Emergence of niche space in rotting wood through fungal-insect interactions

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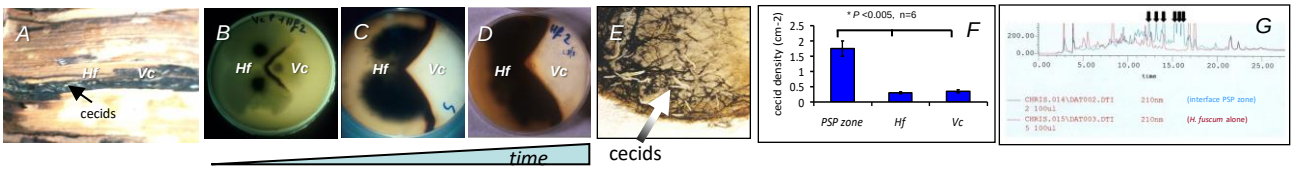
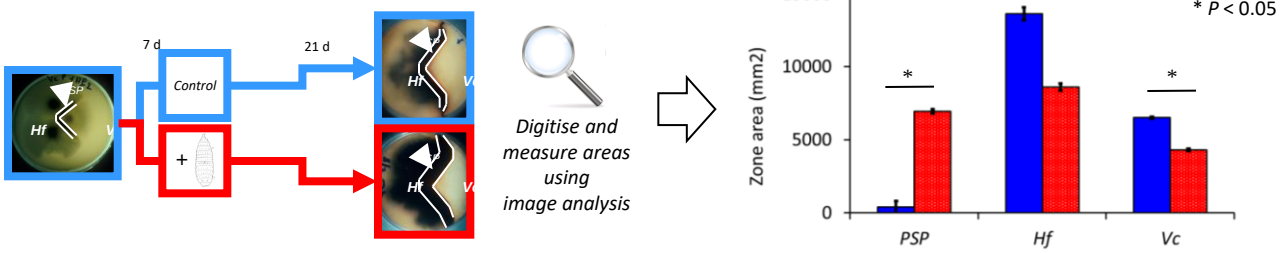
1. Introduction: Fungivorous paedogenetic larvae of *Brittenia fraxinicola* (Diptera, Cecidomyiidae) [*1*] live under the bark of decaying Hazel (*Corylus avellana*) and are associated with interfaces between two species of wood-rotting fungi, *Hypoxylon fuscum* (*Hf*) and *Vuilleminia comedans (Vc)*. We show that the insects specifically inhabit narrow sub-cortical niches of dead wood between adjacent fungal decay columns, which contain zones of melanised pseudosclerotial plate (PSP). Hypothesising that cecids promote fungal interactions and that fungal interactions also positively affect cecid proliferation, we tested this idea both *in vitro* and in a simulated natural model.

2. Cecids are associated with fungal interfaces: When they compete for resources when growing in hazel subcortical wood, the fungi *Hf* and *Vc* secrete damaging chemicals (including Reactive Oxygen Species [ROS]) at their mutual interface, causing formation of dark coloured interfacial PseudoSclerotial Plate (PSP). ***A.*** Cecid larvae (*B. fraxinicola*) are concentrated in PSP zones (arrowed) in pigmented wood between colonies of Hf and Vc. ***B-D.*** When *Hf* and *Vc* are cultured together on agar plates, dark-coloured PSP is formed at the interface; the 3 images show increasing time in culture. Note dark pigment spreads within the *Hf* culture, as well as at the interfacial PSP zone. ***E.*** When cecid larvae are introduced onto the plates 3 d after fungal inoculation, and allowed to self-distribute on the plate, they concentrate specifically at the interface/PSP zone (note dark tracks of previous movement). Larvae stay in the PSP zone because they display a high rate of turning. ***F.*** Graph shows the density of cecid larvae in the three zones. Note that cecids are attracted only to interfacial PSP zone, not pigmented areas. ***G***. HPLC reveals unique chemicals (arrows) in the interfacial PSP zone.

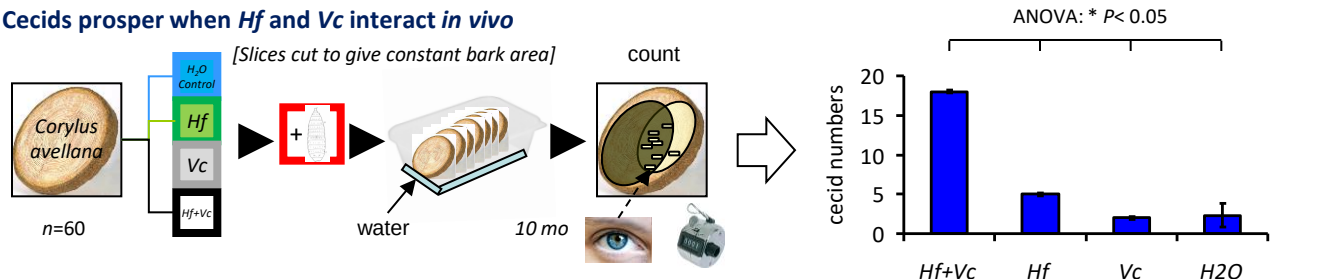


3. Cecids influence fungal interactions *in vitro*:



When cecid larvae are added to interacting cultures of the two fungal species, the area of PSP is increased at the expense of the area exclusively occupied by each fungus. [Cecids → ↑ PSP, ↓ Hf, ↓ Vc]. We suggest this is because the insects breach the boundaries between the fungal colonies, allowing PSP-associated chemicals produced by the fungi to diffuse more extensively.

4. Cecids prosper when *Hf* and *Vc* interact *in vivo*



Hazel wood slices were inoculated with either *Hf* or *Vc* or both fungi. When fungi were established, cecids were added. Controls were not inoculated with fungi but developed their own endogenous fungi. Water in the container kept humidity high and prevented cecids from moving between wood slices. After 10 months, the total number of cecids per log slice was counted. Cecid numbers were significantly higher in *Hf+Vc* interacting cultures. There was more PSP in wood inoculated with Hf+Vc + cecids (data not shown).

5. Summary

- Paedogenetic cecids, *Brittenia fraxinicola*, exploit narrow sub-cortical niches of dead hazel (*Corylus avellana*) wood colonised by the fungi *Hypoxylon fuscum* and *Vuilleminia comedans*. The insects specifically inhabit chemically distinct fungal interaction zones.
- The presence of cecids influences interactions between the fungi, causing an expansion of the interaction zone.
- Interactions between fungi promote cecid proliferation.
- The interaction between insects and fungi appears to be an example of niche construction [*2*] in which *B. fraxinicola* interacts with the fungi that it eats to promote the formation of its own habitat.

References

[*1*] Wyatt, I.J. (1967) Pupal paedogenesis in the Cecidomyiidae (Diptera). III. A reclassification of the Heteropezinae. *Trans. R. Ent. Soc.* **119**, 71-98.

[*2*] Odling-Smee, J.F., Laland, K.N. and Feldman, M.W. (2003) *Niche Construction: The Neglected Process in Evolution.* Monographs in Population Biology. New Jersey, Princeton University Press.

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