



Selection – Mutualistic Networks

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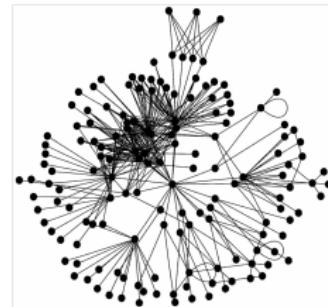
OUTLINE

- ▶ Introduction
- ▶ Overview of Mutualistic Networks
- ▶ Structure and Stability
- ▶ Summary, Questions, and Readings

RECALL: ECOLOGICAL NETWORKS

- ▶ **Ecological Network:** Network of interactions where *nodes* (•) are individuals or (usually, species') populations, and *links* (—) the interactions between pairs of nodes

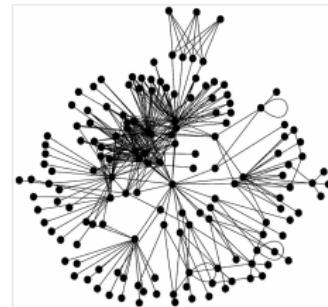
The Silwood Park Food web



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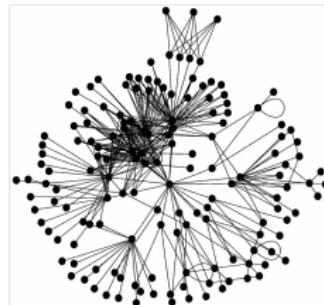
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- ▶ **Ecological Network:** Network of interactions where *nodes* (•) are individuals or (usually, species') populations, and *links* (—) the interactions between pairs of nodes
- ▶ Types:
 - ▶ Trophic networks (+/-) (e.g., food webs)
 - ▶ **Mutualistic networks (+/+) (e.g., plant-pollinator networks)**
 - ▶ Competitive networks (-/-) (e.g., plant-plant or microbe-microbe)
 - ▶ Behavioural networks (+/-, +/+,-/-) (e.g., social networks)

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 - ▶ Plant-Pollinator Networks: Pollination is an indirect benefit to the plant, nectar is a direct (energy) to the pollinator

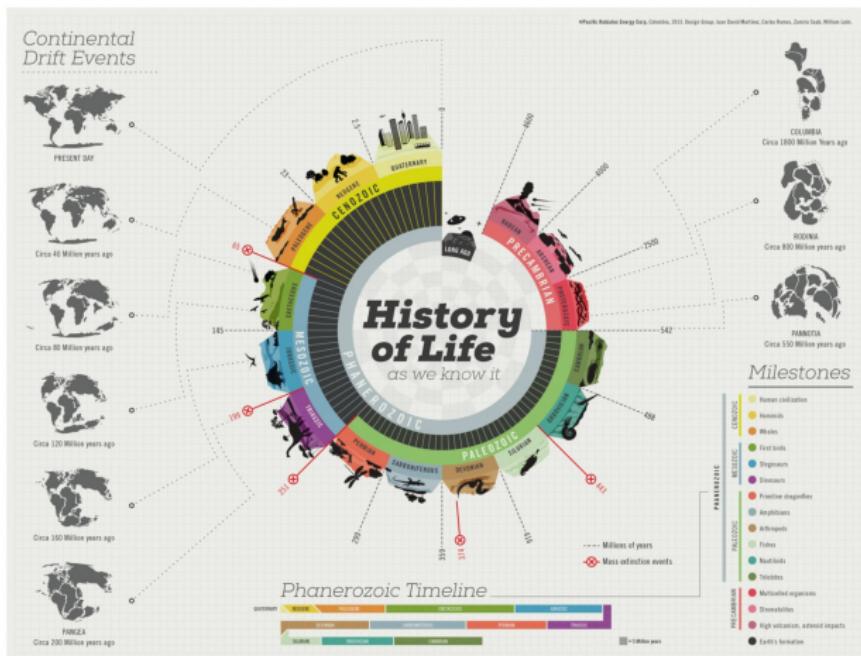
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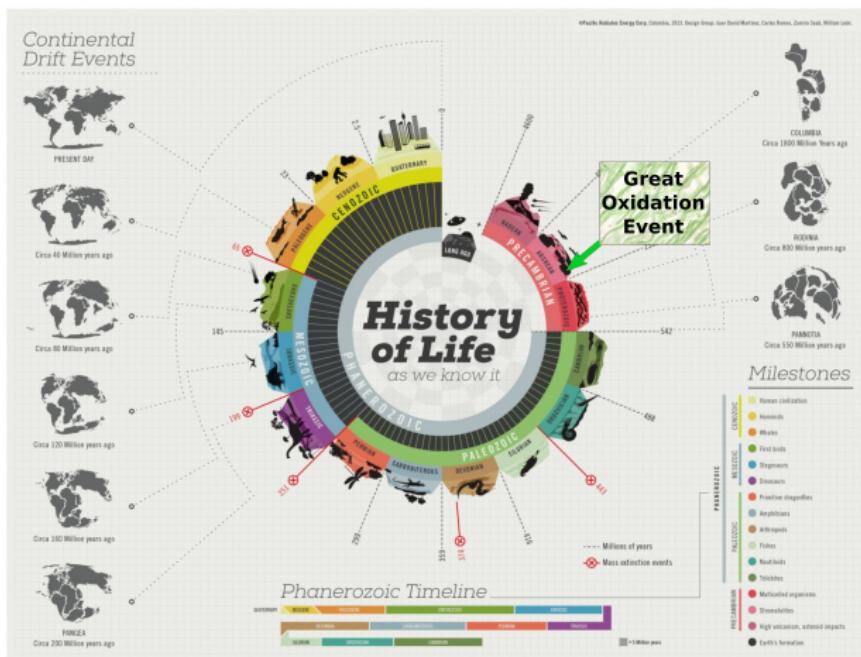
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 - ▶ Ant-Plant association networks: Plant gets protection (direct, but non-energy benefit), Ants get nectar (energy)

