A combined experimental and in silico modelling study of pigment pattern formation in zebrafish

Supervisory team:
Main supervisor: Prof Robert Kelsh (University of Bath)
Second supervisor: Dr Christian Yates (University of Bath)

Collaborators: Prof David Parichy (University of Virginia)

Host institution: University of Bath

Project description:

Pigment patterns are biologically vital for both camouflage and sexual signalling, yet can differ markedly between sister species (those species pairs that diverged from each other evolutionarily most recently). There is a long tradition of both in silico and in vivo investigation of the underlying mechanisms. Pigment pattern formation is thus an excellent system for exploring the mechanisms and constraints underlying evolutionary novelties.

We have developed a detailed in silico representation of pigment stripe formation in the vertebrate developmental model, zebrafish (Danio rerio). Our computer model successfully simulates the patterns seen in wild-type fish (stripes), but also patterns seen in the lab in mutant zebrafish (thinner/thicker stripes and a diversity of spot patterns)(Owen et al. Owen et al, 2018 https://elifesciences.org/articles/52998). Our latest work shows the unexpected importance of differential growth processes in controlling major (stripe orientation) and more minor (dorsal-ventral asymmetries) in pigment pattern (Owen et al., 2021, https://www.biorxiv.org/content/10.1101/2021.06.11.448058v1).

Other zebrafish mutants show a rich variety of other pigment patterns, and we will use several of them, selected for the suspected importance of changed growth parameters, to develop our model and to deepen our biological understanding. Key to this will be direct collaboration with the Parichy lab (University of Virginia) who have recognised expertise in the experimental investigation of pigment patterning processes in vivo. To explore these mutant phenotypes we will develop robust metrics to allow automated comparison of real pigment patterns as measured from fish to those produced in the model. Thus, we will identify the likely cellular bases for the pattern changes seen in these mutants, and in particular testing the biological role of growth-related processes.

Applicants should hold, or expect to receive, a First Class or high Upper Second Class UK Honours degree (or the equivalent qualification gained outside the UK) in a relevant subject. A master's level qualification would also be advantageous. They should be excited by the prospect of joining an interdisciplinary team to use a mathematical modelling approach to explore a fundamental question in evolutionary biology.

Informal enquiries should be directed to Prof. Robert Kelsh, bssrnk@bath.ac.uk.