Disentangling above and belowground insect herbivore interactions: a meta-analysis approach

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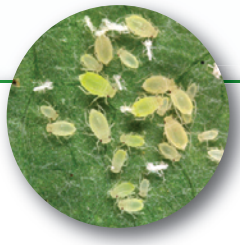
Aboveground (AG) - belowground (BG) insect herbivore interactions have been studied extensively for the last 20 years. Despite this, underlying patterns have been difficult to identify due to differing study systems. Here meta-analysis was used in the first quantitative review in this area.

Questions

1. Is there a general pattern for interactions between AG and BG insect herbivore interactions?
2. Are different performance parameters affected by AG - BG interactions?
3. Does insect order influence the direction of interactions between AG and BG insect herbivores?

Word searches were conducted in Web of Science (ISI) resulting in a final database of 22 studies, primarily published in 13 entomology and ecology journals. Impacts of insects on one another were measured in the journals using a variety of performance parameters and abundance. Meta-analyses were conducted using Hedges *d*' effect size and a mixed-effect model in the software package MetaWin.

Results



- AG insect herbivores generally had a negative impact on BG insect herbivores and BG insect herbivores had a positive impact on AG insect herbivores. However, the meta-analysis showed that these relationships were not statistically significant.
- AG insect herbivores significantly reduced the survival of BG insect herbivores, but did not significantly influence other performance parameters BG. (Figure 1)
- BG insect herbivores from the order Coleoptera had a significant positive influence on AG Homopteran insects, but did not significantly influence other AG insect orders. (Figure 2)

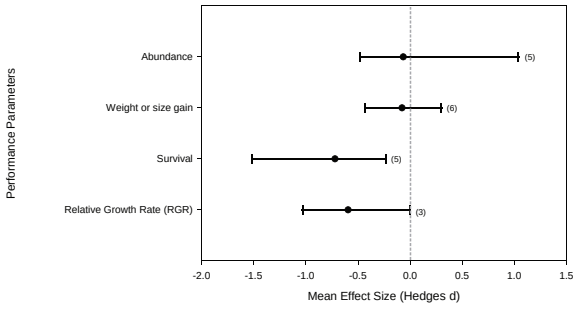


Figure 1. Influence of AG insect herbivores on BG insect herbivore performance parameters. Mean effect sizes with 95% CI's. Effects are significant if their associated CI's do not overlap zero. Numbers in brackets represent the number of studies included in the analysis.

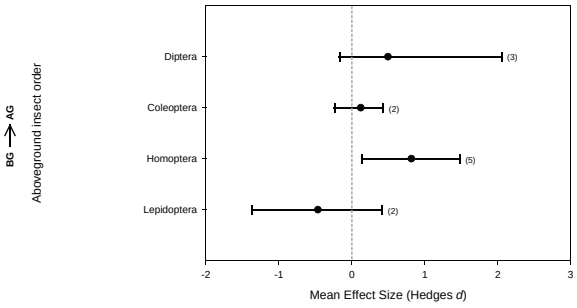


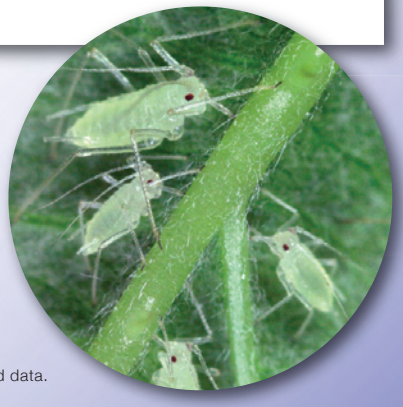
Figure 2. Effect of BG Coleopteran on AG insect orders (BG → AG).

Conclusions

- The overall direction of the interactions between AG and BG insect herbivores found by the meta-analysis corroborate previously hypothesised models, however, they remain trends that are not fully supported with empirical evidence.
- AG insect herbivores negatively influence BG insect herbivore survival.
- AG Homopteran insects were positively influenced by BG Coleoptean insects, supporting previous work (Gange and Brown 1989) that BG insect herbivores induce a stress response in the host plant.

Future Directions

- Increasing the range of insect orders utilised in studies, especially BG.
- Expansion of laboratory studies into field situations.



Acknowledgements
We are grateful to Susanne Wurst for providing unpublished data.

References

Gange, A. C. and Brown, V. K. 1989. Effects of root herbivory by an insect on a foliar-feeding species, mediated through changes in the host plant. - Oecologia 81: 38-42.