ORIGIN OF MUTUALISTIC NETWORKS



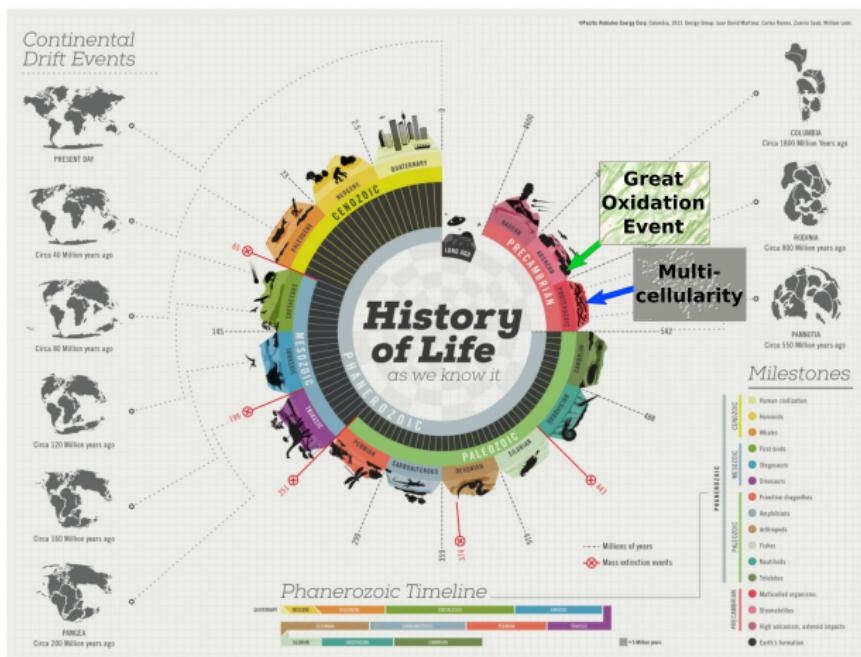
- Mutualistic networks are almost as old as life itself
 - Multi-cellularity possibly arose from a mutualism

