UNIVERSITY OF LIVERPOOL

Department of Evolution, Ecology and Behaviour

LANDSCAPE PROCESSES INFLUENCE MICROBIAL PARTNERSHIPS IN APHIDS

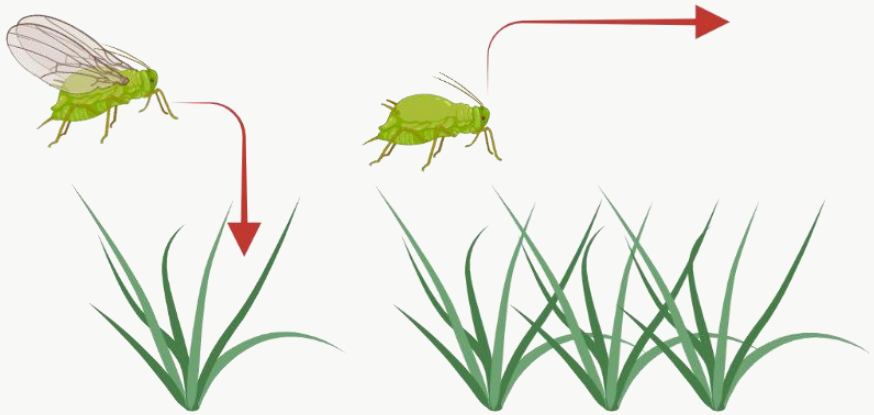


Dr Daniel Leybourne
1851 Research Fellow

October 2025

CEREAL APHIDS: IMPORTANT DISEASE VECTORS

- Cereal aphids vector yellow dwarf virus
- Brought in by winged aphids
- Spread through crop by walking aphids
- Virus can reduce yield by 20-80%





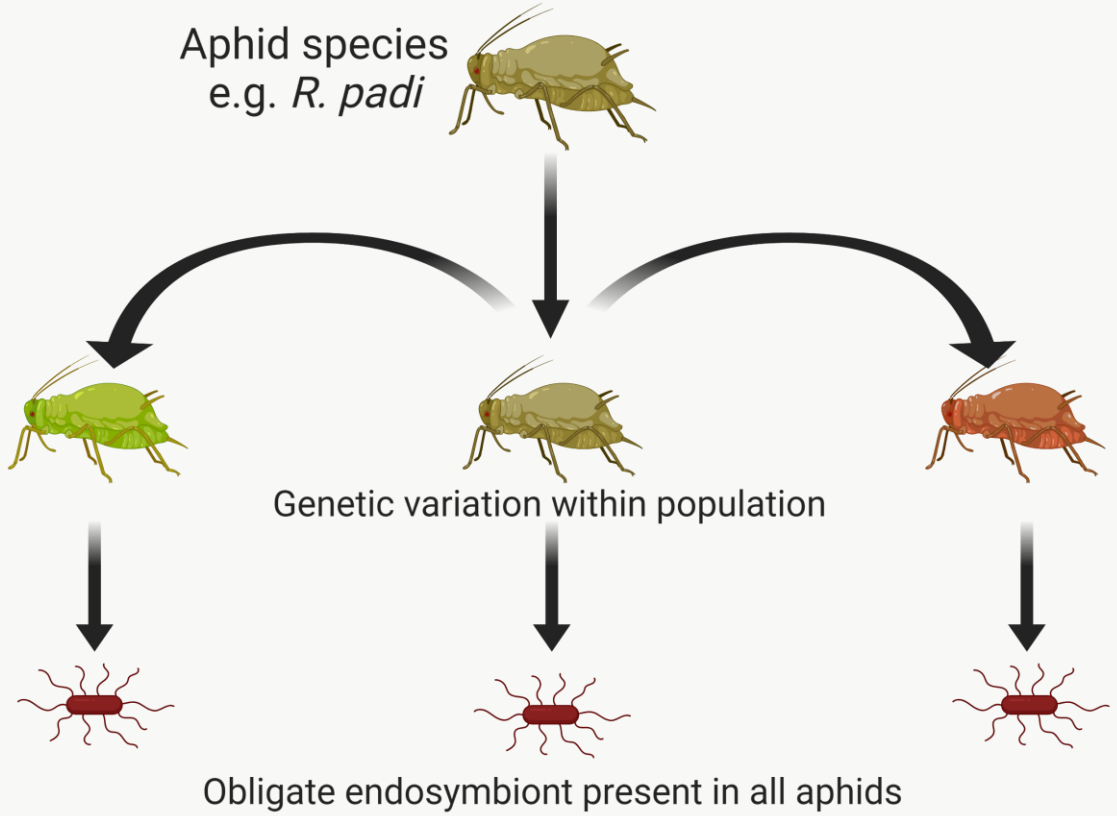




CEREAL APHID SYMBIONTS

Main facultative endosymbionts:

- *Hamiltonella defensa*
- *Regiella insecticola*
- *Serratia symbiotica*
- *Fukatsia symbiotica*
- *Aresnophonus spp.*
- *Rickettsia spp.*
- *Ricketsiella spp.*
- *Spiroplasma spp.*



