

Why are some plant-pollinator networks more nested than others?

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Department of Civil and Environmental Engineering, MIT



Portland, ESA Annual Meeting, August 2017

Science community. *Science*

REPORT

Plant-Pollinator Interactions over 120 Years: Loss of Species, Co-Occurrence, and Function

Laura A. Burkle^{1,2,*}, John C. Marlin³, Tiffany M. Knight¹

Media. *New York Times*

SCIENCE

Decline of Pollinators Poses Threat to World Food Supply, Report Says

By JOHN SCHWARTZ FEB. 26, 2016



TV series. *Black Mirror*

Black Mirror (2011–)



Hated in the Nation

TV-MA | 1h 29min | Drama, Sci-Fi, Thriller | Episode aired 21 October 2016

★ 8.7 /10
9,933



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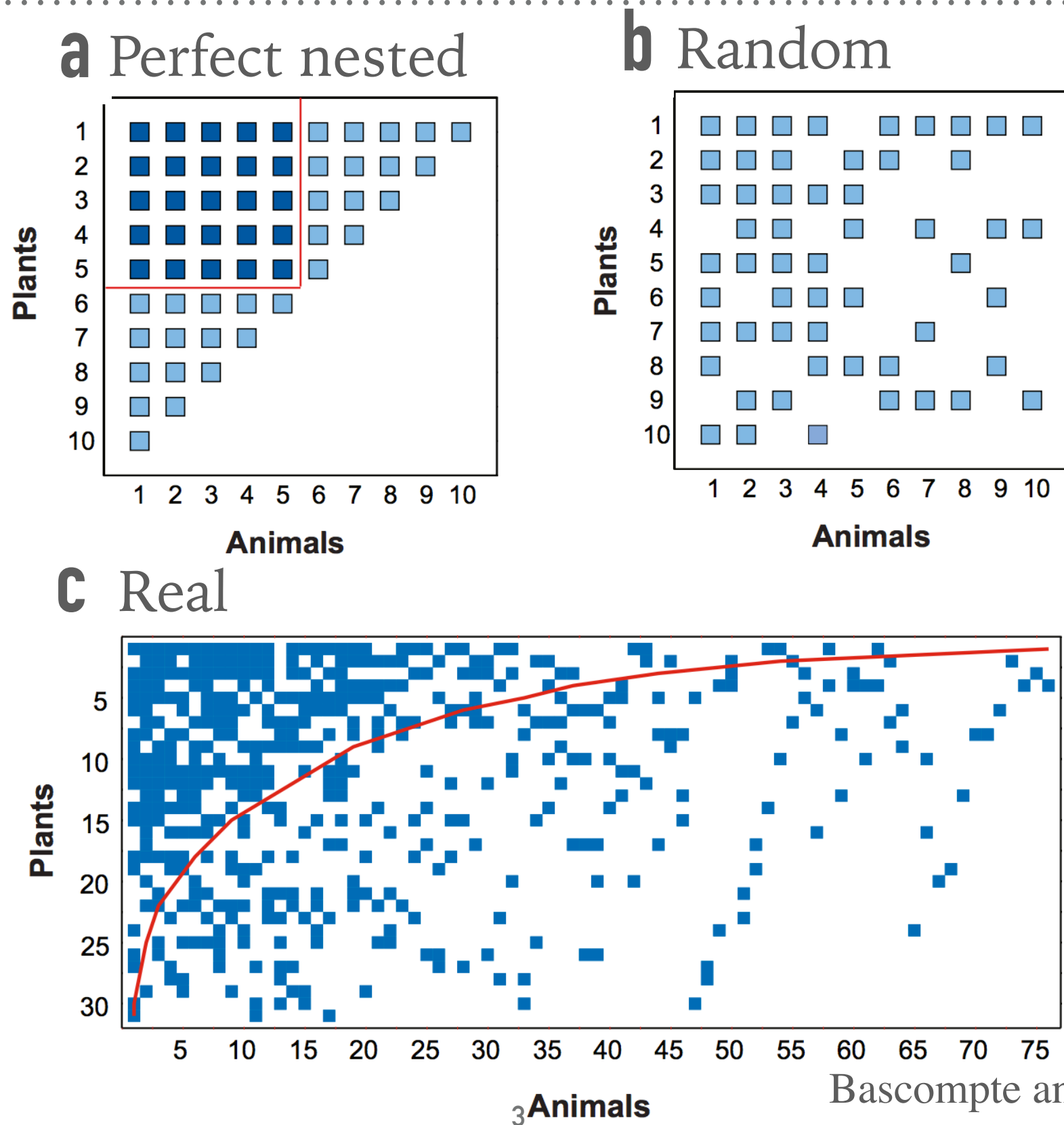
Season 3 | Episode 6

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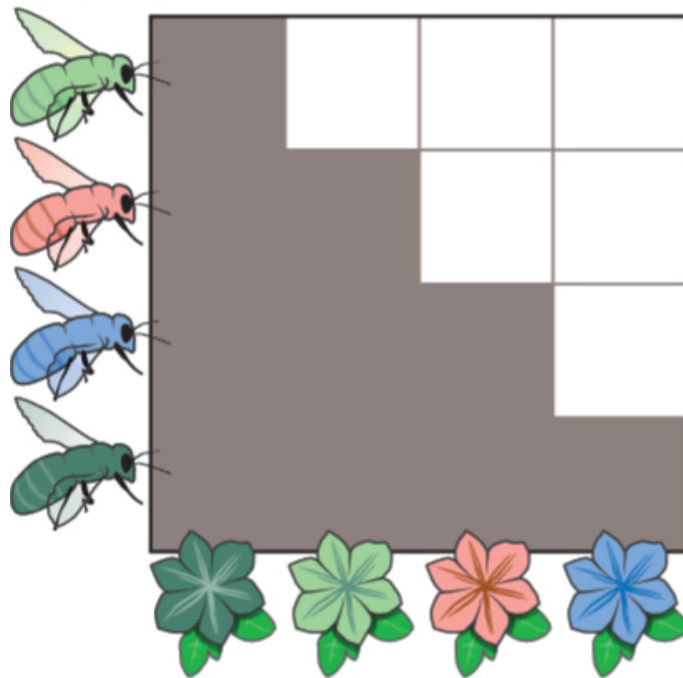
NESTED PATTERN IN PLANT-POLLINATOR INTERACTIONS



