APIMONDIA SCANDINAVIA 2025
SWEDEN | DENMARK | NORWAY

PP-049 [Bee Health]

LIGHT THERAPY APPLIED TO BEES
Protecting bees from climate, toxicity and transport stressors with deep red light
2019 - 2025 interim research report

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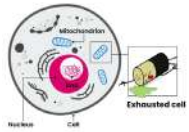
Background
The ophthalmology department at University College London (UCL), led by Prof. Glen Jeffery, studies age-related macular degeneration for human. Over 30 years, they've shown long-wavelength light enhances mitochondrial membrane potential and ATP production. Trials in mammals and insects confirm this response is conserved across species.

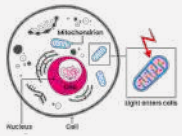
Beefutures began collaborating with UCL in 2019 to explore ways to improve bee health, based on the hypothesis that common stressors cause cellular stress and mitochondrial decline, as outlined in UCL studies.

Mitochondria and ageing principles


Mitochondria are vital for cell health, respiration, and energy. With age, mtDNA mutations impair mitochondrial function, reducing ATP and increasing reactive oxygen species (ROS). If cells can't adapt, they die—leading to lower energy, rising inflammation, and declines in CNS function, mobility, and immunity.

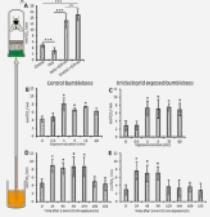
Purpose of the research & scientific questions
- Transpose light therapy from individual insects to whole colonies — how, and how to assess?
- How to bring long-wavelength light exposure to the entire bee colony without negatively impacting their behaviour.
- Assess how various challenges impact colony metabolism — which ones, and how?
- Determine if stress effects on bee colony can be reversed with light exposure.
- Evaluate the scalability of stress and light measurements.
- Consider side effects: overexposure, altered colony dynamics, population changes.

UCL´s background laboratory research

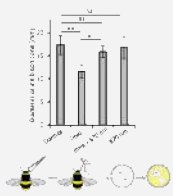


Cellular stress resembles accelerated ageing, marked by reduced ATP and increased ROS. UCL research (see PLOS ONE references) assessed various metabolic markers to evaluate stress and light effects. These metrics provided strong evidence and informed our selection for bee studies.

Respiration & Immunity metrics
Neonicotinoid exposure lab trial on bumblebees



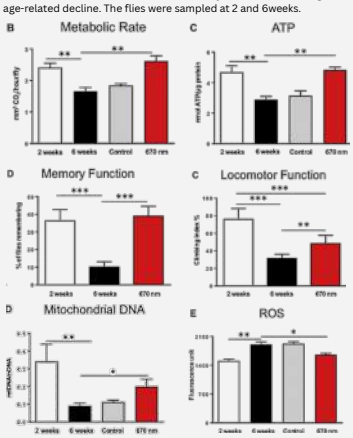
Imidacloprid disrupts mitochondrial function, likely affecting respiration. We measured whole-body CO_2 production in individual bumblebees exposed to imidacloprid for 5 days. Imidacloprid reduced respiration by 36%, an effect reversed by 670nm light administered for 15 minutes twice daily.



To assess if 670nm light preserves immunocompetence, bumblebees were exposed to Imidacloprid and/or 670nm light for 4 days, then challenged with E. coli. Haemolymph was collected 24h later and analysed via inhibition zone assays. Imidacloprid reduced antibacterial activity, partially restored by 670nm light. n = 17 bees/group. Abbreviations: p < 0.05, p < 0.01, ns = not significant, Imid = Imidacloprid.

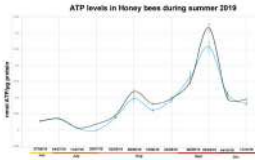
Improving mitochondrial function in *Drosophila melanogaster*

Drosophila, daily 670nm light for one week was used to assess metabolic and functional effects. Researchers measured changes in metabolism, motor function, retinal health, and memory to test if 670nm light mitigates age-related decline. The flies were sampled at 2 and 6weeks.

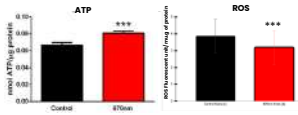


Preliminary field tests with honeybees – ATP/ROS metrics

Six colonies were used from June to October (3 light-exposed, 3 control), all identical in breed, strength, size, and queen age. Beekeeping interventions were consistent across hives. Each week, 10 bees per hive (50/50 nurse and worker) were sampled. ATP and ROS were measured to assess mitochondrial state.

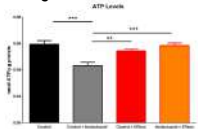


Baselining the ATP profile evolution of the colonies. ATP shifts over the months, lowest in July , rising in August and peaking in Sept/Oct. N= 10 bees par time point.



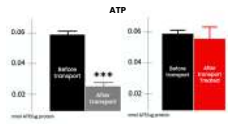
Average ATP & ROS of control colonies vs. 670nm light-exposed colonies throughout the test period. Inverted correlation of ATP/ROS validates the consistency of the readings, confirming higher ATP and less ROS in treated colonies

Inducing stress with neonicotinoids



ATP was measured in bees from four winter-treated hives: control, imidacloprid, 670nm light, and both combined. By winter's end, ATP in the combined group matched control. The imidacloprid-only hive showed low ATP, shivering, poor brood, and collapsed.

