State the objective of the project, describe the research to be carried out, and present reasons for choosing the research topic

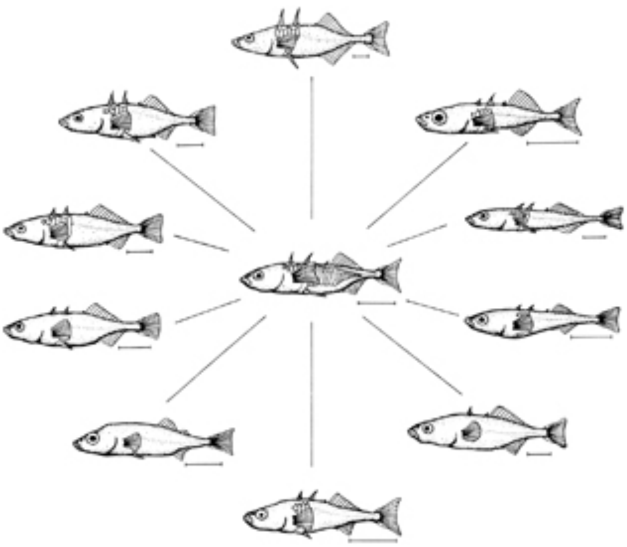
The evolutionary biologist Stephen Jay Gould famously proposed that if the evolutionary history of the Earth were to repeatedly re-played, we might not expect to see the same forms of life evolving on each occasion. Gould's argument summarises one of the central questions in biology: What aspects of evolution are predictable and repeatable?

Consistent variation in the phenotype (appearance, behaviour, physiology) of an organism in contrasting environments is a compelling demonstration of adaptation under Darwinian natural selection. The genetic basis to phenotypic diversity has been a major focus of research over recent years, and has provided profound insights into the mechanisms involved. However, while the environment is unquestionably the major driver of biodiversity, the environmental factors responsible are, surprisingly, often incompletely understood.

Studying phenotypic convergence (the independent evolution of the same characteristics in plants and animals in different populations) provides an opportunity to address evolutionary predictability. We plan a study that examines phenotypic evolution of the threespine stickleback fish to address two key questions:

1. Does evolution always produce the same phenotype in the same environment?
2. Are novel phenotypes produced in unusual environmental conditions?

We will take advantage of the remarkable morphological diversity of the threespine stickleback fish to measure phenotypic variation in stickleback populations across Europe, as well as measuring environmental variables that are believed to influence stickleback evolution. This information will enable us to make a direct link between environment and phenotype and to identify which variables drive phenotypic diversity.



Adaptive radiation in the threespine stickleback. The central image represents the ancestral marine phenotype while the peripheral images are examples of freshwater phenotypes.

To do this we will measure a range of phenotypic traits in sticklebacks from 120 populations from 10 European locations (North Poland, central Poland, Scotland, England, Iceland, Norway, Estonia, France, Romania, Turkey) and match these with environmental variables (including dissolved calcium and phosphorous, salinity, pH, temperature, predation, competition, habitat size). We will use advanced statistical models to identify the basis to phenotypic divergence in replicated stickleback populations to examine whether specific combinations of environmental variables consistently predict phenotype, or whether the same environment can generate multiple phenotypes.

Understanding how biological diversity arises and is maintained is a key question in evolutionary biology, and we anticipate that our results will make a substantial contribution to this question. In addition, understanding the basis to biological diversity has important societal implications. The United Nations Convention on Biological Diversity highlights that at least 40% of the world economy and 80% of the needs of the poor derive directly from biological resources. The estimated financial value of natural goods and services exceeds that of the GDPs of the USA and EU combined. Understanding what processes underpin biological diversity will be crucial to conserving biological resources and thereby in securing human food security and wellbeing, particularly in the face of environmental change. This study will contribute to this wider goal by providing insights into how biodiversity is generated and maintained using a species that has emerged as key model in the study of evolutionary change.