What are the biological processes shaping a local multilevel antagonistic network ?

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MNHN, 15/09/2015

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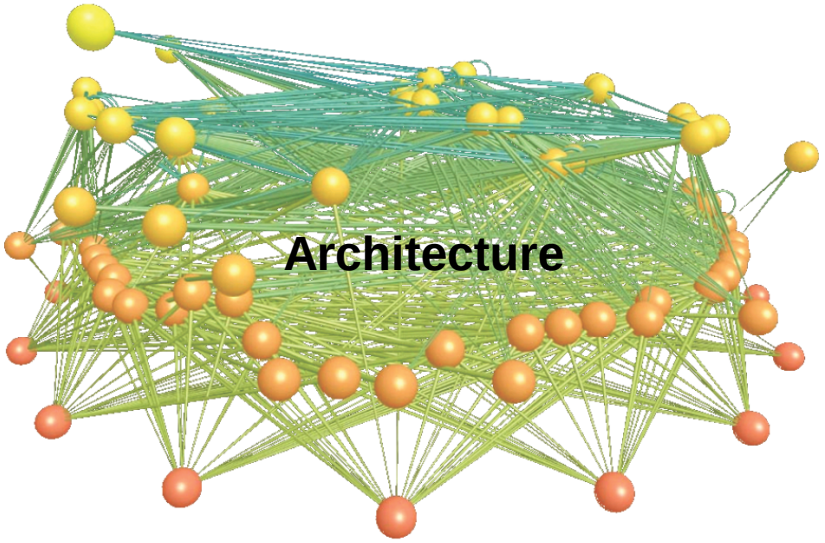
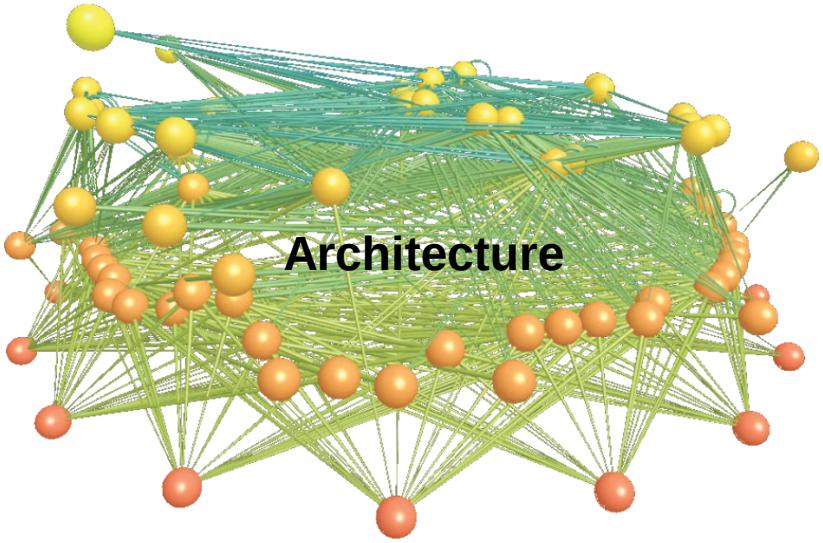
Interaction networks



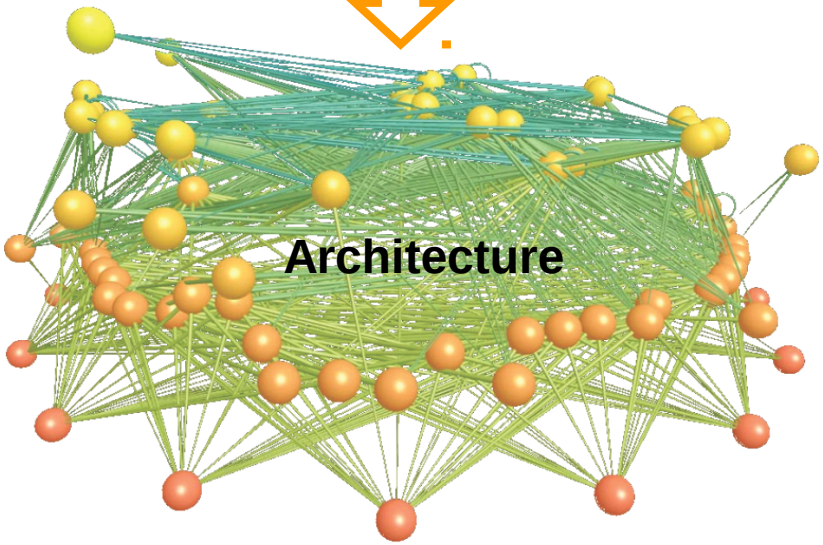
Interaction networks



Community functioning, stability and response to perturbation

Interaction networks

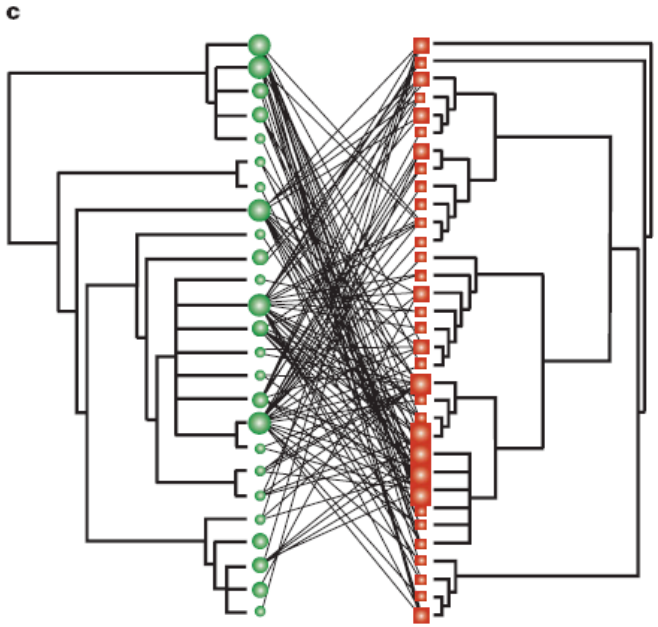
Processes



Community functioning, stability and response to perturbation

What are the processes responsible for network architecture?

