Venom toxicity and deployment method as means of biotic resistance

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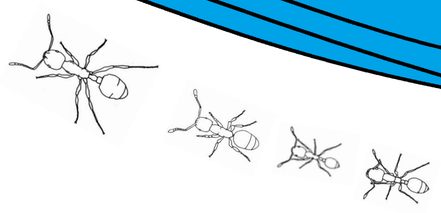
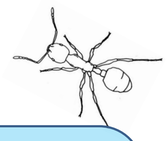


1) Background

Toxicity and the utilization of venom is an essential feature in the ecology of many animal species and has been hypothesized to be an important factor of community composition as it can provide an additional advantage in competitions, especially in ants (Sorrells *et al.* 2011).

Monomorium ants utilize a variety of venom compositions, which have been reported to give them a competitive advantage (Andersen, Blum & Jones 1991). The ant species *Monomorium antarcticum* and *M. smithii* have previously not been found to co-occur with the highly invasive Argentine ant on larger scales , while the two species *M. antipodum* and *M. sydneyense* have been observed to do so. The venom compositions of the two pairs of *Monomorium* species differ in their chemical structure.



2) Hypothesis

- Species with higher venom toxicity would have a higher rate of survival when engaging Argentine ants.
- Mortality of species engaging Argentine ants should differ depending on venom utilization.
- In the absence of venom, aggressive interactions result in a lower survival rate of the species engaging Argentine ants.

Interactions of Argentine ants and *M. antarcticum*, Photo credit George Novak.

Fig. 1. Arena fight assays and venom survival experiments.

3) Methods

We conducted arena fight assays (Fig. 1) with 12 ants of *M. antarcticum*, *M. smithii*, *M. antipodum* and *M. sydneyense* against 20, 40, 80, or 120 Argentine ants and assessed the mortality of *Monomorium* and Argentine ants after 1, 4 and 24 hours. We also observed the behaviour of individual *Monomorium* ants, scored each interaction with Argentine ants on a scale from 0 – 4, with higher numbers representing higher aggression (Suarez *et al.* 1999) and noted how venom was used (spraying/stinging/none).

Synthesized venoms of the four *Monomorium* species were used to test their toxicity on Argentine ants in venom survival experiments. 1 µl of venom solution at concentrations of 1, 5, 10, 15 and 20 µg/µl were used on anaesthetised Argentine ant workers and their status (alive/dead) assessed after one and four hours.