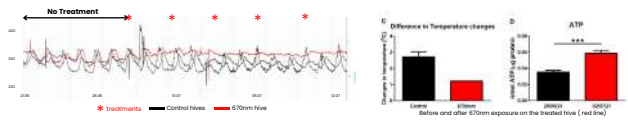
Inducing stress with transportation in truck



ATP was measured in from 20 bees from six equally strong hives transported 50km. Bees were sampled before and after transportation.

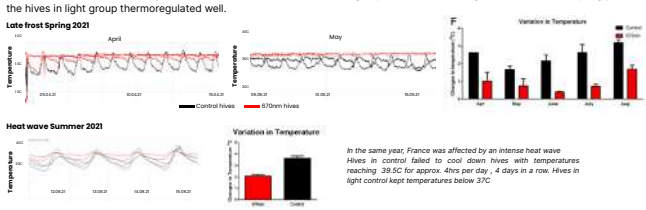
ATP/ROS & honeybee colony thermoregulation performance correlation

Honeybees maintain stable brood nest temperatures day and night. Colonies that fail to thermoregulate are often queenless, broodless, or too weak to control hive temperature. Effective thermoregulation demands coordinated effort: collecting water, fanning, and heating to manage humidity and heat. This process is energy-intensive. The trial revealed that non-thermoregulating colonies also exhibit low ATP, the test also revealed how colonies can recover and maintain thermoregulation with 670nm



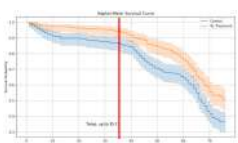
Climate stressors - scaled trial with thermoregulation metrics

Spring 2021 in France featured an abnormally warm March followed by a damaging, cold April frost, which severely impacted vineyards and fruit crops. A climate change attribution study by the World Weather Attribution found that human activity made these post-bud-burst frosts colder by about 1.2°C. All bee colonies in control group failed to thermoregulate for the entire spring period, the hives in light group thermoregulated well.



In the same year, France was affected by an intense heat wave Hives in control failed to cool down hives with temperatures reaching 39.5C for approx. 4hrs per day , 4 days in a row. Hives in light control kept temperatures below 37C

Effect of light therapy on survival in *B. terrestris*



Preliminary testing of 670 nm light exposure on survival used four commercial *B. terrestris* colonies (2 control, 2 RL treatment). A total of 720 workers (180 per colony) were tagged, fed per os, and monitored for daily mortality. From day 37, bees underwent temperature stress (35 °C, 35% RH, 6 hrs/day, 5 days/week). The experiment ended on day 76, and Kaplan–Meier analysis showed a significant survival difference between control and treated groups ($\chi^2 = 14.40$, df = 3, $p < 0.005$).

CONCLUSION, APPLICATIONS, NEXT STEPS

Field research aligned with UCL lab findings, showing that 670nm exposure improves individual insect metabolism and scales to whole colonies. While honeybee health is mainly impacted by parasites like Varroa destructor, various stressors further weaken metabolism and immunity. 670nm light appears to offer protective benefits against common challenges such as transport, neonicotinoids, and climate stress. A non intrusive and low powered device in hive could help beekeepers keeping healthier bees and providing higher foraging force for crop pollination.
Next work will consist in evaluating the influence of 670nm in larve/puppae development. Field tests in pollination will also determine the influence of 670nm on foraging activity of honeybees and bumblebees.

PUBLICATIONS

RESEARCH PARTNERS
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PP-049 [Bee Health]

Light therapy applied to bees, a game changer approach to protect bees from climate, toxicity and transport stressors

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Bee populations are threatened by increasing myriad sources of stressors, from parasites to climate change and insecticide use. Combined with intensive beekeeping practices and long transportation for pollination, these culminate in physiological stress undermining the mitochondrial function of the cell. Over time, mitochondrial dysfunction leads to reduced metabolism and immunity, impaired cell respiration and cell death. Glen Jeffery, Professor of Neuroscience at UCL (University College, London), has been studying the effect of various wavelength radiation on cells for the past 40 years. With focus on ageing and age related retinal disease in human and how the impact of these can be avoided using a range of cellular, molecular and optical techniques. In 2019, the Company Beefutures joined forces with Glen´s team to investigate several aspects of bee health issues, suspecting that many environmental and agricultural stressors could be the overlooked causes of colony declines and overwintering failures. The 3 years of field research conducted in 3 apiaries in France and Norway have revealed shocking discoveries, pointing at a viable pathway to help bees coping with major climatic and toxicity stessors. It demonstrated the portability of the therapeutic effect to a complex superorganism such as bee colonies, linking metabolic metrics of individual bees with overall colony thermoregulation performance. With non intrusive, autonomous and low powered light device in hive, bees treated with light shown much higher resilience to stressors, higher metabolic rate and thermoregulation performance than controlled beehives. In this talk, Glen will give a short introduction to the main principle of photobiomodulation and his discoveries on mitochondrial function improvements. Glen will also present the highlights of the findings on applying light therapy in honeybee hives in the context of neonicotinoid exposure, transportation of bees and climate change stressors.