Phylogenetic constraints

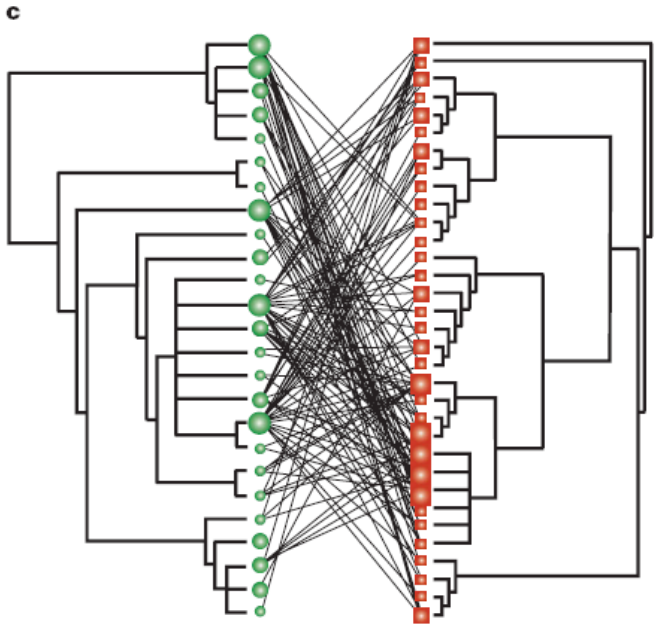


From Rezende et al., *Nature* 2007

Closely related species should interact with the same species

What are the processes responsible for network architecture?

Phylogenetic constraints



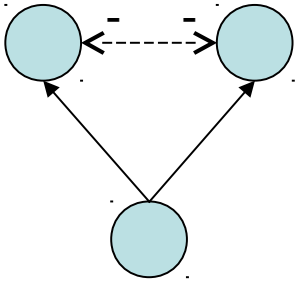
From Rezende et al., *Nature* 2007

Closely related species should interact with the same species

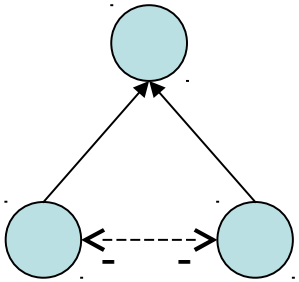
Dynamical constraints

Indirect interactions

From the consumer side:
exploitative competition



From the resource side:
apparent competition



Species should interact with different partner to minimise competition

The Rush Meadow dataset

secondary parasitoids

primary parasitoids

aphids

plants

Sampling along transects every fortnight between 1994 and 2003

For each date:
- Nb of plant units/m^{-2}
- Nb of aphids and mummies
- Mummies reared in the lab for identification

