Interdisciplinary International MSc Project

Visco-elastic properties of cuticular hydrocarbons in ants

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Cuticular hydrocarbons (CHCs) cover the cuticle of virtually every insect. They serve two functions at the same time: making the insect body waterproof and serving as communication cue. Both functions depend on the chemical composition of CHCs, but also on their physical properties: waterproofing and communication only work it the CHC layer is neither too solid nor too liquid (Sprenger et al. 2018, Menzel et al. 2019).

During the internship, we will investigate the relationship between chemical composition and physical properties of cuticular hydrocarbons of ants. Next to European species, we will also work on parabiotic ants from the tropical rainforest in South America. Parabioses are symbiotic relationships between two unrelated ant species, which live together peacefully in the same nest. These nests are so-called ant gardens, and are plant assemblages planted by the ants (see picture). The cuticular hydrocarbons of parabiotic ants are very unusual because they form very long molecules. This probably promotes their high tolerance towards the other species, and here we want to find out whether this is due to particular physical properties of their hydrocarbons (e.g. unusual viscosity). We will also work on fractionated CHC samples, which only contain a part of the entire profile, to understand their general mechanical behaviour. This is of great interest since it is still unclear how the chemical composition translate into the bio-physical properties relevant for waterproofing and communication.

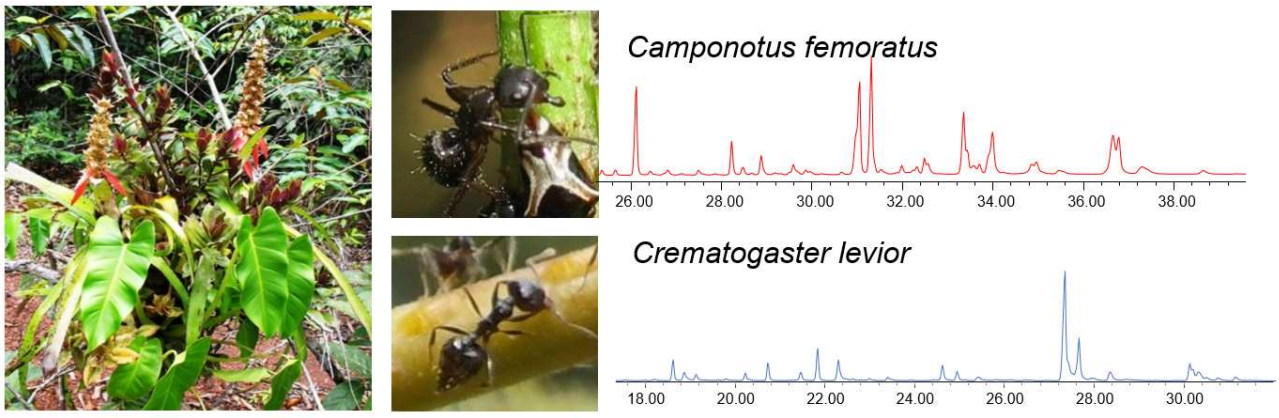

Figure: (left) Ant garden inhabited by the ants *Camponotus femoratus* and *Crematogaster levior.* (right) CHC profiles of the two ant species acquired using gas chromatography-mass spectrometry (GC-MS). Each peak represents a hydrocarbon or a mixture of hydrocarbons.

We search for a highly motivated Master student. The candidate will investigate the visco-elastic properties of CHC profiles of different European and tropical ant species. Due to the extremely small amount of material available, it is impossible to directly measure CHC viscosity with a standard rheometer. Here, he/she will perform **microrheology** experiments, suitable for small amount of material. It allows to measure fluid properties of tiny substance quantities (less than 1 microlitre), which was impossible until recently.

The project takes place at Laboratoire Matière et Systèmes Complexes (MSC), UMR CNRS 7057, located in Paris 13e. The candidate will participate in an international and interdisciplinary collaboration between MSC and Institute of Organismic and Molecular Evolution. He/she will acquire a large range of skills, including micro-rheology and chemical analyses. 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 contact **Dr. Bérengère Abou** (berengere.abou@univ-paris-diderot.fr).

Sprenger P.P., Burkert L.H., Abou B., Federle W., Menzel F. (2018): Coping with the climate: cuticular hydrocarbon acclimation of ants under constant and fluctuating conditions. Journal of Experimental Biology, **221**: jeb171488

F. Menzel, S. Morsbach, J. H. Martens, P. Raeder, S. Hadjaje, M. Poizat, & B. Abou (2019), Communication versus Waterproofing: the Physics of insect cuticular hydrocarbons, Journal of Experimental Biology **222** : jeb210807