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Evidence for well-regulated nutrient sensing in old ant queens

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Background

In most organisms, longevity correlates negatively with fecundity [1,2]. Social insects represent an exception to this trade-off, since reproductive castes can live up to orders of magnitude longer than their sterile siblings[3]. The molecular mechanisms are poorly understood, however, the insulin/insulin-like growth factor (IGF) signalling (IIS) and the target of rapamycin (TOR) signalling pathways offer a potentially important area of research in this respect [2,3]. It has been demonstrated that an upregulation of these nutrient sensing pathways leads to increased fecundity but a reduction in lifespan [2]. Furthermore, a deregulation of nutrient sensing is classed as one of the hallmarks of ageing [3]. We hypothesised that the deregulation of nutrient sensing within old-aged individuals may be less pronounced in social insects. To estimate the strength of regulation within the IIS/TOR pathway we calculated the correlation of expression between pathway members: the connectivity.

References

[1] C. López-Otín et al. (2013) **The hallmarks of aging.** Cell, 153, pp. 1194-1217

[2] T. Flatt et al. (2008) **Drosophila germ-line modulation of insulin signaling and lifespan**. PNAS, 105:6368-6373

[3] M. C. Harrison et al. (2021) **Gene co-expression network reveals highly conserved, well-regulated anti-ageing mechanisms in old ant queens.** doi: 10.1101/2021.02.14.431190 BioRxiv

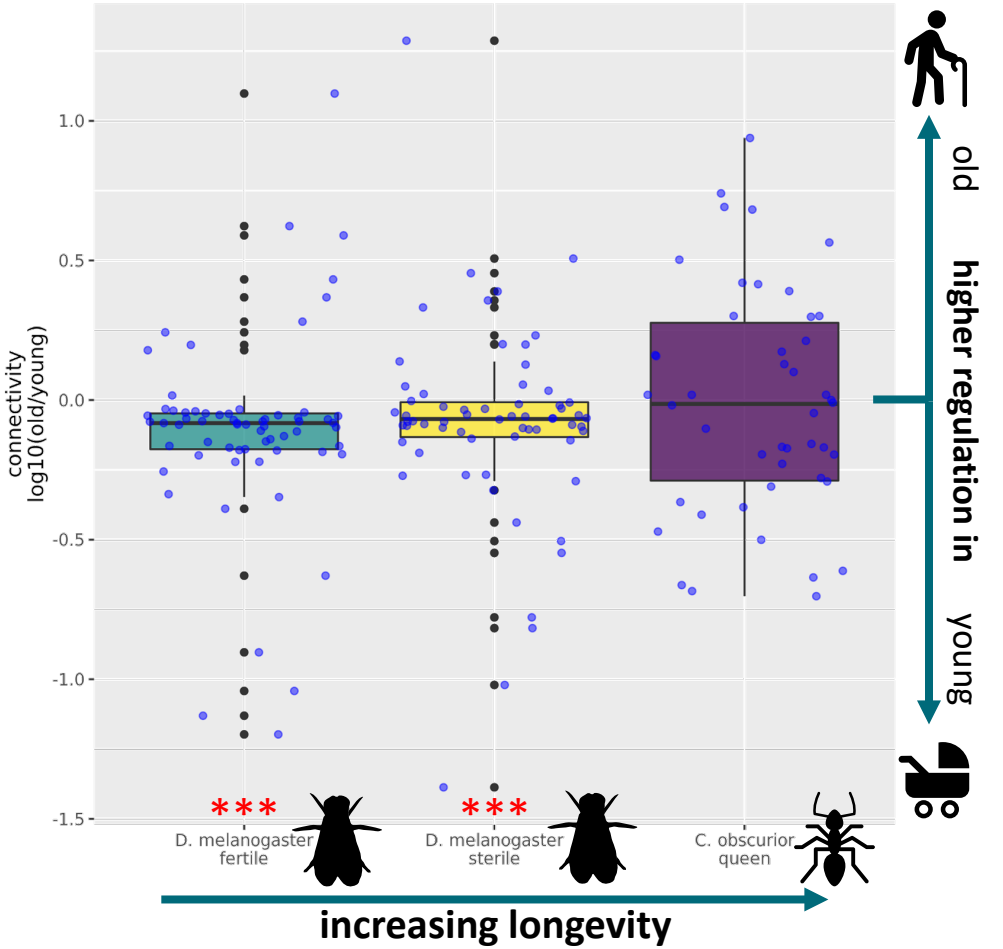
Drosophila melanogaster solitary - fertile
↑ medium reproduction
↓ short lifespan [2]

Drosophila melanogaster solitary - sterile
↓ no reproduction
↑ longer lifespan [2]

Cardiocondyla obscurior eusocial - queens
↑ high reproduction
↑ long lifespan

Results and Discussion

- Connectivity as a proxy for gene regulation is significantly decreasing for IIS/TOR pathway members in fertile and sterile flies with age, but not in ant queens
- Connectivity of IIS/TOR pathway genes remains stable with age in *C. obscurior* contrasting expectations for ageing individuals [1]
- As expected, connectivity declines less in long-lived sterile flies, confirming suitability of connectivity for estimating gene expression regulation
- The well-regulated nutrient sensing in *C. obscurior* fits to results showing even higher overall connectivity in old ant queens compared to young ones [3]
- **These results indicate lifelong, stable regulation of nutrient sensing in ant queens, offering a promising area of research for understanding the reversal of the longevity/fecundity trade-off in eusocial insects**



*** significant decrease in connectivity with age according to Wilcoxon Signed-Rank Test

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