Principal Supervisor: Volko Straub
Co-supervisor: James McCutcheon
PhD project title: Integration of sensory information and food reward
University of Registration: University of Leicester

Project outline

1. Project outline describing the scientific rationale of the project

Gastropods can constitute a significant agricultural and horticultural pest around the world. Furthermore, some species are also known to act as disease vectors for parasites that can affect both livestock and humans. Within Europe, the grey field slug (*Deroceras reticulatum*) and the Spanish slug (*Arion vulgaris*) are considered to have the most significant economic impact, which is expected to greatly increase in many areas due to the introduction and spread of alien species to new habitats. This spread is aided by changes in agricultural practices (e.g. reduction in soil tilling to reduce soil erosion, ‘set aside’ fields for conservation purposes, etc) and in climate (e.g. milder and wetter weather conditions in the UK). For example, the Spanish slug considered native to Spain, Western France and South-East England has been found throughout Europe and appears to have significantly expanded its habitat. Similarly, the grey field slug, another native European species, is now found in America, Central Asia and even New Zealand. Despite their potential for significant world-wide impact on agriculture and horticulture, effective control methods are currently limited and the most common active ingredients in molluscicides, metaldehyde and cholinesterase inhibitors, present a direct risk to humans and pets as well as to wildlife, especially due to bio-accumulation in the food chain. Thus, there is a clear need for the rational development of novel strategies to control molluscs in agriculture and horticulture. However, this is hampered by a lack of a detailed understanding of the neurobiological basis for the control of feeding behaviour. While the neuronal networks that generate the actual feeding movements of the mouth (i.e. opening the mouth, rasping and swallowing) have been studied extensively, there is a limited understanding of the mechanisms that lead from detection of a potential food source to the activation of feeding behaviour. Interestingly, most terrestrial snails and slugs do not appear to possess an innate food preference, but are omnivores that become highly selective feeders after they have encountered a nutritious food source. This strategy makes them highly adaptive to changes in their environment and also very damaging as once they have ‘acquired a taste’ for a specific crop, they will feed selectively on that food source. Thus, a better understanding is needed of the mechanisms that lead to the acquisition of learned food preferences in snails and slugs, which makes them search out a specific food source and then initiates feeding behaviour. In turn, this knowledge could provide important leads for the development of novel control strategies for gastropod pests with potentially less environmental impact than the common current practice of large scale molluscicide use. Therefore, we propose to study the neuronal mechanisms that underlie the integration of chemosensory/olfactory signals (indicating the presence of a potential food source in the environment) and internal reward signals (providing feedback about the nutritional status of a food source), and how they interact to modify decision making. The project will integrate behavioural
studies with electrophysiological, electrochemical and imaging methods to study the adaptive changes in decision making processes and their underlying neuronal mechanisms in the grey field slug, Deroceras reticulatum. We chose this species because of its economic impact as a pest. Results obtained with the grey field slug can be translated readily to other gastropods, but can also serve as a model for the study of decision-making processes in general. We will specifically focus on the dopaminergic system, which acts as a conserved reward system in many animals, and its potential interaction with purinergic signalling, which we have recently identified as an important signalling pathway for the activation of feeding in both aquatic and terrestrial gastropods.

**Relevant BBSRC Strategic Research Priority:** Food security

Techniques that will be undertaken during the project.

- Behavioural experiments to study decision making and learning in terrestrial gastropods.
- Electrophysiological recordings of neuronal activity at the population and single cell level to map and characterise the neuronal mechanisms underlying decision making and learning. This will include extracellular recordings (e.g. local field potentials, whole nerve recordings) as well as intracellular recordings from multiple single cells in both current- and voltage-clamp mode to characterise neuronal and synaptic properties. Analysis of extracellular whole nerve recordings will involve advanced spike sorting to extract information on the behaviour of single units.
- Electrochemical detection of neurotransmitter release including dopamine and ATP.
- Imaging of stained neurons and nerves to map neuronal signalling pathways.
- Construction of neuronal network models to simulate and model the decision making neuronal network.

**Contact:** Dr Volko Straub, University of Leicester