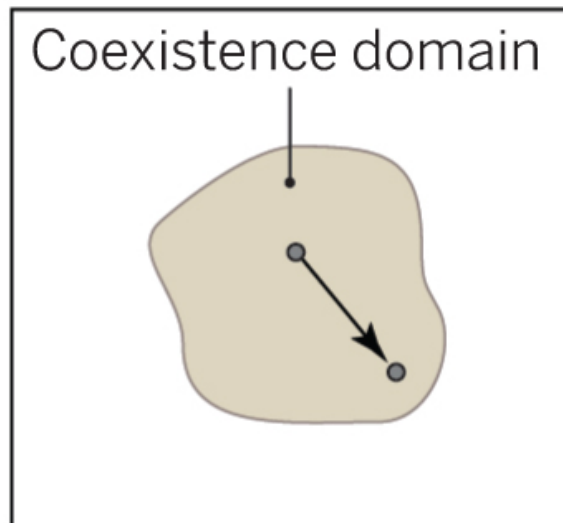
Bascompte and Jordano,
Annu. Rev. Ecol. Evol. Syst. (2007)

WHY MUTUALISTIC NETWORKS ARE NESTED?

Highly nested network = high structural stability

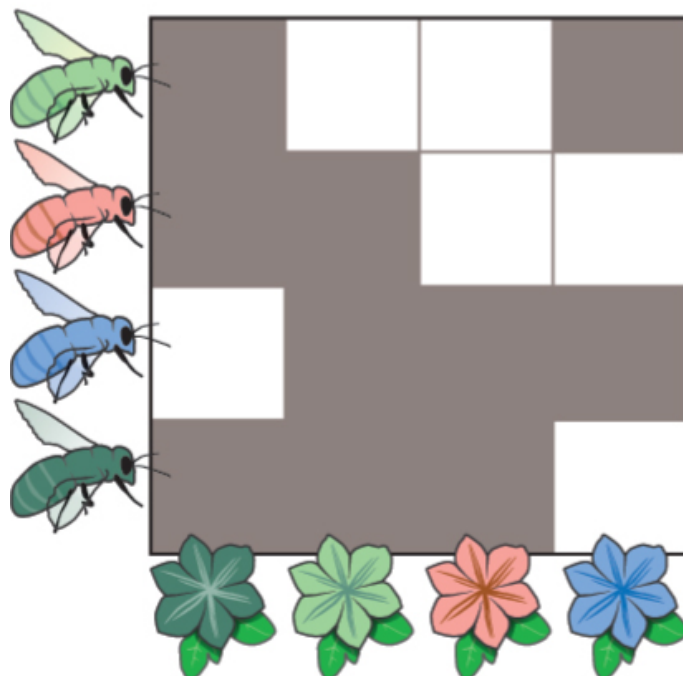


Plant growth rates

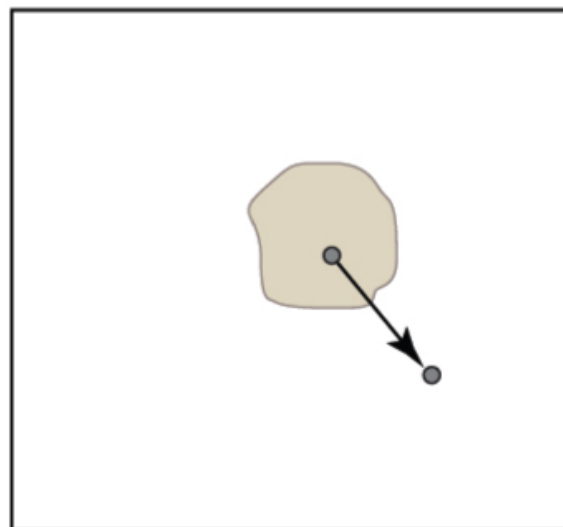


Pollinator growth rates

Less nested network = low structural stability



Plant growth rates



Pollinator growth rates

LACK OF AGREEMENT ON SEASONALITY AND LEVEL OF NESTEDNESS

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Global Ecology and Biogeography, (Global Ecol. Biogeogr.) (2014)



Macroecological trends in nestedness and modularity of seed-dispersal networks: human impact matters

Esther Sebastián-González^{1*}, Bo Dalsgaard², Brody Sandel³ and Paulo R. Guimarães Jr¹

RESEARCH ARTICLE

Human Impacts and Climate Change Influence Nestedness and Modularity in Food-Web and Mutualistic Networks

Kazuhiro Takemoto , Kosuke Kajihara

Published: June 20, 2016 • <https://doi.org/10.1371/journal.pone.0157929>

**ARE SOME NETWORKS
MORE NESTED?**

ARE SOME NETWORKS MORE NESTED?

➤ NODF (raw nestedness measure)



