ParaFishControl

Project News

Issue 1

Advanced Tools and Research Strategies for Parasite Control in European Farmed Fish

29 PARTNERS

13 COUNTRIES

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AUGUST 2016

WELCOME TO THE FIRST NEWSLETTER OF THE PARAFISHCONTROL PROJECT

IN THIS ISSUE:

Enterospora © Dr Ariadna Sitjà-Bobadilla

Welcome from the Coordinator of ParaFishControl

Project Coordinator Dr Ariadna Sitjà-Bobadilla

This has been an exciting year for ParaFishControl! Extensive coordination and management was necessary to organise the work ahead and kick off the various activities from each of the project's different work packages.

We first announced the start of this newly formed and ambitious project to different national and international audiences, and then developed a comprehensive project website to advertise the project's aims and ambitions to the scientific community and general public. We have already made significant progress in achieving the aims of various tasks in the project. Project partners will soon be convening in Copenhagen, Denmark, to celebrate ParaFishControl's first annual meeting.

ParaFishControl Overview

ParaFishControl - Advanced Tools and Research Strategies for Parasite Control in European Farmed Fish

ParaFishControl is a European Union funded project under the Horizon 2020 programme. The overarching goal of ParaFishControl is to increase the sustainability and competitiveness of the European aquaculture industry. The 29 partner strong consortium will achieve this by improving our understanding of fish-parasite interactions and by developing innovative solutions and tools for the prevention, control and mitigation of the most harmful parasitic species affecting the main European farmed fish species.

The Challenge

Aquaculture is the fastest growing food producing sector worldwide, currently providing half of all aquatic animals for human consumption. If responsibly developed and practised, aquaculture can generate lasting benefits for global food security and economic growth. Parasites and related infections can cause significant damage to farmed fish resulting in poor growth performance, impaired welfare and high mortality rates, which can significantly hamper aquaculture production and economic performance. Disease prevention and management are therefore essential for the sustainability of the aquaculture industry.

