**The electric ecology of fresh water habitats**

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Institution: Bristol

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**Full Project Description**

Essential to all biomes, freshwater is put under pressure by urbanisation and human populations, by demands of intensive agriculture, and various damages incurred through anthropogenic pollution. There is a pressing need to increase our understanding of freshwater ecosystems, their resilience and vulnerabilities, ensuring their continued support of human populations and roles in biosphere-level processes. Enhancing our knowledge of fresh water habitats and the biodiversity they support will further our capacity to develop effective and timely protection strategies. This task necessitates the development of efficient, affordable and deployable methods. Specifically, this project aims to further our understanding of the invertebrate fauna, using innovative sampling methods based on electric recording. The project’s main objectives are

1) Determine presence, structure and origin of electric fields in natural fresh water environments.

2) Characterise electric field signatures due to macro- and micro-fauna, in both field and lab conditions.

3) Determine the detectability of invertebrate fauna as a function of water electric conductivity, establishing the role of electrolytes.

4) Develop a conceptual framework, and an experimental and deployable methodology for a fast and reliable detection and identification of organisms using bio-electric fields.

Training in collection and analysis of samples will constitute the background to the assessment of invertebrate diversity and distribution. The student will be trained in recording and analysis of electric fields. The student will engage with the key stakeholder, Dr. de la Rosa in La Selva Research Station in Costa Rica, to collect data from neotropical streams and ponds. Data collection will also take place around the South-West of England. Population densities and compositions will be monitored at different times of the year, and concurrently compared to electric measurements. Specimens and water samples will be brought to the lab where a detailed characterisation will be undertaken. In conjunction with Dr. Fullekrug, the electrical signature of swimming invertebrates will be determined using existing and newly developed picoammeters and electrometers. One bio-inspired hypothesis is that the electric signals that predatory electroreceptive fish use to localise and hunt their prey can be used to recognise the presence and activity of invertebrate species. To date, aquatic electric ecology at this length scale is only poorly understood. This project aims at better understanding the spatial and temporal structure of electric fields in the fresh water environment, and how it can be used for a detailed monitoring of water quality and health of its macro- and micro- fauna. In practice, the variations in current densities will be monitored using multielectrode arrays, and recording local conductivity in time. Here, the student will be trained in electric and electro-physiological techniques, using the expertise of both Robert’s and Fullekrug’s labs. The student will be integrated in the main supervisor’s lab and have tight contact with Prof Genner, gaining expertise in aquatic biology and ecology. Regular meetings with Dr. Fullekrug and will take place, naturally benefiting from current ongoing collaboration. The student will have access to logistic, academic and financial support (eg. Costa Rica travel, consumables) from an ERC advanced investigator grant to D. Robert.

**Real Life challenges this project will address**

Monitoring the population structure and dynamics of organisms, and their interactions within defined ecosystems, or habitats, is paramount to understanding ecological resilience and sustainability. We propose here to investigate how weak electric fields in fresh water microhabitats can enable the monitoring of fauna and flora in a detailed yet long-term, non-contact and non-invasive fashion. Can the presence and activity levels of key arthropod species, as water quality indicator species, be monitored remotely using an advanced time series analysis? This approach certainly goes beyond the conventional sporadic and spatially limited EC measurements, holding the possibility of revealing thus far inaccessible faunistic and phenological information.

**What you should know about this project**

Living organisms generate weak but significant electric fields around themselves. In this project, the electric fields present in fresh water environments will be characterised with the goal to identify the presence and identity of the invertebrate macro- and micro-fauna. The multidisciplinary research team has a strong track record in sensory ecology and measurements of weak bio-electric fields, providing the background and supervision necessary to lead this project to success.

**What expertise you will develop**

The project will include the sampling of aquatic invertebrate species in diverse macro and micro-habitats. Expertise will be developed in identification of this microfauna and diversity of freshwater ecosystems. In particular the student will develop expertise in high resolution electrical measurements in freshwater habitats, including time series data acquisition and analysis. This work has a multidisciplinary nature as it will encompass participation to the development of measurement and sensing techniques, as well as their application in the field. This project thus provides skill and capacity building from concept to application, at the interface between ecology, behavioural biology and sensing technologies.

**Why this project is novel**

One of the techniques used to rapidly evaluate the quality of water relies on measurements of electric conductivity (EC). Certainly useful and practical, this assessment focusses on the effective conductivity of water around dedicated and rather large probe, which is expressed in Siemens per metre and can vary from microS/m to S/m. Considering the research field of electroreception in aquatic animals (eg. gymnotid fish), it is apparent that more information is available from the electric fields that are pervasive in the aquatic environment. This project aims at tapping into the potentially information-rich electric fields that exist in freshwater environments, exploring spatial and temporal domains at a scale conventionally never considered. Practically, this entails measuring electric conductivity and record time-resolved signals sampling microhabitats, and their variation in time and magnitude. Our preliminary measurements show that the presence and motion of micro-invertebrates generate alterations in electric fields. To our knowledge, such information has never been collected in freshwater microhabitats. Another novelty resides in the opportunity to generate information reveal the species composition living in a body of water on the basis of electric signals alone.

**Rest of Supervisory Team:**

**Stakeholder Organisation** La Selva Biological Station, Costa Rica

**Stakeholder Supervisor** Carlos de la Rosa

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