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Both interaction and environmental niche breadth affect the detection of community assembly processes

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Background:

Much work suggests that community assembly processes can be disentangled based on emerging trait diversity patterns, with **convergence indicating environmental filters** and **divergence competitive exclusion**.

Random reshuffling of species abundances across sites

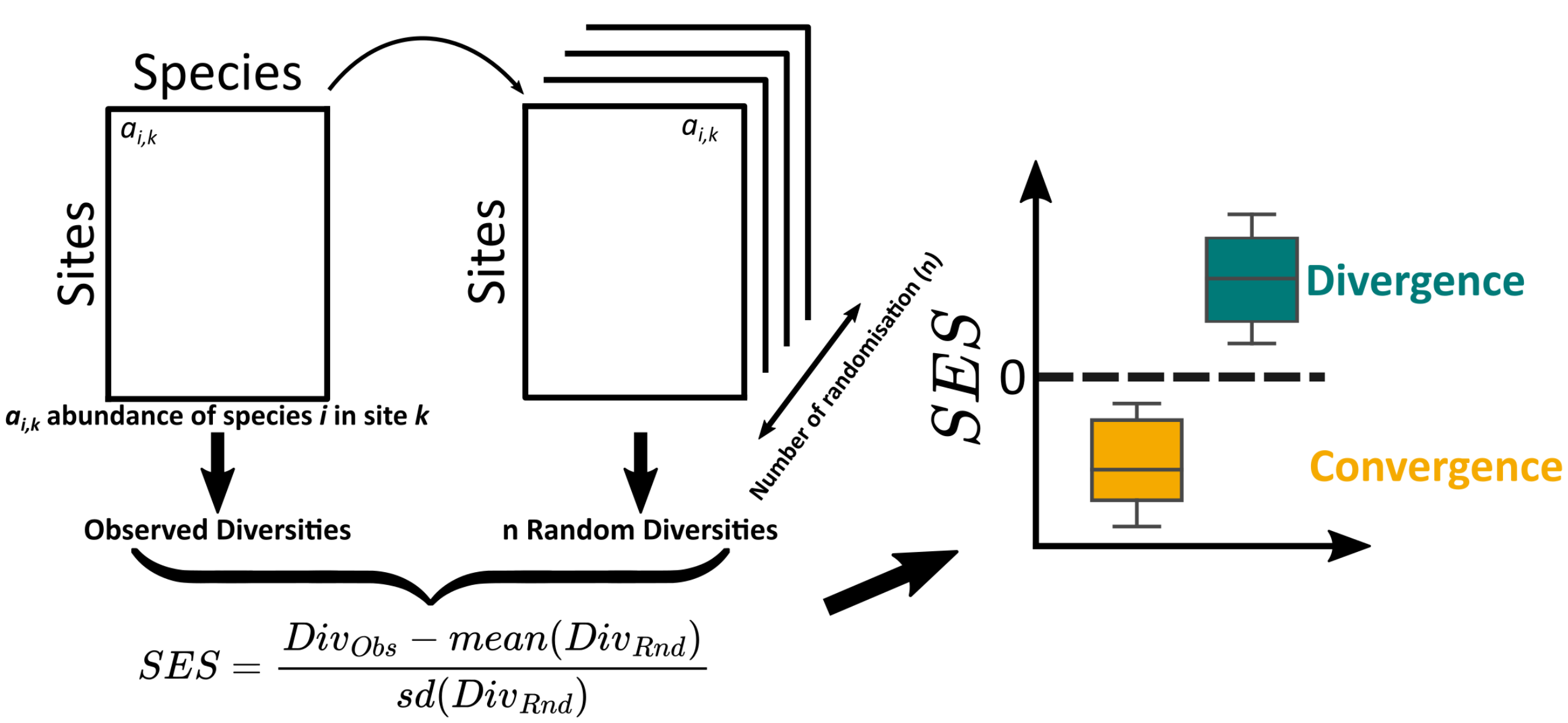


Figure 1: Computation of the trait patterns

Main critics: Over-simplification [1] & ignores that hierarchical competition can also lead to trait convergence [2]

Our main questions:

How do trait patterns vary under different competitive regimes?

How does the ability to detect competition depend on intensity of biotic and abiotic processes, and species characteristics?

Model description:

A spatially explicit individual-based model to simulate community assembly under various processes.

Species are characterized by 3 traits, determining species' environmental preferences and biotic interactions (limiting similarity or hierarchical competition).

