Effects of diesel exhaust particles on the health and survival of the buff-tailed bumblebee *Bombus terrestris* after acute and chronic oral exposure

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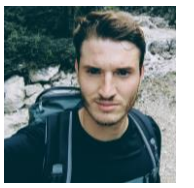
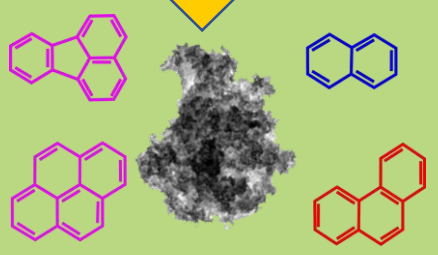


Background & Research Question

Pollution, e.g. traffic-derived particulate matter, is the second largest driver for species decline after habitat fragmentation. Highly active, flying insect pollinators near heavily trafficked areas are exposed to high amounts of diesel **exhaust particles (DEP)** and associated polycyclic aromatic hydrocarbons (PAH) which are discussed to be the major driver for the particles' toxicity. Most studies performed to assess the toxicity of stressors towards pollinators are performed with honeybees. Honeybee hives can buffer measurable toxic effects from stressors due to their high number of individuals. Small hive or solitary pollinators don't exhibit the number of individuals for this buffer-capacity, making them more susceptible for stressors. **To assess dose-dependent effects of DEP on small hive pollinators, we exposed workers from the buff-tailed bumblebee *Bombus terrestris* to various concentrations of DEP/ sugar solution suspension in acute and chronic oral toxicity tests**

1. Generation of DEP after NEDC-UDC guidelines



DEP containing PAHs

2. Particle characterisation

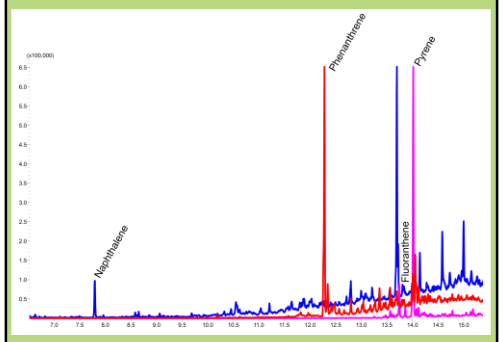


Fig.1: Peaks of relevant PAHs analysed in SIM mode via GC-MS

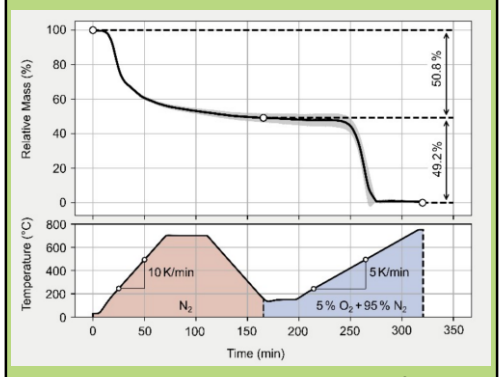
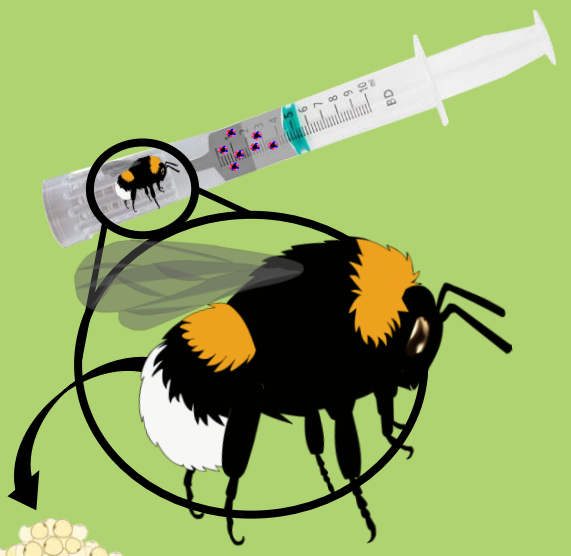


Fig.2: Thermogravitational anlysis of the particles

3. Acute and chronic oral exposure to DEP



Subsequent measurement of fat body content as proxy for the bumblebees' health condition

