture production systems were used as references for criteria development.

Local farmers were involved in criteria development and assigning weights to the different factors of production. Models and fieldwork findings indicated that Sierra Leone has adequate natural resources for developing aquaculture. Large family sizes offer an available family labour force and hired labour is cheap. Access to land and the tenure system is conducive for aquaculture development. However, the land use pattern in traditional farming systems, shifting cultivation and bush fallow practices are a major impediment for integration of fish farming into the traditional crop farming system by local people.

Apart from land, other inputs and support services, including credit facilities and extension services are either lacking or inadequate to stimulate large-scale aquaculture development in the country. Many local or indigenous freshwater species of fish could easily be developed for culture-based fisheries, but this requires fundamental research. Local markets for fish exist, but commercial production has to be carefully planned for aquaculture to compete favourably with products from the capture fisheries. Models developed in this study can be used as tools in developing strategies for systematic fisheries/aquaculture development in the country, and to predict future trends in the aquaculture development process.




Suitability model for Commercial Production




Suitability model for Subsistence Production

# *Gyrodactylus* infection routes

## Mayra Grano-Maldonado

My poster presentation at the PhD conference focused on the strategies employed by detached individuals of *Gyrodactylus* in the colonisation of new hosts. *Gyrodactylus salaris* has devastated the resident salmon population in a number of Norwegian rivers into which it has been introduced. Although this parasite does not possess free-swimming stages, which allow the movement between hosts, this parasite is capable of rapidly colonising naïve hosts even in non-shoaling populations of fish. This study aimed to investigate processes that assist infection in gyrodactylids.

When naïve sticklebacks were exposed to detached gyrodactylids for varying periods of time, the results suggest that, in addition to direct attachment to fins, many parasites initially attach to the head region and inside the mouth and then migrate across the body surface from these initial colonisation sites. Live observations suggest that activity of detached worms increases as a host approaches, with the host response to the movement placing it close enough for the worm to either attach directly to the head tissues or to be drawn into the buccal cavity by the fish. Once inside the buccal cavity, those worms that are not fully ingested can then attach to the lining of the mouth or the pharynx (Figure 1) and from there may crawl out to preferred sites on the skin. It is proposed that this may be a previously unrecognised route for host infection by this species and also affects decisions made concerning screening for more pathogenic species e.g. *Gyrodactylus salaris*.

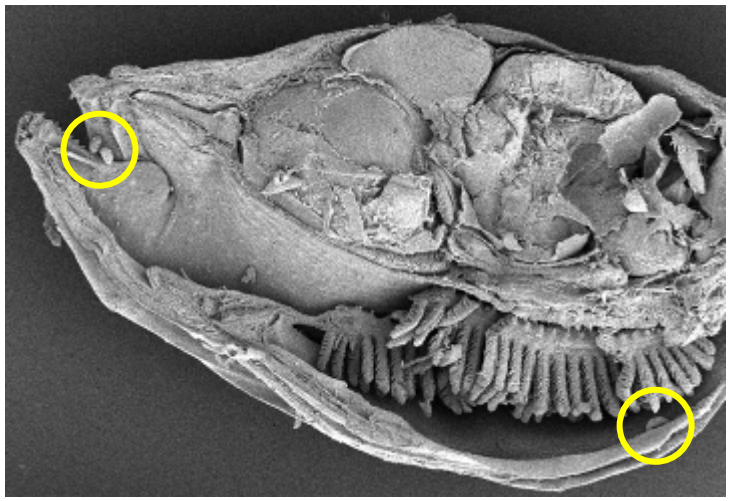


Figure 1. Scanning electron micrographs of *Gyrodactylus* inside the mouth and pharynx of its stickleback host.

# Our new Director

## Professor Brian Austin

Professor Brian Austin arrives as the new Director of the Institute of Aquaculture on 1st July 2009. By way of introduction we include a biography here.