Community assembly through death-birth and dispersal events. Establishment ($P_{i,k}$) of new individuals is a function of the relative importance of environmental ($\mathcal{E}_{i,k}$) vs. biotic filters ($C_{i,k}$).

Important parameters:

ω → Niche breadth, from specialist to generalist species

σ → Interaction breadth, from interaction between highly similar species only to wider interactions

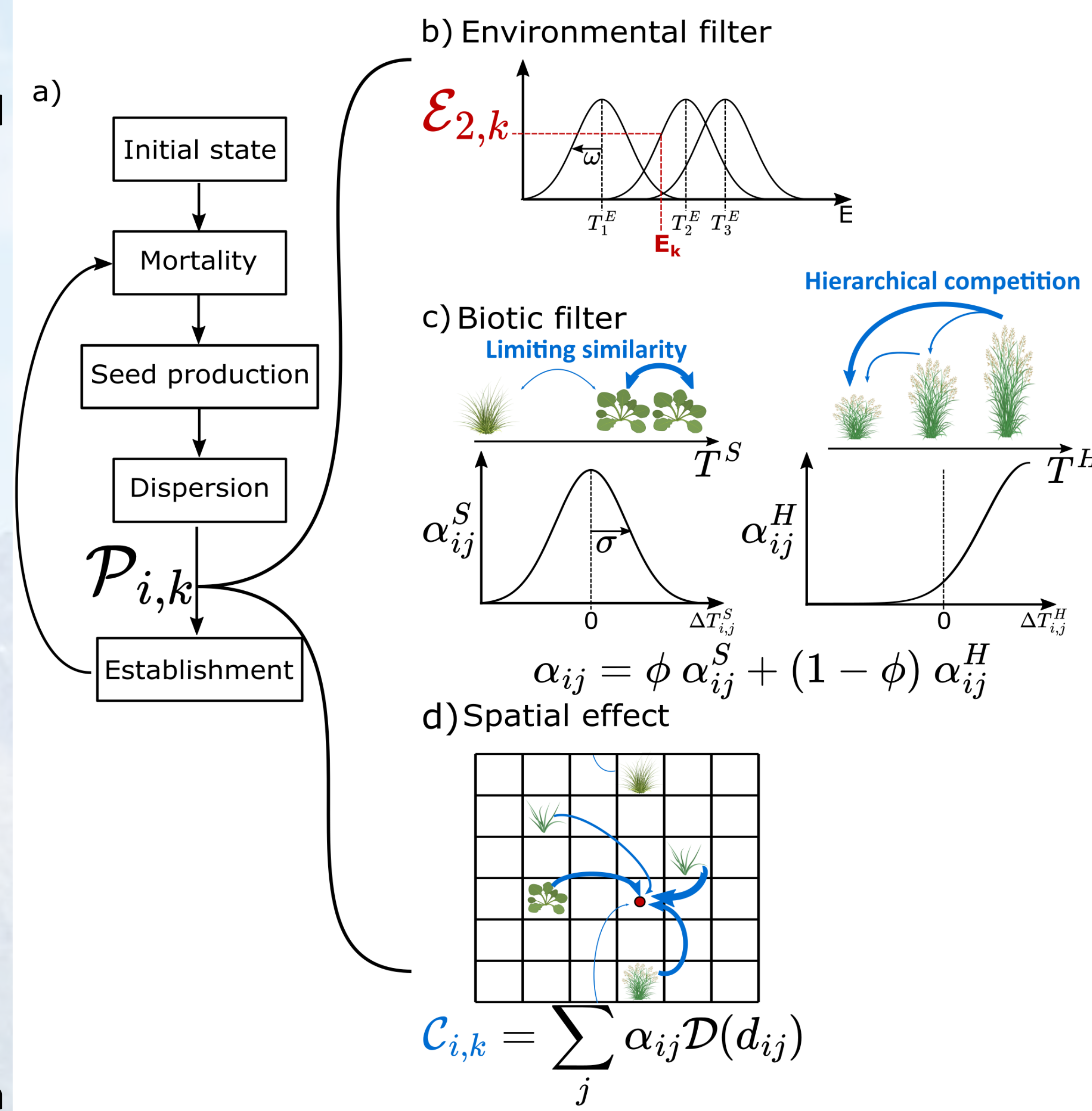


Figure 2: Schematic representation of the community assembly model.

Results:

Figure 3: Expected simulated patterns under different assembly processes: environmental filtering, symmetric competition and hierarchical competition.