The number of individuals of each species per m^2
Who eats whom in what numbers

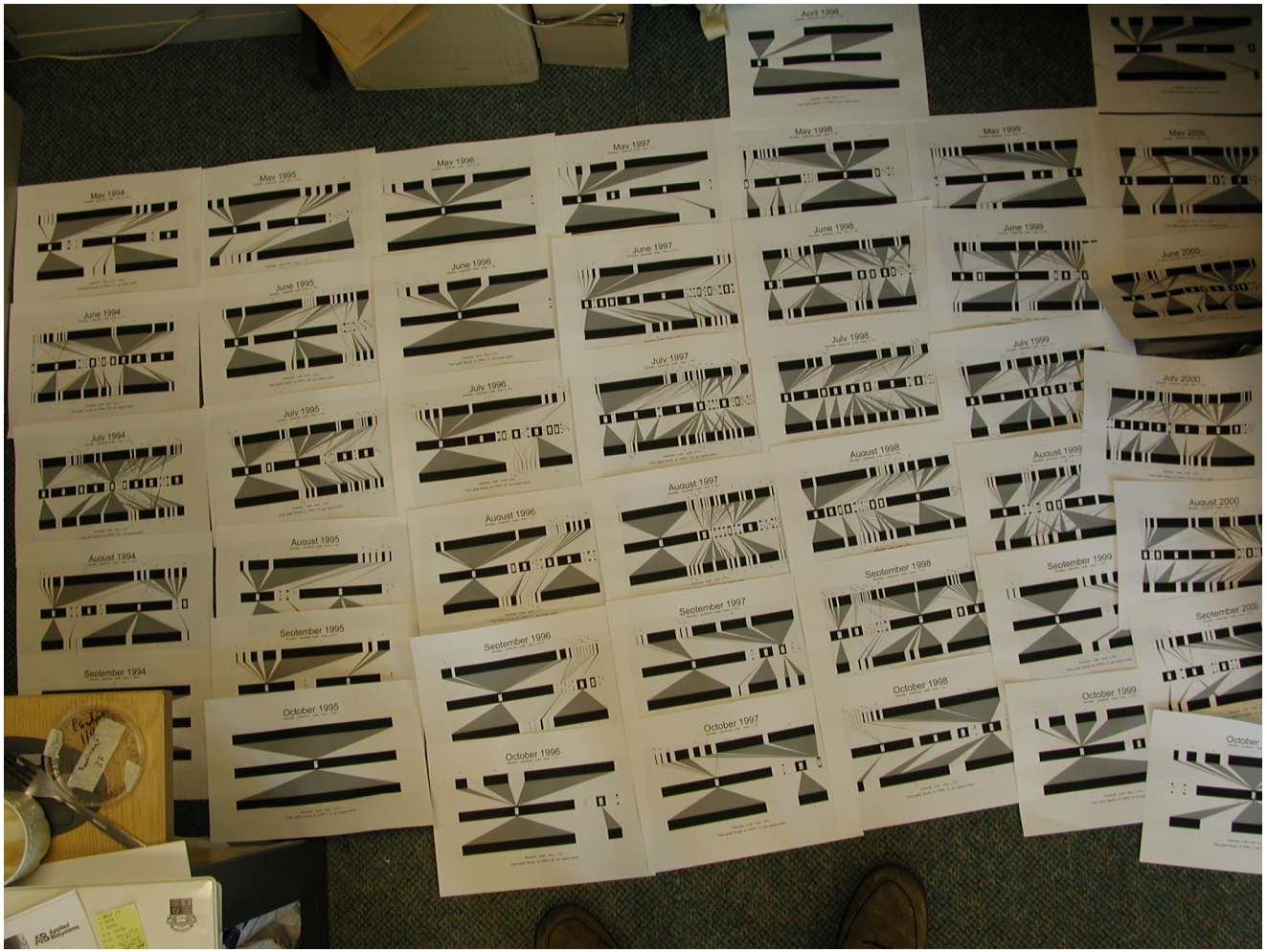
The Rush Meadow dataset

secondary parasitoids

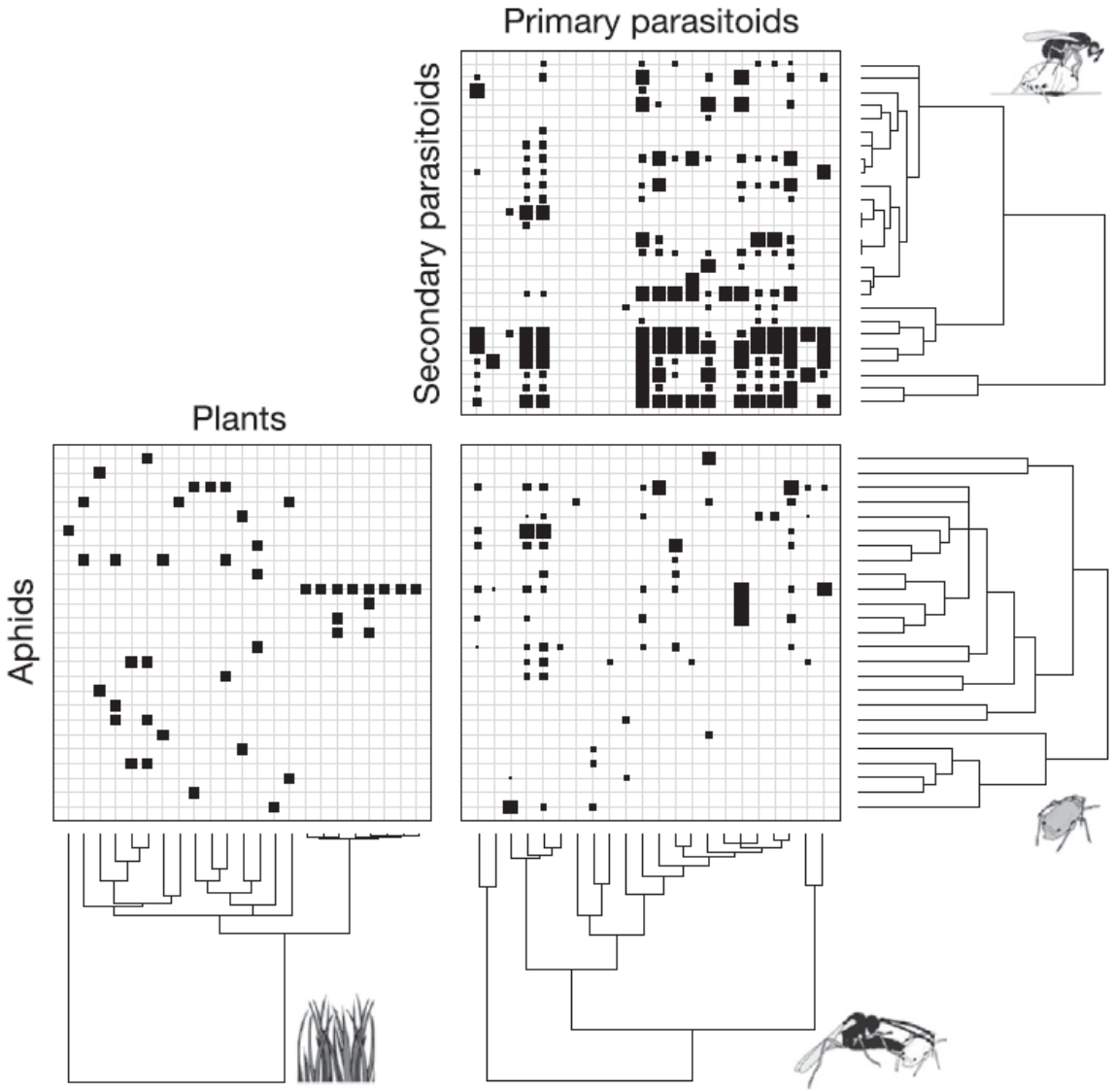
primary parasitoids

aphids

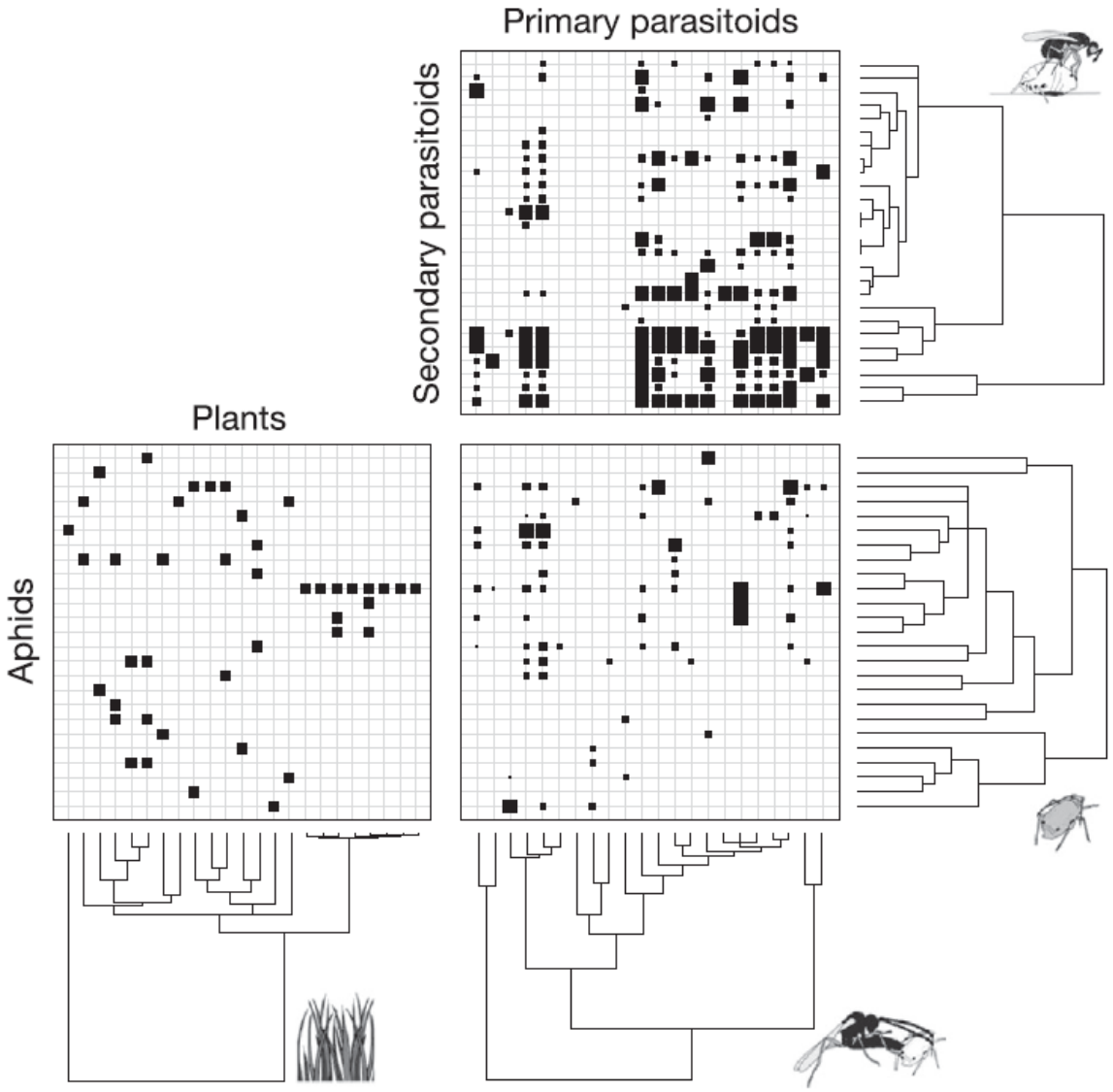
plants



The Rush Meadow dataset



Methods



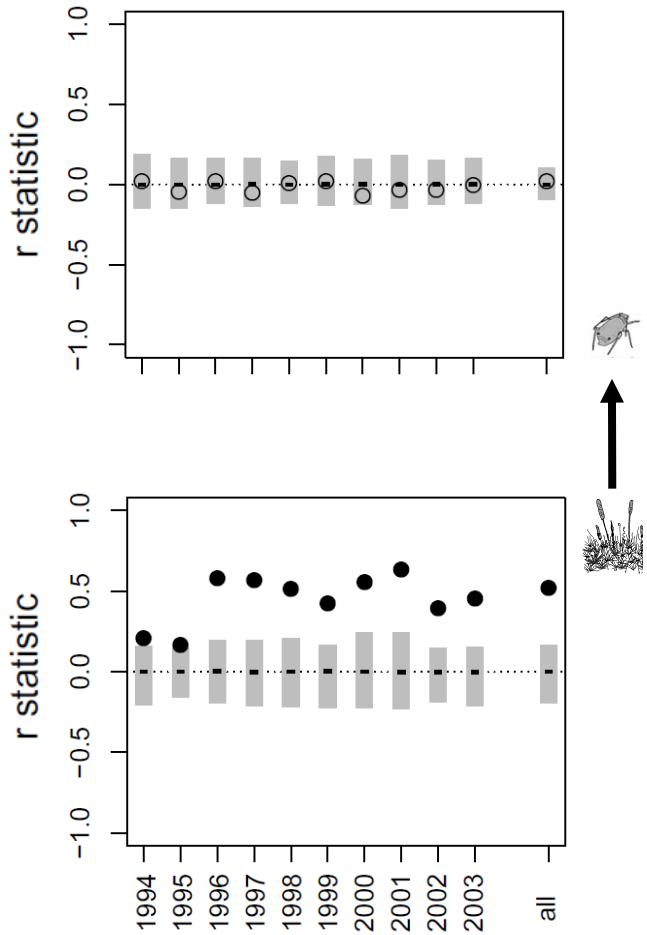
For each level

phylogenetic distances among species

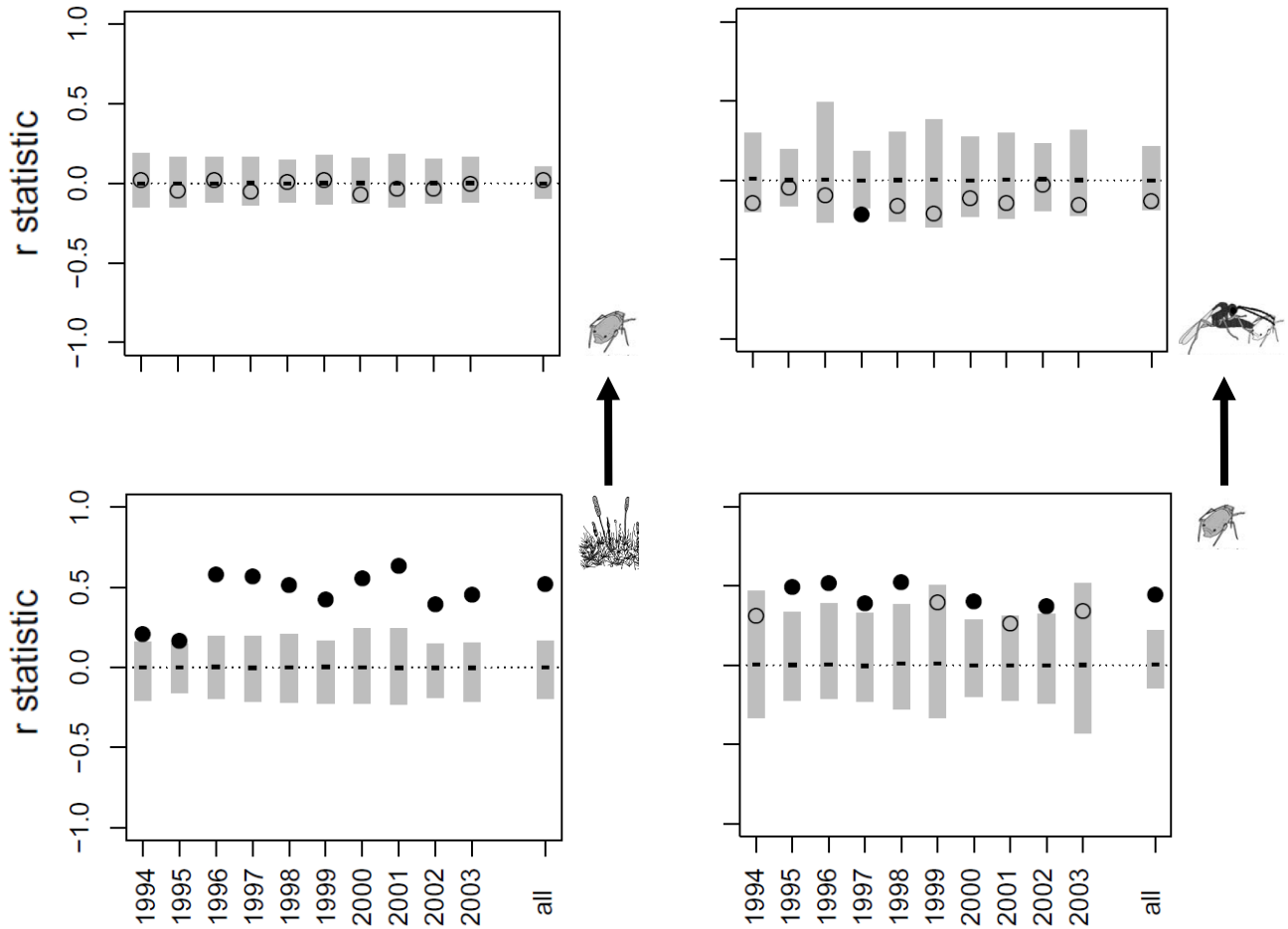
correlation ? Mantel test