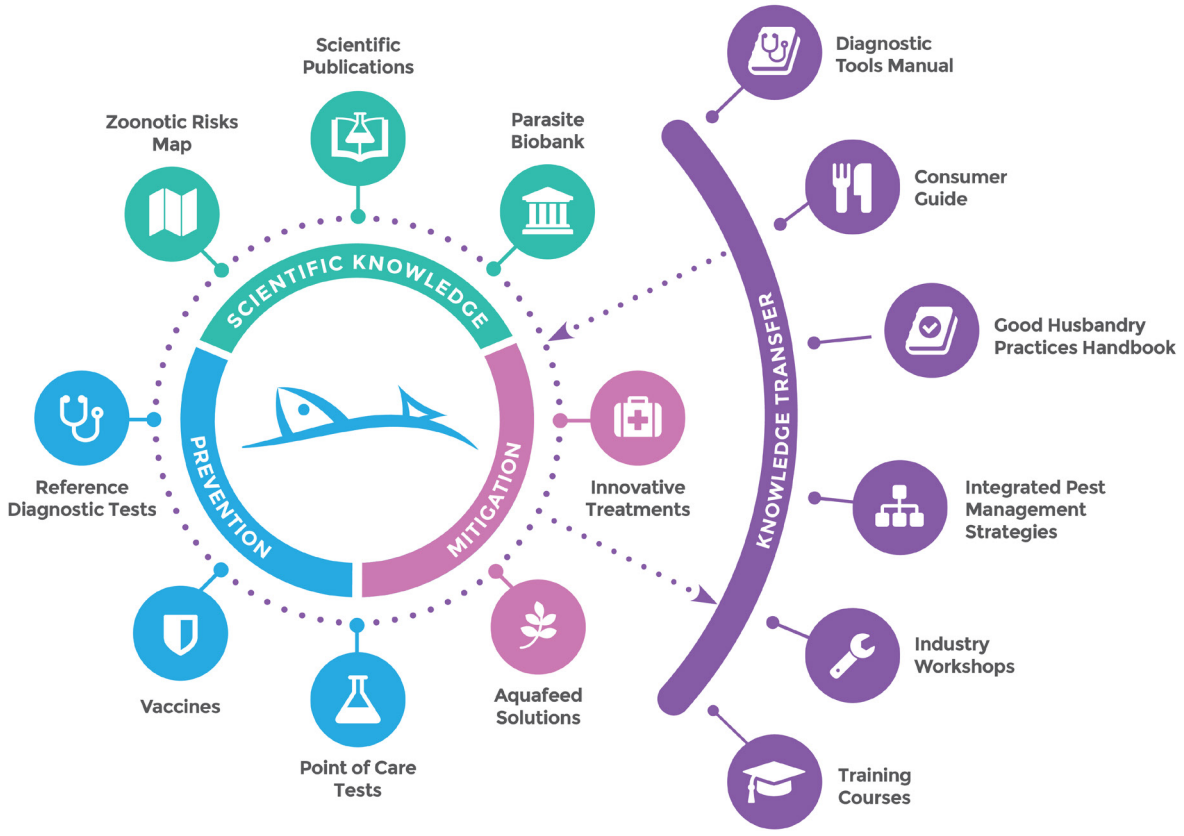
Addressing the Challenge

The concept of **ParaFishControl** is to strengthen the applied knowledge base for parasites of European farmed fish, bridging the gap between fundamental knowledge of parasite biology, host-parasite interactions and the development of practical applications for the prevention, diagnosis and treatment of the principal parasitic diseases, as well as characterising transfer of parasites between wild and farmed fish populations. Activities in **ParaFishControl** will be carried out over five years in working groups arranged into nine work packages which are cross-cutting and integrate all fish host species and their relevant parasites.

ParaFishControl will carry out a dynamic programme to ensure dissemination of the research findings to a variety of stakeholders such as scientists working in academia or industry, fish farmers/growers, fish health professionals, agricultural advisors, breeders, consumers and policy makers as well as the public.

The **ParaFishControl** website is one of the major dissemination tools for the project. Visit: **www.parafishcontrol.eu**

Expected Outcomes



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Scientific Knowledge

Parasite Biobank

The ParaFishControl Biobank will host a collection of parasite samples organised as a technical unit that ensures a complete traceability of the samples and associated data. This tool will act as a donor-cession system allowing future multidisciplinary studies. This Biobank will be linked to the already established PARASITE BioBank for zoonotic parasites in fishery products.

Useful for: Researchers

Scientific Publications

Scientific findings achieved throughout ParaFishControl will be published in international peer-reviewed scientific journals and presented at international conferences to advance the field. Publications and data will be available through free online repositories and/or open-access journals.

Useful for: Researchers

Zoonotic Risk Map

ParaFishControl will identify the aquaculture food products and farming practices with parasites that represent a health hazard due to potential parasite contamination.

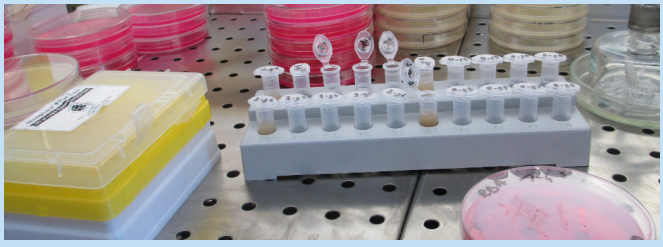
Useful for: All stakeholders including policy makers and environmental agencies

Prevention

Reference Diagnostic Tests

ParaFishControl will also focus on the harmonisation and validation of current procedures for the confirmatory diagnosis of parasitic infections at the laboratory level. The implementation of these procedures will allow for a more proficient, accurate and homogeneous diagnosis of parasites at laboratory level, reducing the uncertainty and facilitating accurate monitoring of parasites in fish production and fish trade. Reference methods will assist their implementation by veterinary health laboratories and providers, who currently cannot provide these services due to deficient know-how and absence of validated methods and reagents.

Useful for: Fish health professionals and diagnostic laboratories



Vaccines

Currently, there is no commercial vaccine against any fish parasite. ParaFishControl therefore aims to develop several different candidate vaccines focusing on those parasite infections for which natural immunity seems to prevent re-infection.

Useful for: Biotechnological and pharmaceutical laboratories

Point of Care Tests

ParaFishControl will generate improved and novel sensitive, reliable and cost-effective point-of-care diagnostic tests for parasitic infections, based on current and newly developed knowledge and tools.

Useful for: Fish health professionals and fish farmers

Mitigation

Innovative Treatments

ParaFishControl is working on improving existing and developing novel treatments for both ecto- and endoparasites. The approach includes extensive screening of antiparasitic products already available in the pharmaceutical industry for other uses, as well as searching for prebiotics, probiotics and bioactive compounds from diverse sources. Innovative water treatments and biological controls will target parasites prior to infection.

Useful for: Fish health professionals and fish farmers

Aquafeed Solutions

ParaFishControl is expected to generate new feed formulations against parasitic diseases and will increase the knowledge base for fish immunity improvement that could be used for other future formulations. Research institutions and industry are working together to develop improvements of fish immune status through the use of in-feed immune-stimulants and other additives that will target host immunity.

Useful for: Feed producers and ultimately for fish farmers

Knowledge Transfer

Industry Workshops

A ParaFishControl Industry Forum is being set up to facilitate engagement between the consortium, industrial companies and fish farmer associations to ensure essential Knowledge Exchange.

Useful for: Fish farmers and industrial companies

Consumer Guide

ParaFishControl will compile information about parasitic diseases and safe products for consumers to reinforce their confidence in farmed fish products.