Figure 4: When interactions are limited to highly similar species ($\sigma = 0.1$), symmetric competition produces evenly spaced clusters in trait space (see also [3]), that could be interpreted as env. filtering. This does not happen when interactions occur more broadly ($\sigma = 0.4$).

Expected convergence: Env. filtering

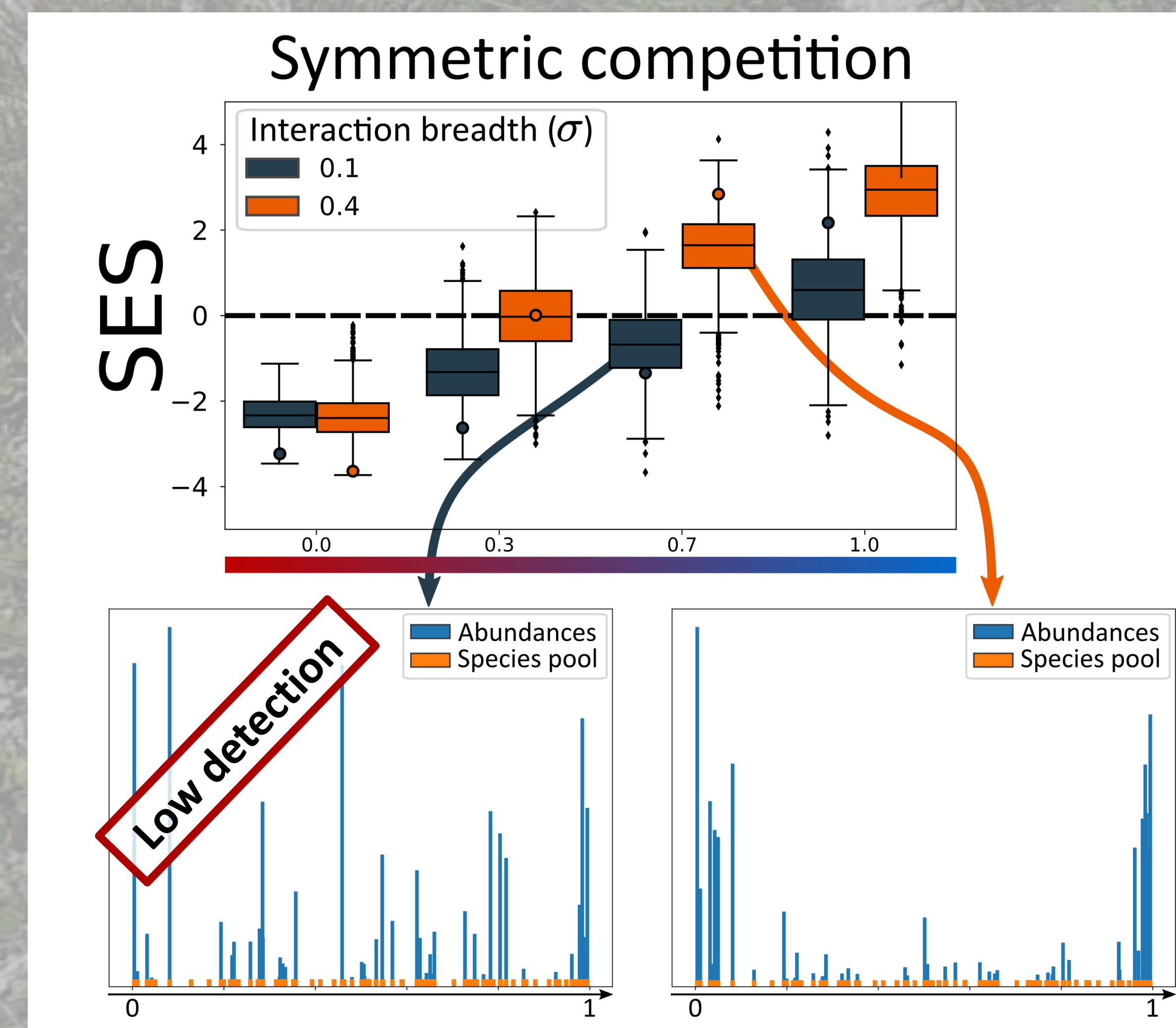
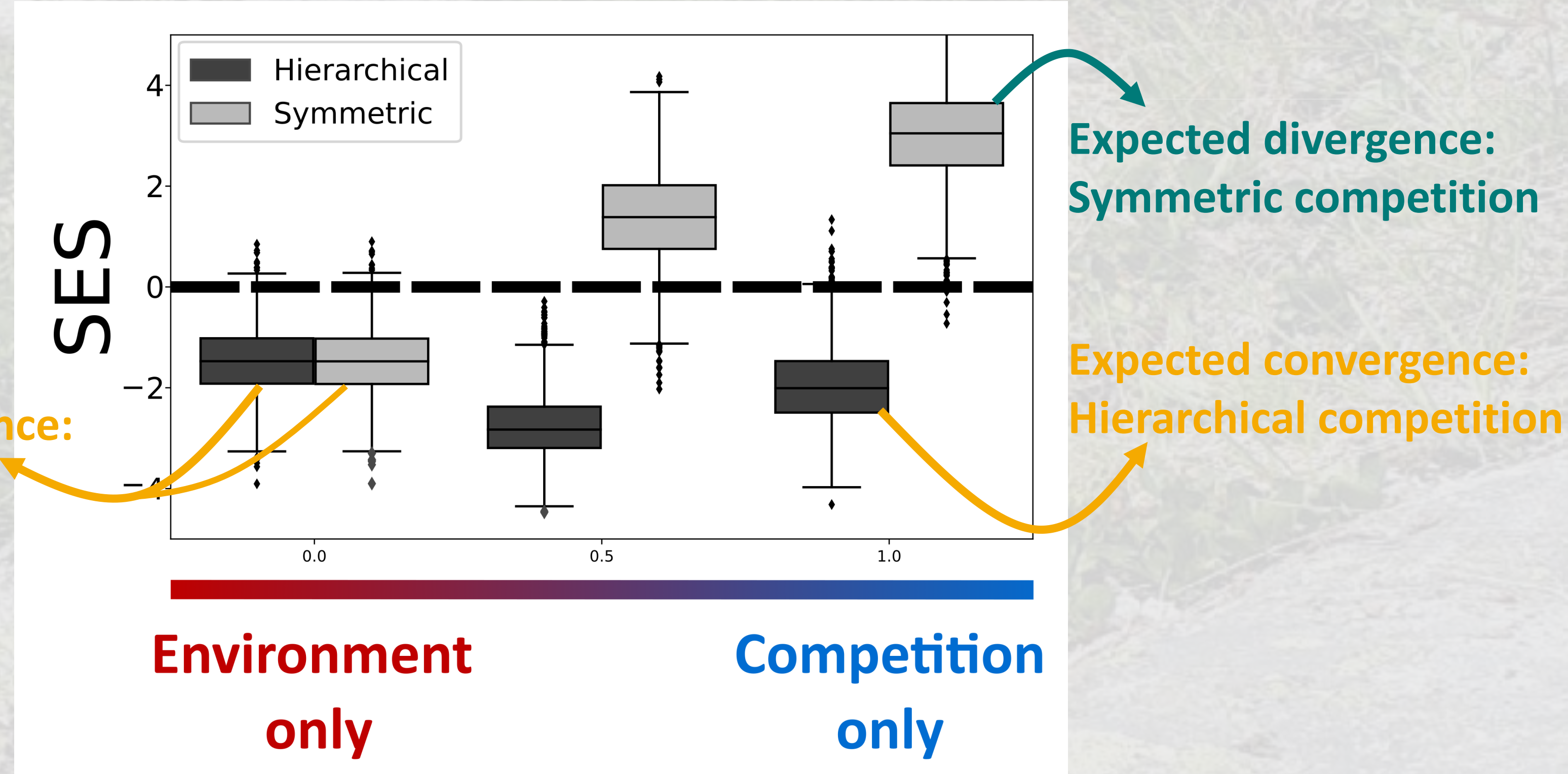
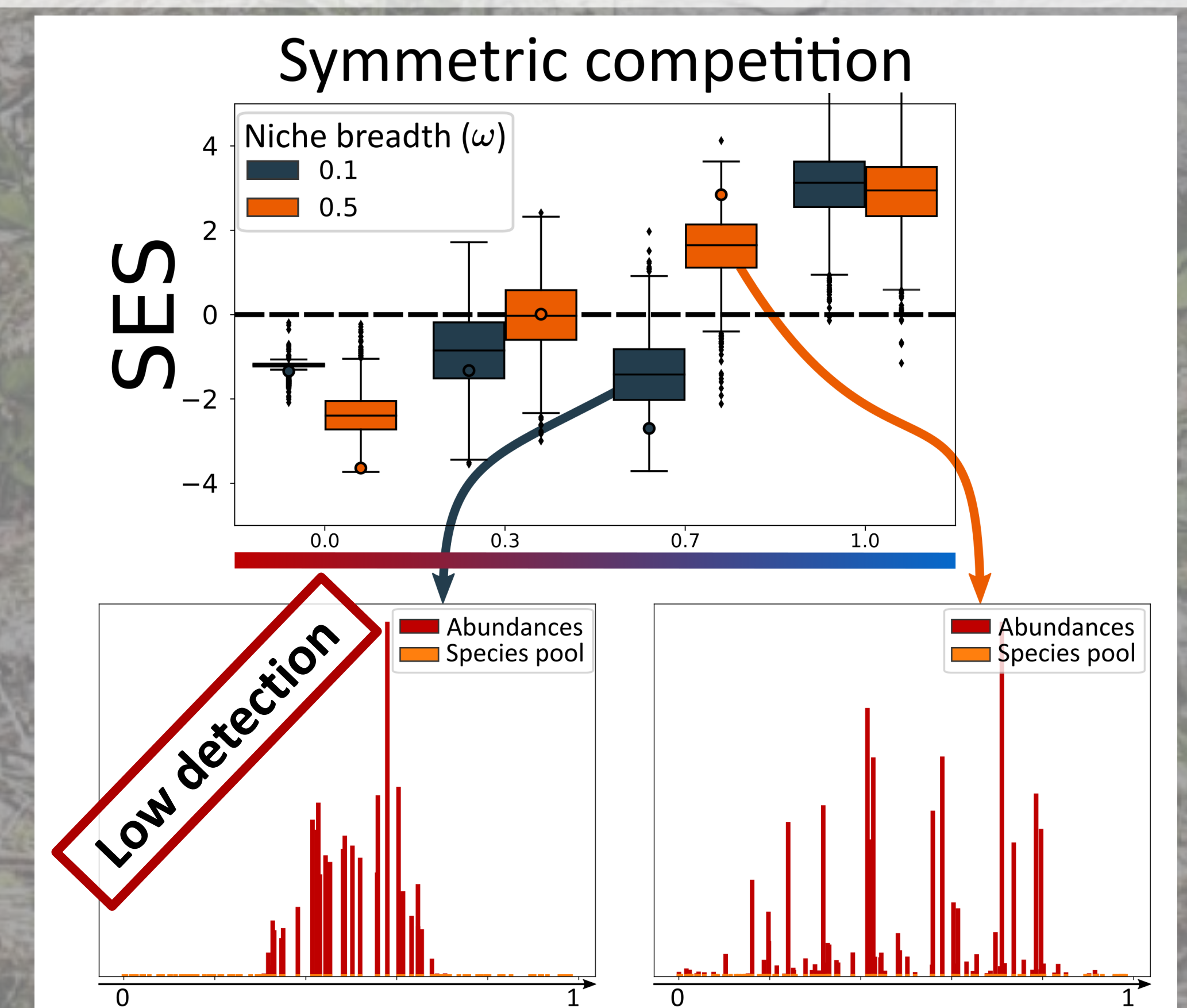