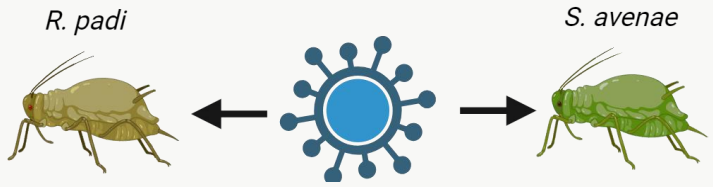


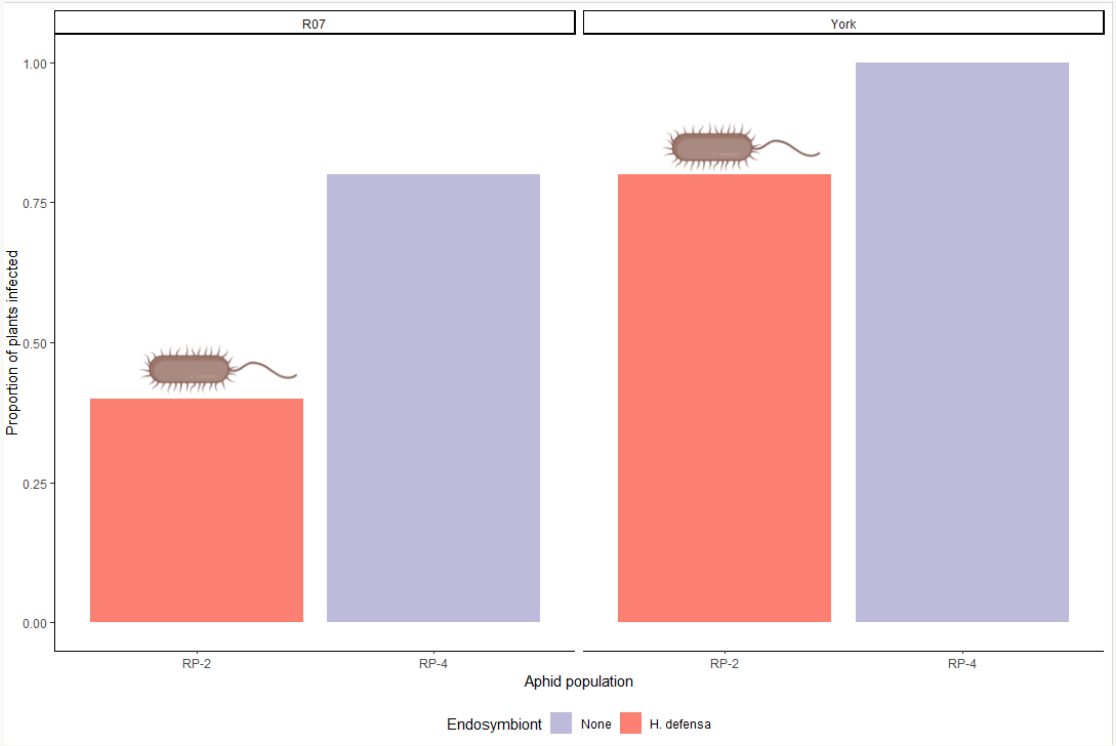


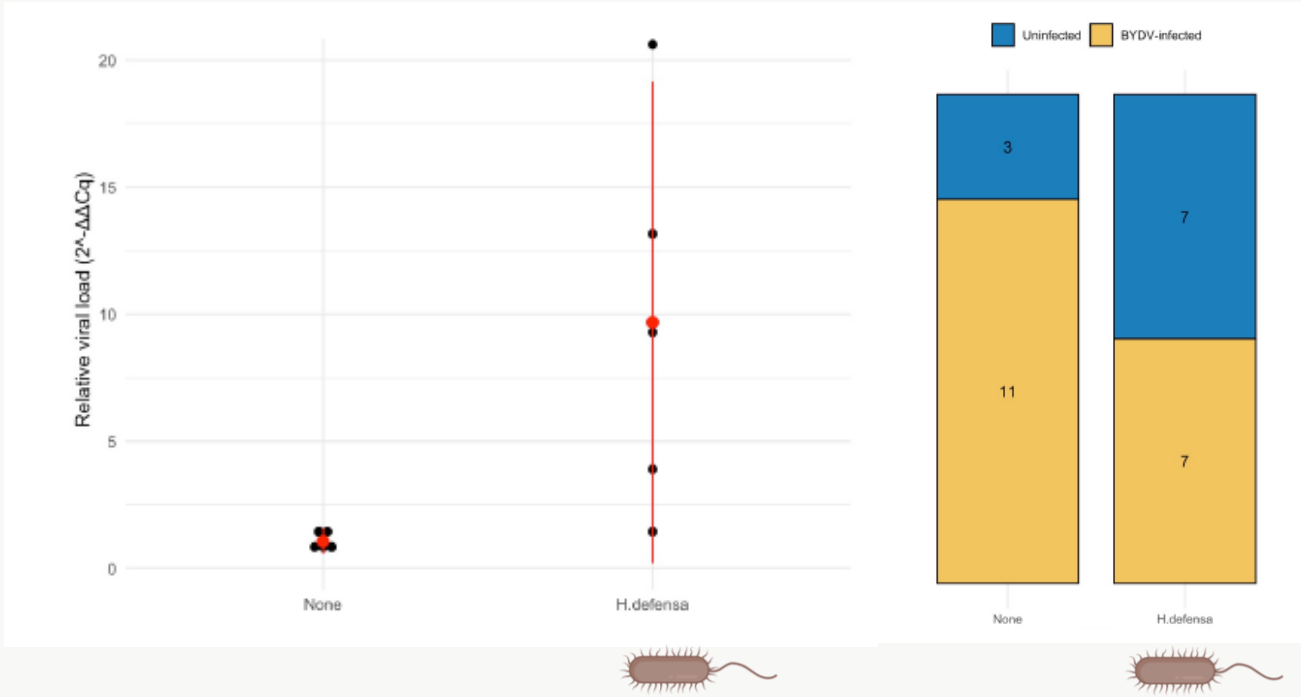


CEREAL APHID SYMBIONTS

barley yellow dwarf virus



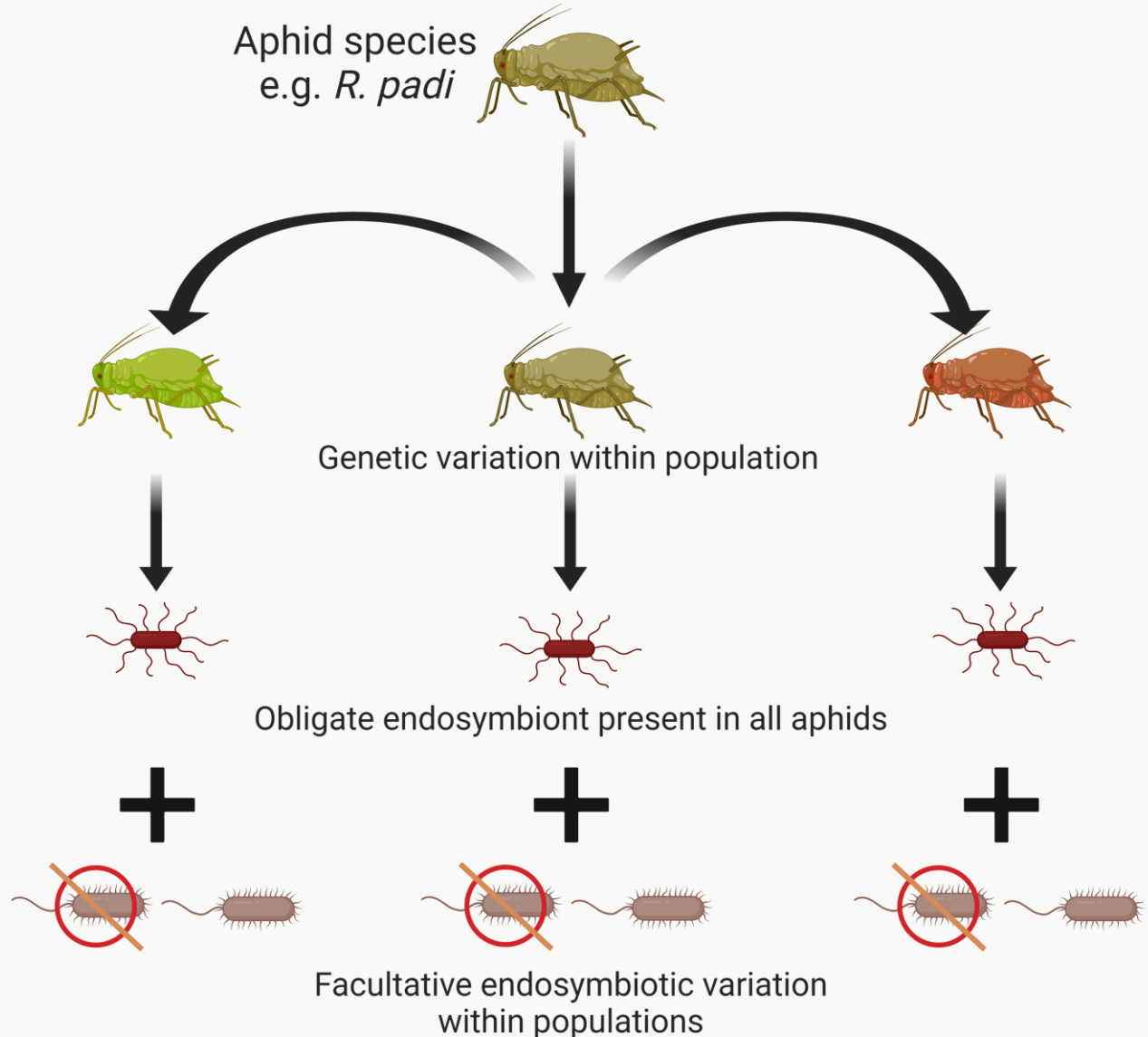




HOW COMMON ARE CEREAL APHID SYMBIONTS?

Main facultative endosymbionts:

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- *Regiella insecticola*
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WHAT IS DRIVING VARIABLE SYMBIOTIC ASSOCIATIONS?

Alexander von HUMBOLDT STIFTUNG

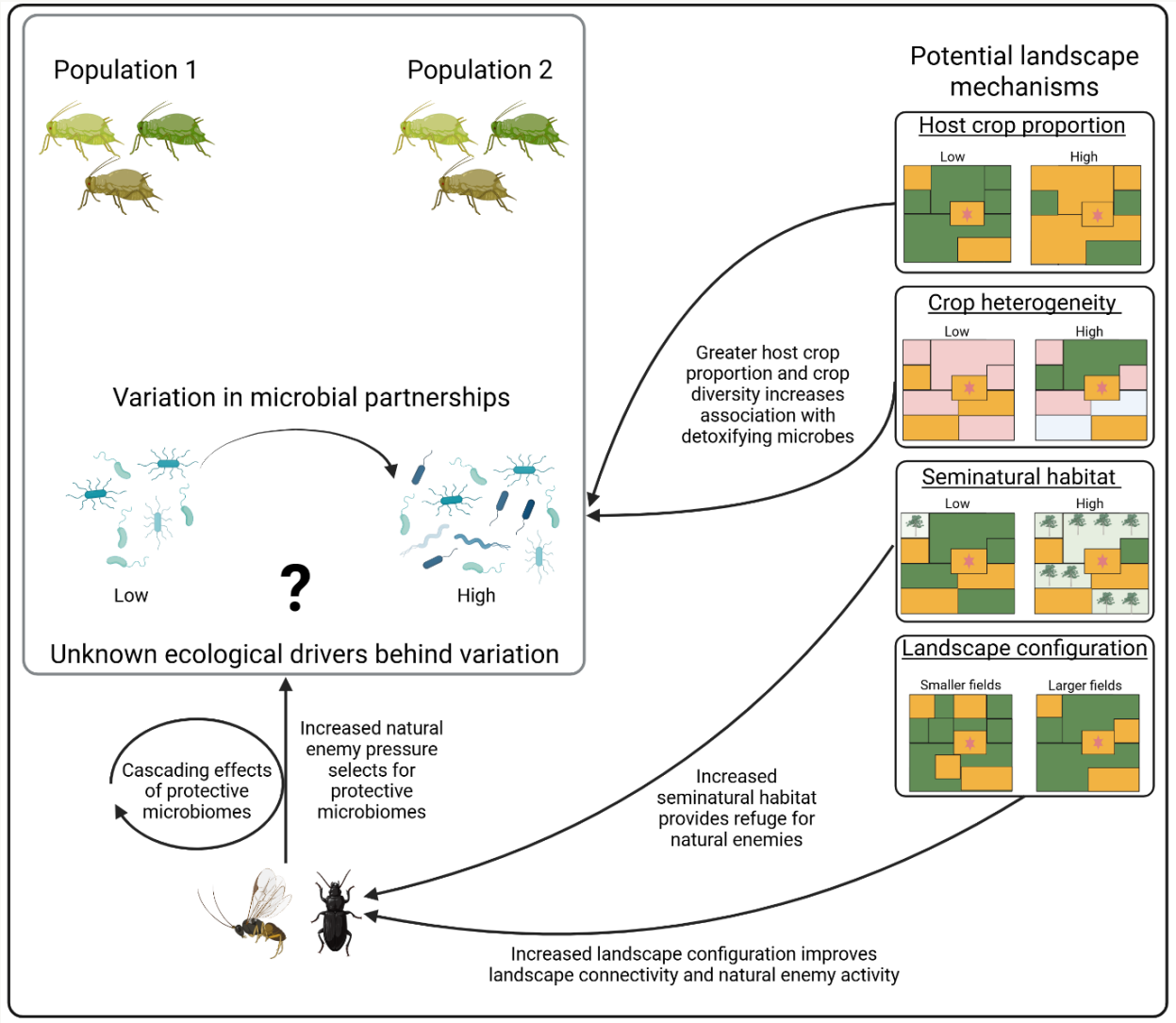
Leibniz Universität Hannover

Landscape processes influence insect populations – do these exert similar effects on symbionts?