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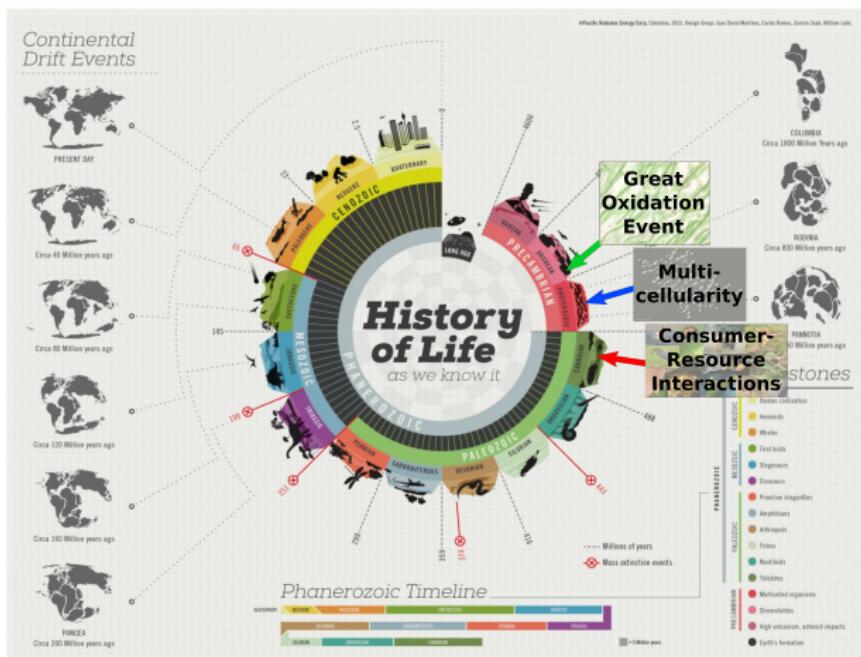
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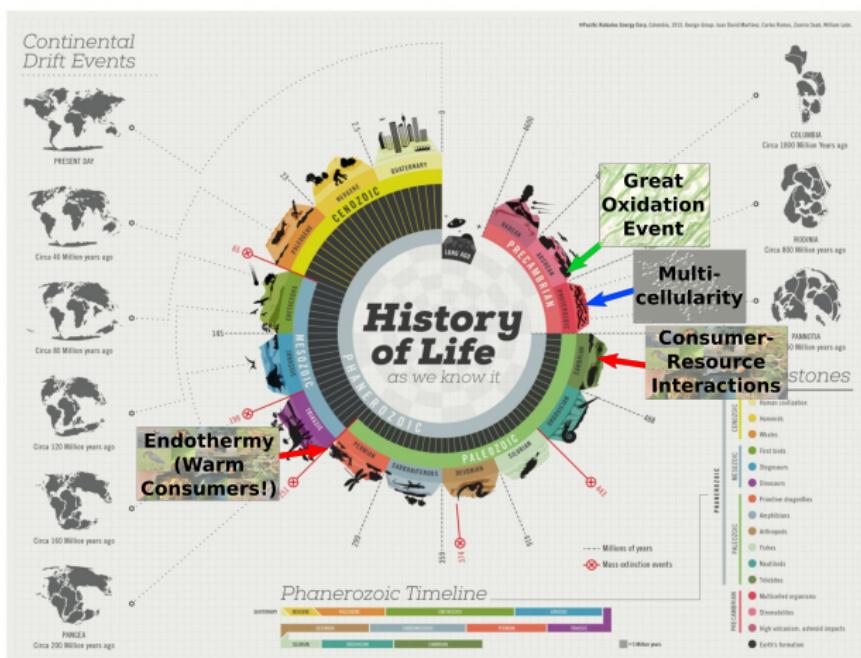
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WHY STUDY MUTUALISTIC NETWORKS?

