

Fish-Parasite 'Omic Interactions: Deciphering Genomic, Proteomic, and Nutritional Mechanisms Driving Host Resistance

Supervisory team:

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Host institution: Cardiff University

CASE partner: Centre for Environment, Fisheries and Aquaculture Science (Cefas)

Project description:

Introduction and Rationale: Ectoparasites pose significant threats to commercial fish stocks. Infection results in variable but distinct host responses, ranging from susceptible, responders to resistance. These responses are accompanied by physiological and biochemical changes, particularly in lipid profiles, potentially leading to detrimental effects on fish growth, immunity, and market value. Our research has demonstrated that dietary supplements modulate disease resistance, though the genetic and proteomic underpinnings of these interactions remain poorly understood. This studentship will investigate the genetic mechanisms that regulate host-parasite dynamics and how manipulation of fish populations towards higher resistance might impact their nutritional and market characteristics.



Objectives:

1. Investigate the genomic, transcriptomic, and proteomic profiles associated with susceptibility, resistance, and responder phenotypes in fish infected with *Gyrodactylus*.
2. Explore how dietary supplementation interacts with host-parasite interactions at the molecular level.
3. Assess the influence of parasite infections on the nutritional content of fish, particularly focusing on lipid metabolism.
4. Determine whether increasing the proportion of resistant fish in a population alters their nutritional content.
5. Examine the effectiveness of dietary supplements in providing cross-resistance to co-infections with different parasite species.

Research Plan: The project will leverage recently acquired high-quality full-genome (Illumina/Nanopore) data annotated using whole body RNAseq data for model species: *Gyrodactylus turnbulli* and *G. bullatarudis*. We will focus on the genetic and proteomic factors that define host susceptibility and resistance. Laboratory experiments (following Home Office training) will be designed to manipulate the dietary conditions of infected fish, focusing on understanding how dietary supplements affect disease resistance at the molecular level. Fish will be categorized into susceptible, resistant, and responder groups (susceptible fish, whose parasite load kept increasing and most likely reached fatal point, responding fish, whose parasite number peaked (> 10 parasites) around Day 9 but then drastically dropped by Day 17 and resistant fish with a low parasite load of less than 10 gyrodactylids over the infection period), and their infection trajectories linked to their 'omic responses.

Simultaneously, we will conduct lipidomic analyses to track changes in the lipid profiles of infected fish populations. Given our previous findings of lipid reduction in infected fish, this study will assess the extent to which resistance induction affects lipid and nutritional profiles, providing valuable insights into the nutritional consequences of selecting for resistant phenotypes. Additionally, co-infection studies will be conducted to evaluate whether dietary supplements enhance fish resilience to multiple parasitic infections.

Impact: This research will provide new insights into the genetic and molecular factors underpinning host resistance to ectoparasites with broad implications for fish farming and commercial fisheries. Understanding the interactions between diet, genetics, and parasitism will allow for targeted interventions, improving fish health and reducing economic losses. Moreover, the project will assess whether selecting for resistance could inadvertently affect fish quality, which is crucial for the commercial viability of resistance-bred stocks.

Outcomes: This project will generate valuable genomic, proteomic, and lipidomic data, contributing to our understanding and modelling of host-parasite interactions in fish. It will also inform the development of novel dietary and genetic interventions to enhance disease resistance in aquaculture, while considering potential trade-offs in fish quality and nutrition. The findings will be relevant for sustainable fish farming practices and improving stock resilience against parasitic threats.

Our aim as the SWBio DTP is to support students from a range of backgrounds and circumstances. Where needed, we will work with you to take into consideration reasonable project adaptations (for example to support caring responsibilities, disabilities, other significant personal circumstances) as well as flexible working and part-time study requests, to enable greater access to a PhD. All our supervisors support us with this aim, so please feel comfortable in discussing further with the listed PhD project supervisor to see what is feasible.