Figure 5: Ability to detect competition depends on species' environmental specialization. In communities with dominant specialist species ($\omega = 0.1$), detecting symmetric competition is hardly achievable, despite it being the primary assembly process. The process becomes detectable when generalist species dominate



Conclusions:

- Hierarchical competition produces patterns indistinguishable from environmental filtering.
- Symmetric competition can produce various patterns, difficult to distinguish from env. filtering when:
 - Interactions happen between very similar species
 - Specialised species (low niche breadth) dominate
- This suggest that trade-offs (fostering low niche and interaction breadth) affect trait patterns, and detectability.

Perspectives:

- Species pool structure, *i.e.* trait correlations, influence observed patterns.
- Since small-scale heterogeneity of env. filters can lead to divergence [4], investigating the effect of the environmental structure (uniform, random, autocorrelated) on trait patterns is crucial.
- Adding the spatial dimension (*individual's eye view*) within communities could help distinguish processes from trait patterns

References:

- [1] Mayfield, M. M. and Levine, J. M. (2010). Opposing effects of competitive exclusion on the phylogenetic structure of communities. *Ecology Letters*, 13(9) :1085–1093.
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- [4] Willis, C. *et al.* (2010). Phylogenetic community structure in minnesota oak savanna is influenced by spatial extent and environmental variation. *Ecography*, 33(3) :565–577.