- ▶ Pollination services



Source: <https://morningchores.com/pollination>

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- ▶ Ecosystem functioning



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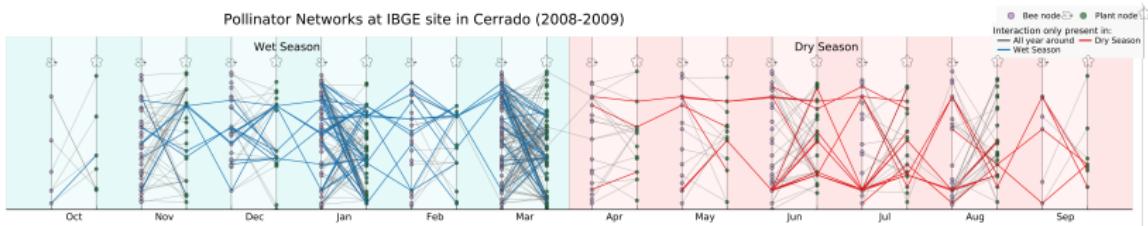
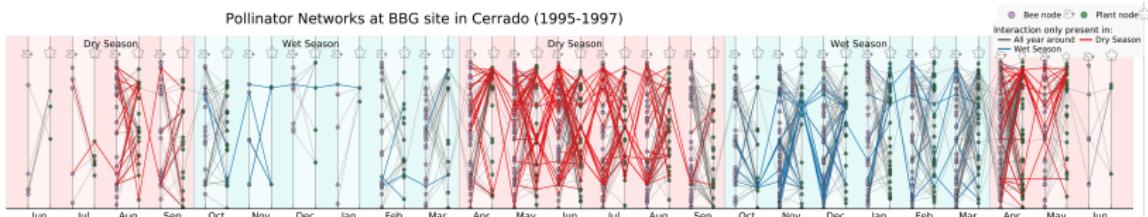
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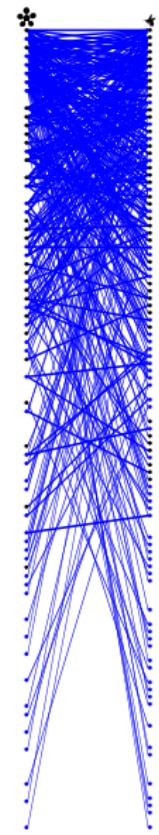
Rabeling et al PLoS One 2019



<https://commons.wikimedia.org/w/index.php?curid=763031>

STRUCTURE AND STABILITY

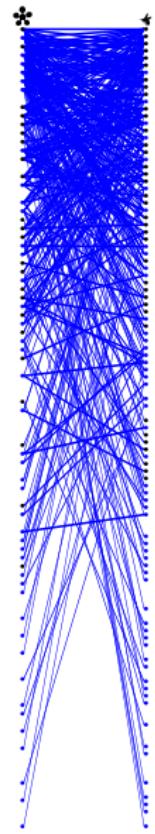
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¹Like other ecological networks: Review lecture on Ecological Interaction Networks

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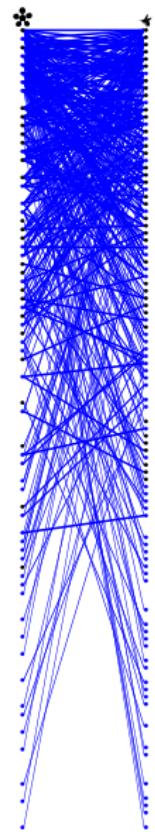
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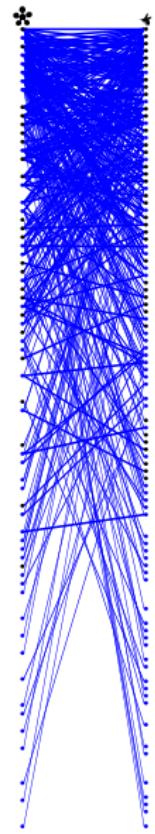
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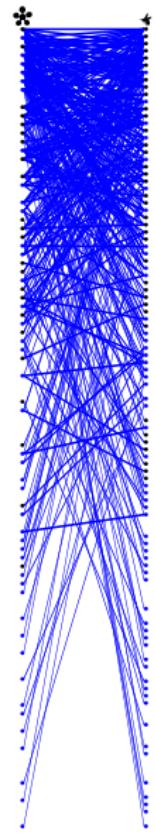
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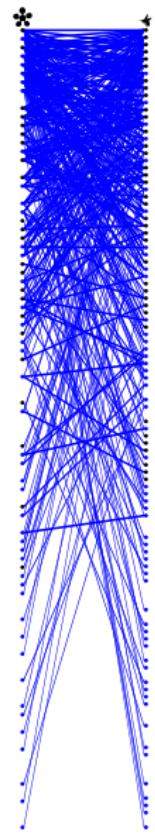
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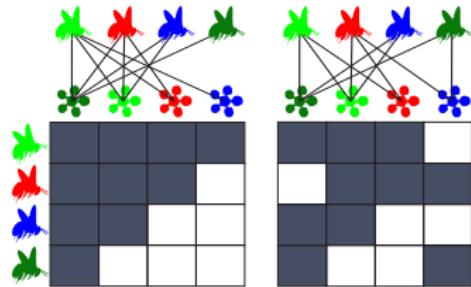
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- ▶ Mutualistic networks have *Modules*¹
 - ▶ But modules in these systems are less easy to identify and are poorly understood



