Project title:	**Sexually deceptive orchid pollination strategies: is one true love or broad sex appeal best?**
Project code:	**OU2**
Host institution:	**The Open University**
Theme:	**Evolution & Ecosystems or Biogeochemistry**
Key words:	pollination, sexual deception, volatile organic compounds, orchids
Supervisory team:	Dr Julia Cooke, The Open University, julia.cooke@open.ac.uk; Prof Claire Turner, The Open University, claire.turner@open.ac.uk; Prof David Gowing, The Open University, david.gowing@open.ac.uk

Project Highlights:

- Work on sexual deception, a pollination strategy unique to orchids, arguably the most charismatic of flowers
- Use Britain's unique ecological history as an opportunity to assess pollination strategies and conservation issues
- Use the latest techniques to analyse pheromones and colour and answer questions about pollination strategies and the evolution of trickery

Overview:

Sexually deceptive orchids achieve pollination by mimicking the pheromones and appearance of female insects. The orchids entice males to try to mate with the flowers and pollen is spread through repeated deception among flowers. In this way orchids avoid the costs of producing nectar, but mimicking pheromones and colour is presumably expensive. Sexually deceptive orchid species vary in the number and diversity of pollinator species they attract, ability to self-pollinate, and if they share pollinators with other species.

It is not known how these different strategies affect pollination success, plant abundance and the population resilience of these often-vulnerable species. *Is it better to mimic one pollinator or several? Is it too expensive to mimic several species perfectly, but imperfect mimicry is enough? And when a pollinator becomes locally extinct, releasing a species from a specific selection pressure, are deceptive traits no longer maintained?*

There are four species of the sexually deceptive orchid genus *Ophrys* in Britain, all of which also occur Specifically, this project aims to:

1. Determine the impacts on mimicry of losing selection pressure when a pollinator becomes extinct
2. Measure and compare how closely orchids mimic insects when they mimic one versus many pollinators
3. Quantify the reproductive success of different strategies
4. Use cost-benefit analysis to assess which strategy leads to more resilient populations

Fig 1. Ophrys apifera *(left) is pollinated in Europe by a single bee species, which is absent in Britain resulting in solely self-pollination. In contrast,* Ophrys insectifera *does not self-pollinate but attracts three pollinators from two genera in two insect orders.*

Quantification of the costs and benefits of floral sexual deception will benefit the scientific community by contributing answers to long-standing questions about evolutionary mechanisms. This system will be a useful model for plant-pollinator interactions, and particularly for the evolution of trickery in nature. By better understanding pollinator strategies of native orchids, this project could contribute to their conservation, which is particularly import given the vulnerable status of some of the species.

Methods:

Measuring the colour, shape and scents released by the orchid species and their pollinators will allow quantification of the strength of the mimicry, by comparative analysis among species and populations.

Monitoring orchid reproductive output will assess strategy success. Scent will be quantified by condensing volatiles collected from plants *in situ,* and from their insect pollinators, for analysis in a mass spectrometer. Floral and insect colour will be analysed with conventional digital camera photos using new analysis tools. Reproductive success can be measured by counting the large capsules that house the tiny seeds without the need for collection. These methods allow for many measurements without damage to plants, as some of the species are listed as vulnerable in the UK. By comparing between populations and species with different pollinators, this project will quantify the costs and benefits of deceiving one versus multiple pollinators. We will determine how a species responds to a relaxation of selective pressure by comparing populations of *Ophrys apifera* in locations with and without a pollinator (United Kingdom and France).

Training and skills:
CENTA students are required to complete 45 days training throughout their PhD including a 10 day placement. In the first year, students will be trained as a single cohort on environmental science, research methods and core skills. Throughout the PhD, training will progress from core skills sets to master classes specific to CENTA research themes.
Through the project, the student will gain specific skills in:

- Field collections and surveys, and the statistical analysis of the data
- Functional ecology, including drivers of evolutionary processes
- Analysis of floral colour and VOCs
- Comparative and cost-benefit analyses
- Scientific communication and networking through presenting posters and talks at departmental seminars, national society meetings and an international conference.

Dr Cooke and Prof. Turner will oversee the student's training, but the project will also benefit from the involvement of Prof. David Gowing (OU, botanical ecology). The student will also be expected to attend the BES Ecophysiology Field Techniques workshop, and encouraged to take advantage of online teaching opportunities through the various Open University programmes.

Partners and collaboration (including CASE):
Collaboration with the Botanical Society of the British Isles (BSBI) will provide the student with locality data and local contacts for orchid populations.

Possible timeline:
Year 1: Literature review. Confirmation of access consents. Learning analytical techniques. Fieldwork comprising collection/analysis of colour/scent, monitoring of pollination success of *O. apifera* in Britain and France; also for pollinator in France. Familiarisation with measurement protocols; attend BES Field Techniques Workshop.
Year 2: Collection/analysis of colour/scent, monitoring of pollination success of four *Ophrys* species in Britain. Preparation of 1st manuscript on *O. apifera*. Presentation at BES conference.
Year 3: Write-up thesis and papers on pollination strategies and perfect vs imperfect mimicry. Present results at the European Ecological Federation Congress or similar international meeting.

Further reading:

1. Gaskett, A. C. 2011. Orchid pollination by sexual deception: pollinator perspectives. Biological Reviews 86: 33-75.
2. Spaethe, J., M. Streinzer & H.F. Paulus. 2010. Why sexually deceptive orchids have coloured flowers. Communicative & integrative biology 3: 139-41.
3. Mant, J., R. Peakall & F.P. Schiestl. 2005. Does selection on floral odor promote differentiation among populations and species of the sexually deceptive orchid genus Ophrys?. Evol. 59: 1449-63.

Further details:
Students should have a strong background in, and enthusiasm for field and lab work and functional ecology. Drivers licence an advantage. The student will join well-established teams researching ecological strategies and volatile organic compounds (VOCs) at the Open University.
Please contact Julia Cooke (julia.cooke@open.ac.uk) for further information.
Applications should include:

- a cover letter outlining why the project is of interest and how their skills match those required,
- an academic CV containing contact details of three academic references
- a CENTA application form, downloadable from www.centa.org.uk/media/1202/centa-studentship-application-form.docx
- and an Open University application form, downloadable from: http://www.open.ac.uk/students/research/sites/www.open.ac.uk.students.research/files/documents/Application%20form.docx

Apologies that some bits of information are requested multiple times on different forms. Please fill in everything requested.

Applications should be sent to
STEM-EEES-PhD-Student-Recruitment@open.ac.uk
by 5 pm on 25th January 2017