The Open University

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Sexually deceptive orchid pollination strategies

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CENTA

THE Alice McCOSH TRUST

The Wild Flower Society

Sexually deceptive bee orchid pollination strategies: is one true love or broad sex appeal the best?

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Plate 1: *Ophrys sphegodes* (Early Spider Orchid)

Plate 2: *Ophrys insectifera* (Fly Orchid)

Plate 3: *Ophrys fuciflora* (Late Spider Orchid)

Plate 4: *Ophrys apifera* (Bee Orchid)

Background to the project

Most flowering plants attract pollinators by offering them a reward, such as sugar-rich nectar or protein-rich pollen. The orchid genus *Ophrys* is different because they attract insect pollinators by mimicking the attractive visual, olfactory and tactile signals of the female insect. The male insects are tricked into attempting to copulate with the flowers, and carry pollen from one flower to the next as they do so. This strategy is called sexual deception, and relies on the plants being able to mimic the insect closely enough to fool the male insects and circumvent their learnt avoidance of the flowers.

The *Ophrys* species present in the UK differ in the number of pollinator species they attract, and one species has become predominantly self-pollinated:

- *Ophrys sphegodes* (Early Spider Orchid) — 1 solitary bee species
- *Ophrys insectifera* (Fly Orchid) — 2 solitary wasp species in 1 genus
- *Ophrys fuciflora* (Late Spider Orchid) — 2 solitary bee species in 1 genus, 1 beetle species, 2 hoverfly species in 1 genus
- *Ophrys apifera* (Bee Orchid) — predominantly self-pollinated but shares 1 solitary bee species pollinator with *O. fuciflora*

With plants and animals under increasing pressure from habitat loss, land-use changes, pollution and pesticides, climate change, and loss of associated species; it is imperative to understand how ecological systems function in order to predict their responses in an uncertain future. We do not fully understand the pollination strategies of *Ophrys* orchids, and therefore cannot fully predict how they might respond to various pressures.

Is attracting one pollinator species more effectively better than attracting many pollinator species less effectively, in terms of pollination rates? If a pollinator is no longer required, as with the self-pollinating *Ophrys apifera*, will the attractive signals be lost? This project aims to answer these questions and thereby contribute to the conservation efforts for these charming flowers.

Programme of Investigation

Preparatory work conducted in the first year of this project has included putting together distribution maps for the orchids and their pollinators. Orchid records were provided by the Botanical Society of Britain and Ireland (BSBI) Distribution database (DDb) and the Orchids of Britain and Ireland (Harrap and Harrap, 2005). Pollinator records were provided by the National Biodiversity Network (NBN) Atlas, the Field guide to the bees of Great Britain and Ireland (Falk, 2015) and the Global Biodiversity Information Facility (GBIF). The flowering periods of the orchids and flight periods of the pollinators were charted from records (figure 1).