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THE ROLE OF NESTEDNESS

- ▶ **Nestedness of a network:** a network structural pattern where specialist pollinators species visit plant species that are subsets of those visited by more generalist pollinators

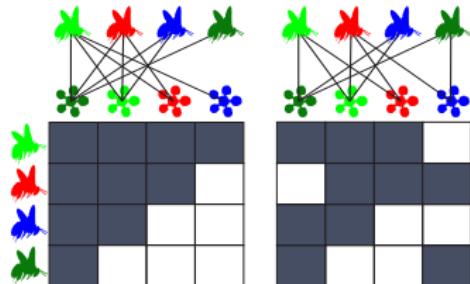


Pawar, Science 2015

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Illustrated: The network on the left is perfectly nested, while the one on the right is not

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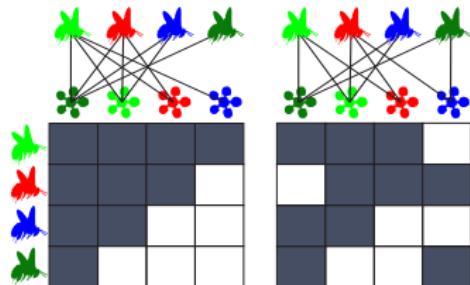


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 - ▶ A generalist pollinator visits and pollinates many different plant species (same criteria can be applied to plants)

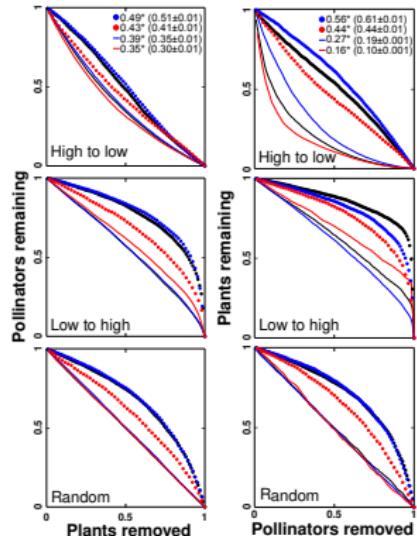


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- Nestedness also means asymmetry in specialization: Specialist plants are pollinated by generalist animals, but generalist plants are pollinated by both specialist and generalist pollinators²



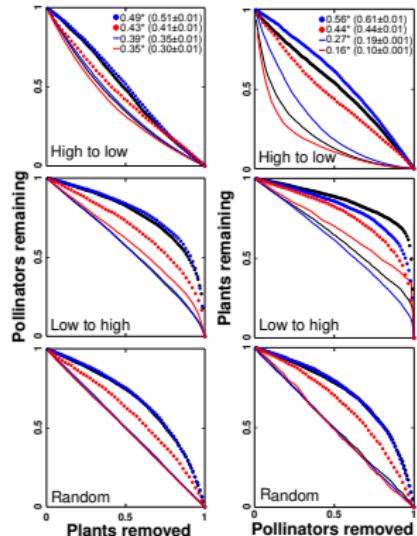
Rabeling et al, PLoS One 2019

- But role of nestedness remains debated...

