Interdisciplinary international MSc Project:

Physico-chemical properties of communication signals in mutualistic ants

Cuticular hydrocarbons (CHCs) cover the cuticle of virtually every insect. They serve two functions at the same time: they protect the insect body against water loss and serve as communication signals. Both functions depend on the chemical composition of CHCs, but also on their physical properties, e.g. phase behaviour and viscosity (Sprenger et al. 2018). Recently, we discovered that the CHC layer is a mixture of solid and liquid parts, which continuously melt or solidify as temperature changes (Menzel et al. 2019). This was a surprise - previous theories assumed a homogenous CHC layer. Our finding changes how we think about waterproofing and communication in insects.

This master thesis will investigate the relationship between chemical composition and physical properties of cuticular hydrocarbons of ants, focusing parabiotic ants from the tropical rainforest in South America. Parabioses are symbiotic relationships between two 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 (Fig. 1). The CHCs of parabiotic ants consist of unusually long molecules. This seems to promote their high tolerance towards the mutualist, and we want to find out how this is related to the physical traits of the CHCs. It is still unknown how chemical composition influences physical properties of the CHC layer – and how this translates into biological functionality.

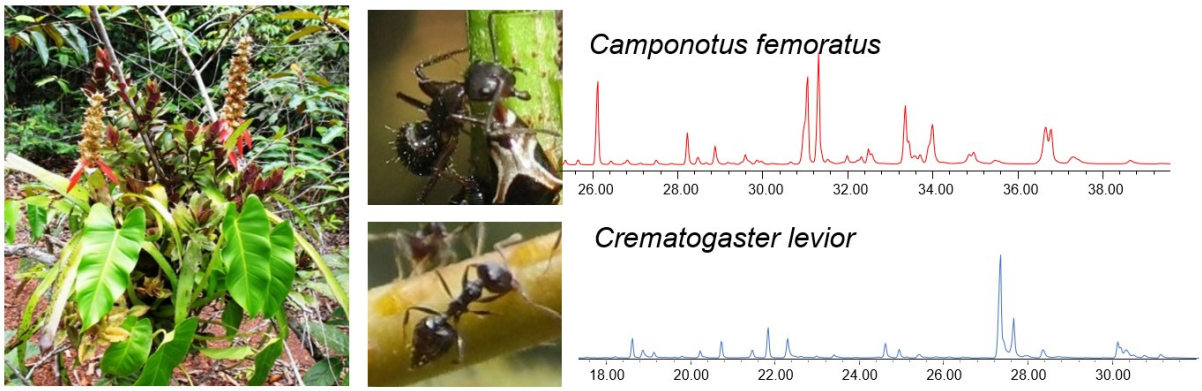

Fig. 1 (left) Ant garden inhabited by the ants *Camponotus femoratus* and *Crematogaster levior*. (right) CHC profiles of the two ant species acquired using gas chromatography-mass spectrometry (GC-MS). Each peak represents a hydrocarbon or a mixture of hydrocarbons.

We search for a highly motivated Master student to investigate the link between chemical composition and physical properties of insect cuticular hydrocarbons. The candidate will investigate CHC chemistry using gas chromatography-mass spectrometry (GC-MS) in our lab in Mainz. For 2-3 months, he/she will then study the physical properties of CHC layers in the **lab of Dr. Bérengère Abou in Paris** (Laboratoire Matière et Systèmes Complexes, CNRS, Université de Paris). Here, he/she will use a newly developed microrheological technique (About et al. 2010) to investigate mechanical properties of the CHC layer.

The candidate will participate in an international and interdisciplinary collaboration. He/she will acquire a large range of skills, including microrheology, chemical analytics and biostatistics. No prior knowledge of chemistry or physics (nor French) is required. The stay in France is covered financially. The working language in both labs is English. Starting date is flexible, from January 2022 or later. If you are interested or have further questions, please do not hesitate to contact **Dr. Florian Menzel** (menzelf@uni-mainz.de).

References

Abou B, Gay C, Laurent B, Cardoso O, Voigt D, Peisker H, Gorb, S (2010): Extensive collection of femtolitre pad secretion droplets in the beetle Leptinotarsa decemlineata allows nanolitre microrheology. Journal of The Royal Society Interface, 7(53), 1745-1752.

Menzel F, Morsbach S, Martens JH, Räder P, Hadjadje S, Poizat M, Abou B (2019): Communication vs. waterproofing: the physics of insect cuticular hydrocarbons. Journal of Experimental Biology 222: jeb210807

Sprenger PP, Burkert LH, 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