ecological distances among speces

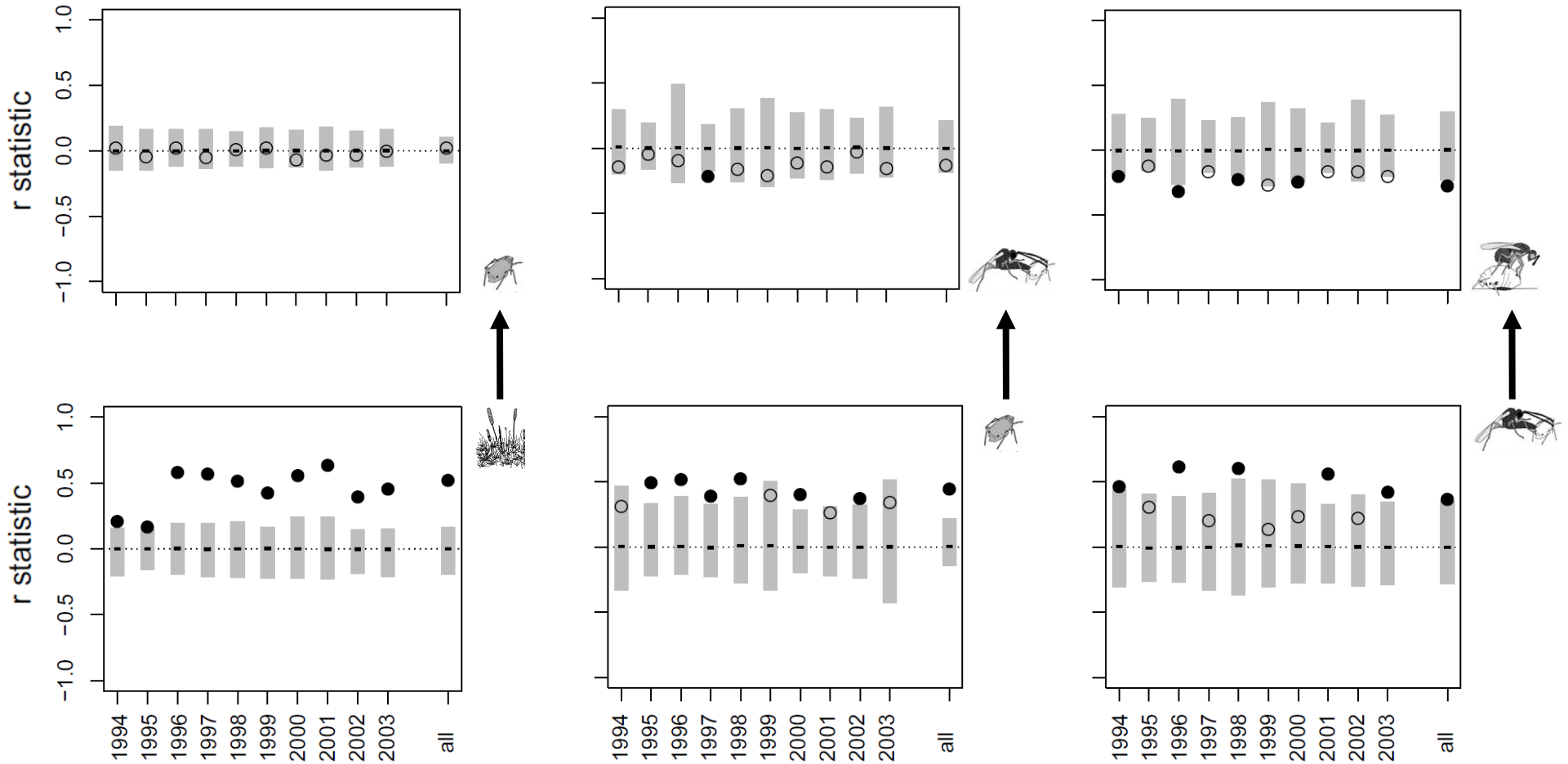
Results: plant-aphid level



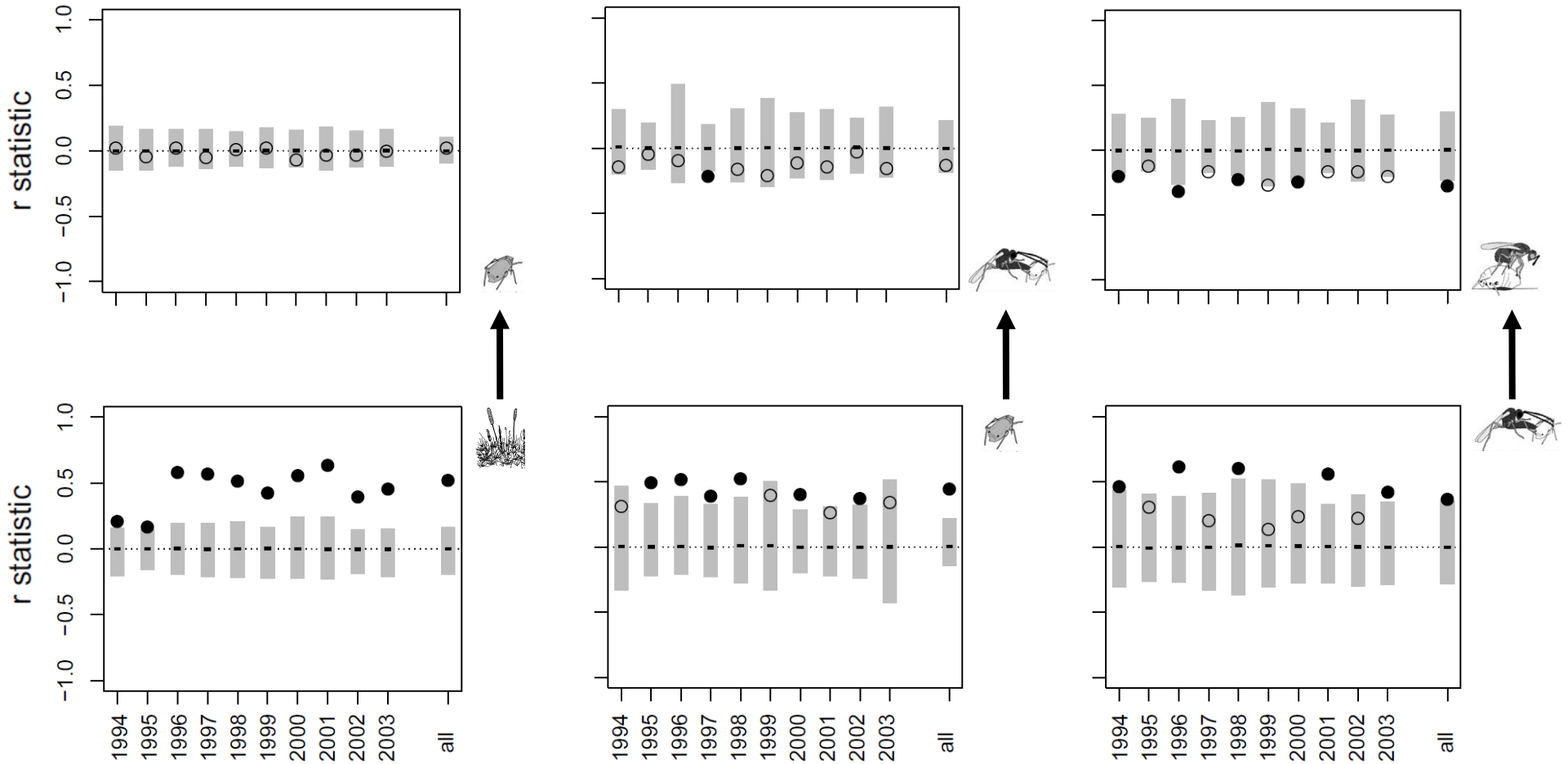
Results: aphid-primary parasitoid level



Results: primary – secondary parasitoid level



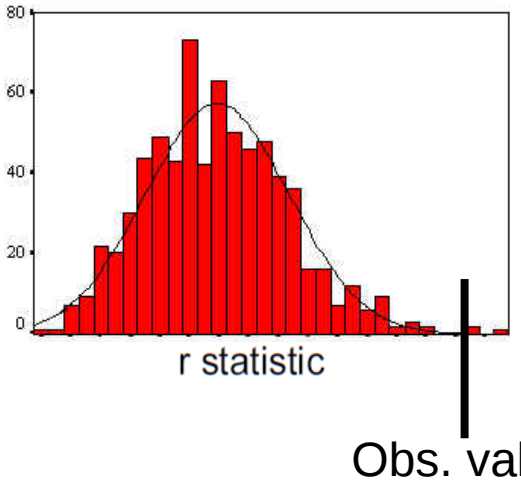
Results: primary – secondary parasitoid level



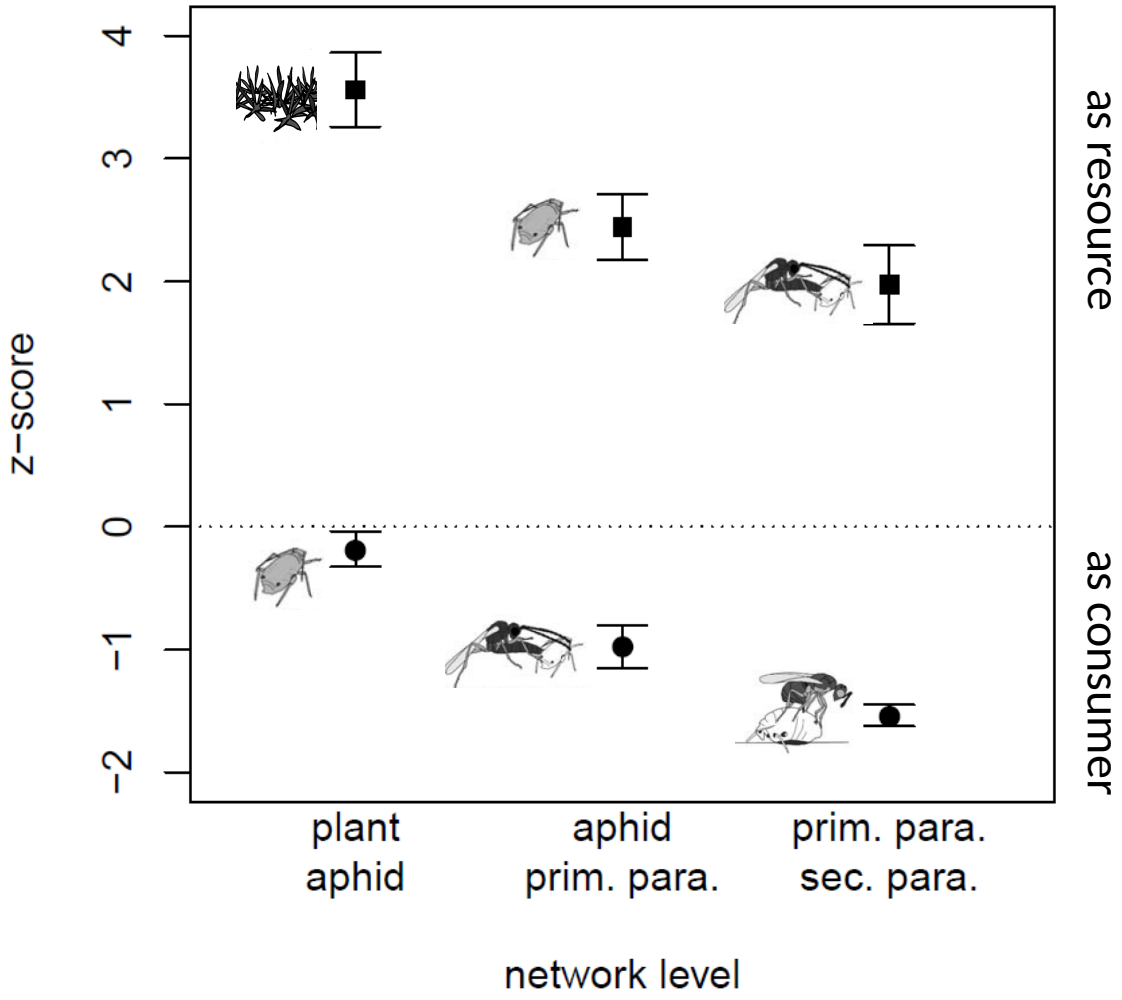
Strong **phylogenetic signal** for prey levels ⇒ Vulnerability traits are **phylogenetically constrained**