Useful for: Consumers, consumer organisations and food safety authorities

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Diagnostic Tools Manual

ParaFishControl will collect recommended standard protocols for parasite diagnosis, update them according to new findings and make them accessible through a central web-based repository. This will enable the detection and differentiation between different species with different risk factors and management needs, and will help to generate an updated data source of methods and protocols for the diagnosis of relevant parasitic diseases in European fish aquaculture.

Useful for: Fish health professionals

Training Courses

Two training courses focusing on the results and tools of the different ParaFishControl research activities will be produced for Master's and PhD students, as well as post-doctorate fellows, farmers, veterinarians and aquaculture schools. Additionally, workshops on "Fish parasite diagnosis" and "Immunoprophylactic control of parasitic diseases in aquacultured fish" will be held.

Useful for: Researchers/academics and aquaculture industry

Integrated Pest Management Strategies

ParaFishControl will compile a series of manuals describing Integrated Pest Management Strategies (IPMS) for parasite management and handbooks describing good practices, incorporating IPMS and new diagnostic methods. These will be distributed to stakeholders with the collaboration of the European Association of Fish Pathologists.

Useful for: Aquaculture associations

Good Husbandry Practices Handbook

ParaFishControl will monitor marine and freshwater fish farms to provide data for the diagnosis of zoonotic helminths and effects of different farming practices on their diffusion. An innovative Food Safety Programme with protocols and good practice guidelines will be established to avoid and decrease more zoonotic risks in farmed fish.

Useful for: Fish farmers

Feeding fish in submerged cages in Italy © F. Cardia, Food and Agriculture Organisation Aquaculture photo library

Project News

Exchange Between ParaFishControl Partners

From left: Dr Boglárka Sellyei, Azmi Al-Jubury (University of Copenhagen), and Réka Borzák © Kurt Buchmann

Carolina Aquilino Amez © Kurt Buchmann

Collaboration and exchange of students and researchers between ParaFishControl partners has already begun. The University of Copenhagen in Denmark has had the pleasure of having Dr Carolina Tafalla's PhD student Carolina Aquilino Amez from Instituto de Investigaciones Agropecuarias in Spain for three months in the lab. Carolina is studying immune gene expression with special emphasis on chemokine profiles in rainbow trout during infection with the parasitic ciliate *Ichthyophthirius*. In addition, two staff members (Réka Borzák (PhD student) and Dr Boglárka Sellyei) working under Dr Csaba Szekely at the Hungarian Academy of Sciences have also been sent to Copenhagen, where they have learned techniques to culture parasite populations in the lab and how to test various drugs in vitro.

ParaFishControl in the Media

ParaFishControl was featured in the International Aquafeed Editorial (March 2016), p. 30-33.
More info: bit.ly/2a5SsYc

ParaFishControl was featured as "Project Highlights" in the Spanish Observatory Newsletter in May 2016, Aquaculture, No. 10 31/05/2016.
More info: bit.ly/29n27ae

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ParaFishControl Events

ParaFishControl Kick-off Meeting 2015

The ParaFishControl kick-off meeting took place in Benicàssim, Spain, 26-29 May 2015.

Partners at the ParaFishControl kick-off meeting in Benicàssim, Spain

ParaFishControl Annual Meeting 2016

The first ParaFishControl Annual Meeting will take place in Copenhagen, Denmark, 13-15 September 2016.

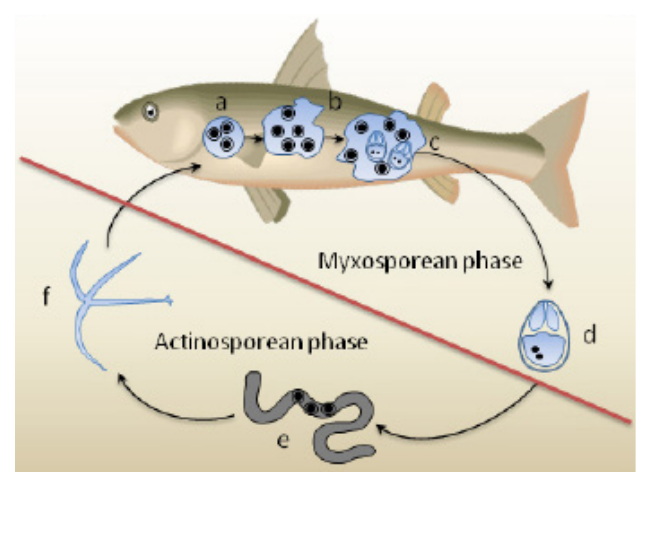
Copenhagen, Denmark © Wikimedia Commons

Parasite Portraits #1

Myxozoans and Oomycetes

In this first series of "parasite portraits" we introduce two groups of parasites studied by ParaFishControl: the myxozoans and the oomycetes.

