Predator-prey interactions under near-future environmental change: The combined effects of increasing temperature and turbidity

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Full Project Description
In aquatic habitats, temperature and water turbidity are critical environmental variables that are increasing globally. Substantial effects of turbidity on predator-prey interactions are already known, which are often mediated by changed activity in animals. Few studies have explored the effect of temperature, although this will also affect the activity of aquatic organisms via metabolic rate as most are ectotherms. This project will use a combination of approaches to explore how increased temperature and turbidity interact to induce changes in predator and prey activity, and in turn how these changes affect the rates of prey consumption and hence community dynamics. The project will use two model systems, a temperate system in the UK and a tropical system in Trinidad. In the state-of-the-art fish laboratory at Bristol, sticklebacks and damselfly larvae will be used as predators and aquatic invertebrates as prey. Activity will be quantified using computer vision tracking software for each species in isolation under different treatments of turbidity and temperature. Predator-prey pairs will then be tested together under these treatments to quantify changes in activity relative to when species are tested alone, effects on encounter and detection rates, and the resulting rates of prey consumption. For prey, mortality when tested alone will be compared to rates of mortality when tested with predators to determine their relative effects. These findings will be compared to foraging models to determine whether current models of hunting and anti-predator behaviour are adequate to recreate the experimental findings. In Trinidad, guppies and their main aquatic predator, the pike cichlid, will be used. Previous work has demonstrated altered activity in guppies due to temperature or turbidity, but never their combined effects. Temperature and turbidity will be manipulated in mesocosm experiments. This will be complemented with field sampling, where fish communities will be quantified using eDNA and population sizes estimated using traditional sampling techniques, and related to site temperature and turbidity (both of which vary considerably among streams in Trinidad). Modelling based on these findings will then be used to extrapolate impacts of elevated temperature and turbidity on the stability of these communities in the near future. The impact of increased temperature and turbidity has physiological effects that can directly impact animal populations. In contrast, this project will explore how small changes in behaviour can potentially scale up to large ecological effects, having a greater impact than the direct effects. The necessary funding is within the budget of the studentship, and the supervisory team will
provide any further facilities and resources. The stakeholder, the Freshwater Habitats Trust, will help guide the project’s design and train the student in the public engagement.

**Real Life challenges this project will address**

Anthropogenic activity is impacting aquatic habitats across the globe. In freshwater habitats, climate change and urbanisation are driving increases in temperature, while deforestation, quarrying and run-off of fertilizer from agricultural land are increasing water turbidity. No studies have explored how these changes are simultaneously impacting predator-prey interactions, and how changes in the relative abundances of predator and prey species can be explained by altered behavioural dynamics.

**What you should know about this project**

The project will be the first to quantify how ecologically realistic increases in temperature and turbidity affect interactions between predator and prey, and the ecological consequences of these effects, in aquatic habitats. Experiments and sampling will take place at the University of Bristol fish facility, mesocosms at the University of the West Indies and streams in Trinidad. The candidate must be physically able to conduct fieldwork in hilly tropical rainforest. Samples for eDNA analysis will be collected in the field and analysed at the University of Bristol, and computational models will be developed at Bristol and the University of Exeter. The supervisory team have a diverse and complementary set of skills to provide first class training for the student.

**What expertise you will develop**

The student will gain expertise and an in-depth knowledge of how predator-prey interactions are affected by environmental change. The student will develop a range of transferrable skills: experimental design, field skills in temperate and tropical aquatic ecosystems, the use of eDNA to identify species presence, cutting-edge statistical methods to analyse data, simulation modelling, and engagement with stakeholders involved in conserving aquatic resources. Throughout the project there will be significant opportunities for the student to influence the design and direction of the project. The project will provide a unique combination of experience and skills that the student will be ready to apply to other real-world challenges when the PhD project ends.

**Why this project is novel**

For the first time, the combined effects of temperature and turbidity on predator-prey interactions will be investigated, testing how the effects on behaviour scale up to altered community composition. While many studies have explored the role of water turbidity on predator-prey interactions, few have explored the effect of near-term changes in temperature that are expected from climate change, and how this interacts with turbidity.
Rest of Supervisory Team:

Stakeholder Organisation: Freshwater Habitats Trust

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