Oikos 117: 1227–1239, 2008

doi: 10.1111/j.2008.0030-1299.16644.x,

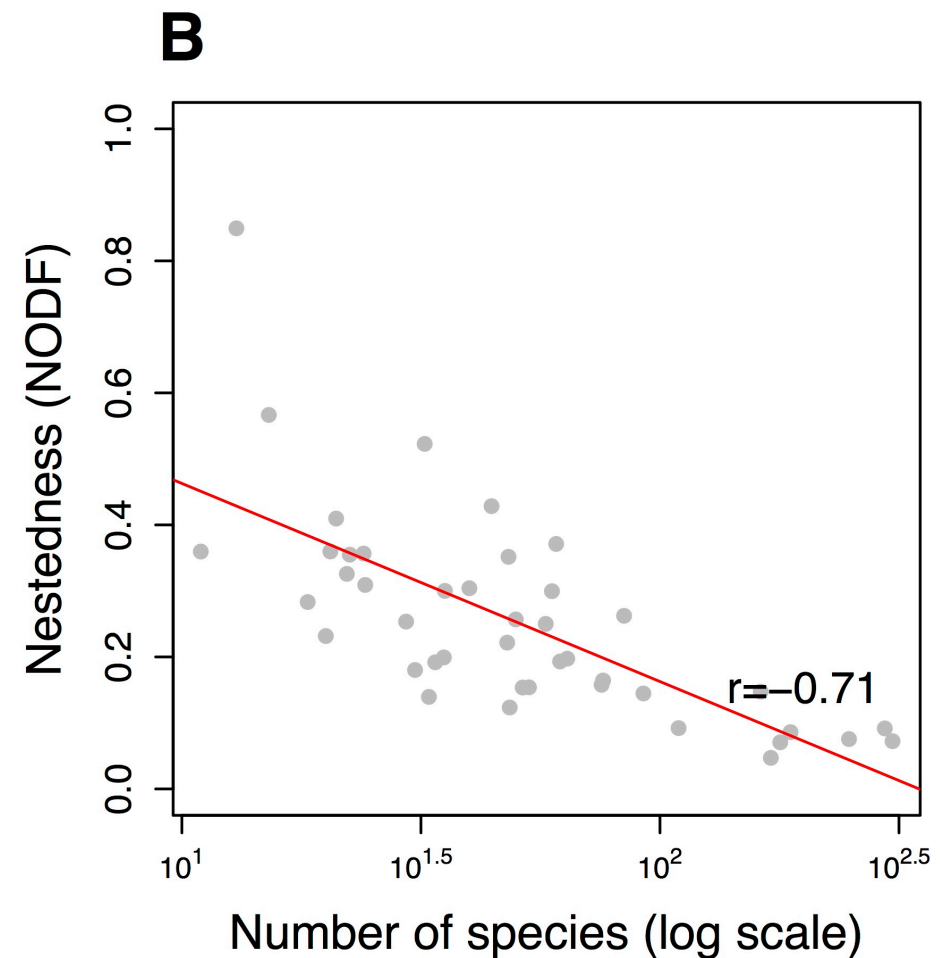
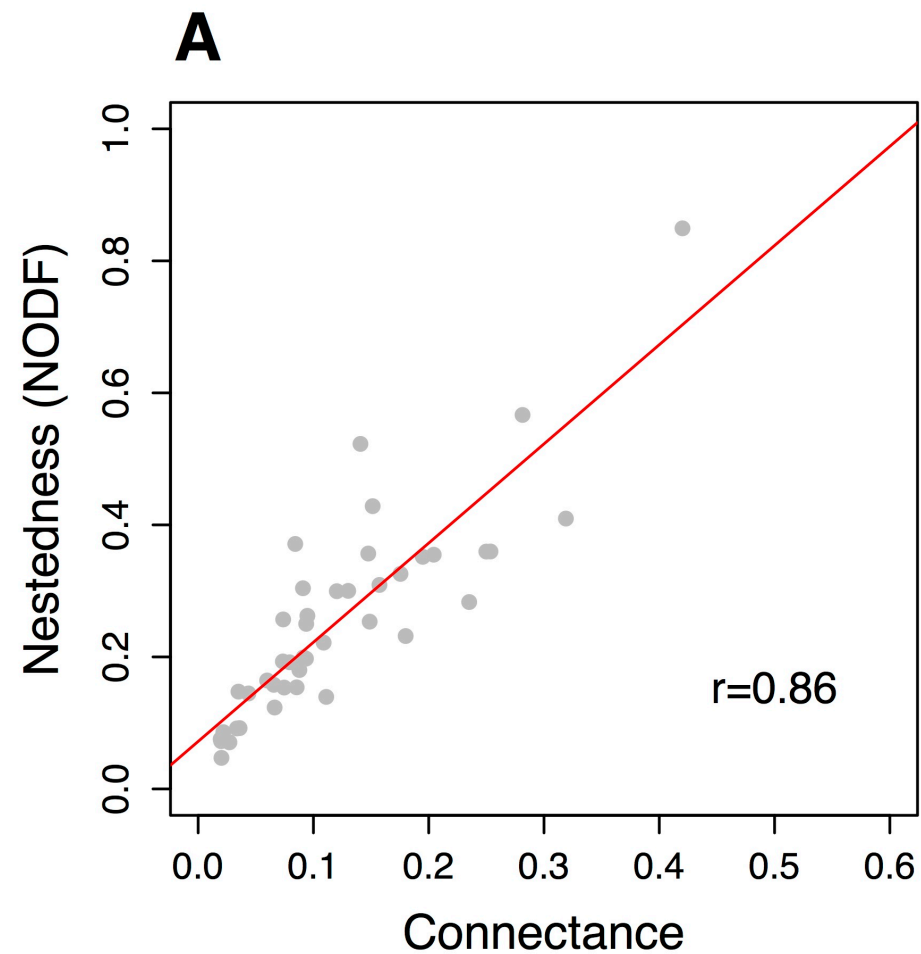
© 2008 The Authors. Journal compilation © 2008 Oikos

Subject Editor: Ulrich Brose. Accepted 18 March 2008

A consistent metric for nestedness analysis in ecological systems: reconciling concept and measurement