Myxozoans



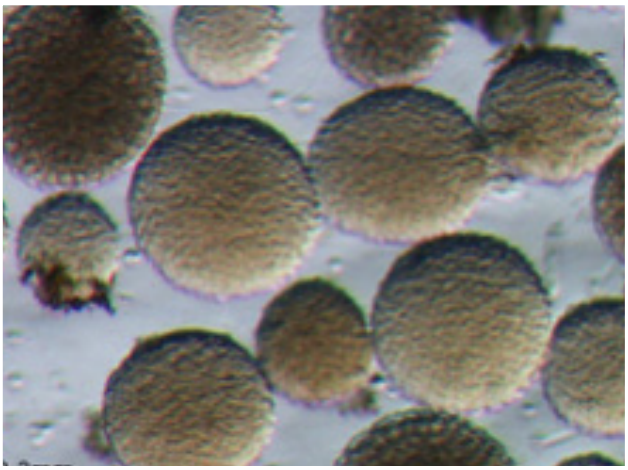
Myxosporean cycle drawing by Ariadna Sitjà-Bobadilla

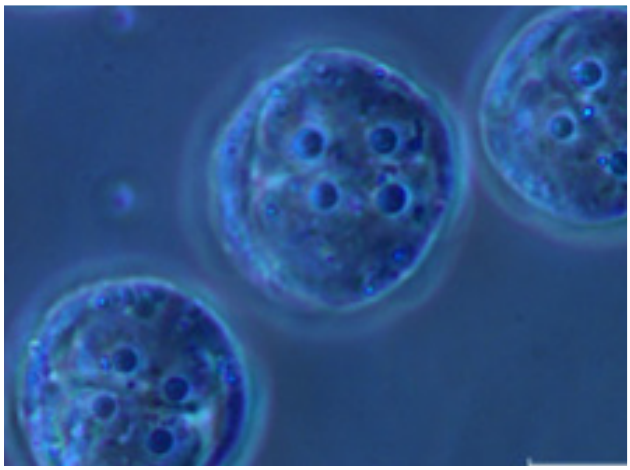
Myxozoans are a diverse group of microscopic metazoan (multicellular, eukaryotic) parasites - consisting of over 2,700 species - that live in both marine and freshwater habitats. Many of these parasites have a two-host lifecycle, involving a fish and an annelid (ringed or segmented) worm or bryozoan (aquatic invertebrate animal also known as a moss animal), which they infect via spores. It is clear today that these parasites are a group of highly reduced forms within a group of animals called cnidarians (including jellyfish, corals and hydroids). They have undergone a dramatic evolution from free swimming, self-sufficient jellyfish-like creatures into their current form of obligate parasites composed of a mere handful of cells. Evidence for this is based on molecular insights like group-exclusive genes and comparisons of their entire genetic makeup. Like cnidarians, myxozoans possess structures similar to stinging cells, but instead of a stinging barb they use a non-stinging filament to attach to their host. Myxozoans are divided into two groups: malacosporea and myxosporea. Important fish parasites are found in both groups.

1. Tetracapsuloides bryosalmonae

The parasite *Tetracapsuloides bryosalmonae* is responsible for one of the most economically damaging salmonid diseases to aquaculture in Europe and the USA. It belongs to the malacosporean clade of myxozoans and causes proliferative kidney disease (PKD) in salmonids. As its name "*bryosalmonae*" suggests, this parasite uses salmonid and bryozoan hosts. Bryozoans infected by *T. bryosalmonae* release actinospores from spore sacs into the water column. The actinospores deploy their non-stinging filaments and attach to the surface of the fish's gill, driven by chemical cues found in the fish's mucus. The infective elements (sporoplasms) of the actinospore enter the host within 30 minutes. One single sporoplasm is capable of causing clinical PKD. The parasite spreads to several tissues and organs via the circulatory system, with the main targets being the kidney and spleen. It causes severe damage to these organs and supresses key elements of the fish's innate immunity which renders the fish susceptible to other infections. Fish recovering from the disease are immune to re-infection. Farmers have used this feature to

early expose fish to waters that have low numbers of parasites – a similar principal to vaccinations - to prevent severe fish losses. However, this is not a viable long-term solution to control the disease due to production bottlenecks caused by the logistics involved in this procedure. This immunity to re-infection provides the spur for vaccine development. An understanding of the underlying molecular mechanisms that drive clinical disease in the kidneys of infected fish will identify other means of controlling disease severity and associated fish mortalities.





Parasite spore sacs following release from overtly-infected bryozoans (left). Individual parasite spores showing the distinctive array of four polar capsules (right) © Dr Hanna Hartikainen, Swiss Federal Institute of Aquatic Science and Technology (EAWAG), Dubendorf, Switzerland

Progress in PKD research: Myxozoan Transcriptomic Profiling and Selection of Vaccine Candidates

Owing to their fragility, it was not previously possible to physically isolate *T. bryosalmonae* from fish tissues, with previous research focusing only on the stages associated with the bryozoan host. ParaFishControl partner the Scottish Fish Immunology Research Centre (SFIRC) tackled this challenging task by sequencing and *de novo* (from the beginning) assembling a transcriptome from heavily infected fish kidney tissues. A transcriptome constitutes all of the messenger RNA molecules expressed from the genes of an organism. This enabled a direct comparison of fish-derived parasite genes with those expressed in an actinospore sac transcriptome.

