

# Social brains and behaviour in cooperative insect societies

## Supervisors

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## Project description

**The social brain hypothesis suggests that the cognitive demands of living in large, individually-based social groups selects for large brain size and enhanced cognitive abilities. This hypothesis has received some support from comparative studies of mammals and birds, but there have been very few experimental tests of the hypothesis. We will carry out experiments to test the causal relationship between sociality and brain evolution and development using a wild population of a paper wasps in southern Spain.**

Primitively eusocial insects, which unlike 'higher' eusocial insects do not exhibit morphological or task specialisation, exhibit wide variation in group size and social complexity. Group members form individually-based dominance hierarchies, exhibit individual recognition (e.g. based on facial patterns in *Polistes* paper wasps) and form long-term social memories of individual identity and strength. Within species, socially dominant females, and those that found nests in multi-female groups rather than alone, have been found to possess larger mushroom bodies (MBs) than subordinate or solitary-founding females. Mushroom bodies are regions of the insect brain thought to be important in learning and memory.

Together these studies support the idea that individuals that live a socially rich or socially demanding life possess or develop brains that are morphologically distinct from conspecifics. However, previous studies have been correlational, and so the causal nature of this relationship is unknown. This PhD project will address this gap in knowledge using a combination of innovative field experiments, bioimaging, and theoretical modelling.

### Aims

The specific aims of the project are

1. To test experimentally the causal relationships between social status, group size and brain structure in a primitively eusocial insect, the paper wasp *Polistes dominulus*.
2. To test experimentally how social aggression influences brain development and cognitive performance.
3. To develop new theoretical models to explain variation in social aggression, social memory and emergent social structure in animal societies.

## Methods

The project will use an established study population of paper wasps *Polistes dominulus* in southern Spain. Group members will be individually marked and videoed. Social status will be manipulated by temporary or permanent removal of dominant individuals. Aggression will be manipulated using synthetic hormones. Imaging of dissected wasp brains will be carried out at the University of Exeter and micro CT images obtained in collaboration with the Natural History Museum, London. Training in mathematical modelling of behaviour will be provided at Bristol and Exeter.

## References:

Thompson FJ, Donaldson L, Johnstone RA, Field J, Cant MA. 2014. Dominant aggression as a deterrent signal in paper wasps. *Behavioral Ecology* 25:706-715

Molina Y, O'Donnell S. 2007. Mushroom body volume is related to social aggression and ovary development in the paper wasp *Polistes instabilis*. *Brain, Behavior and Evolution* 70: 137-144.