Brian was educated at University of Newcastle where he received a B.Sc. (1972) in bacteriology and Ph.D. (1977) in microbial ecology/taxonomy. He spent 3 years as a postdoctoral fellow/research associate at the University of Maryland (1975-1978), working on bacterial taxonomy/ ecology of aquatic ecosystems, and started an interest in the causes of aquatic animal diseases, initially involving New England lobsters. This was followed by 6 years (1978-1984) as the senior bacteriologist in the Fish Diseases Laboratory, Weymouth.

In 1984 he moved to Heriot-Watt University as a NERC-funded New Blood Lecturer in Aquatic Microbiology, specialising in the diagnosis, taxonomy, control and pathogenicity mechanisms of bacterial fish pathogens. He was promoted to Reader in Microbiology (1989) and subsequently to Professor of Microbiology in 1992. Since the 1990s, he has developed an interest in the application and mode of action of probiotics in aquaculture. He also has a long term interest in the taxonomy, pathogenicity mechanisms and control of *Vibrio harveyi*, which has emerged as a significant pathogen of penaieds and finfish, particularly in Asia and South America. Apart from fish diseases, Brian has an interest in medical microbiology, particularly approaches for mitigating the harmful effect of hospital superbugs.

# PhD conference pix

Official opening and welcome

Professor Patrick Smith presents award to one of the winners, Sara Picon

Enjoying the sponsored lunch

Discussions around the posters



# Recent visitors

## Fishmongers' Company

We were honoured to receive visitors from the Fishmongers' Company in May: Mr and Mrs Robin Holland-Martin (next Prime Warden of the Fishmongers' Company), Keith & Jane Waters (Keith Waters is the Clerk to the Fishmongers' Company) and Andrew Wallace, Director, Association of Salmon Fishery Boards. We are grateful to The Fishmongers' Company for providing an annual scholarship to cover fees for a student on the MSc programme.

Dr Dave Penman showing the visitors around the tropical aquarium

# Aquaculture in practice – MSc sector tour

Hervé Migaud, Andrew Davie, John Taylor

Our MSc programmes are not all about learning in the classroom or laboratory, gaining practical experience is just as important. At the end of the first semester all students get to partake in the "Aquaculture in Practice" module which is a whistle-stop tour of the Scottish aquaculture sector. During the week-long road trip the students get to experience, first hand, the diversity that Scottish aquaculture has to offer.

Students visit freshwater and marine systems, rearing a range of species from shellfish to flatfish, punctuated by a series of lectures given by farm, hatchery, cage site and harvest plant managers and vets. They follow production cycles from the hatchery all the way through to harvest, before seeing the processing and packaging that is required prior to marketing and selling the final product. But that is not all, a small but valuable component of the trip is a behind the scenes tour of Scotland's national aquarium to experience the public face of fish care and culture.

Not only do the students get to see the sector at work but there is also the opportunity to meet and talk with key representatives to get their views on where the sector is going.

As you will see from the photographs from this year's tour, most of the week is spent amongst the magnificent scenery of the West coast of Scotland; a welcome break from the classroom. It has to be acknowledged that such a tour is only possible thanks the close working relationship the Institute has with the Scottish aquaculture sector, which grants the students access behind the scenes.

The 2008/09 MSc class

Jim Treasurer of Viking Seafarms (Ardtoe) discussing marine larval rearing with some of the class

At Lochailort salmon hatchery

Touring the fish processing facilities of Glasgow-based Dawnfresh Seafoods Ltd

Some of the class with Dougie Hunter, Technical Services Manager Marine Harvest (far left) about to visit one of Marine Harvests' salmon cage sites.

Getting ready to visit a salmon cage site in the shadow of a snow covered Ben Nevis

If you would like to advertise in Aquaculture News, contribute a short article on your current research or update former classmates about your progress contact Anton on a.j.immink@stir.ac.uk


www.aqua.stir.ac.uk