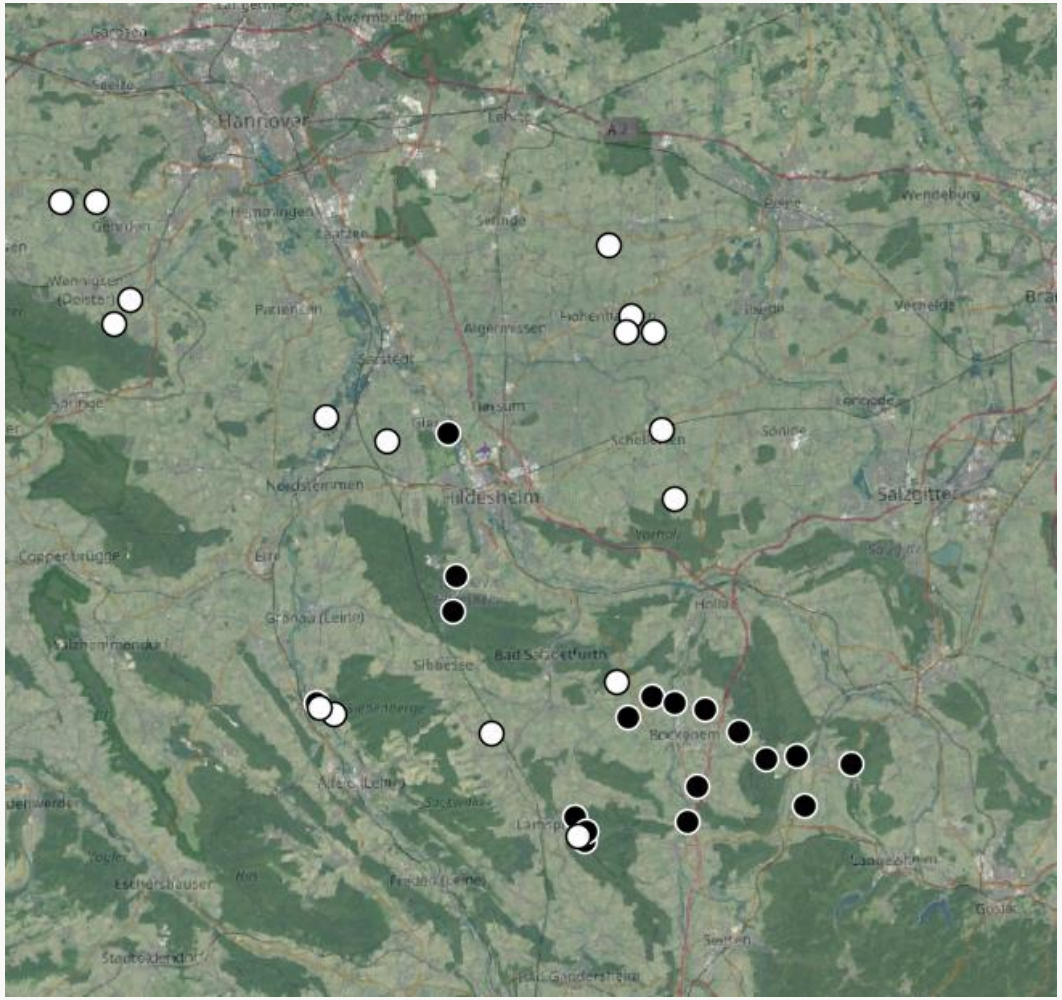
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2. Protective phenotypes often come with fitness trade-offs - cascading consequences and seasonally-dynamic symbiont associations.

3. Host crop proportion and crop heterogeneity - insect microbiome can be influenced by insect diet.

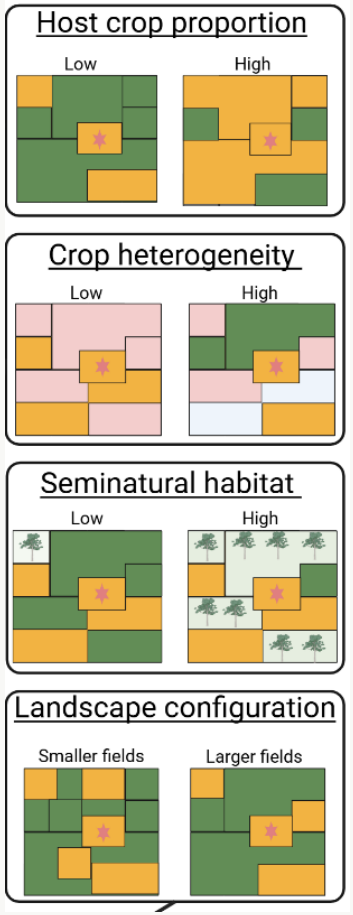


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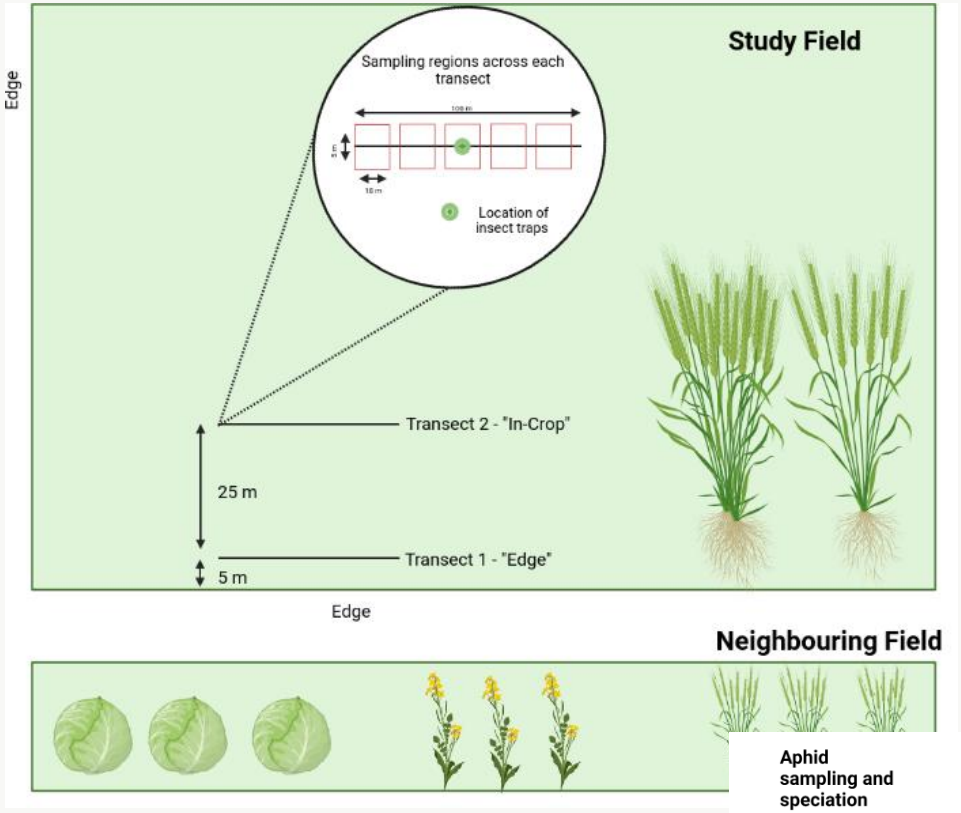