**Mário Almeida-Neto, Paulo Guimarães, Paulo R. Guimarães Jr, Rafael D. Loyola and
Werner Ulrich**

NODF CORRELATES WITH CONNECTANCE AND COMMUNITY SIZE

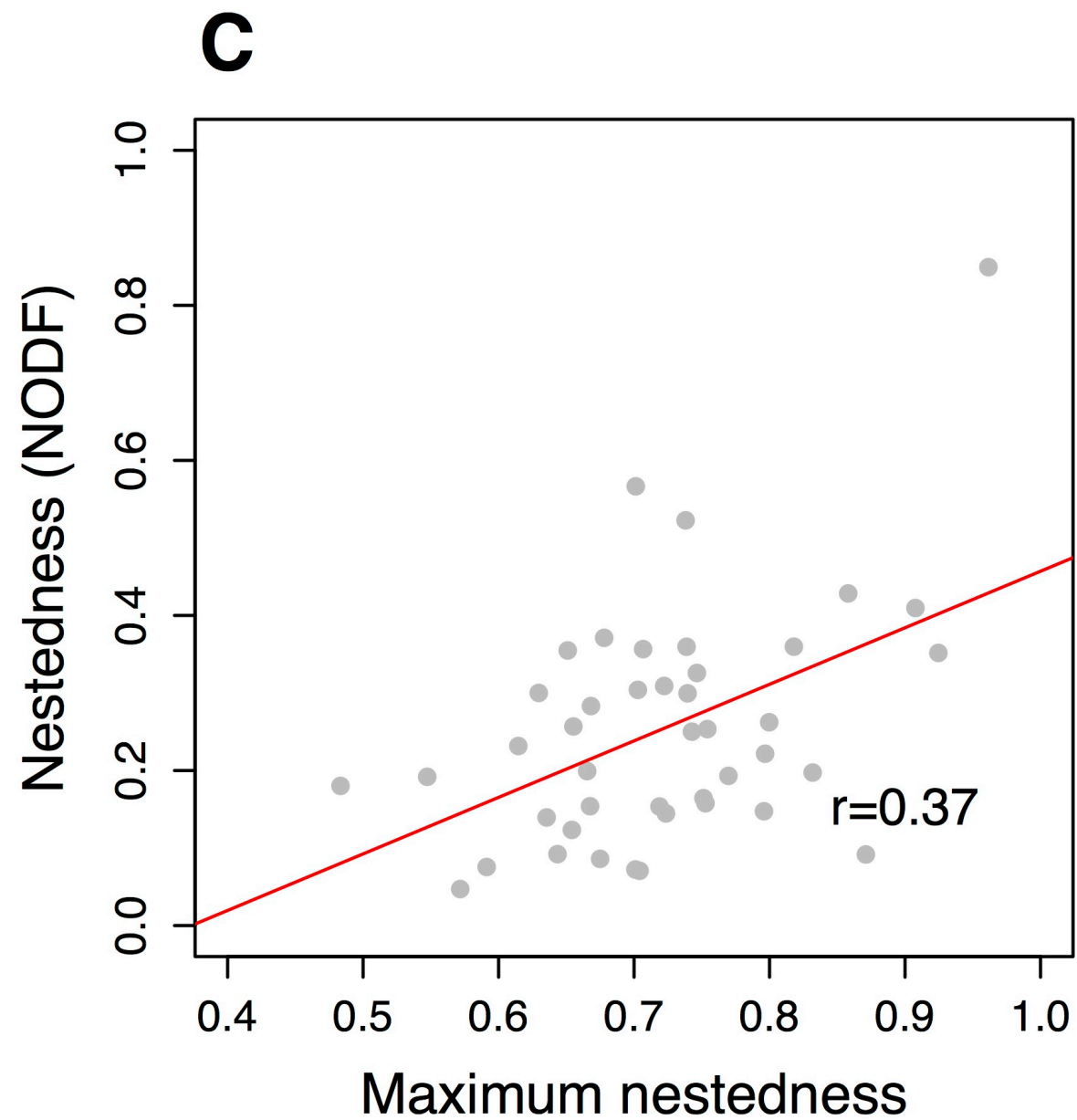


MAXIMUM NODF MATTERS

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	Test score	Max test score	Normalized score
Student A	99	100	99%
Student B	120	150	80%

