Interdisciplinary International BSc/MSc Project

How to maintain the two essential functions of insects in a changing climate?
Microrheology and chemistry of cuticular hydrocarbons in ants

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Cuticular hydrocarbons (CHCs) cover most insect cuticles. They fulfil two functions at the same time: they make the insect body waterproof and they act as a signal for communication. The effectiveness of these two essential functions depends on the rheology of the cuticular layer and is linked to the chemical composition of this layer which can contain more than 100 hydrocarbons. In particular waterproofing and communication only work if the CHC layer is neither too solid nor too liquid (Sprenger et al. 2018, Menzel et al. 2019, Baumgart et al. 2022).

In this project, we will study the relationship between the rheology and chemical composition of cuticular hydrocarbons in ants, under acclimatisation conditions. The rheology of the cuticular layer can be affected by climatic variations and no longer fulfil its role. Answering this question is essential for understanding how insects, a species that is largely in decline, will be able to respond to the constraints of climate change. We will study how chemical composition translates into biophysical properties relevant to waterproofing and communication.

From a practical point of view, cuticular hydrocarbons are available in minute quantities, making the usual rheology techniques unsuitable for their use. Recently, new developments in the insect world have emerged at Laboratoire Matière et Systèmes Complexes, by combining a fluid collection procedure and the adaptation of a microrheology technique to volumes of the order of 10pL (Abou et al. 2010). The motivated candidate will study the viscoelastic properties of CHC profiles of different European and tropical ant species, using these developments in microrheology. A fundamental aspect will be devoted to fractionated CHC samples, which only contain a part of the entire profile, in order to understand their general mechanical behaviour.

This exciting project, which spans physics, chemistry and biology, takes place at Laboratoire Matière et Systèmes Complexes (MSC), located in Paris 13e. It will be carried out in international and interdisciplinary collaboration with the Institute of Organic and Molecular Evolution. A short-term internship at the University of Mainz (Germany), for chemical and behavioural analyses, is possible. If you are interested or have further questions, please do not hesitate to contact Dr. Bérengère Abou (berengere.abou@u-paris.fr).

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