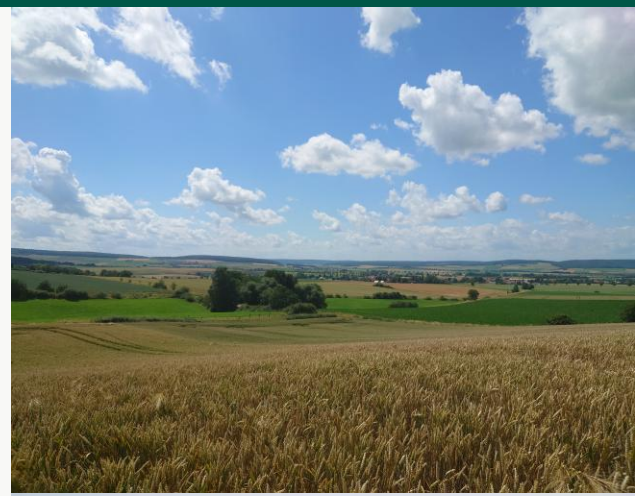


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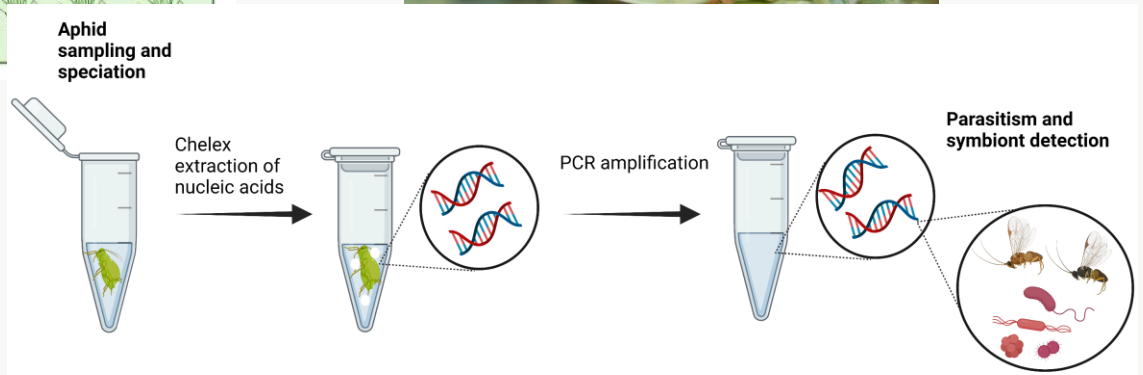








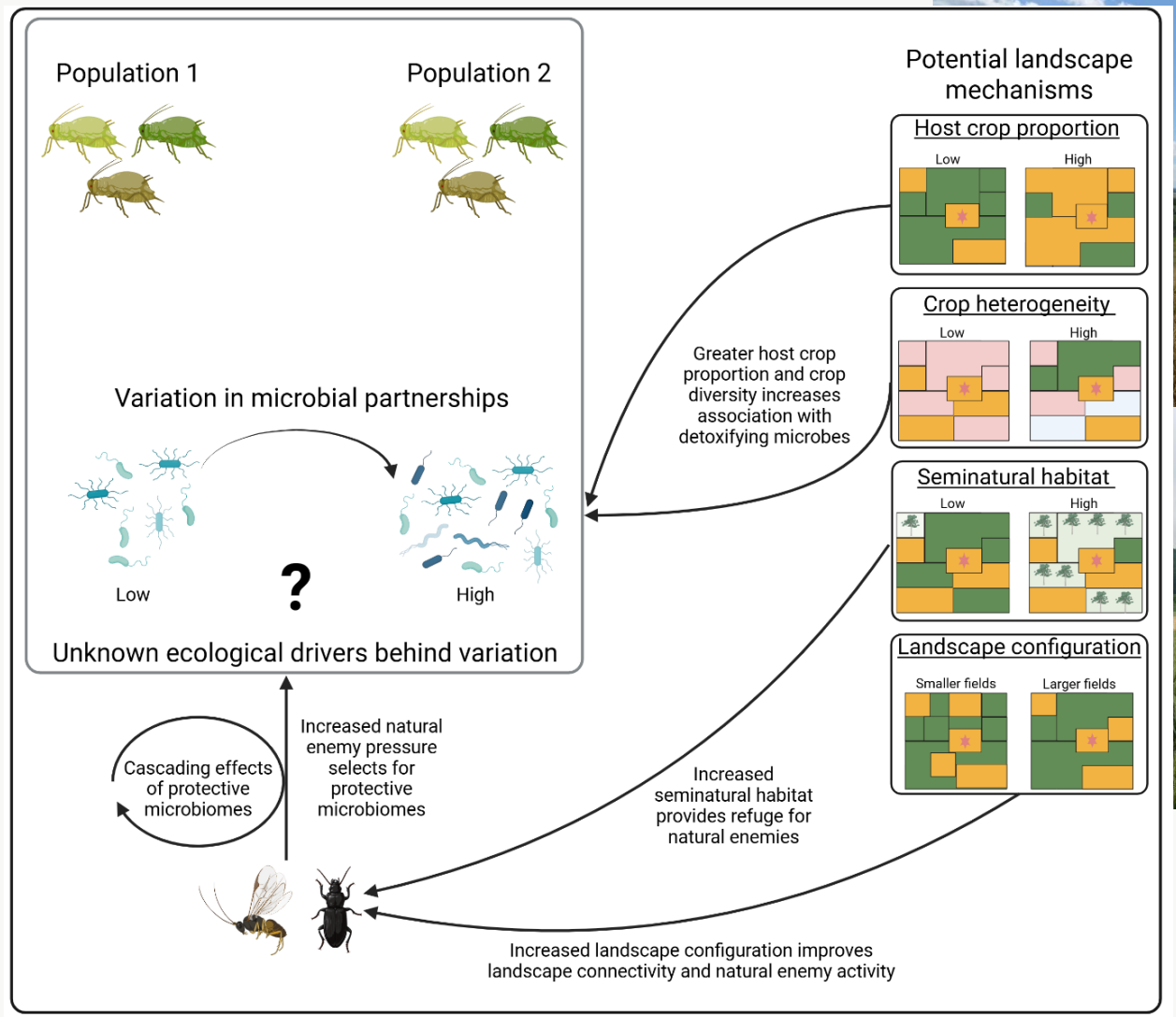




WHAT IS DRIVING VARIABLE SYMBIOTIC ASSOCIATIONS?

Three datasets:

1. Aphid abundance
   Ten quadrats / field
   (MD, RP, SA)
2. Natural enemy abundance
   Two locations / field
   (Parasitoid and Carabid)
3. Endosymbiont presence and diversity
   (per individual aphid)