²In contrast to *reciprocal specialization* where specialist pollinators interact with specialist plants

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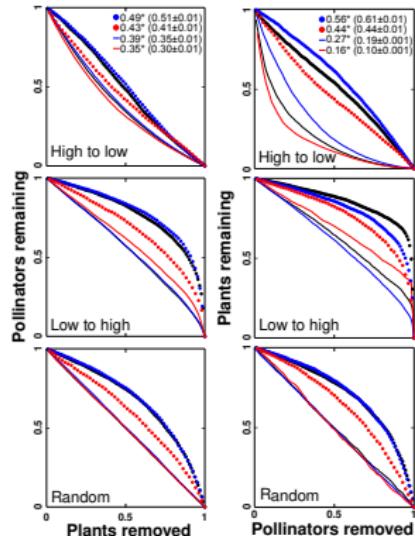
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THE ROLE OF NESTEDNESS

- ▶ Nestedness also means asymmetry in specialization: Specialist plants are pollinated by generalist animals, but generalist plants are pollinated by both specialist and generalist pollinators²
- ▶ All these properties have been linked to *robustness* of pollination networks to species loss:
 - ▶ If you remove a random species in a more nested network, it is less likely to collapse
 - ▶ *But role of nestedness remains debated...*



Rabeling et al, PLoS One 2019

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TEMPORAL VARIATION IN MUTUALISTIC NETWORKS

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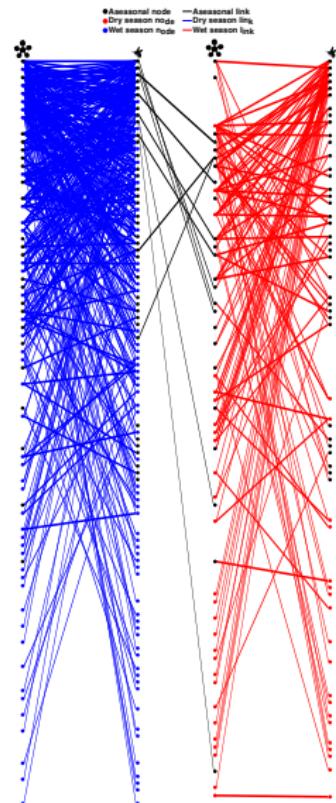
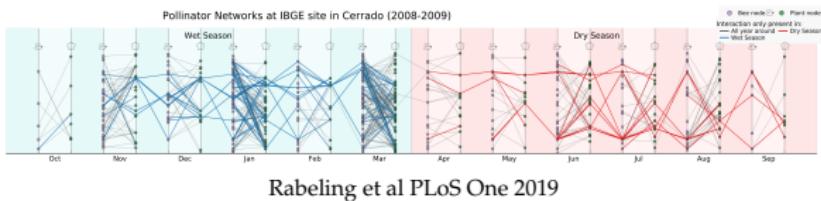
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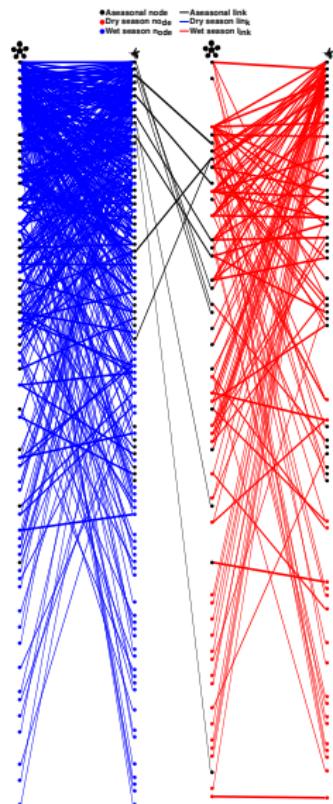
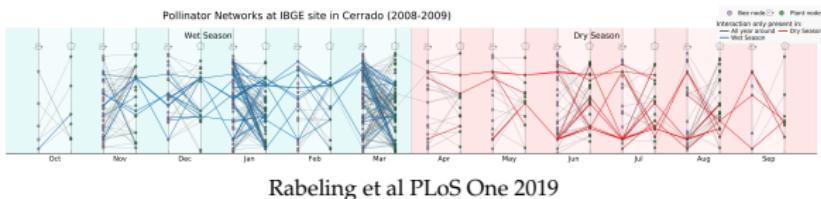
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cerrado s.s.