Phylogenetic anti-signal for predator levels ⇒ Foraging traits are **phylogenetically labile**

Results: signal strength



$$z = \frac{x - \mu}{\sigma}$$



Conclusion and perspectives:

Phylogenetic signal varies within network

Interaction as resources are phylogenetically constrained ➔ evolutionary history of species
Interaction as consumer are not ➔ exploitative competition

	Interactions as consumer		Interaction as resource	
	r (S.E.)	*P*	*r* (S.E.)	*P*
Chesapeake Bay	0.231 (0.057)	<0.001	0.330 (0.092)	0.002
Coachella*	0.159 (0.057)	0.040	0.635 (0.036)	<0.001
Skipwith Pond*	0.101 (0.050)	0.077	0.459 (0.046)	<0.001
St-Martin Island	0.270 (0.067)	<0.001	0.131 (0.073)	0.051
Ythan estuary*	0.099 (0.027)	<0.001	0.206 (0.035)	<0.001

Bersier & Kehrly, Ecol. Complex. 2008

Conclusion and perspectives:

Phylogenetic signal varies within network

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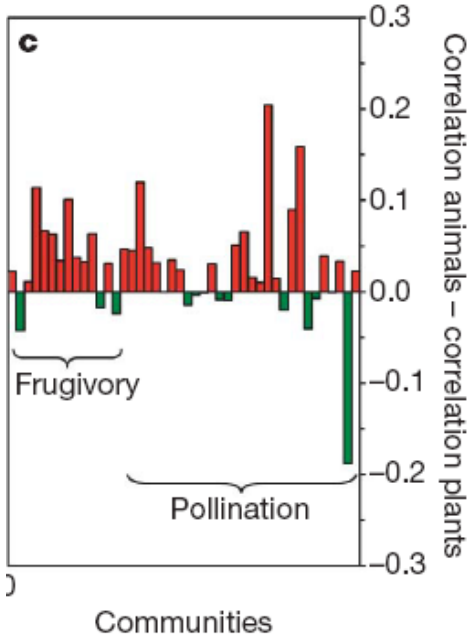
A pattern dependant on the interaction type?

