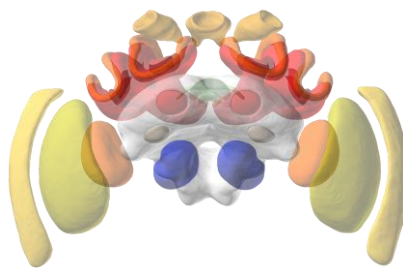


**PROJECT TITLE: The impact of climate change on bumblebee behaviour and physiology****DTP Research Theme:** Changing Planet**Lead Institution:** University of Bristol**Lead Supervisor:** Harry Siviter, University of Bristol, School of Biological Sciences**Co-Supervisor:** Stephen Montgomery, University of Bristol, School of Biological Sciences**Co-Supervisor:** Paul Williams, Natural History Museum, Department of Life Sciences**Project Enquiries:** [harry.siviter@bristol.ac.uk](mailto:harry.siviter@bristol.ac.uk)**Project keywords:** Animal behaviour, climate change, Neuroanatomy, Conservation, Ecology, Insect

*Bumblebees are key pollinators of crops and wildflowers (photo credits Harry Siviter)*



*A schematic of a bumblebee (*Bombus terrestris*) brain (photo credit 'Insect Brain Database').*

**Project Background**

Bumblebees are important pollinators, but many species are undergoing dramatic range declines. While the drivers of these declines are multifaceted, climate change is a major contributing factor<sup>1,2</sup>. Most bumblebee species are adapted to cooler climate conditions. For example, they have long hairs that keep them insulated, and typically forage when temperatures are lower. Consequently, as global temperatures increase, bumblebees may be vulnerable to hotter temperatures and potentially shift their range and behaviour. However, long-term data from Europe and North America, indicate that the population distributions of most bumblebee species are not moving north in response to climate change, while their southern limits are retracting<sup>1</sup>. Consequently, bumblebees will have to adapt to higher temperatures and extreme weather events. Understanding, the behavioural, and physiological response of bumblebees to these temperatures is therefore of paramount importance for predicting the true impact of climate change on bumblebee populations<sup>2,3</sup>.

**Project Aims and Methods**

The aim of this project is to determine the **behavioural and physiological response of bumblebees to higher temperatures associated with climate change**. We will support the candidate to incorporate their own ideas and expertise into the project, but we envisage 3 principle objectives.

*Objective 1: Determine how exposure to higher temperatures influences bumblebee learning and memory.* A foraging bumblebee visits hundreds of flowers a day and has to track the profitability of floral rewards in an everchanging floral marketplace. Using a free-moving proboscis extension reflex experimental design<sup>4</sup>, you will expose bumblebees to higher climatic temperatures under laboratory conditions and determine how this influences bumblebee olfactory and colour learning.

*Objective 2: How does exposure to higher temperatures influence bumblebee brain development, maturation and age related decline?* Here, you will expose individual bumblebees to higher temperatures and use immunohistochemistry and advanced confocal microscopy to reveal brain and synaptic structure. Using this approach you will quantify changes in brain morphology and physiology under different temperature regimes to examine interactions between environmental conditions, learning and ageing.

*Objective 3: Has climate change influenced bumblebee physiology?* Here, in collaboration, with researchers at the Natural History Museum, you will use museum specimens to determine how the physiology and morphology of bumblebees have changed over the last ~100 years in response to climate change.

### Candidate requirements

We seek an enthusiastic, highly motivated student with a broad interest in animal behaviour, cognition, neuroanatomy, ecology, and conservation. You should have a background in one or more of these disciplines and an eagerness to learn about the others. We welcome and encourage student applications from under-represented groups and value a diverse research environment. The project can be adapted to support the accessibility and work place requirements of the successful candidate.

**Project partners:** The project will take advantage of the expertise and facilities at both the University of Bristol, and the Natural History Museum. The candidate will have access to state-of-the-art incubation chambers at the University of Bristol, which will enable you to conduct highly controlled temperature-based experiments. The University also has an in-house confocal microscope and a CT-scanner. You will also have the opportunity to conduct research on the bumblebee collection at the Natural History Museum, and obtain experience working directly with museum specimens.

**Training :** Training will depend on the interests and the expertise of the candidate. Opportunities will include (but not limited to) training in (i) laboratory based behavioural assays (ii) core lab techniques and microscopy (iii) working with museum specimens (iv) bumblebee ecology and fieldwork and (v) statistical analysis.

### Background reading and references (please feel free to email for PDF's)

1. Kerr, J. T. *et al.* Climate change impacts on bumblebees converge across continents. *Science* (80-. ). **349**, 177–180 (2015).
2. Maebe, K. *et al.* Bumblebee resilience to climate change, through plastic and adaptive responses. *Glob. Chang. Biol.* **27**, 4223–4237 (2021).
3. Williams, N. M. & Hemberger, J. Climate, pesticides, and landcover drive declines of the western bumble bee. *Proc. Natl. Acad. Sci.* **120**, (2023).
4. Siviter, H. & Muth, F. Exposure to the novel insecticide flupyradifurone impairs bumblebee feeding motivation, learning, and memory retention. *Environ. Pollut.* **307**, 119575 (2022).

### Useful links

<http://www.bristol.ac.uk/biology/courses/postgraduate/>

### Bristol NERC GW4+ DTP Prospectus:

<https://www.bristol.ac.uk/study/postgraduate/research/great-western-four-doctoral-training-partnership-nerc/>

### How to apply to the University of Bristol:

<http://www.bristol.ac.uk/study/postgraduate/apply/>

**Please note:** If you wish to apply for more than one project please contact the Bristol NERC GW4+ DTP Administrator to find out the process for doing this.

**The application deadline is Tuesday 9 January 2024 at 2359 GMT. Interviews will take place from 26 February to 8 March 2024.**

**For more information about the NERC GW4+ Doctoral Training Partnership please visit**

<https://www.nercgw4plus.ac.uk>.

**General Enquiries:** Bristol NERC GW4+ DTP Administrator

Email: [bristol-nercgw4plusdtp-admin@bristol.ac.uk](mailto:bristol-nercgw4plusdtp-admin@bristol.ac.uk)