The mechanistic basis of sensory processing for bee-plant interactions

Supervisory team:
Main supervisor: Prof Natalie Hempel de Ibarra (University of Exeter)
Second supervisor: Prof Daniel Robert (University of Bristol)
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Collaborators: Prof Daniel Osorio (University of Sussex), Dr Misha Vorobyev (University of Auckland, NZ), Prof Neil Fox (University of Bristol), Dr Isaac Chenchiah (University of Bristol)

Host institution: University of Exeter (Streatham)

Project description:
Bees are one of the most important and best-known group of pollinating insects. They play fundamental roles in human agricultural, environmental and economic activities, from food production to sustainable management of landscapes, habitats and biodiversity. Bees are also much studied insects, with regards to their behaviour, neurobiology and ecology. They are particularly interesting because they have evolved a very close dependence on flowers as they feed from them throughout their whole life. Therefore, bees are highly sensitive to sensory cues and signals that allow them to quickly find flowers and bring back rich and nutritious floral rewards back to the nest for provisioning their brood.

For a long time, the attention of researchers and naturalists has been captured predominantly by the colours, shapes and odours of flowers [1,2], but recently, using sophisticated novel equipment, it became possible to measure and characterise other sensory information provided by flowers that bees can detect. This includes weak electric fields present around flowers. Bees sense their presence and strength through their body hairs [3] and can learn to utilise this information to forage on rewarding flowers [4]. Much of the sense of electroception is still unexplored, for instance it is unknown how from which distance bees can actually detect floral electric fields, or sensitive are they to it in the presence of other floral cues.

The topic for this project links between various areas of bee-plant interactions that underpin pollination services: the ecology, behaviour and sensory neurobiology of bees. This novel project provides ample opportunity to extend and integrate ideas and findings from current research on how bumblebees and honeybees process and learn sensory information and how they detect electric fields designing controlled behavioural experiments. The questions that you can explore center on how bees detect, perceive and learn multimodal combinations of different floral cues, scent, colour, tactile and electrical cues of crop plants. Because pollination is pivotal to global food production, it is important to understand the mechanisms in more depth and approach the complexity of plant-pollinator interactions in novel ways to detect patterns and relations, in ways that potentially allow us to uncover principles that can be generalised to other pollinating insects. It is also possible within this project to include physiological techniques.

We look for a candidate with strong quantitative skills for data analysis and keen interest in neuroscience, behaviour and evolution. You will benefit from working within a lively, collaborative, inclusive and interdisciplinary research environments and access to sophisticated experimental facilites and equipment. You will be based on the UoE's Streatham campus, in the Exeter Bee Lab of the Centre for Research in Animal Behaviour (CRAB), supervised by Professor Natalie Hempel de Ibarra, and also spending time in the lab of the second supervisor, Professor Daniel Robert, at the University of Bristol, as well as interacting with their collaborators in material and biophysics.

[1] Hempel de Ibarra, N. et al. (2014) Mechanisms, functions and ecology of colour vision in the honeybee. J Comp Physiol A, 200(6), 411-433.
[2] Wright, G.A., Schiestl, F.P. (2009). The evolution of floral scent: the influence of olfactory learning by insect pollinators on the honest signalling of floral rewards. Functional Ecology, 23(5), 841-851.
[3] Sutton, G.P. et al. Robert, D. (2016). Mechanosensory hairs in bumblebees (Bombus terrestris) detect weak electric fields. PNAS 113(26), 7261-7265.

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.