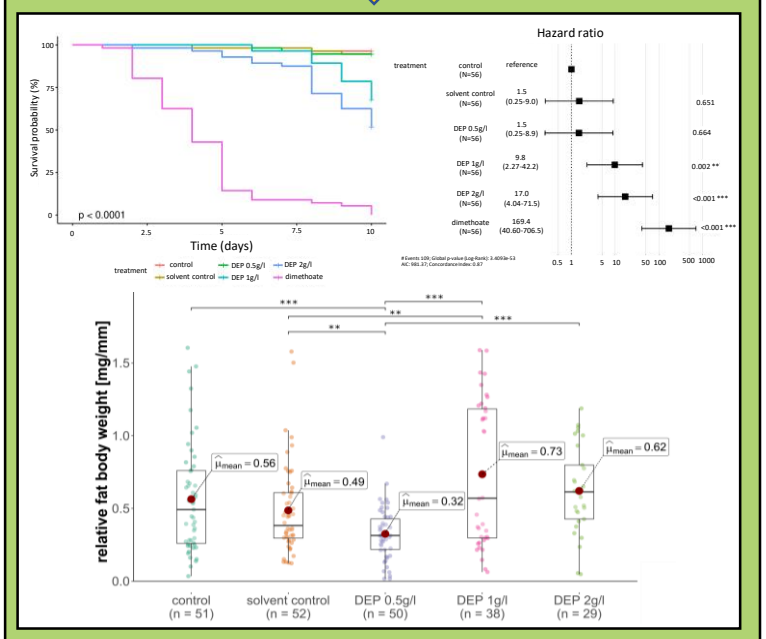
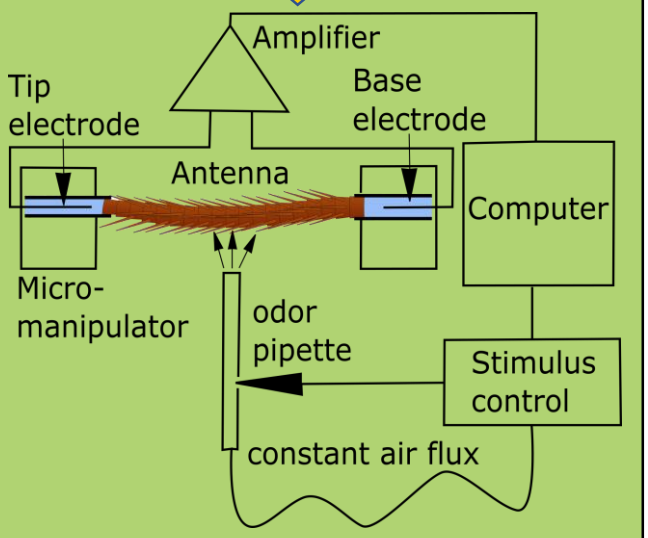


Fig.3: survival analysis of *B. terrestris* individulas exposed to DEP and controls after 10 days (top). Relative fat body content of living bumblebees after the 10-day exposure experiment (bottom)

4. Impact on perception

Exposure of Bumblebees to DEP in airstream



Elektroantennographic analysis of the exposed antennae

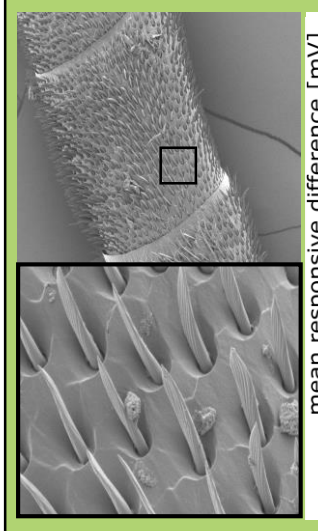


Fig.4: SEM Image of an antenna exposed to DEP

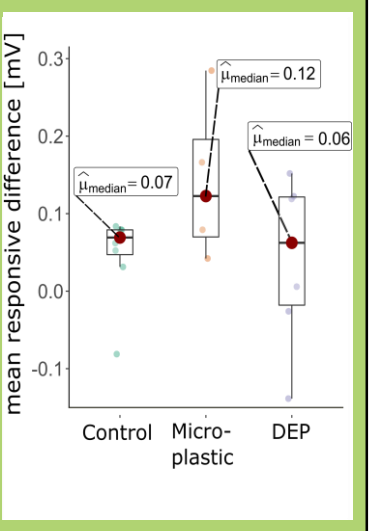


Fig.5: Difference in stimulus perception between treatments after DEP and MP exposure

Discussion

It was shown, that exposure to DEP led to memory loss, reduced learning ability, and reduced stress tolerance in honey bees, in addition, we showed a reduction in pollinator survival rate after dose-response experiments. The fat body weight was significantly reduced in bumblebees exposed to 0.5 g/l DEP. The fat body content is proxy for an insects' health. A reduction of fat body increases the susceptibility to additional stressors. In preliminary experiments no significant differences in the stimulus perception of bumblebee antennae exposed to DEP compared to control bumblebees were recorded. A full picture will be recorded in further experiments

Key References: Arrese, E. L., & Soulages, J. L. (2010). Insect fat body: Energy, metabolism, and regulation. *Annual Review of Entomology*, *55*, 207–225. https://doi.org/10.1146/annurev-ento-112408-085356; Gaga, E. O., & Arı, A. (2019). Gas-particle partitioning and health risk estimation of polycyclic aromatic hydrocarbons (PAHs) at urban, suburban and tunnel atmospheres: Use of measured EC and OC in model calculations. *Atmospheric Pollution Research*, *10*(1), 1–11. https://doi.org/10.1016/j.apr.2018.05.004; Gradish, A. E., Van Der Steen, J., Scott-Dupree, C. D., Cabrera, A. R., Cutler, G. C., Goulson, D., Klein, O., Lehmann, D. M., Lückmann, J., O'Neill, B., Raine, N. E., Sharma, B., & Thompson, H. (2019). Comparison of Pesticide Exposure in Honey Bees (Hymenoptera: Apidae) and Bumble Bees (Hymenoptera: Apidae): Implications for Risk Assessments. *Environmental Entomology*, *48*(1), 12–21. https://doi.org/10.1093/ee/nvy168; Reitmayer, C. M., Ryalls, J. M. W., Farthing, E., Jackson, C. W., Girling, R. D., & Newman, T. A. (2019). Acute exposure to diesel exhaust induces central nervous system stress and altered learning and memory in honey bees. *Scientific Reports*, *9*(1), 1–9. https://doi.org/10.1038/s41598-019-41876-w;Sánchez-Bayo, F., & Wyckhuys, K. A. G. (2019). Worldwide decline of the entomofauna: A review of its drivers. *Biological Conservation*, *232*(January), 8–27. https://doi.org/10.1016/j.biocon.2019.01.020;