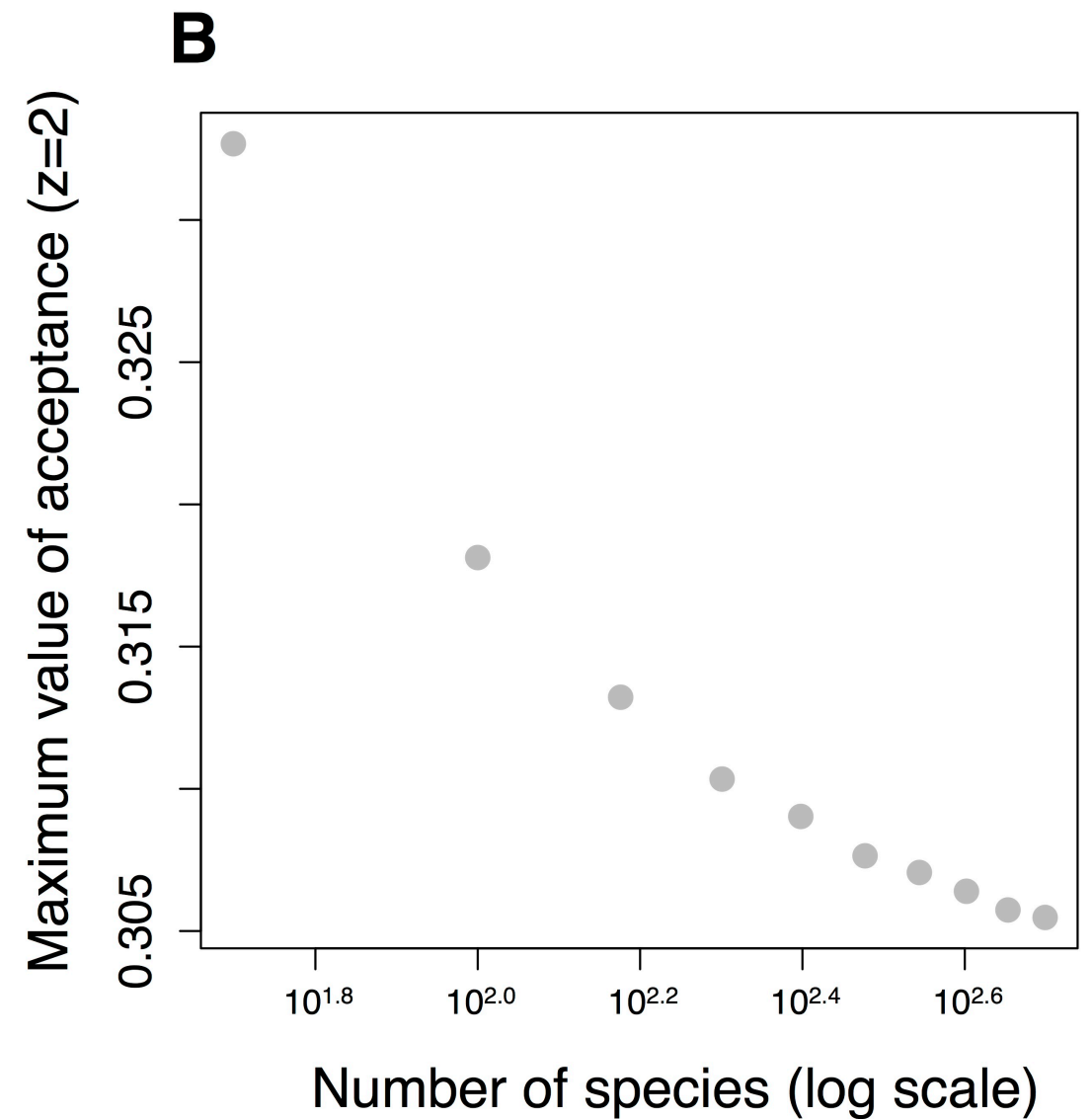
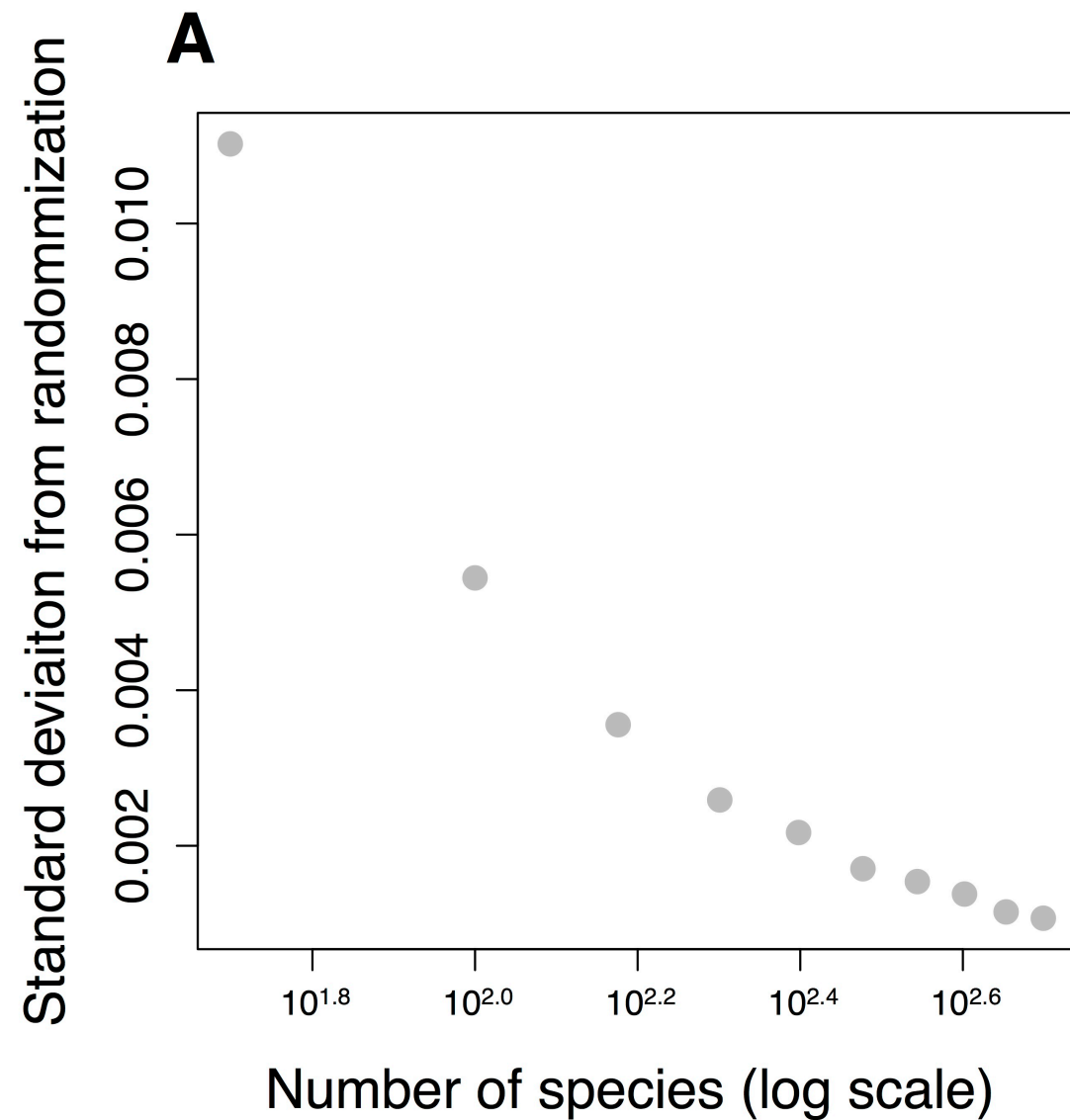
NODF CORRELATES WITH MAXIMUM NODF