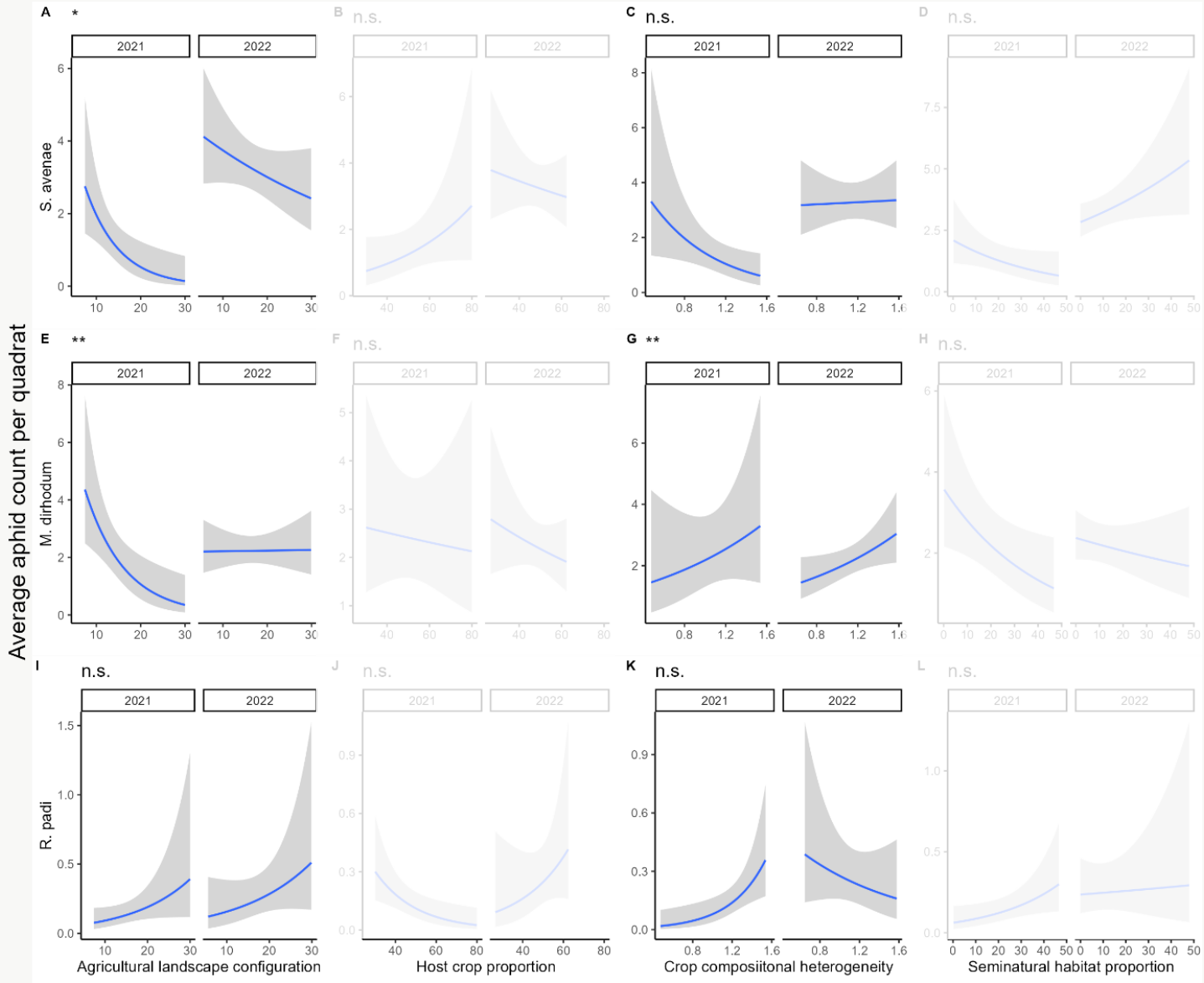


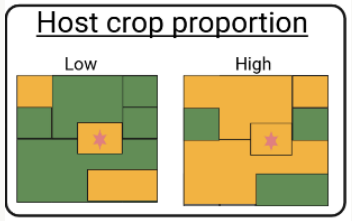
LANDSCAPE STRUCTURE AND APHID ABUNDANCE

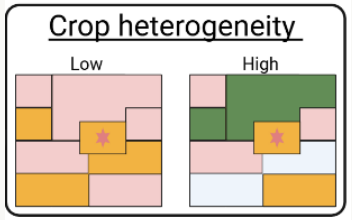


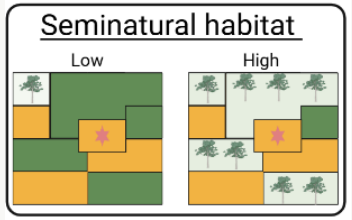


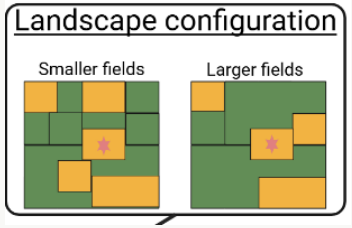






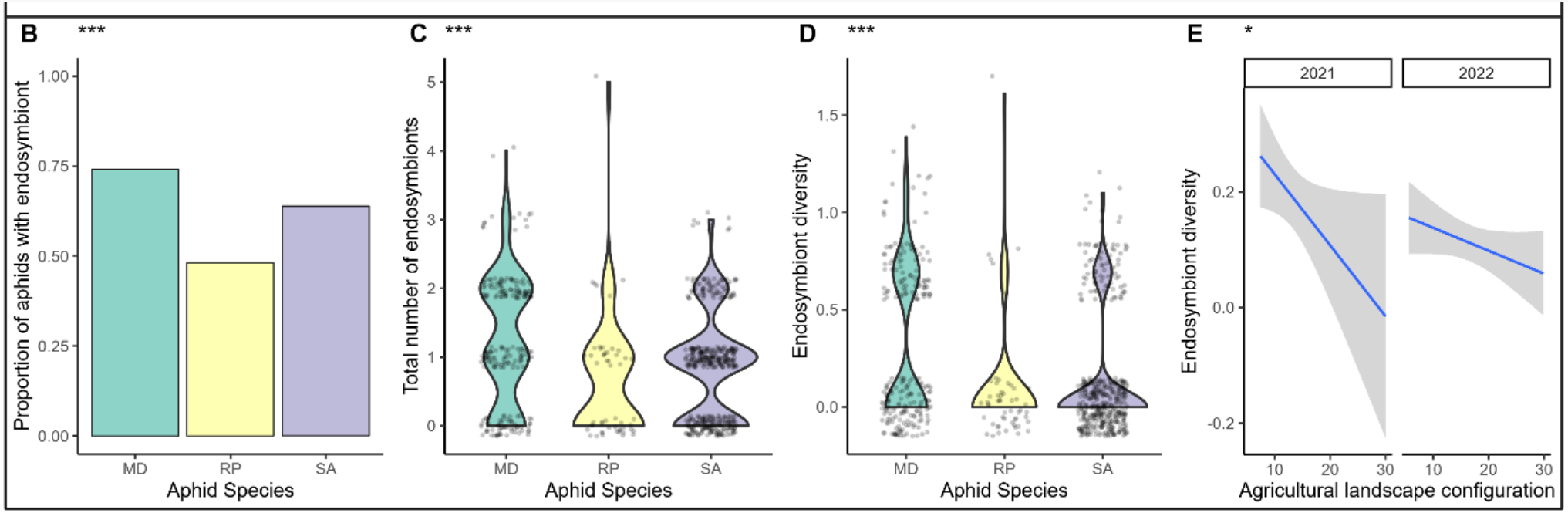




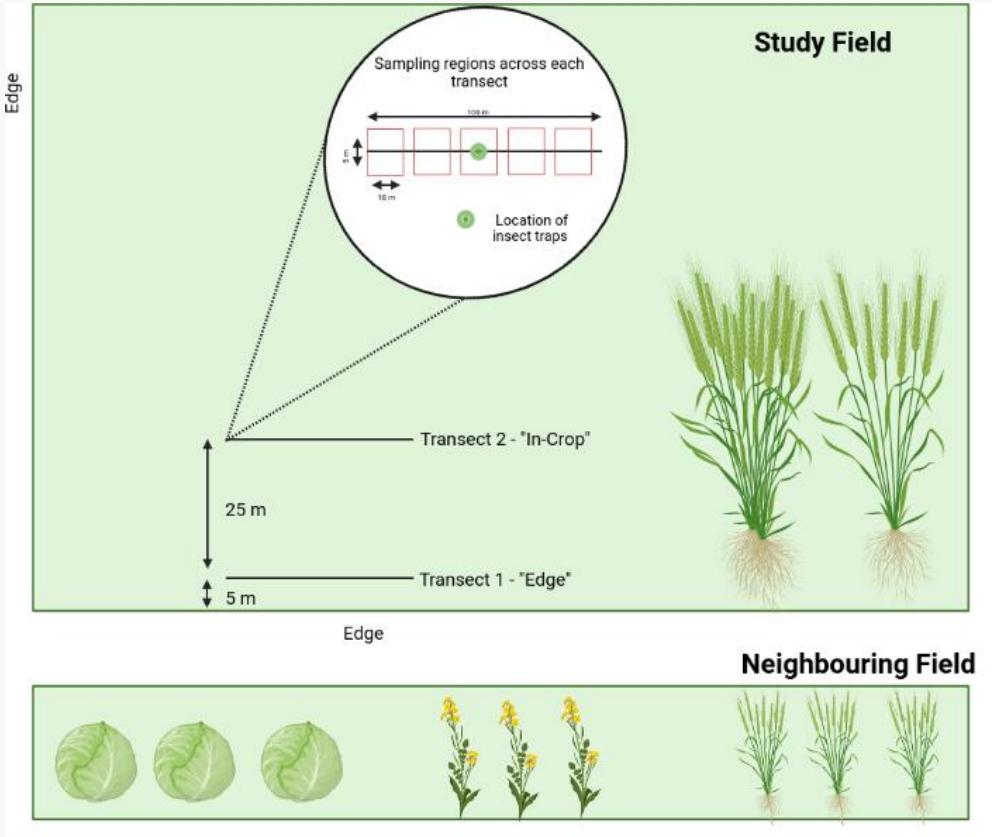


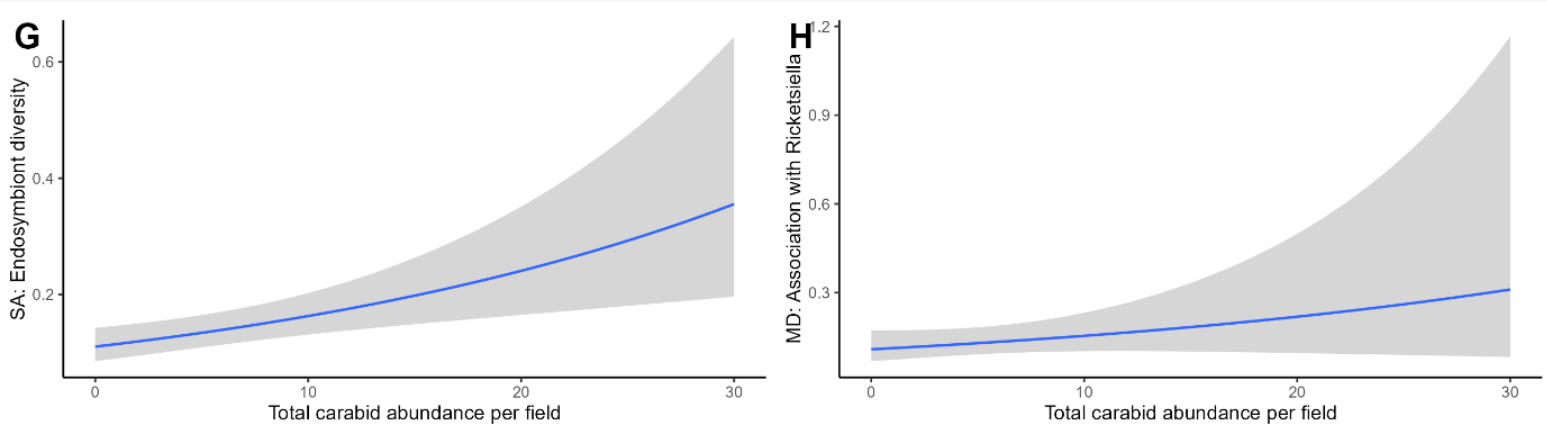
APHID SYMBIONTS

- *M. dirhodum:* 221 samples; *R. insecticola* most common
- *R. padi*: 53 samples; *H. defensa* most common
- *S. avenae:* 432 samples; *R. insecticola* most common