Seed dispersal

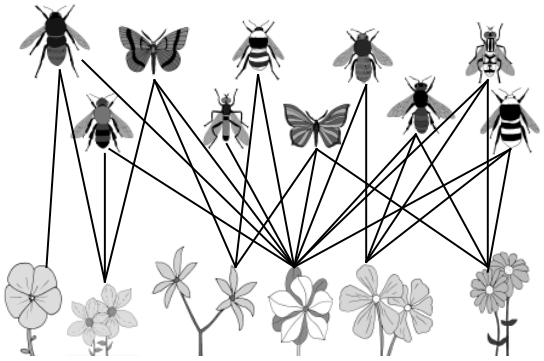
pollination



Rezende et al. Nature 2007

A need for a proper comparison

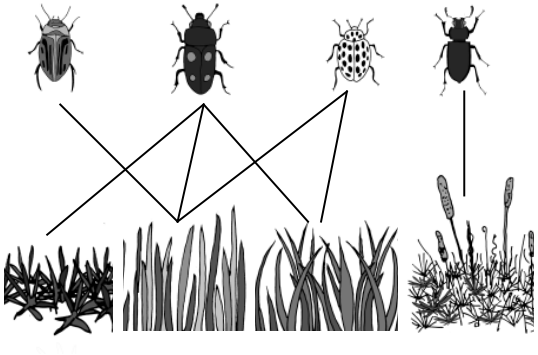
Mutualistic



42 plant-pollinator webs

?