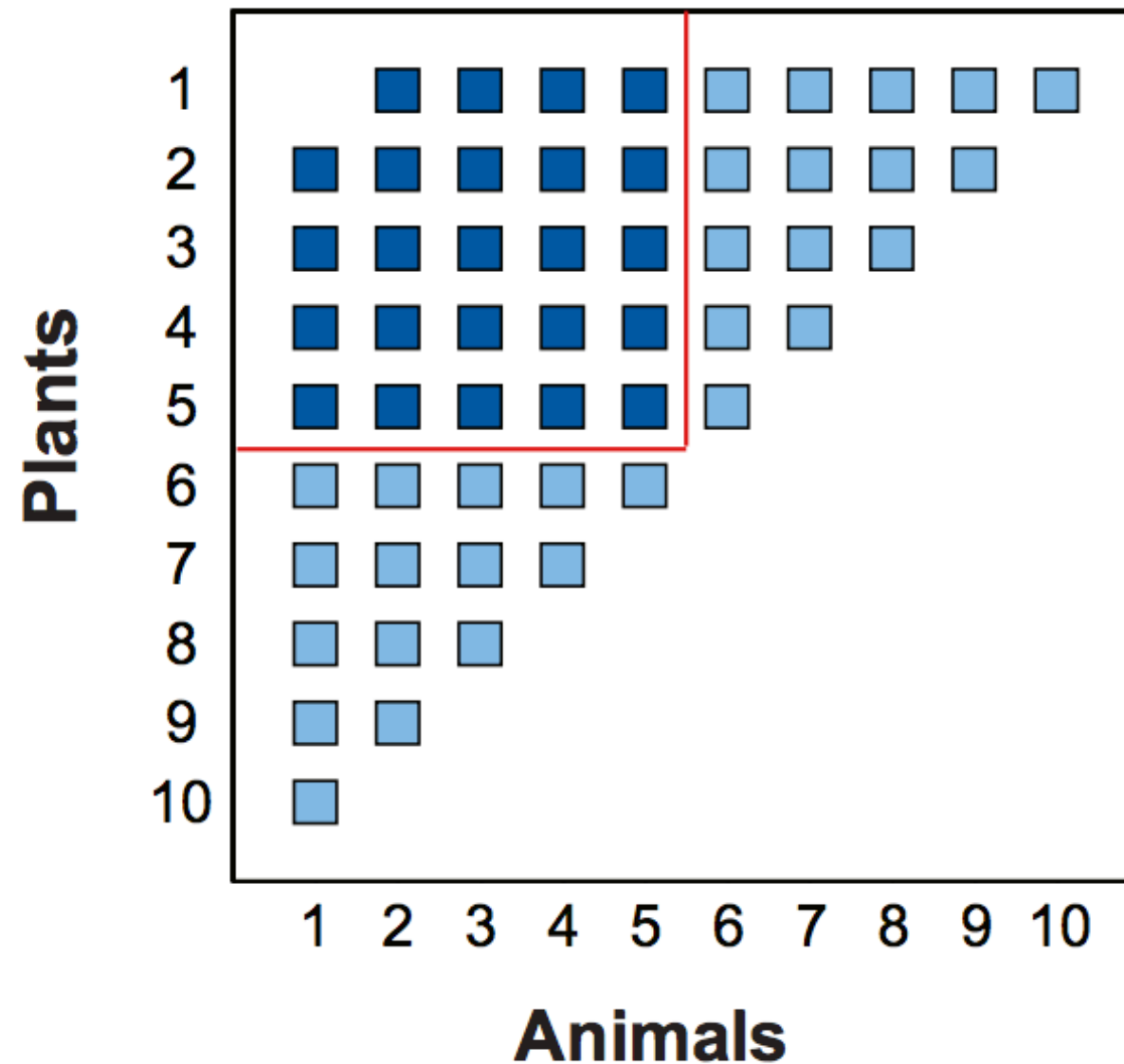
ARE SOME NETWORKS MORE NESTED?

- NODF
- z-score of NODF. Depends on null models:
 - equiprobable model
 - probabilistic model
 - fixed model

REJECTION OF NULL MODEL IS EASIER WITH LARGER COMMUNITY SIZE

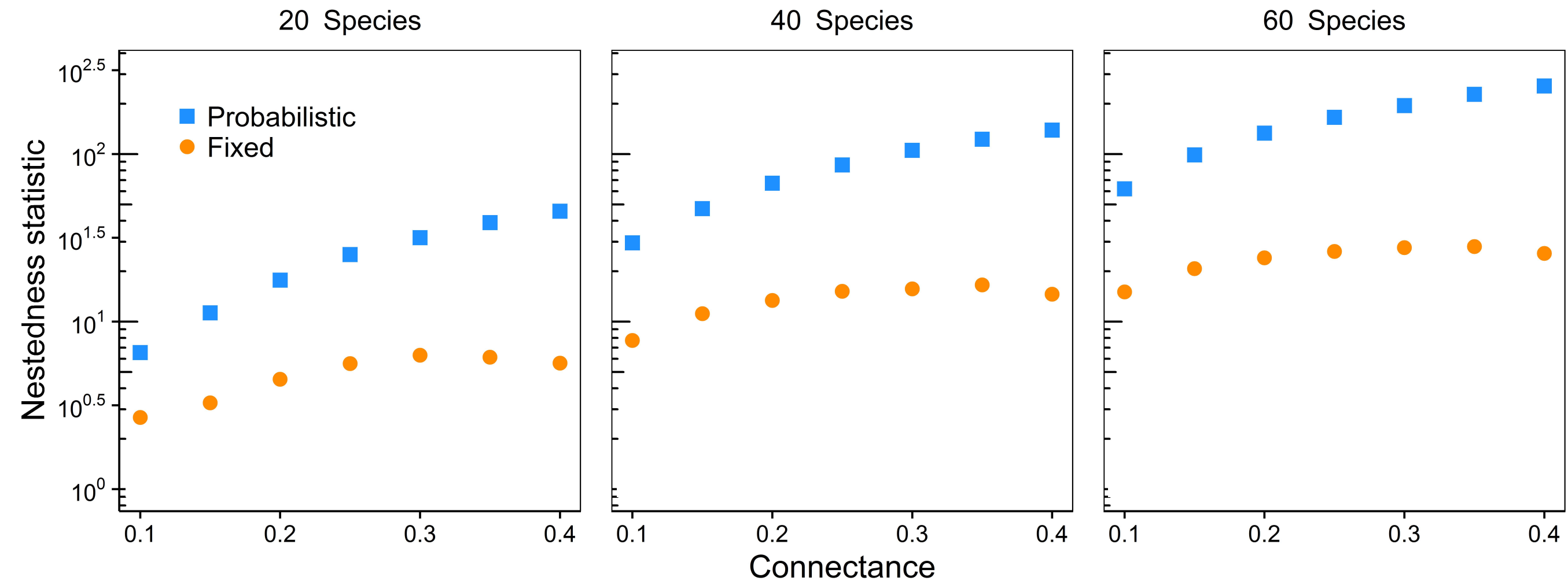


INCONSISTENCY OF Z-SCORE ON ALMOST OPTIMUM STRUCTURE



Adapted from Bascompte and Jordano,
Annu. Rev. Ecol. Evol. Syst. (2007)