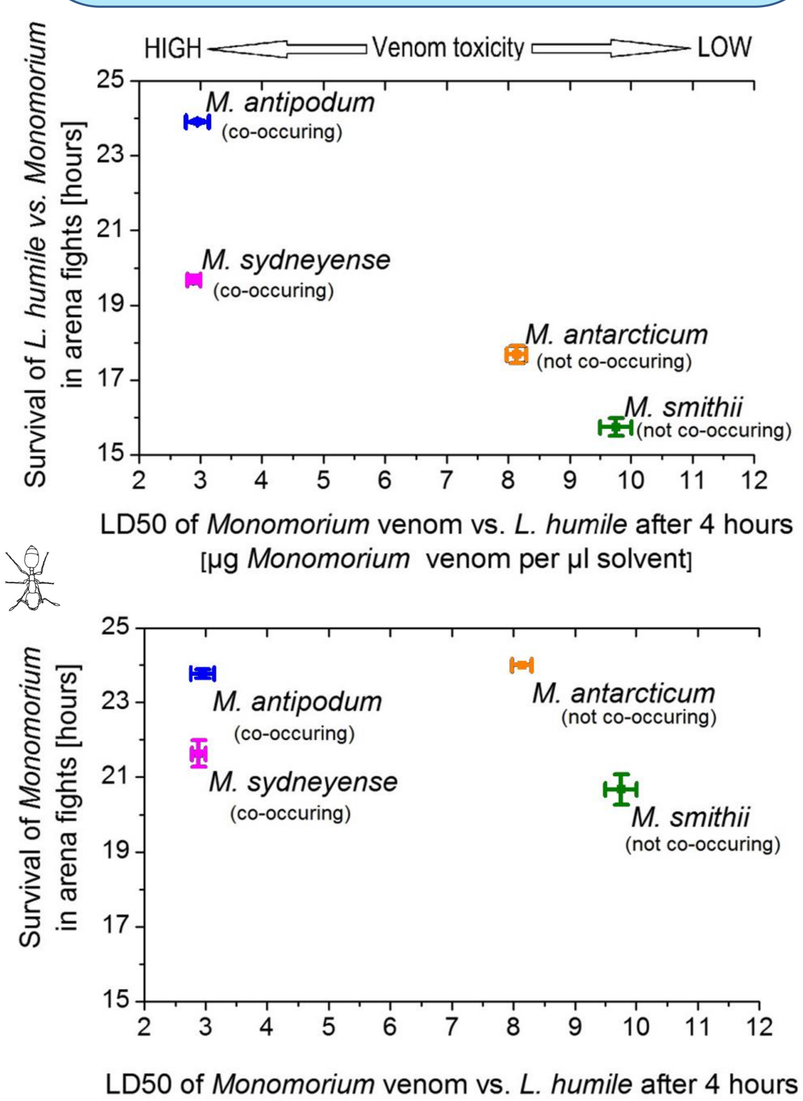


Fig 2. *Monomorium* toxicity and ant survival. Overall survival time of Argentine ant workers in arena fights against 4 *Monomorium* species correlated with the LD50 of the venom of that *Monomorium* species (upper) and the overall survival time of *Monomorium* workers in arena fights against Argentine ants correlated with the LD50 of the venom of that *Monomorium* species (lower).

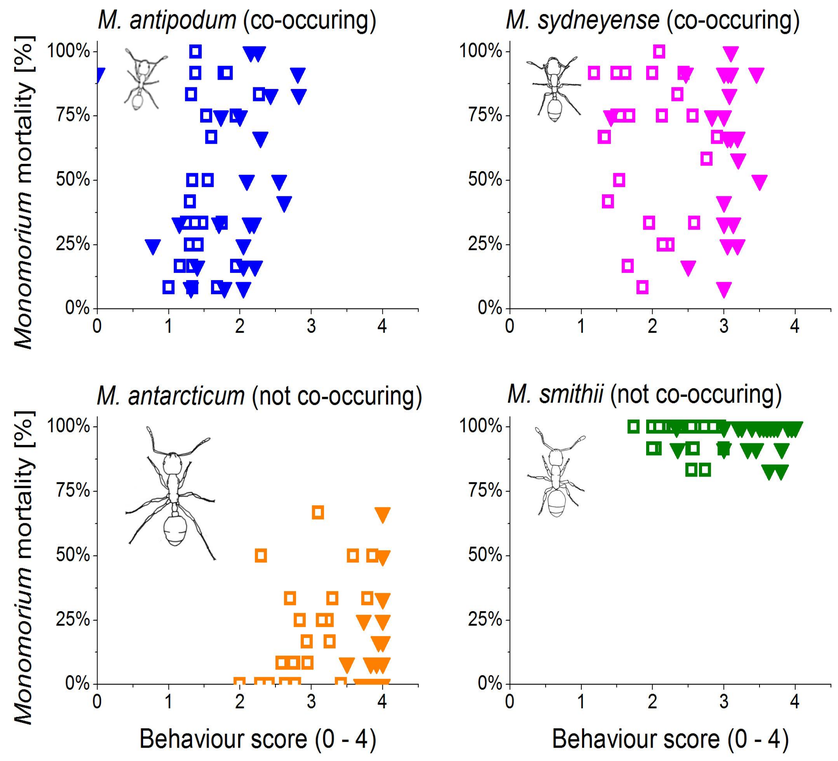


Fig 3. *Monomorium* mortality in arena fights. Mortality of *Monomorium* workers in arena fights against Argentine ants depending on Average Individual Aggression within the same replicate (open squares) and Average Maximum Aggression within the same replicate (closed triangles)

4) Results

Venom survival experiments showed that the toxicity of the two *Monomorium* species which do not co-occur (*M. antarcticum*, *M. smithii*), is lower than the toxicity of the two *Monomorium* species (*M. antipodum*, *M. sydneyenese*) which do. No correlation between *Monomorium* toxicity and their survival in arena tests was found (Fig. 2). Three *Monomorium* species displayed significant variability in venom usage depending on the number of Argentine ant workers encountered ($p < 0.001$). A significant relationship between venom utilization and worker mortality was found in *M. antipodum* ($p < 0.001$). M.antarcticum was almost significant ($p = 0.07$) Different patterns for mortality and behaviour were observed in all four species when encountering Argentine ants (Fig. 3). Average *Monomorium* mortality varied significantly between species, with *M. antarcticum* having the lowest (Average 2%) and *M. smithii* the highest mortality (Average 96.8%). For *M. antarcticum (*$p = 0.035$) and *M. antipodum (*$p = 0.008$), a significant positive correlation between worker mortality and aggression was found.

5) Conclusions

Contrary to what earlier studies (Andersen, Blum & Jones 1991) had hypothesized, we found no relationship between toxicity and survival. However, venom utilization influenced the mortality of *Monomorium* as did aggressive interactions.

Our study demonstrates that different factors and strategies contribute to the ability of a species to withstand the pressure of a dominant invader at high abundance.

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