When (plant) life gets in the way: Investigating how vegetation attenuates sex pheromone odour plumes and communication between conspecifics

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This multi-disciplinary studentship will investigate how the plume dynamics of sex pheromone signals released by moths are attenuated by vegetation and the effects that this has on moth mate searching and ecology. The studentship will provide excellent and diverse opportunities for training, enabling the student to develop skills on the boundaries between ecology, fluid dynamics and atmospheric modelling.

Many insects rely heavily upon their sense of smell for communication. A classic example of this can be found in the moths, which commonly use olfactory stimuli, particularly in mate location. It is usually the female moth that releases sex pheromone, which attracts flying conspecific males to find and mate with her. Due to the ephemeral nature of this pheromone signal there has been strong selective pressure for males to evolve a finely honed sensitivity to the females' sex pheromones. It is well understood that the actual structure of a pheromone plume in the air is critical in facilitating a male moth to follow that plume and locate a female (figure 1A, B) [1]. Studies have investigated the distances that such attraction can occur over, but only in open environments[2]. However, vegetation can attenuate the transport of airborne compounds and will influence the structure of an odour plume[3].

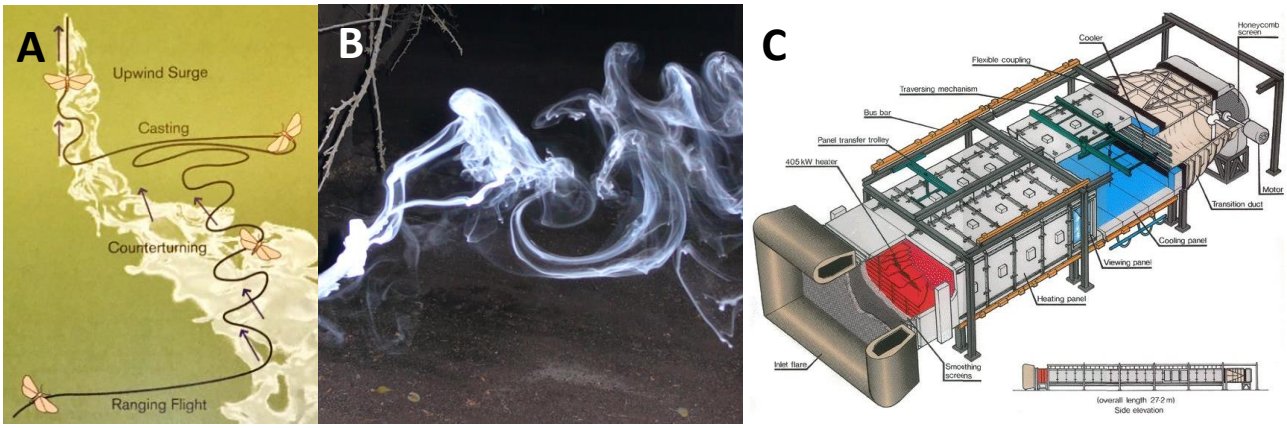

Fig 1 **A** A template of moth manouvers as governed by sequential interactions with filaments of a pheromone odour plume (adapted from Cardé 2016 [5]); **B** Visualisation of the dispersion of an odour plume in a Californian Almond orchard using titanium tetrachloride smoke; **C** A schematic of the EnFlo wind tunnel to be used in the project. The working area is 20 (L) x 3.5 (W) x 1.5 m (H)

This studentship will be the first to address the fundamental ecological question: how does vegetation impact on plume structure and the chances of finding a mate?

To address this question, you will develop skills and learn techniques from multiple-disciplines. The studentship is structured to encourage research in four key areas, fluid dynamics, mathematical modelling of odour plumes and foraging behaviour[4], moth behavioural ecology and ecological field research. Depending upon your own expertise and interest, there is scope to drive forward those areas that interest you most. You will have the opportunity to utilise the EnFlo NCAS Meteorological Wind Tunnel, the only one of its kind in the UK (Fig 1C).

This studentship will provide the first investigations of the fine-scale structure of odour plumes in complex environments and the impacts that this has on the foraging behaviour of moths.

Training opportunities:

The student will receive training in both empirical and quantitative methods. They will learn techniques in fluid dynamics research and also in behavioural ecology.

The student will receive significant training on working with wind tunnels and related recording equipment at the University of Surrey, and further training in 3D-flight analysis of insect navigation at the University of California, Riverside. In order to receive this training, the student will have the opportunity to spend time (approximately 2-4 weeks) at UC Riverside and experience one of the most modern dedicated entomology research facilities worldwide.

Student profile:

The project is suitable for students with a first or upper second-class degree in the physical/engineering sciences or applied mathematics and a keen interest in the biological/ecological sciences, or a student with a degree in the biological/ecological sciences but who can demonstrate a good understanding of physical/engineering sciences and/or mathematics. The student should be keen to conduct laboratory studies and show a capacity to quickly learn and master new technologies and techniques.

References:

[1]**Girling**, **Cardé** (2007) *J. Chem. Ecol.* 33:1927-1945
[2]**Cardé**, Cardé, **Girling** (2012) *J. Animal Ecol.* 81:268-276
[3]Al-Dabbous, Kumar, **Robins** (2013) Proceedings 15th International Conference on HARMO, 468-472
[4]Bau, **Cardé** (2015) *Integr. Comp. Biol.* 55:461-477
[5]**Cardé** (2016) Moth Navigation along Pheromone Plumes. In: Pheromone Communication in Moths. Allison and Cardé (eds.). *University of California Press, Berkeley*, 173-189

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