

Effects of Ozone on Honeybee Pheromone ~ Elucidation of Correlation with Colony Collapse Disorder ~

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Colony Collapse Disorder (CCD), an abnormal phenomenon where most worker bees in a healthy honeybee colony disappear and decreases its foraging efficiency, has been occurring around the world since the 1950s and a problem ever since. Its damage is immense with the number of bees in the U.S. decreasing by 61% between 1947 and 2008 and 31.6% in 2019¹⁾. Although pesticides and pathogens have been cited as the major cause of CCD, pheromones are also thought to be one cause of CCD. Honeybees use pheromones for communication, and an example is the Nasonov gland pheromone. Bees secrete aggregation pheromones called Nasonov gland pheromones from their Nasonov glands as a means of communicating and maintaining the bee colony. It has been apparent that the amount of pheromone and the ratio of its components are proportional to the amount of resource.

Since pheromones are known to have a similar structure to the odor components of flowers, and since previous studies have shown that ozone alters the odor of flowers and making them less attractive to honeybees²⁾, we hypothesized that ozone may also affect Nasonov gland pheromones, which are necessary for communicate. Therefore, this study was conducted to determine how geraniol, the main component of Nasonov gland pheromone, is altered by ozonolysis. A film of geraniol approximately 0.8 cm in diameter was exposed to 1000 ppmv of ozone. Rate constants were determined from the time change of FT-IR spectra.

As a result, bulk reaction rate constant of $2.3 \times 10^{-21} \text{ cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$ was obtained. The bulk phase rate constant being slower than the gas phase rate constant $9.3 \times 10^{-16} \text{ cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$ is likely influenced by uptake coefficient and diffusion coefficient. Furthermore, the viscosity of the thin film increased with long exposure due to polymerization. The decrease in the amount of pheromones due to polymerization may be one reason why bees cannot smell the scent.

1) Robert C. Kelly. The Balance, Colony Collapse Disorder and Its Impact on the Economy.

<https://www.thebalancemoney.com/bee-colony-collapse-disorder-facts-and-economic-impact-3305815>. Accessed 2023/01/05.

2) Démares, Fabien, et al. "Acute Ozone Exposure Impairs Detection of Floral Odor, Learning, and Memory of Honey Bees, through Olfactory Generalization." *Science of The Total Environment*, vol. 827, June 2022, p. 154342, <https://doi.org/10.1016/j.scitotenv.2022.154342>.

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