For vaccine studies, the SFIRC is focusing on those transcripts that are expressed in both infected hosts (bryzoan and fish). The group has already initiated vaccine trials. In addition to vaccine testing, they will be exploring the host transcriptomic responses to initial parasite invasion in the gill tissues, and control the activity of molecules, called suppressors of cytokine signalling (SOCS), as part of ParaFishControl. An understanding of the mechanisms of early gill immune disruption and those that drive chronic disease pathology will provide valuable insights into other pathways that could be exploited to control this disease in future studies.

By: Marc Faber, Sohye Yoon, Eduardo Depaiva Alves, Prof Chris J. Secombes, Dr Jason W. Holland (University of Aberdeen, Scottish Fish Immunology Research Centre and Centre for Genome Enabled Biology and Medicine)

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2. Enteromyxum leei

Enteromyxum leei myxospores within a primary cell, showing the two characteristic polar capsules with the coiled polar filament © Ariadna Sitjà-Bobadilla

The parasite species *Enteromyxum leei* is one of the focal organisms studied in ParaFishControl because of its high economic impact on Mediterranean farmed fish. It belongs to the myxosporean clade of myxozoans and has a wide geographical and host range within marine fish (at least 60 species from 22 different families, mainly Perciforms (perch-like bony fish)). In gilthead sea bream (*Sparus aurata*) it causes severe catarrhal enteritis (inflammation of the intestine) that impairs osmotic balance and nutrient absorption. In sharpsnout sea bream (*Diplodus puntazzo*) the parasite is more pathogenic, causing epizootics (a disease outbreak) in fishes in a few weeks. Disease signs include anorexia, weight loss and anaemia, which end up in cachexia (weakness and wasting of the body due to severe chronic illness) and mortality. This is why the disease is named the knife-like fish syndrome. One unique feature of this myxozoan is its ability to spread via a horizontal pathway (transmission from peers in the same age group) that favours the spread of enteromyxosis in farmed fish stocks, where cannibalism and high densities aid this transmission process. This means that the myxospores released from infected fish do not need to find an alternate host (a putative invertebrate) in which to develop the actinospores that will infect other fish. Instead, other fish parasite stages, when released into the water, can enter new fish and infect them. This allows researchers to keep the infection model in the laboratory by holding naïve fish with infected fish together (also called cohabitation), or exposing them to water from infected tanks, or by inoculating them orally or anally with infected intestinal scraps.

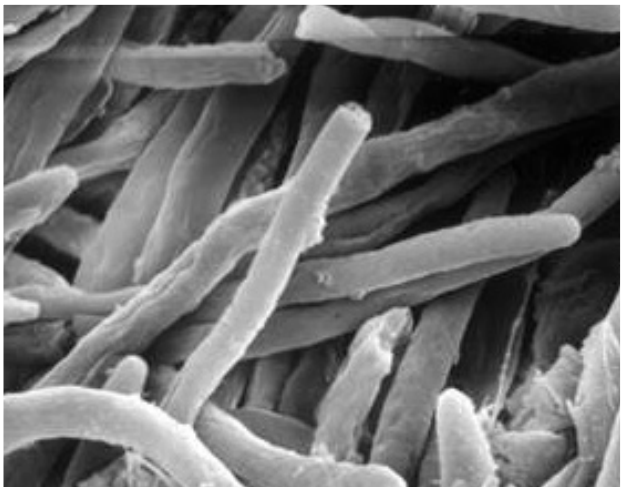
Several aspects of this parasite will be covered in ParaFishControl. The transcriptome/genome will be screened to define vaccine candidates and drug targets, following a strategy similar to that for *T. bryosalmonae*. Other approaches to combat this disease will include selecting biological compounds, including plant extracts, to produce functional feeds, and antibody-based immunotherapy. A point-of-care diagnostic method will be developed to allow for the fast and easy detection of this myxozoan at the farm site. More information on the epidemiology of this parasite will be gathered during expert consultations and farm visits, to try to establish precise risk factors and develop integrated pathogen management strategies to control this disease. Newfound information on *E. leei*, discovered during the course of ParaFishControl, will form an important part of the curriculum for ParaFishControl training courses and workshops. It will also be distributed in manuals and handbooks to be published at the end of the project.