TEST OF COMBINED NESTEDNESS ON SIMULATION

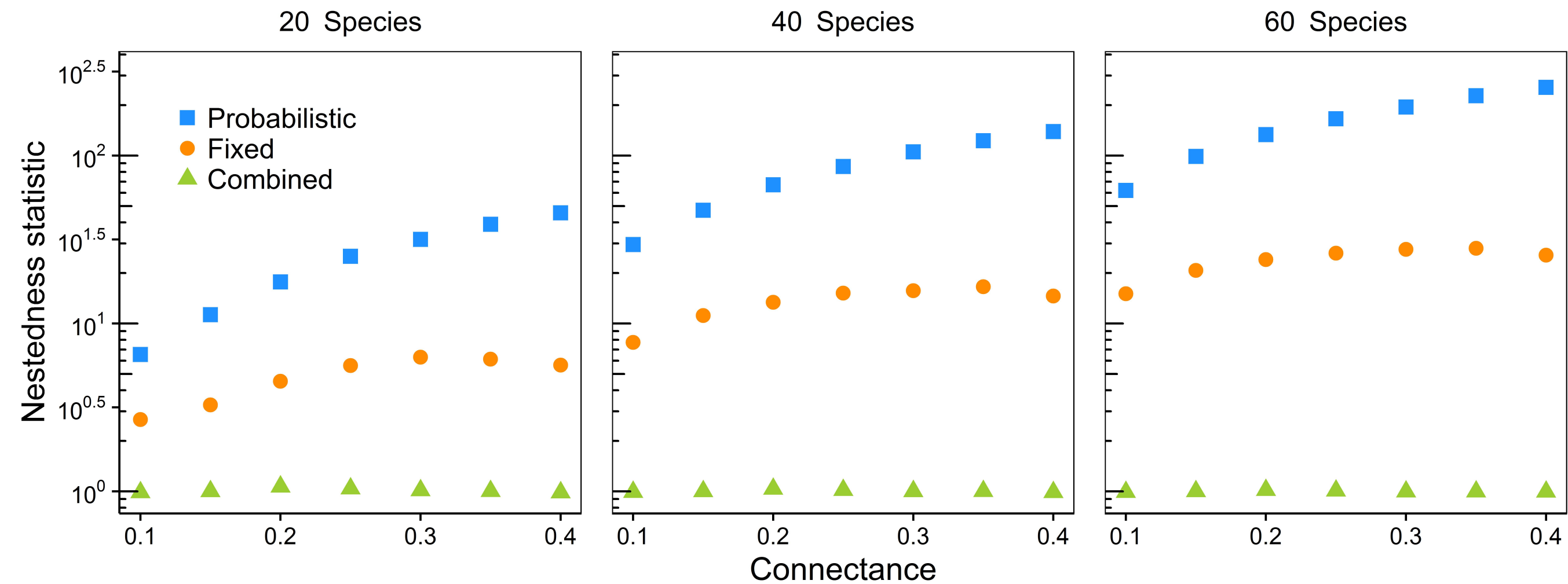


ARE SOME NETWORKS MORE NESTED?

- NODF
- z-score of NODF. Depends on null models:
 - equiprobable model
 - probabilistic model
 - fixed model
- **combined NODF: $\text{NODF} / (\max(\text{NODF}) * C * \log(S))$**