NATURAL ENEMIES, APHID SYMBIONTS



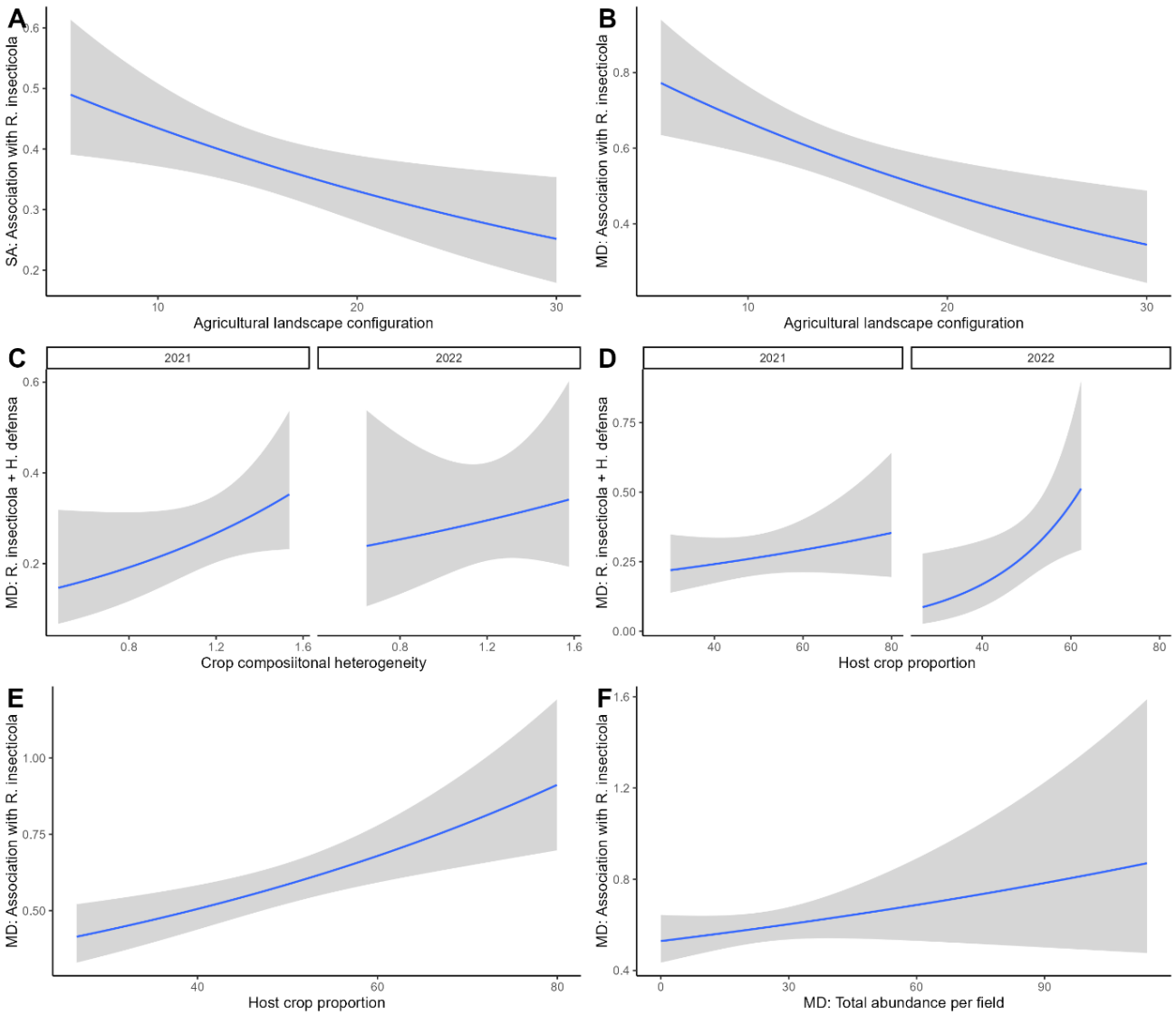


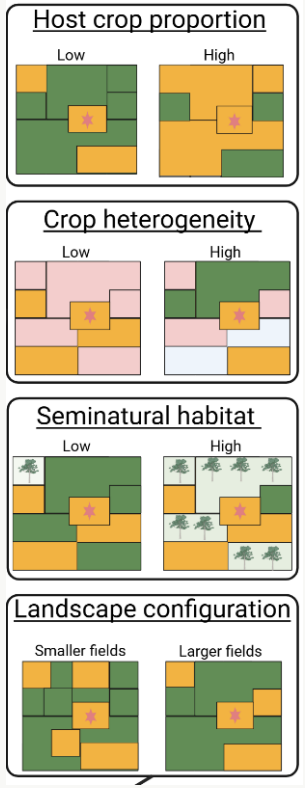




- *S. avenae:* Endosymbiont diversity increases as Carabid pressure increases
- *M. dirhodum:* Prevalence of *Ricketsiella spp.* increases as Carabid pressure increases

LANDSCAPE STRUCTURE, APHID SYMBIONTS





- *R. insecticola:* Association decreases in both aphids as field size increases (connectivity reduces)
- *R. insecticola & H. defensa* co-infection*:* Increases in *M. dirhodum* as crop heterogeneity and host crop proportion increases
- *R. insecticola:* Association in *M. dirhodum* also affected by host crop proportion and aphid population size