Plate 5: experimental set-up for obtaining UV and visual photographs

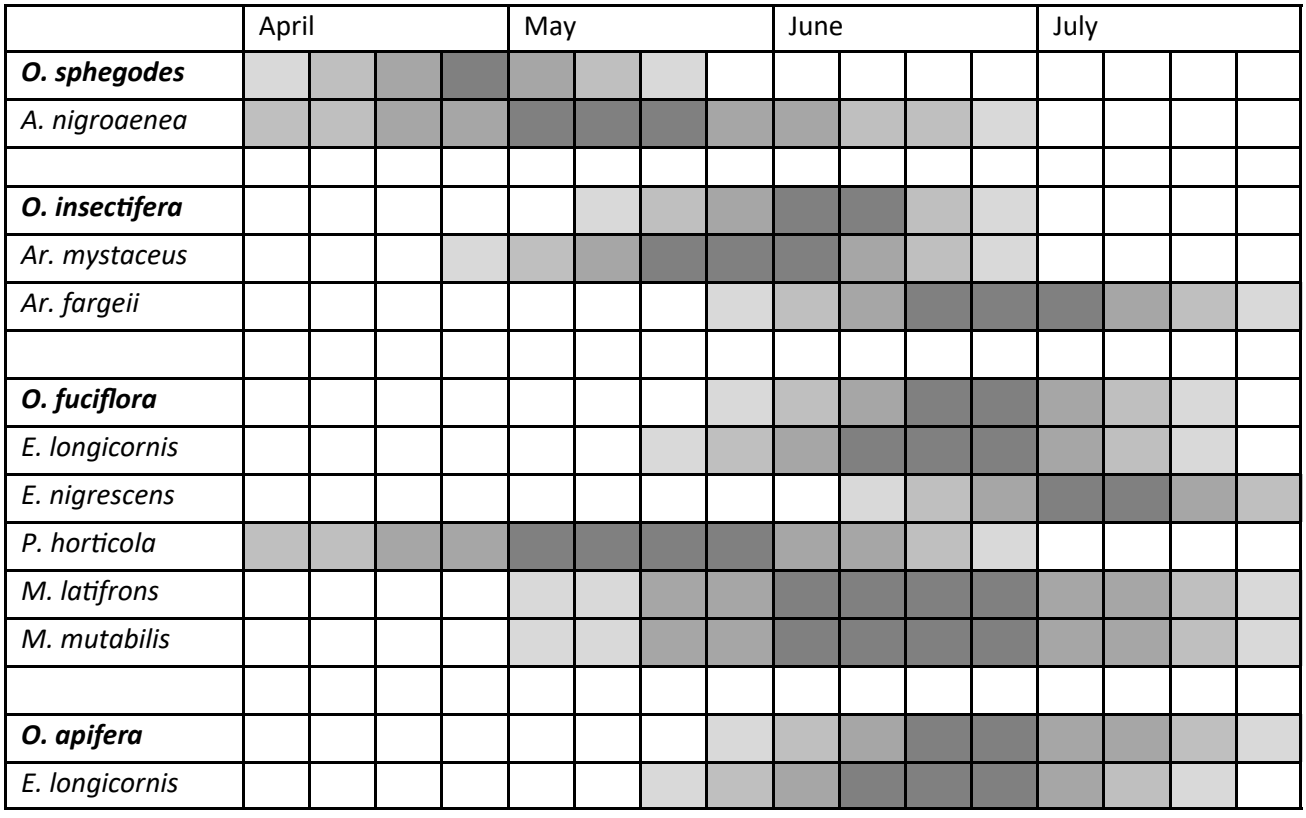

Figure 1. Flowering periods and flight periods recorded for each UK *Ophrys* orchid species and their main pollinator(s), with darker regions indicating peak flowering or flight period.

Pollination rates were recorded for each orchid species from field sites across the centre and south of England, based on visual inspection of the flowers and whether a seed pod was produced. This will provide the basis for comparing pollination efficiency both within and between *Ophrys* species. Photographs in both the visual spectrum and ultraviolet (UV) spectrum were taken for a selection of the flowers in each species (plate 5), to be combined into a multispectral image for analysis using specialised imaging software. Insects have a different visual system from humans and are able to see UV light. Therefore it is important to analyse the visual attractive signals of the flowers based on what the insects would be seeing. Scents were obtained from an *Ophrys apifera* (Bee Orchid) individual to prepare for the analysis of olfactory signals, using a Pye Air Entrainment Kit to pump purified air over the orchids and onto a sorbent tube that captures the scents on an absorbent material (plate 6). These samples will be analysed using gas chromatograph mass spectrometry (GCMS) to identify the amounts and types of

compounds the orchids are producing to attract the pollinators. At this stage of the project, this method is being tested and refined; in subsequent years more samples from a number of individuals will be obtained and analysed.

Future work

Work planned for year 2 of the project includes obtaining more photo and scent samples from orchids in all four UK species, and obtaining photo and scent samples from pollinator females for comparison. This will enable the attractive signals being produced by the orchids to be reliably identified and analysed.

Field work planned for the flowering season in year 2 includes obtaining samples from *Ophrys apifera* (Bee Orchid) populations in Europe, and its one pollinator species which is more ubiquitous in mainland Europe than in the UK. This will allow a more thorough investigation to be conducted on whether the attractive signals being used by *O. apifera* have been lost in one or both populations because of their ability to self-pollinate, or whether the UK population is producing different attractive signals to the European populations since they are less frequently pollinated by insects in the UK.

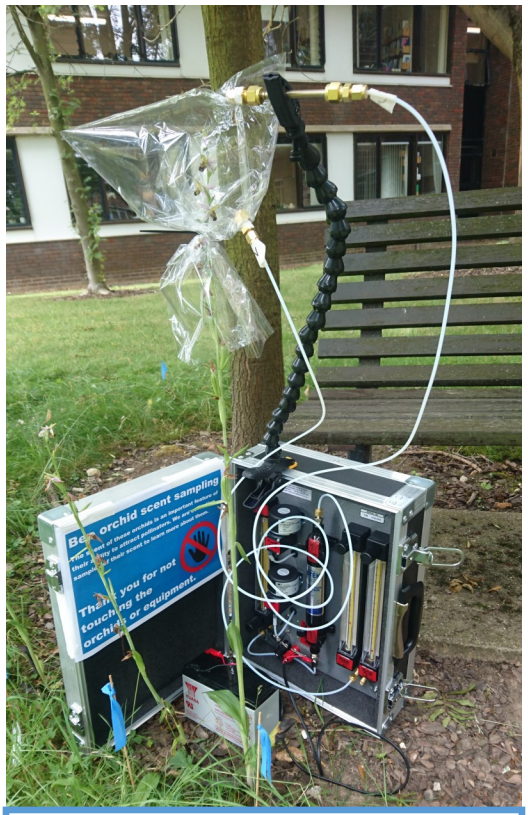

Plate 6: experimental set-up for obtaining scents from orchids using an air purification and pumping system

Future reports will include updates on the progression of the field work, and the results from the investigations.

Acknowledgements

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Fieldwork costs	1st Season	2nd Season
Accommodation	£200	£200
Transport	£750	£1245
Total	**£950 (Alice McCosh Trust)**	£1445
Other project costs		
Camera Equipment, UV standards etc	£2520	£0
Other equipment	£230	£330
Analysis	£1250	£1900
Conference attendance	£0	£300
Total	£4650	£2530
Project total	£9575 (covered jointly by CENTA, The Alice McCosh Trust and the Wild Flower Society)	

Further reading

Harrap, A. and Harrap, S. (2005) Orchids of Britain and Ireland: A Field and Site Guide. 1st edn. London: A. & C. Black.