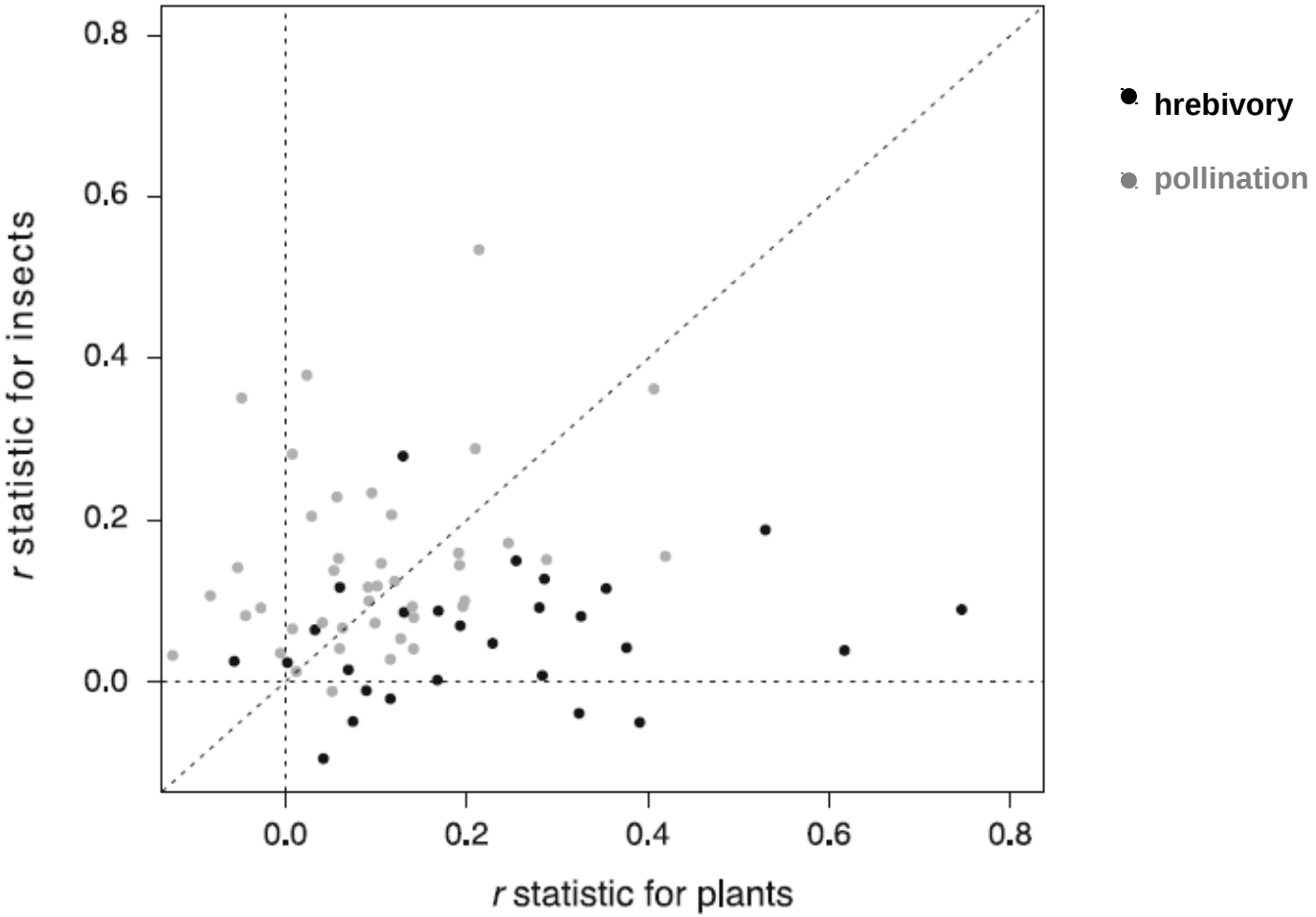
Antagonistic



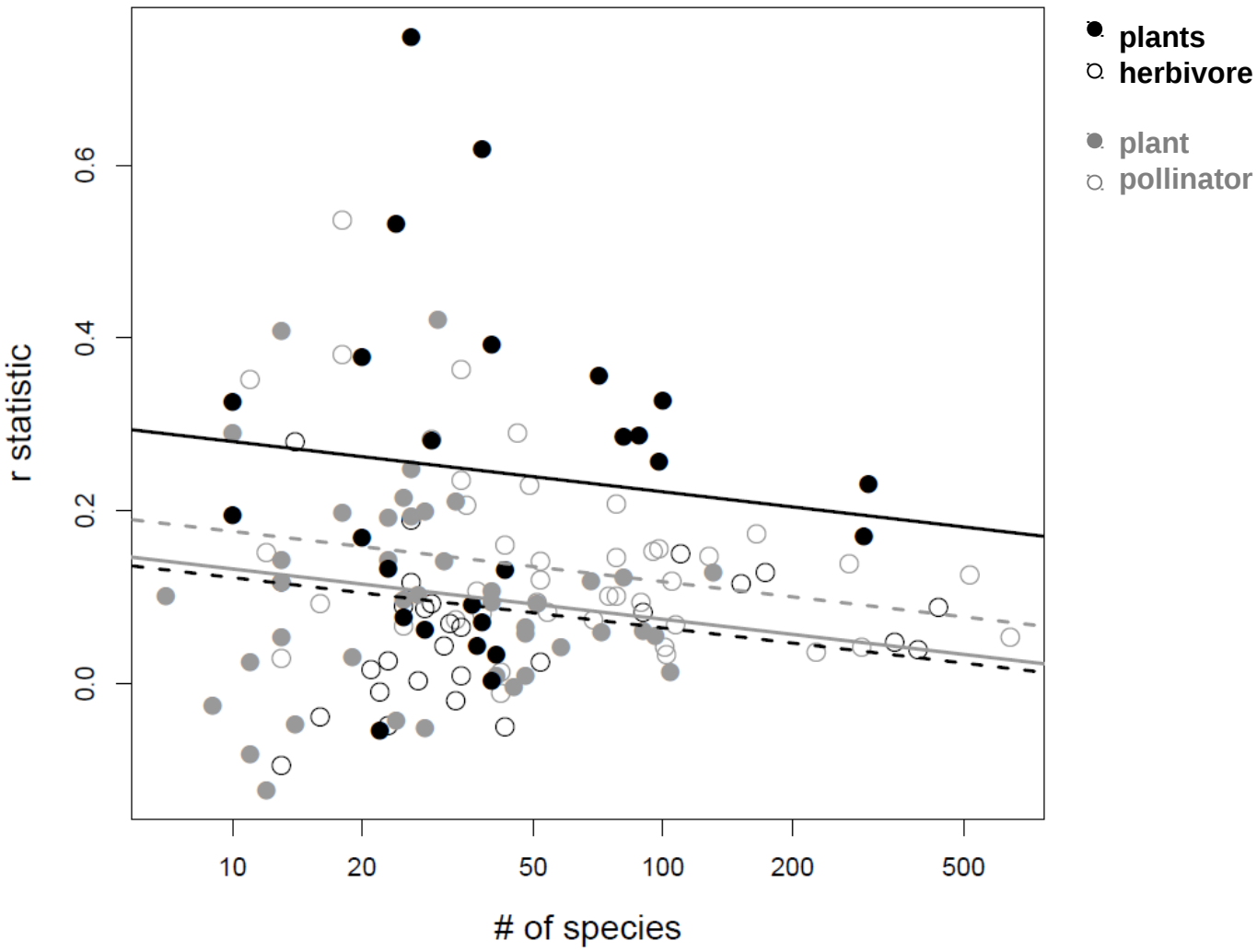
27 plant-phytophagous insect webs

Taxonomic distances as a proxy for phylogenetic distances

Results: difference among network types

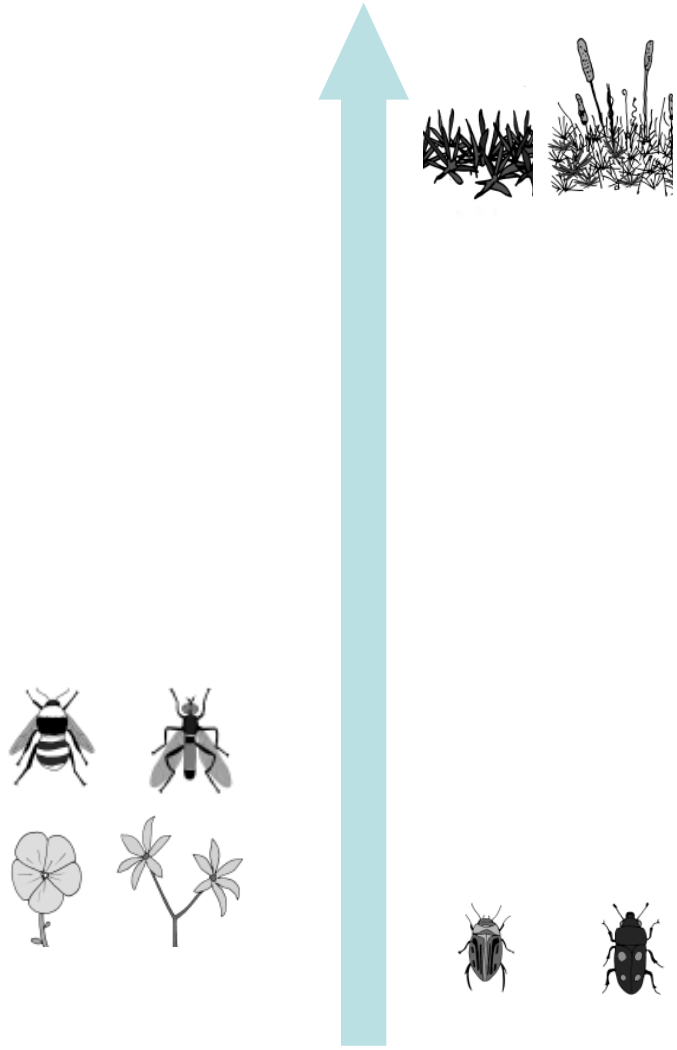


Results: difference among interacting partners



Conclusion

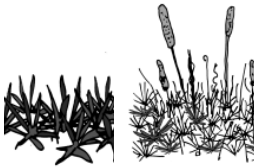
Strong conservatism: related species interact with the same partners



Weak conservatism: related species do not interact with the same partners

Conclusion

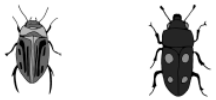
Strong conservatism: related species interact with the same partners



Plant defences are strongly phylogenetically constrained ➔
Complexity of biosynthetic pathways

“intermediate” level for pollinator positive indirect interaction? ➔

Herbivore foraging traits are labile
➔ Host shift is relatively common to escape exploitative competition



Convergence of floral traits pollination syndrome ➔

Weak conservatism: related species do not interact with the same partners

Thanks to

Frank van Veen

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and Thank you!

Elias, M., Fontaine, C., & Frank van Veen, F. J. (2013). Evolutionary History and Ecological Processes Shape a Local Multilevel Antagonistic Network. *Current Biology*. 23 pp 1355–1359

Fontaine, C., & Thébault, E. (2015). Comparing the conservatism of plant pollinator and plant herbivore interactions. *Population Ecology*. 57 pp 473–481