By: Dr Ariadna Sitjà-Bobadilla and Dr Oswaldo Palenzuela (Fish Pathology Group, Institute of Aquaculture Torre de la Sal, Consejo Superior de Investigaciones Científicas (CSIC), Castellón, Spain)

Oomycetes

The oomycetes are often referred to as water moulds, but this common name is misleading as most species are in fact terrestrial pathogens. Oomycetes form a distinct group of fungus-like eukaryotic microorganisms. They were considered fungi in the past, but are actually more closely related to brown algae and diatoms. They are microscopic and form long visible filaments. Oomycetes reproduce both sexually and asexually, and occupy both saprophytic (live on dead or decomposing matter) and pathogenic lifestyles.

1. *Saprolegnia*



Saprolegnia © Kurt Buchmann

Salmon fry © Morteb Sichlau Bruun

The genus *Saprolegnia*, the causal agent of saprolegniasis, is endemic to all freshwater habitats worldwide and has been found on various wild and farmed fish species, including salmonid species like Atlantic salmon, rainbow and brown trout, and non-salmonid species like perch, eel, catfish and carp. Saprolegniasis is characterised by white and grey patches of mycelial (a mass of branching, thread-like hyphae) growth on the skin and fins of adult fish, and cotton-like filamentous mycelium on eggs. With progression of infection, fish usually become lethargic and less responsive to external stimuli, making them easy targets for predators. Respiratory distress may be evident if the gills are involved, and death can follow rapidly. When infecting fish eggs, *Saprolegnia* establishes itself first on dead ones and then extends to neighbouring healthy ones.

Factors which may be involved in the development of saprolegniasis include traumatic damage to the skin, concurrent infections and low water temperatures. The most identified species of *Saprolegnia (S. parasitica, S. diclina, S. ferax and S. australis* of which *S. diclina* and *S. ferax*) are predominantly found on fish eggs, while the others are found mostly on fish. Most species produce asexual sporangia (in which the spores are formed) at the very tip of their long filamentous structures where the free-swimming spores are released to invade a new host. Sexual reproduction, thought to enable

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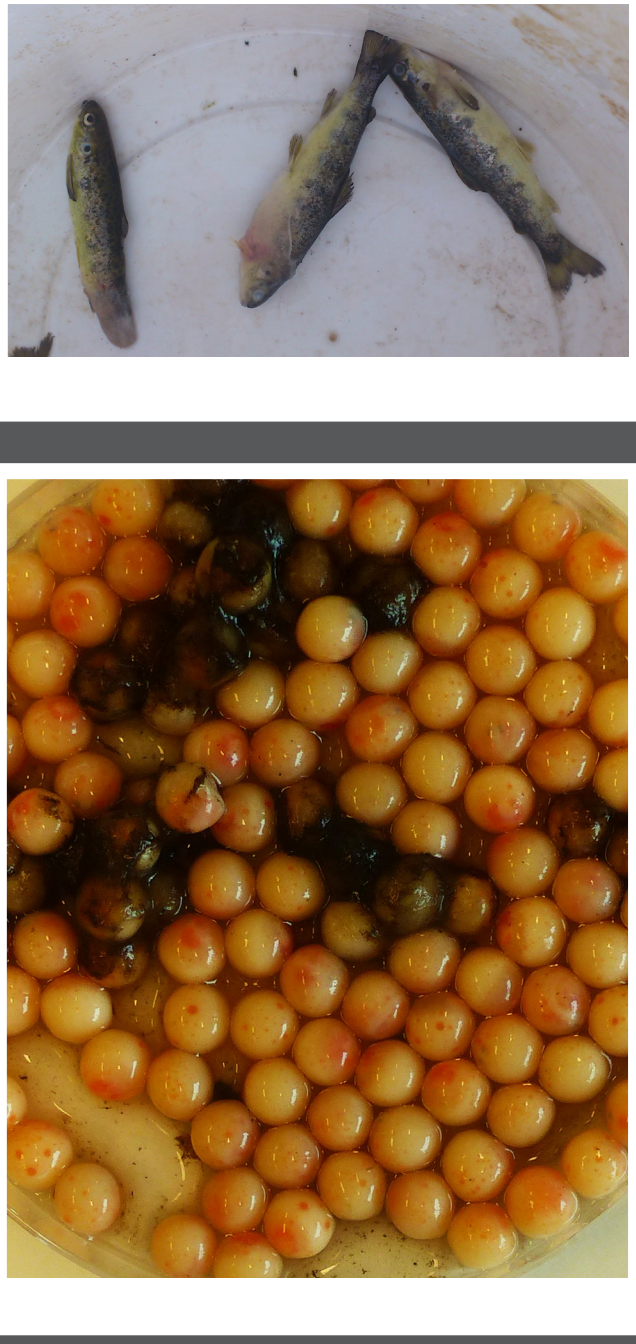
survival under harsh conditions, occurs by the formation of oospores - a thick-walled sexual spore that develops from a fertilised oosphere in some fungi. However, not all strains and species can form oospores under laboratory conditions.

