**Diversity and speciation of aquatic macroinvertebrates of Malawi**

**Lead Supervisor Name** Professor Martin Genner

**Lead Supervisor Contact Details**

m.genner@bristol.ac.uk

**Lead Supervisor Location/Student Home Institution**

Institution: Bristol

School: Biological Sciences, Faculty of Life Sciences

**Full Project Description**

Freshwater faunas are increasingly threatened by urbanisation, agricultural intensification, water abstraction, dam building, overfishing and invasive species. In sub-Saharan Africa, expanding human populations place increasing pressure on freshwater habitats. There is a need to understand the potential impacts on freshwater biodiversity, as well as the importance of various ecological variables in generating and maintaining that diversity. This project aims to improve understanding of macroinvertebrate diversity within riverine systems in the African country of Malawi, using field sampling, DNA barcoding and environmental DNA metabarcoding. The project will also test the role of natural ecological heterogeneity as a driver of evolutionary divergence, focussing on apparent ecological speciation of riverine and lacustrine Potamonautes crabs (our recent work suggests heavily armoured lacustrine P. lirrangensis and lightly armoured riverine P. montivagus are recently diverged ecomorphs). This work will require ecological surveys, microCT scanning and comparative genomics

The project will aim to

1) DNA barcode (COI) key invertebrate taxa within rivers of the Lake Malawi catchment.

2) Quantify macroinvertebrate community structure using environmental DNA (COI) metabarcoding along land use, urbanisation and altitude gradients, during seasonal extremes (dry and rainy).

3) Test environmental variables as drivers of diversity in macroinvertebrates, focussing on Potamonautes crabs along replicate lacustrine-riverine gradients. Phenotyping will include 3D morphometrics of exoskeleton microCT scans.

4) Test for population-genomic divergence among replicate river-lake environmental gradients, using genomic (likely ddRAD) data, and reconstruct the phylogeographic history using Approximate Bayesian Computation.

The student will be trained in key skills for quantifying and understanding ecological and evolutionary processes that generate and maintain macroinvertebrate diversity and distributions. The student will be supported by a stakeholder, the Malawi Department of Fisheries, who are developing an aquatic health monitoring programme using macroinvertebrate proxies, led by Dr Sungani. Metabarcoding and population genomics will be facilitated by the Bristol Genomics Facility, with expertise shared by Prof. Genner’s group who are engaged with eDNA-based work in freshwater (Africa, Mexico) and marine systems (NERC Highlight Topic SeaDNA project 2015-2019), as well as comparative genomic work (NERC Standard Grant 2019-2022, with Dr Sungani). Expertise in Approximate Bayesian Computation will be provided by Prof. Beaumont. Morphological work (microCT scans) will use a Nikon XTH225ST scanner at Bristol, with analyses advised by Prof. Wills (including a shared Genner-Wills GW4+ PhD student studying fish morphology 2018-2022). There will be opportunity to collaborate with Prof. Neil Cumberlidge (Northern Michigan), a world authority on freshwater decapods.

**Real Life challenges this project will address**

African freshwater ecosystems are being increasingly impacted by changes in land use, dam building, pollution, overfishing and invasive species. However, there is still very little understanding of the nature of these impacts on indigenous biodiversity, including species with key ecological roles such as aquatic macroinvertebrates. This project will take the first steps to establishing the ability of environmental DNA as an assessment and monitoring tool for African freshwaters, while taking steps to understand the role of environmental gradients in promoting the evolution and maintenance of that diversity.

**What you should know about this project**

Freshwater macroinvertebrate faunas represent excellent indicators of the health of streams, rivers and lakes. In Africa, they could be used to assess the scale of human impacts, but very little is known about their species richness, distributions and habitat preferences. This project will aim to explore the diversity of this fauna using newly developed genomic methods, while addressing important issues in conservation and evolutionary ecology.

**What expertise you will develop**

The project will include sampling aquatic macroinvertebrate assemblages and their habitats, identification of specimens through morphological and molecular barcoding methods, application of environmental DNA for biodiversity assessment, use of cutting edge metabarcoding and genomic tools, and application of 3D microCT scanning for comparative morphological analyses.

**Why this project is novel**

Sub-Saharan Africa is undergoing unprecedented human population growth that is placing increasing pressure on freshwater resources. This project will be among the first to quantify the spatial patterns of aquatic macroinvertebrate diversity using eDNA metabarcoding, and how faunas are impacted by urbanisation and agriculture. This project will also explore the mechanisms that have promoted the evolution of crustacean macroinvertebrate diversity, using a unique recently discovered study system.

**Rest of Supervisory Team:**

**Stakeholder Organisation** Department of Fisheries, Malawi

**Stakeholder Supervisor** Harold Sungani

**Co-Supervisor 1** Professor Matthew Wills

Affiliation: Bath

Email: M.A.Wills@bath.ac.uk

**Co-Supervisor 2** Professor Mark Beaumont

Affiliation: Bristol

Email: m.beaumont@bristol.ac.uk