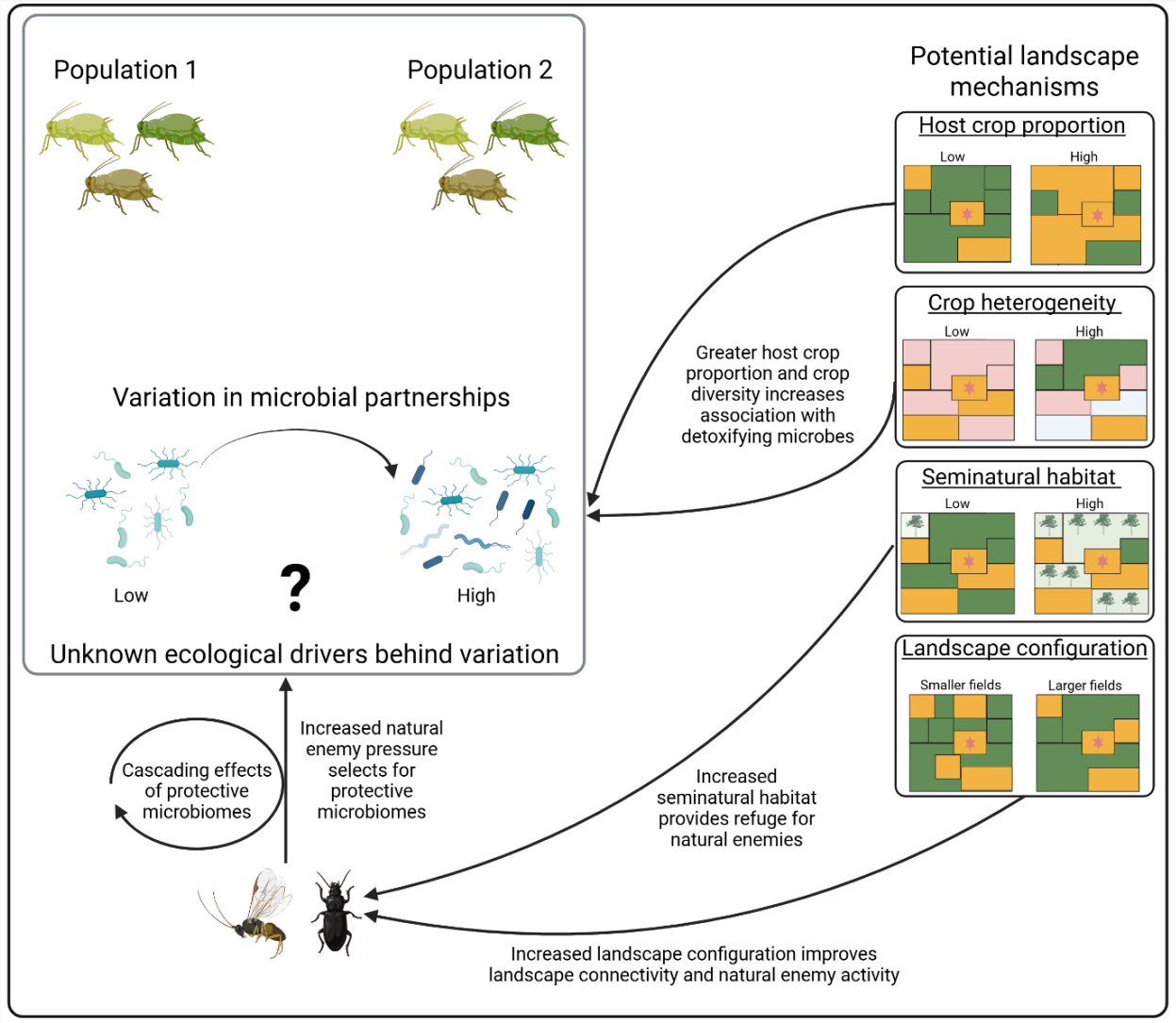
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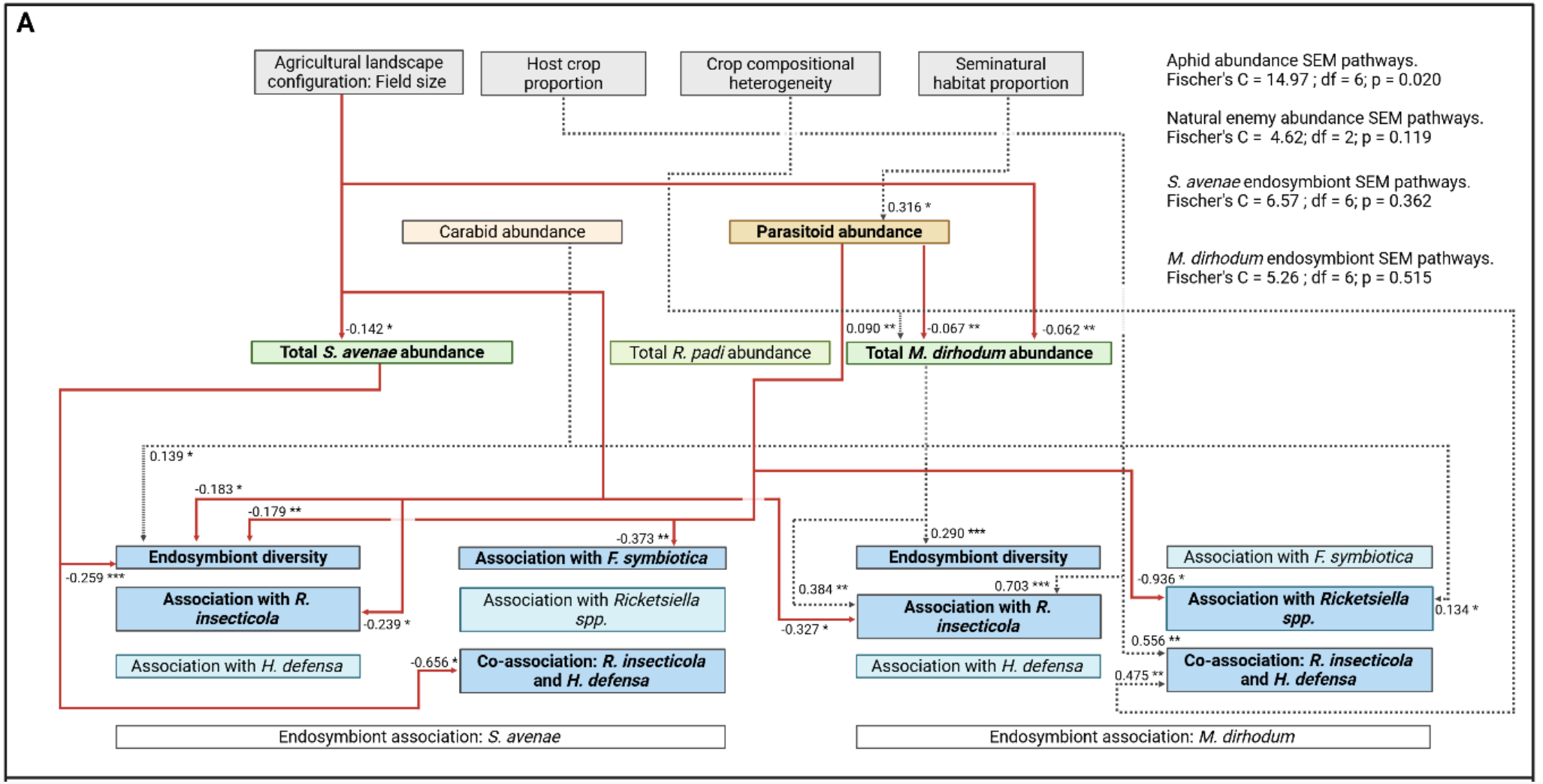
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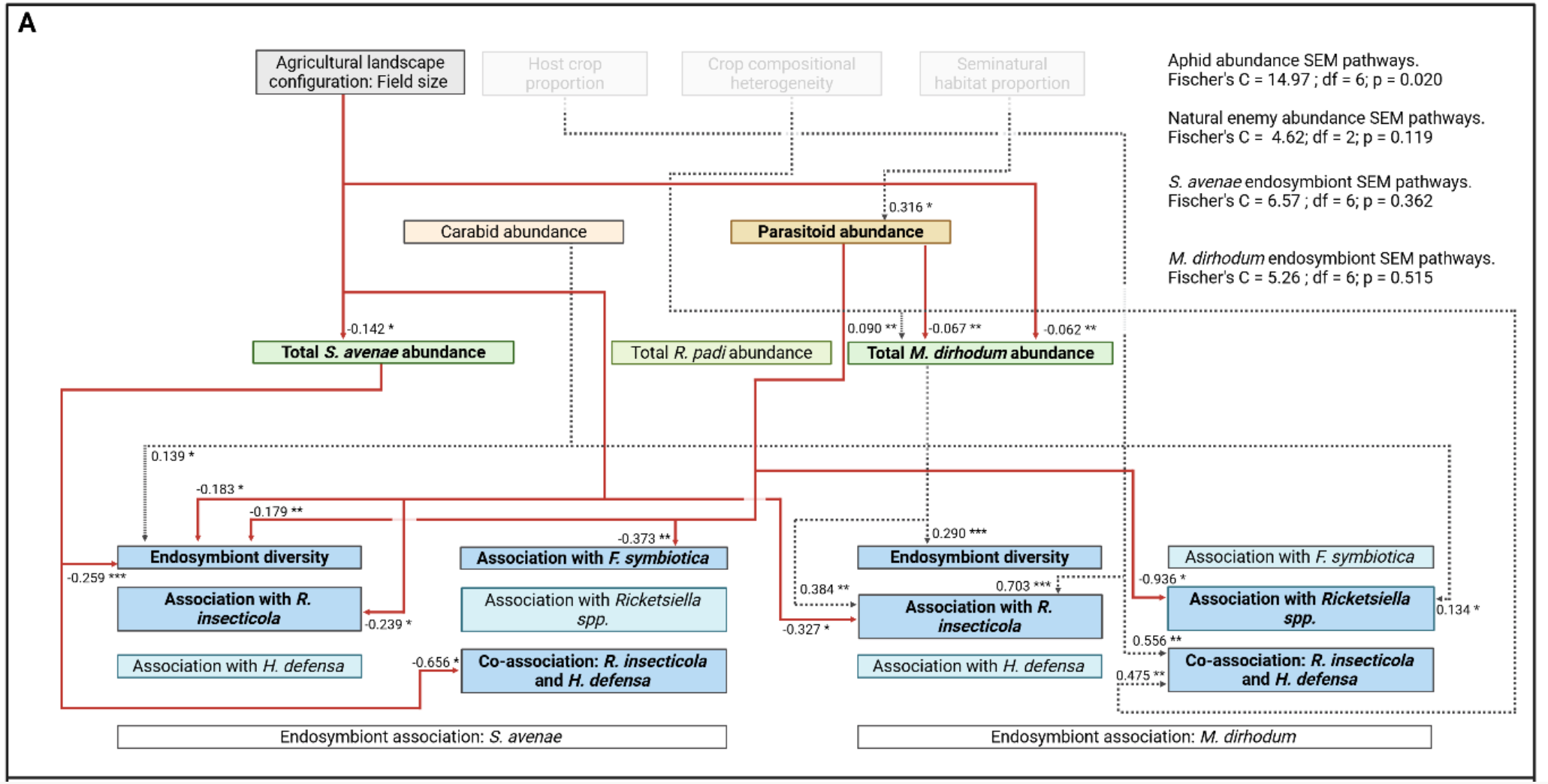
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LANDSCAPE STRUCTURE, NATURAL ENEMIES, APHID SYMBIONTS