Saprolegniosis causes approximately 10% yield losses in eggs and young fish, but higher percentages have been reported. In aquaculture, *Saprolegnia* is nowadays mostly controlled by treatments with antimicrobial agents such as formalin and/or bronopol (Pyceze). However, due to health concerns of fish farm workers, formalin is likely to be banned in European aquaculture. A better insight in the mechanism of the pathogenicity, the diversity between species and the role of anti-oomycete compounds producing commensal bacteria is required to develop more sustainable control measures.

In ParaFishControl, the idea of parasite control by probiotics will be explored on *Saprolegnia*. Commensal Actinobacteria for example, have been shown to effectively reduce saprolegniasis in salmon eggs by inhibiting attachment of *Saprolegnia* spores. The most efficient probiotic bacterial variants will be selected, their anti-parasite mechanisms clarified, and strategies for reduction of *Saprolegnia* in eggs under farming conditions developed. Additionally, the virulence strategy of *Saprolegnia* and the host immune response will be investigated to develop vaccines, as well as the transfer of *Saprolegnia* from fish farms to the wild. Effector proteins that translocate into host cells will be investigated and species-specific markers for quantification and studying biodiversity in fish farms will be developed. Furthermore, the prevention of *S. parasitica* spore infectivity to salmon and carp will be investigated by different partners. The bacterial extracts/secretes will then be included in the screenings of biological compounds with anti-parasitic effects.

By: Dr Irene de Bruijn (NIOO-KNAW), Prof Pieter van West (University of Aberdeen) and Dr Javier Diéguez Uribeondo (Real Jardín Botánico, Madrid, CSIC).



Saprolegniasis on young salmon (top). Infected salmon eggs (bottom) © Irene de Bruijn

Global News Bites

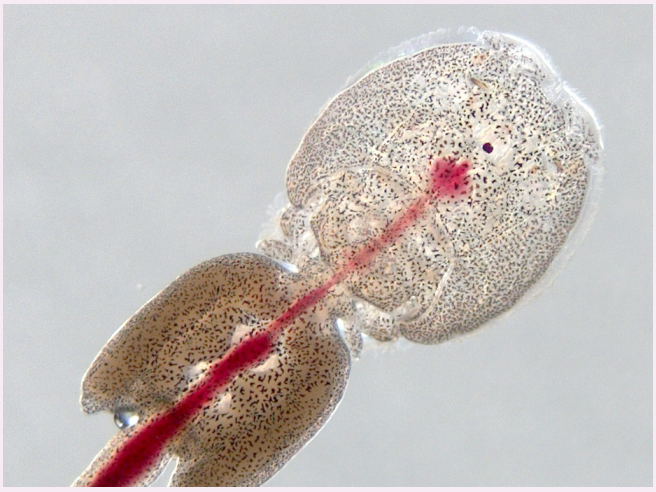
Global per Capita Fish Consumption has Hit a Record High

Commercial seafood production

The Food and Agriculture Organization (FAO) report said this record high was the result of improved aquaculture and reduced waste. Manuel Barange, director of FAO Fisheries and Aquaculture Policy and Resources, welcomed the fact that global per capita fish consumption has passed the 20kg per year threshold.

Source: Aquaculture Magazine, **bit.ly/2aHjzbu**
For the report: FAO, **bit.ly/29mBOBo**

Scotland's Sea Lice Control Takes Another Step Forward



Adult female sea louse with salmon blood in gut © James Bron

The drive to control sea lice through non-medicinal approaches has taken another step forward with the start of a new £2.1 million (€2.5 million) lumpsucker project, co-funded by the Scottish Aquaculture Innovation Centre (SAIC). Spanning three years, the research project aims to tackle a range of commercial bottlenecks and objectives, supported by a much better understanding of lumpsucker biology and behavior in captivity.

Source: SeafoodSource, **bit.ly/2a8mM8e**

Parasites Help Brine Shrimp Cope with Arsenic Habitat Contamination

Brine shrimp, *Artemia salina*, laboratory picture © Hans Hillewaert

Do parasites weaken their hosts' resilience to environmental stress? Not always, according to a study. Rather than weakening its brine shrimp intermediate host, this tapeworm infection enhances the shrimps' ability to cope with arsenic contamination in the water - and the same holds true in the warmer waters predicted by climate change models.

Source: ScienceDaily, **bit.ly/2a3Aq7r**

ParaFishControl Publications

Antiparasitic effects of antimalarial drugs (chloroquine and artemisinin) on *P. dicentrarchi* (ciliate): Keywords: Artemisinin; *Philasterides dicentrarchi*; chloroquine; inorganic pyrophosphatases; intracellular pH

Mallo N, Lamas J, DeFelipe A-P, Sueiro R-A, Fontenla F & Leiro J-M (2016). Enzymes involved in pyrophosphate and calcium metabolism as targets for anti-scuticociliate chemotherapy. *Journal of Eukaryotic Microbiology* 0, 1–11; doi:10.1111/jeu.12294

