From cognition to nutrition: predicting bee movements in agricultural landscapes

Project ID: 3704

Supervisory team

Lead supervisors: Dr Natalie Hempel de Ibarra (University of Exeter) & Prof Luca Borger (Swansea University)
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Registered institution: University of Exeter (Streatham)
Host institutions: University of Exeter/Swansea University

Project description: Bees are among the most important pollinating insects, underpinning the sustainable management of crop production in agricultural landscapes. Bee species differ in their behaviour and movement patterns, and nutritional preferences, resulting in distinct patterns of floral resource use across space and time. These differences arise from how individual foragers assess floral rewards and make foraging decisions and are strongly affected by landscape features such as edges and roads, which can differentially affect different species[LB1] (eg Zitomer et al (2025) Landsc Ecol). Scaling from individuals to populations, variation in abundance and activity can alter flower visitation patterns and pollination services for crops and wild plants.Landscape features such as hedgerows, and crop configuration influence pollinator movement affecting the connectivity and permeability of the landscape for different pollinators. Understanding the mechanistic processes by which these features facilitate or constrain navigation and foraging remains a major challenge in pollinator biology. Addressing this question is crucial for predicting pollinator responses to changing agricultural environments.This project aims to uncover how spatial (movement costs) and nutritional (rewards) factors influence pollinator movement in fragmented agricultural landscapes where nutritionally diverse floral hotspots coexist with crops. Using state-of-art tracking of individually marked foragers in field experiments, with honeybees and bumblebees, the research will quantify, contrast and compare bee movements in crop systems linked by hedgerows and wildflower corridors in rural Devon. Combining quantitative data analysis with predictive movement modelling, the project will investigate how the spatial matrices of foraging spots with varied nutritional diversity result in foraging decisions and movement patterns, and how individual patterns scale up to colony and multi-species space-use maps that determine the quality of pollination services for crops.We are seeking a highly motivated graduate with a background in natural or life sciences. The project involves field experiments, behavioural tracking, quantitative data analysis, spatial measurements, remote sensing, and movement modelling. A strong interest in quantitative approaches and modelling is essential.The student will join an interdisciplinary research environment spanning the University of Exeter and Swansea University. The supervisors provide expertise in behaviour, movement ecology, remote sensing, and statistical and bio-mathematical modelling, offering specialist training in predictive modelling approaches and access to a broad network of interdisciplinary collaborators specialising in agent-based modelling, navigational biorobotics and computer sciences. The project offers opportunities to work with industrial partners in Devon. The successful candidate is expected to engage with existing collaborations with practitioners in agriculture and landscape management.

Our aim as the SWBio DTP is to support students from a range of backgrounds and circumstances. Where needed, we will work with you to take into consideration reasonable project adaptations (for example to support caring responsibilities, disabilities, other significant personal circumstances) as well as flexible working and part-time study requests, to enable greater access to a PhD. All our supervisors support us with this aim, so please feel comfortable in discussing further with the listed PhD project supervisor to see what is feasible.