Stressed honeybee queens: do maternal effects change egg composition and worker behaviour?

Supervisory team:
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Project description:

Honeybees are important pollinators of agricultural and wild plants, yet they also face numerous emerging challenges in a strongly human-modified world, including pesticides and diseases. A key challenge is caused by the large-scale conversion of natural and semi-natural habitat into urban or intensively farmed land, which leads to a lack of forage and nutritional stress. Such poor nutrition could result in reduced bee health and potential colony death unless there are adaptive responses by bees. Here, we describe an exciting PhD project to investigate how honeybee queens respond to nutritional stress in changing landscapes and the consequences for their worker offspring, using ecological, molecular and mathematical modelling approaches.

Recent work has discovered that poor nutrition of colonies induces honeybee queens to lay larger eggs, thereby potentially transferring nutrients and compounds to brood that mitigate against the negative impacts of malnourishment. However, it is currently unknown if queens only increase egg size or also adjust the composition (e.g. of proteins, sugars or hormones) and whether these maternal effects have an impact on adult workers. It is widely appreciated across insects that egg size is a significant predictor of later survival and fitness traits, yet the consequences of egg size – and maternal ability to adjust it - are poorly understood in honeybees. A better understanding of maternal effects in honeybees would help us better understand the impacts of landscape changes and poor foraging conditions on colony health.

The candidate will use cutting-edge molecular tools to analyse how different foraging landscapes (urban, agricultural, and semi-natural environments) and experimental manipulations of pollen and honey stores affect the molecular and nutritional composition of queen-laid eggs. This will be combined with radio-frequency identification (RFID) tracking of individually marked bees originating from large and small eggs to assess the long-term effects of these maternal effects on worker behaviour and lifespan. They will monitor these individually tagged bees from their first day after emergence to their death to assess, for example, if workers originating from small eggs are smaller and show a lower foraging performance. Based on the results of the behavioural tracking experiments, the candidate will develop predictive models to assess how variation in resource allocation by queens could affect colony growth and pollination capacity in rapidly changing environments.