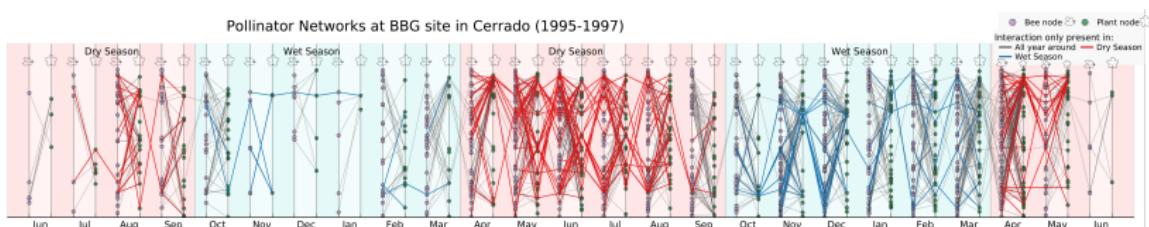
campo cerrado

campo sujo

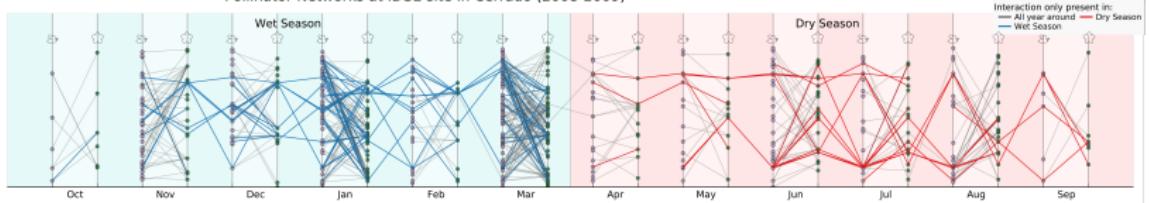
campo limpo

Gottschberger & Silberbauer-Gottschberger, Acta Bot. Brasilica 2018

Pollinator Networks at BBG site in Cerrado (1995–1997)



Pollinator Networks at IBGE site in Cerrado (2008–2009)



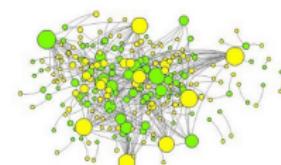
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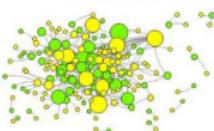
(a) Cerrado



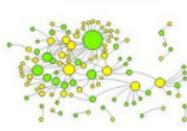
Year-round networks



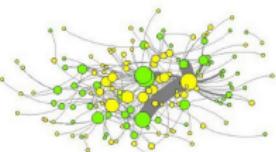
Rainy season networks



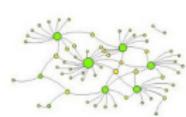
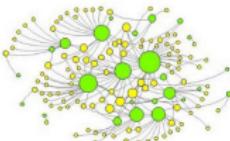
Dry season networks



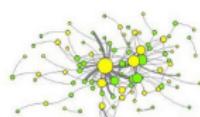
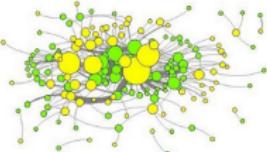
(b) Chaco



(c) Vereda

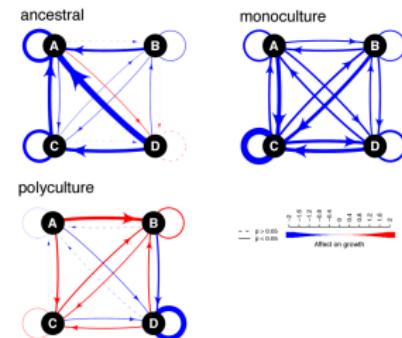


(d) Pantanal

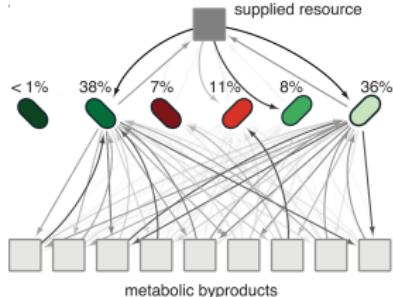


MICROBIAL MUTUALISTIC NETWORKS

- Microbial networks are important model systems for understanding mutualism vs competition



