**Project Title**

How does behaviour underpin the impact of invasive tilapia on native fish?

**Lead Supervisor Name**

Dr Christos Ioannou

**Lead Supervisor Contact Details**

c.c.ioannou@bristol.ac.uk

**Lead Supervisor Location/Student Home Institution**

Institution: Bristol

School: School of Biological Sciences

**Full Project Description**

Invasive species have a huge impact on the structure of freshwater communities and are a major source of biodiversity loss. Physiological, morphological and life history traits that are associated with invasive potential have been studied extensively. How invasive and native species interact through behaviour, however, has rarely been documented, particularly in aquatic habitats where observing behaviour is problematic. Aquaculture using Nile tilapia Oreochromis niloticus is growing exponentially throughout the tropics as an affordable source of animal protein; however, its spread is associated with feral populations becoming established outside its native range and subsequent negative effects on native fish assemblages. Many of these negative effects are hypothesised to be mediated by behaviour: Nile tilapia are believed to competitively exclude native fish from shelters (exposing native fish to greater predation risk), outcompete native fish for food, and their foraging behaviour reduces macrophyte algae abundance and increases water turbidity. Despite some evidence of these effects, e.g. from behavioural laboratory studies, observing and quantifying the extent to which they occur in natural systems has remained elusive.

This project will use artificial shelters equipped with underwater cameras in mesocosms and at field sites in Tanzania to quantify in unprecedented detail the interactions between Nile tilapia, an increasingly problematic invasive species in tropical freshwater ecosystems, and native cichlid fish species. Artificial shelters will provide a greater standardisation of monitored areas, and act as local hotspots of activity between fish species that use shelters where a representative proportion of behavioural interactions can be recorded. Competition for food will also be quantified by experimentally presenting food at these artificial shelters. eDNA and local catch records of fisheries will be used to identify sites that have been colonised by the Nile tilapia, and these will be paired with control sites that are ecologically similar and geographically close but where Nile tilapia are currently absent. Local catch records will also be used to identify the other fish species present, alongside an eDNA metabarcoding approach based on mitochondrial 12S sequences and a bespoke reference library that will be created based on existing samples. The project will provide training from a world-class supervisory team with strong track records in each of their fields: molecular methods (eDNA, by Genner), designing optimal shelters and recording set ups (by Ioannou and Genner), quantifying behavioural interactions from video (by Ioannou and Thornton), and advanced statistical data analysis (by Ioannou). Training in fieldwork and fish species identification in Tanzania will be provided by Tamatamah and Genner, who will also supervise and facilitate engagement with local stakeholders including fisheries managers and governmental policy makers.

Although more difficult to study, behaviour is potentially very important in invasive species biology as behaviour is often more flexible and adaptable than other traits. This challenging project will develop a new approach to monitoring behaviour underwater, shining new light on the very real-world threat posed by invasive species in aquatic environments. Such data can then be used to improve risk assessment models which generally ignore behavioural interactions.

**Real Life challenges this project will address**

The world’s freshwater habitats are estimated to be home to 40-45% of all fish species, and due to the greater separation between freshwater systems, there are greater levels of local adaptation and endemism than in marine or terrestrial habitats. Invasions by non-native species have been documented to be having devastating effects on native fauna, with an impact similar in extent to habitat destruction. This project focuses on the Nile tilapia which has been spread widely across tropical freshwaters due to its importance in aquaculture (the ‘aquatic chicken’), and is considered invasive in every region where it has been introduced. By establishing how the Nile tilapia and native species interact in invaded habitats, it may become possible to exploit the tilapia’s behaviour to control their abundance without impacting native species. This would be a step toward making aquaculture of tilapia more sustainable, with both reduced impacts on biodiversity and on local people reliant on native species as capture fisheries.

**What you should know about this project**

The project will be the first to observe and quantify behavioural interactions between an invasive fish (the Nile tilapia Oreochromis niloticus) and native fish under natural conditions. Data collection will take place in Tanzania during extended periods of fieldwork, where the student will design and deploy artificial shelters with underwater cameras that are optimised to record behaviour of invasive and native cichlids at each site. Artificial shelters will provide a greater standardisation of monitored areas, and act as local hotspots of activity between fish species that use shelters where a representative proportion of behavioural interactions can be recorded. The presence and abundance of Nile tilapia will be determined from local fisheries capture records and using novel molecular methods (eDNA).

The supervisory team have complimentary skills and track records which will support the project: Ioannou’s expertise in behavioural experimentation using fish and statistical data analysis, Genner’s expertise in fish ecology and conservation, eDNA and experience of fieldwork using cichlids in Tanzania, Thornton’s expertise in behavioural experimentation under natural conditions using free-living wild animals, and Tamatamah’s expertise in freshwater fisheries and experience with stakeholders across East Africa.

**What expertise you will develop**

The student will gain expertise and an in-depth knowledge of invasive species biology and animal behaviour. The student will develop a range of transferrable skills: the use of eDNA to quantify fish species assemblages, field skills in tropical aquatic ecosystems, cutting-edge statistical methods to analyse data, and engagement with stakeholders that rely on natural aquatic resources. The project will provide a unique combination of experience and skills that the student will be ready to apply to other real-world challenges after the PhD project ends.

**Why this project is novel**

Although animal behaviour has been argued to be essential in understanding invasive species biology for the last 20 years, studies of behavioural interactions between invasive and native species remain rare. This is especially true of aquatic environments where observing behaviour is particularly difficult. Using advances in underwater camera technology, this project will be the first to quantify in its non-native range the behaviour of the Nile tilapia, a very real threat to tropical aquatic systems due to its increasing use in aquaculture globally. The impacts of Nile tilapia are often believed to be mediated through behaviour, such as competition for resources (food, shelter, and in some cases, mates). The project will determine which behavioural interactions between the Nile tilapia and native species are most important in invaded habitats, and how these are affected by ecological variables.

**Rest of Supervisory Team:**

**Co-Supervisor 1**

Dr Martin Genner

Affiliation: Bristol

m.genner@bristol.ac.uk

**Co-Supervisor 2**

Dr Alex Thornton

Affiliation: Exeter

alex.thornton@exeter.ac.uk

**Co-supervisor 3**

Dr Rashid Tamatamah

Affiliation: Other

tamatamah@tafiri.go.tz