The existence of two isoforms of H+-PPase in *P. dicentrarchi* (ciliate): Keywords: H+-PPase; *Philasterides dicentrarchi*; alveolar sacs; osmoregulation; turbot

Mallo N, Lamas J, DeFelipe A-P, DeCastro M-E, Sueiro R-A, Leiro J-M (2016). Presence of an isoform of H+-pyrophosphatase located in the alveolar sacs of a scuticociliate parasite of turbot: physiological consequences. *Parasitology* 143, 576-587; doi:10.1017/S0031182015001997

Combined antiparasitic and anti-inflammatory effects of curcumin on turbot scuticociliatosis: Keywords: Cathepsin L-like; curcumin; leishmanolysin; *Philasterides dicentrarchi*; proteases; S-adenosyl-L-homocysteine hydrolase

Mallo N, DeFelipe AP, Folgueira I, Sueiro RA, Lamas J, Leiro JM (2016) Combined antiparasitic and anti-inflammatory effects of the natural polyphenol curcumin on turbot scuticociliatosis. *Journal of Fish Diseases*; doi:10.1111/jfd.12503

Vaccine-induced change in gene expression in turbot: Keywords: Turbot; microarray; vaccines; *Philasterides dicentrarchi*; peritoneal cells; gene expression

Fontenla F, Blanco-Abada V, Pardob BG, Folgueirac I, Noiaa M, Gómez-Tatod A, Martínezb P, Leiroc JM, Lamas J (2016). Vaccine-induced modulation of gene expression in turbot peritoneal cells: A microarray approach. *Molecular Immunology* 75, 188–199; doi:10.1016/j.molimm.2016.06.001

A review on immunity to gastrointestinal microparasites of fish: Keywords: Apicomplexa; Microsporidia; Myxozoa; resistance; protection; immune evasion.

Sitjà-Bobadilla A, Estensoro I, Pérez-Sánchez J (2016). Immunity to gastrointestinal microparasites of fish. *Developmental & Comparative Immunology* 64, 187-201; doi:10.1016/j.dci.2016.01.014

Two distinct aurantiactinomyxon morphotypes as developmental stages in *Thelohanellus kitauei*: Keywords: *Thelohanellus kitauei;* life cycle; Aurantiactinomyxon; 18S rDNA; *Branchiura sowerbyi*; China; Hungary

Zhao D, Borkhanuddin MH, Wang W, Liu Y, Cech G, Zhai Y, Székely C (2016). The life cycle of *Thelohanellus kitauei* (Myxozoa: Myxosporea) infecting common carp (*Cyprinus carpio*) involves aurantiactinomyxon in *Branchiura sowerbyi*. *Parasitology Research*; doi:10.1007/s00436-016-5215-y

***Trichoderma sp.* fungi associated with salmon eggs show activity against *Saprolegnia*:** Keywords: Salmon; Saprolegniasis; *Microdochium; Trichoderma*

Liu Y, Zachow C, Raaijmakers JM, de Bruijn I (2016). Elucidating the diversity of aquatic *Microdochium* and *Trichoderma* species and their activity against the fish pathogen *Saprolegnia diclina*. *International Journal of Molecular Sciences*, 17, 140; doi:10.3390/ijms17010140

ParaFishControl

Project News

Issue 1

Events Calendar

Date	Event	Location	URL
	September 2016		
15-16	**2nd meeting of the EAFP UK and Ireland branches** (European Association of Fish Pathologists)	Stirling, UK	bit.ly/2at5grz
20-23	**Aquaculture Europe 2016** (European Aquaculture Society)	Edinburgh, UK	bit.ly/29qX5Ka
20-22	**First International Conference in Aquatic Animal Epidemiology** (International Society of Aquatic Animal Epidemiology)	Oslo, Norway	bit.ly/1mg7jTb
26-28	**The 11th International Sea Lice Conference**	Westport, Ireland	bit.ly/29ZO22X
	October 2016		
12-14	**46th WEFTA meeting** (West European Fish Technologists Association)	Split, Croatia	bit.ly/2a0ZpIN
	November 2016		
3-5	**FABA2016** (International Symposium on Fisheries and Aquatic Sciences)	Antalya, Turkey	bit.ly/2arL0K8
10-12	**HydroMediT 2016** (2nd International Congress on Applied Ichthyology and Aquatic Environment)	Messolonghi, Greece	bit.ly/2abLy4q
28-1	**LAQUA16** (Latin American & Caribbean Aquaculture 2016, World Aquaculture Society)	Lima, Peru	bit.ly/2amaS8r
	2017-2019		
25-27 Apr 2017	**Seafood Expo Global**	Brussels, Belgium	bit.ly/1mZE3LG
Sept 2017	**18th International EAFP Conference** (European Association of Fish Pathologists)	Belfast, UK	bit.ly/2alhfba
17-20 Oct 2017	**Aquaculture Europe 2017** (European Aquaculture Society)	Dubrovnik, Croatia	bit.ly/2ap6QOj

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