Lawrence et al PLoS Biology 2012
supplied resource

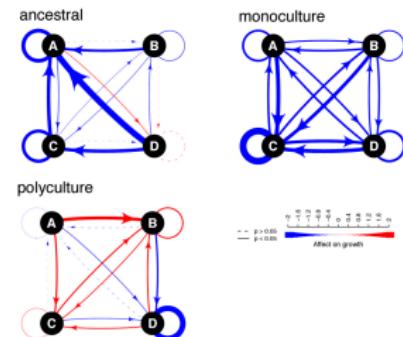


Goldford et al Science 2018

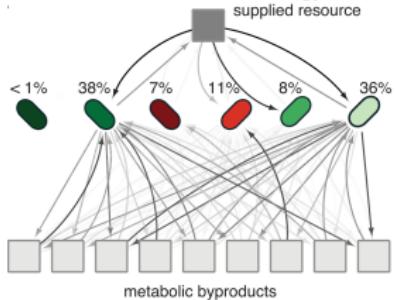
³Review lectures on Energy and Metabolism as well as Consumer-Resource Interactions

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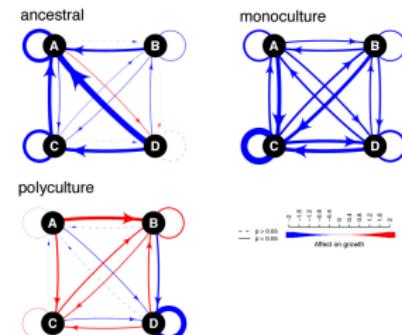


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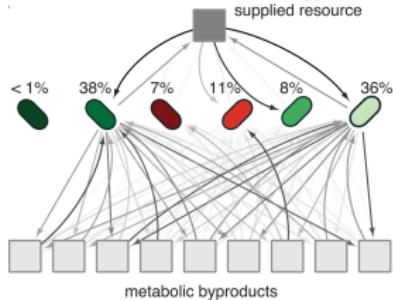
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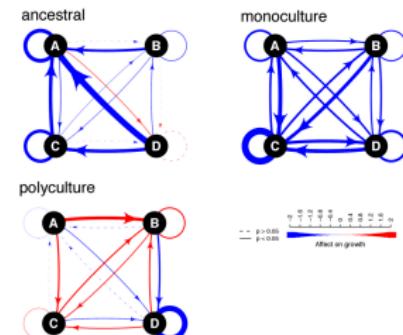


Goldsford et al Science 2018

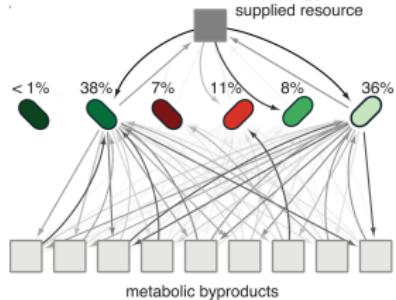
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- ▶ Increasing mutualism increases the rate of microbial community functioning (e.g., decomposition of leaf litter)
- ▶ Temperature can accelerate this effect³



Lawrence et al PLoS Biology 2012
supplied resource



Goldsford et al Science 2018

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SUMMARY

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- ▶ The structure of mutualistic networks affects their stability, resilience, and robustness

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- ▶ Microbial networks can rapidly switch from being competitive to cooperative (mutualistic) over time

DISCUSSION QUESTIONS

1. What are the differences between trophic (e.g., food web) and mutualistic networks?
2. Can we truly study Mutualistic and Trophic networks separately?
3. What role might body size play in Mutualistic (e.g., plant-pollinator) networks?
4. How do you think global climate change might affect plant-pollinator networks and pollination services?
5. How do you think increasing mutualism increases the rate of microbial community functioning (e.g., decomposition of leaf litter)? What role can temperature play in this? How does this relate to the global carbon cycle? (Hint: Leaf litter decomposition releases CO₂)

READINGS

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