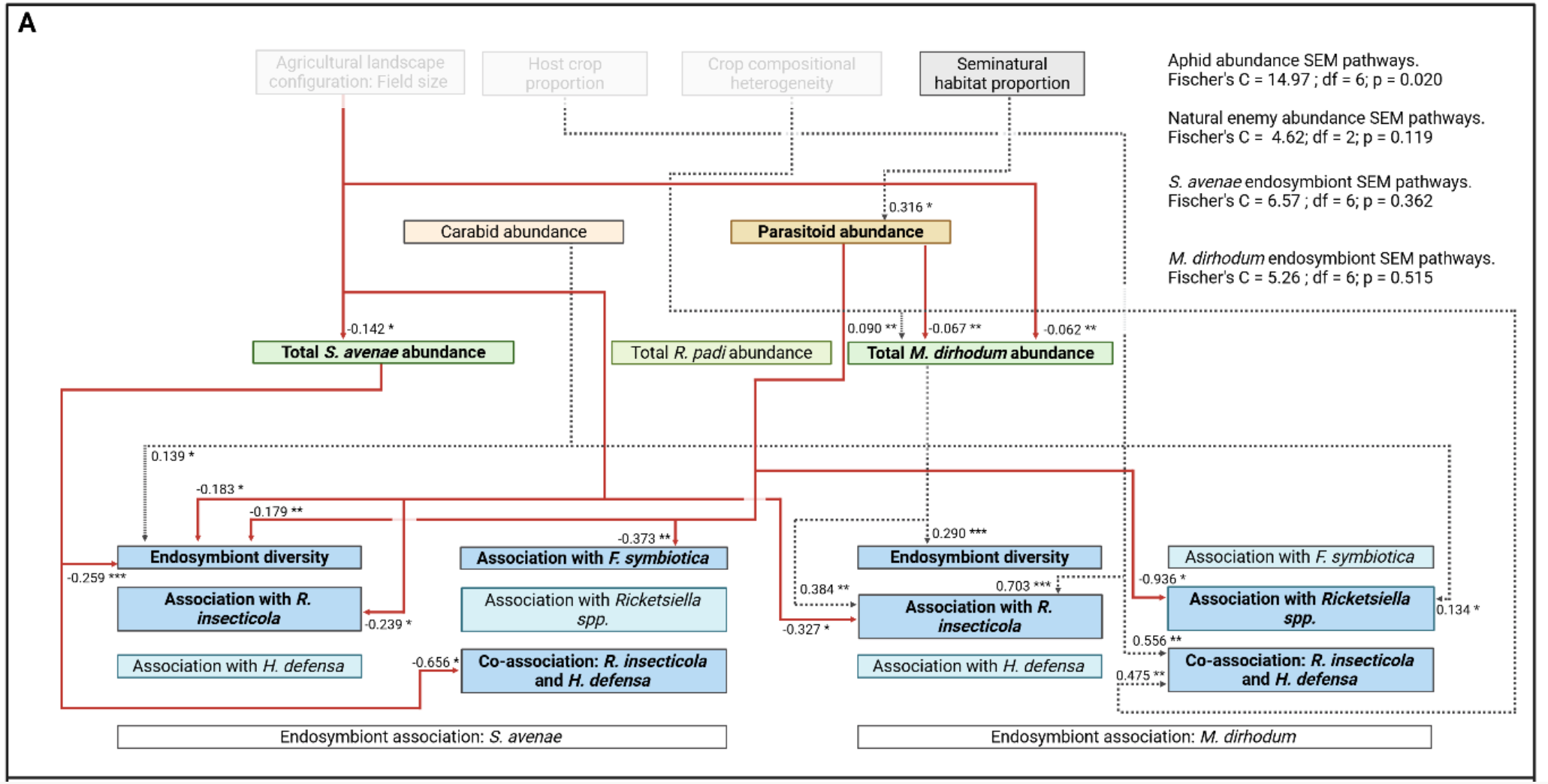


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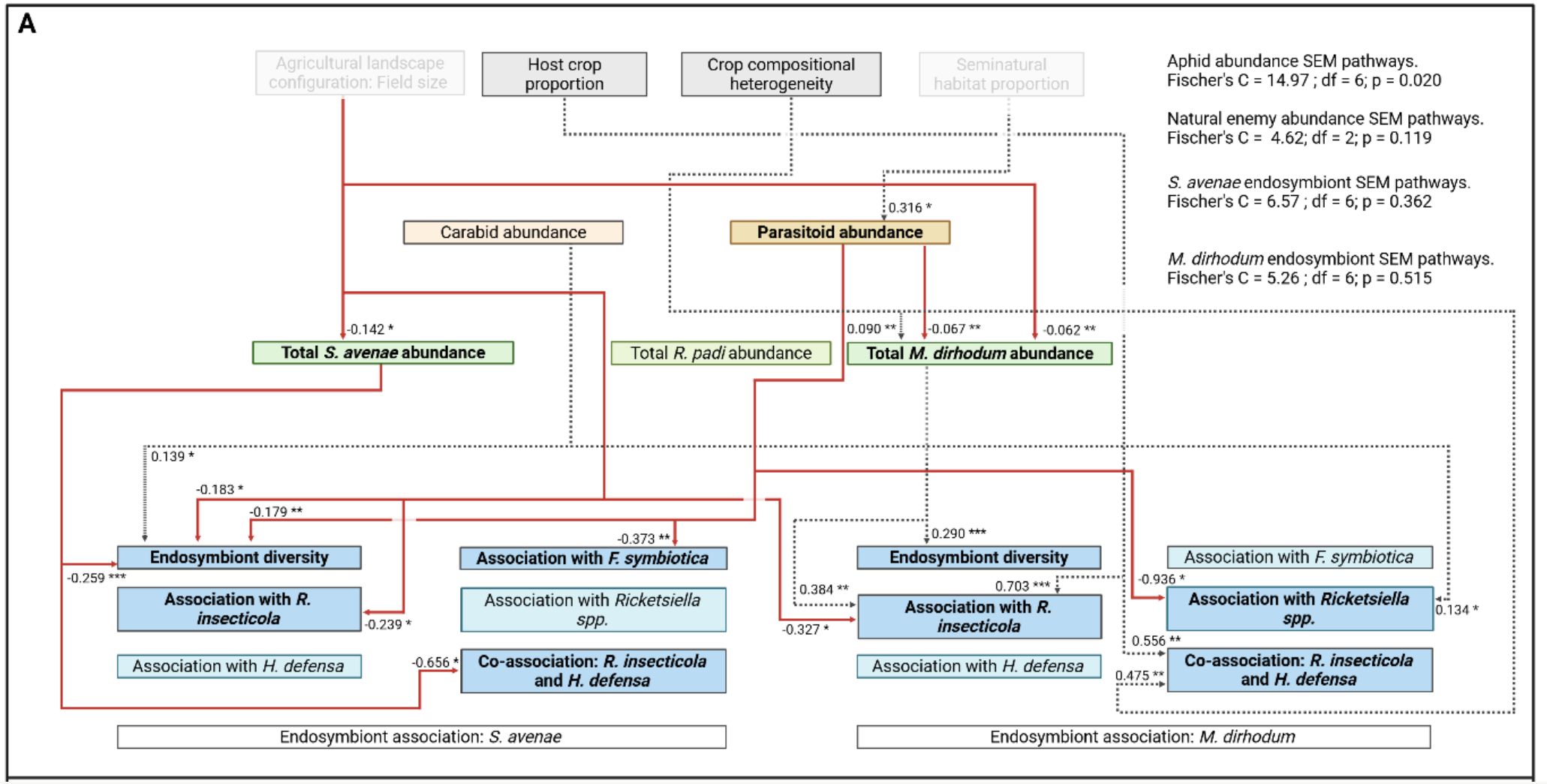
- Connected landscapes support more protective microbiomes

LANDSCAPE STRUCTURE, NATURAL ENEMIES, APHID SYMBIONTS



- Connected landscapes support more protective microbiomes
- Variable responses to different natural enemy groups

LANDSCAPE STRUCTURE, NATURAL ENEMIES, APHID SYMBIONTS



- Connected landscapes support more protective microbiomes
- Variable responses to different natural enemy groups
- Contrasting responses between species – MD influenced by crop heterogeneity and host crop proportion

CONCLUSION & THANK YOU (감사합니다)

- Top-down and bottom-up factors influence symbiont associations
- Variation in endosymbiont association and diversity between three cereal aphid species
- Connected landscapes (lower agricultural configuration) support more protective microbiomes
- Many cryptic drivers that are influenced by direct and indirect factors (including aphid population regulation)



- Prof Emily Martin (Giessen)
- Dr Sharon Zytynska (Manchester)
- Petra Melloh (Hannover)
- Eric Muehlnikel (MSc, Hannover)
- Zoological Biodiversity Group (Hannover/Giessen)