Adaptive architecture in animal societies:
how ants tune their nests to optimise performance under competing pressures

PhD position (fully funded, University of Bristol)

Background

Many social animals construct complex environments that shape how their societies function, from insect nests to coral reefs and human cities. These structures are not passive: their architecture regulates movement, interactions, and the flow of information, resources, and disease. Understanding how such architectures can be tuned to balance competing demands is a fundamental challenge – and one with direct relevance beyond biology. During the recent pandemic, architects and urban planners explored how spatial design could limit contagion; biological systems shaped by millions of years of evolution may already have solved versions of these problems.


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Social insects provide a uniquely powerful model, as they build elaborate nests that control how individuals move and interact, and can be reshaped in response to changing pressures. Yet despite their importance, these systems remain surprisingly understudied, largely because they are buried underground, placing them beyond the reach of conventional experimental approaches.

The project

In this interdisciplinary project, you will study **how ant colonies remodel their nest architecture in response to competing pressures, and how these changes influence collective performance**.
(1) You will use controlled laboratory experiments to map how colonies reshape their nests under specific pressures – pathogen exposure, resource availability, seasonal variation – **revealing architectural solutions refined by millions of years of evolution**.
(2) You will test whether these architectural responses are adaptive by building faithful replicas of real nests and measuring their effects on colony performance and resilience – **quantifying, for the first time, to what extent architecture underpins a colony's ability to withstand stress**.
(3) You will extend these findings beyond simplified laboratory systems, studying nests in natural and semi-natural contexts, combining direct excavation and casting with emerging geophysical approaches for non-destructive imaging, **to ask whether the same architectural principles operate in the wild.**

Methods and approaches

To address these questions, you will use a combination of advanced imaging, fabrication, and analytical methods that make underground nest architecture fully accessible to experimental investigation. You will use **microCT scanning** and **3D surface scanning** to map nest architecture in three dimensions. To analyse these data, you will develop **custom code in R, Python, and/or C++** to convert nest scans into spatial networks and visibility graphs. You will apply **network-based analyses** to quantify connectivity, accessibility, and robustness, generating predictions about how individuals, resources, and disease spread through the nest. You will then test these predictions in controlled manipulative experiments by producing faithful physical replicas of real nests using a combination of **3D printing and lost-wax casting in aerated concrete**. Finally, fieldwork will take you beyond the laboratory, including **setting up mesocosms, casting natural nests**, and working with geophysical experts to deploy **ground-penetrating radar** for non-destructive imaging of field nests. In addition, you will benefit from the **University of Bristol's doctoral training environment**, with access to a wide range of courses in data analysis, programming, scientific writing, and presentation skills, as well as opportunities for interdisciplinary collaboration and career development.

The team

The project will be based in the Ant Lab led by Dr Nathalie Stroeymeyt at the University of Bristol, within a dynamic and collaborative research environment. The work is part of the ERC-funded SMARTNESTS programme (June 2026-May 2031), which brings together expertise in behavioural biology, imaging, and experimental system design. The student will interact with an interdisciplinary team and benefit from collaborations with engineers and geophysicists.

Candidate profile

We are looking for highly motivated candidates with a strong interest in biological systems, collective behaviour, or complex systems. Applicants should hold (or be close to completing) a degree in biology, ecology, physics, engineering, computer science, or a related discipline, with a final grade of 2:1 or more. The project combines experimental work, quantitative analysis, and computational approaches. Prior experience in one or more of these areas (e.g. programming, data analysis, imaging, or experimental design) is desirable but not essential. Curiosity, creativity, and a willingness to work across disciplines are key.

Expected start date

Between September 2026 and January 2027.

Funding

This studentship is available for a 3.5-year PhD for applicants eligible for home (UK) tuition fees. It includes a tax-free stipend at the current UKRI rate (£19,237 per annum), with tuition fees (home rate) and research costs fully covered.

How to apply

Please send your application by email to nathalie.stroeymeyt@bristol.ac.uk as a single PDF including:

(i) a full CV (including details of your academic record and relevant experience);
(ii) a statement outlining your past research experience, current interests, and why you are interested in this project (maximum 2 pages);
(iii) the names and contact details of at least two referees;
(iv) copies of (or links to) your publications and/or your Master's thesis (if available).

Please use the following subject line: **PhD application – Adaptive architecture – [Your surname].**

Application deadline: 5 June 2026

Shortlisted candidates will be invited to interview. The selected candidate will then be asked to submit a formal application through the University of Bristol admissions system.