Using physiology to improve the sustainability of fish production in aquaculture

Supervisory team:
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Collaborators: Anglesey Aquaculture Ltd, Skretting

Host institution: University of Exeter

Project description:

Aquaculture is rapidly growing and recently overtook wild-capture fisheries as our dominant source of seafood[1]. Aquaculture needs to minimise non-sustainable feed requirements (i.e. marine fishmeal), water use, and the environmental impact of released effluents. Recirculating aquaculture systems (RAS) offers these benefits but also generate other potential problems associated with water quality (specifically accumulation of excreted CO_2) both in marine and freshwater settings. High levels of CO_2 can cause acid-base disturbances in fish which have energetic costs and physiological consequences on vital systems (e.g. respiration, ion balance, and nitrogenous waste excretion) as well as growth and behaviour. However, it is not known how the impacts of CO_2 (causing blood acidosis) may be influenced by a) the natural blood alkalinisation that occurs during digestion (called the "alkaline tide" – first discovered in teleost fish in our lab[2] or b) elevated ambient ammonia (also causing alkalinisation[3]) often prevalent in aquaculture.

The student will join a dynamic and well-founded team using *in vivo* physiological and molecular approaches to investigate how these factors affect homeostasis during digestion, excretion, energetic costs, and the growth efficiency of aquaculture fish. Rotation projects will be:

1) *in vivo* and *in vitro* physiological analyses of how elevated CO_2 and ammonia impacts upon blood acid-base chemistry and oxygen transport, ion regulation and energetics of digestion using *in vivo* physiological techniques including automated respirometry (Wilson laboratory).

2) gene expression changes (qPCR) relevant to physiological processes and environmental conditions of the above *in vivo* physiology experiments (Santos laboratory).

This project will benefit from BBSRC projects with Skretting (the largest global producer of aquaculture diets), and Anglesey Aquaculture Ltd (the largest sustainable marine aquaculture system in Europe). Ideal model species available for this research include salmon, trout and seabass. This research environment provides excellent support to develop the PhD student scientifically as well the industrial collaborations to focus on solutions for truly sustainable fish production in the global aquaculture industry. Specific objectives are to determine the individual and combined effects of elevated CO_2 and ammonia on the physiology of digestion and growth in fish, and to suggest solutions (either dietary or environmental) to optimise growth efficiency for sustainable recirculating aquaculture systems.

1) FAO (2010). The State of World Fisheries and Aquaculture 2010. Rome:FAO.

2) Cooper CA, Wilson RW (2008). Post-prandial alkaline tide in freshwater rainbow trout…. *J.Exp.Biol*:**211**:2542-2550.

3) Wilson RW, Taylor EW. (1992). Transbranchial ammonia gradients and acid-base responses to external ammonia in trout. *J.Exp.Biol*:**166**:95-112.