Causes and Consequences of Individual Variation in Aerobic Scope and its Association with Immune Response

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Background and Motivation: The immune response is enormously important for defending animals against infection but the physiological costs of this response remain largely unknown. While there is some evidence that mounting an immune response increases energy expenditure, the extent of these costs and the underlying mechanisms are not understood. The study of aerobic scope – the difference between an animal's baseline and maximal levels of aerobic metabolism – is a promising framework for investigating these costs. Any aerobic capacity directed toward a given oxygen-consuming physiological process results in a reduced ability to perform all others. Immune function, however, has been completely overlooked in this context. Both immune function and aerobic scope can connect environmental factors with behaviour, life-history strategies and ultimately individual fitness, but a direct relationship between the immune system and aerobic scope has never been investigated. This studentship will therefore investigate trade-offs between immune function and other sources of oxygen demand within individual animals. Fish are a vital component of biodiversity but have been ignored in terms of immunoecological research.

This project will therefore lead to a range of further experimental and theoretical studies investigating the role of the immune response in physiological ecology, life-history variation, and responses to environmental change in fish. For instance, several environmental pollutants stimulate the immune response of fish and likely cause a decrease in aerobic scope and probably compromise growth and swimming ability. The interactive effects of temperature increase and hypoxia on immune function and aerobic scope are also critical avenues for future research likely to stem from this project. One potential application is aquaculture where growth maximises profit but the trade-off between the immune response and growth is not understood. Another direction for applications is sports medicine; if intense exercise reduces immune function, understanding the underlying mechanisms would be valuable. Fish are ideal for studying this area because they can be subjected to treatments not possible in humans.

Objectives: This project will address four main questions:
1) How does an immune response affect metabolic rate, aerobic scope, and swimming ability?
2) How does intense exercise affect immune function in relation to aerobic scope in individuals?
3) How are aerobic scope and behavioural personality traits related to immune function?
4) Is there a trade-off between immune function and growth rate within an animal's aerobic scope?

Training Opportunities: This project integrates aspects of animal physiology, behaviour, ecology, and evolution and therefore provides broad training. In addition, as the examination of fish immunology from an ecophysiological perspective is virtually non-existent to date, this project would provide the student with unique training opportunities and a chance to establish a distinctive niche of research expertise. Specifically, the student will receive training in a number of diverse skills including the measurement of metabolic rate using respirometry, the measurement of locomotor performance, behavioural observation, and techniques associated with measuring immune responses to infection at the cellular level (e.g. flow cytometry, histology). The student will also gain general experience in experimental design and statistical analyses.

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