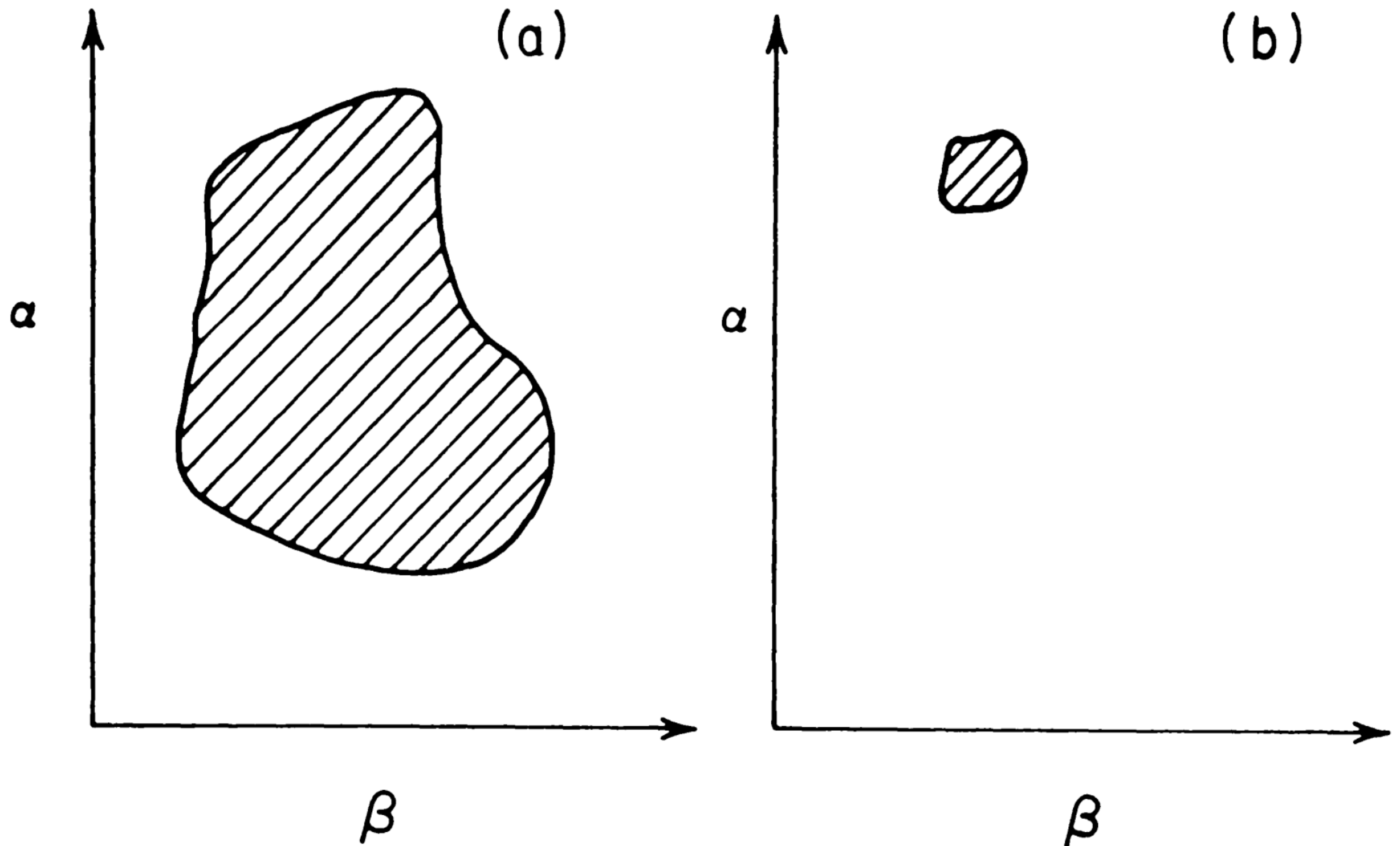
COMBINED NODF IS CONSISTENT WITH CONNECTANCE AND COMMUNITY SIZE

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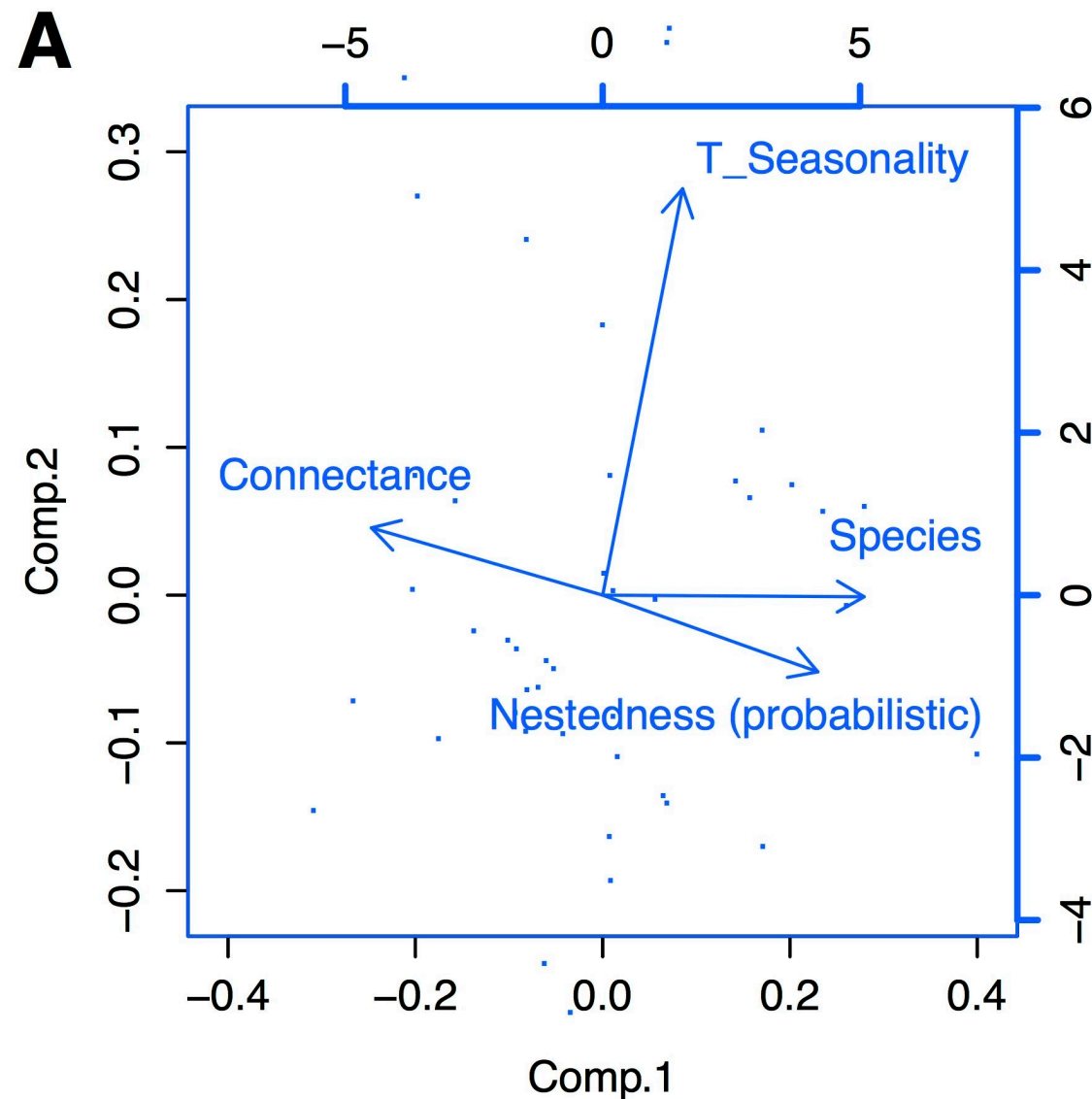


WHY ARE SOME NETWORKS MORE NESTED?

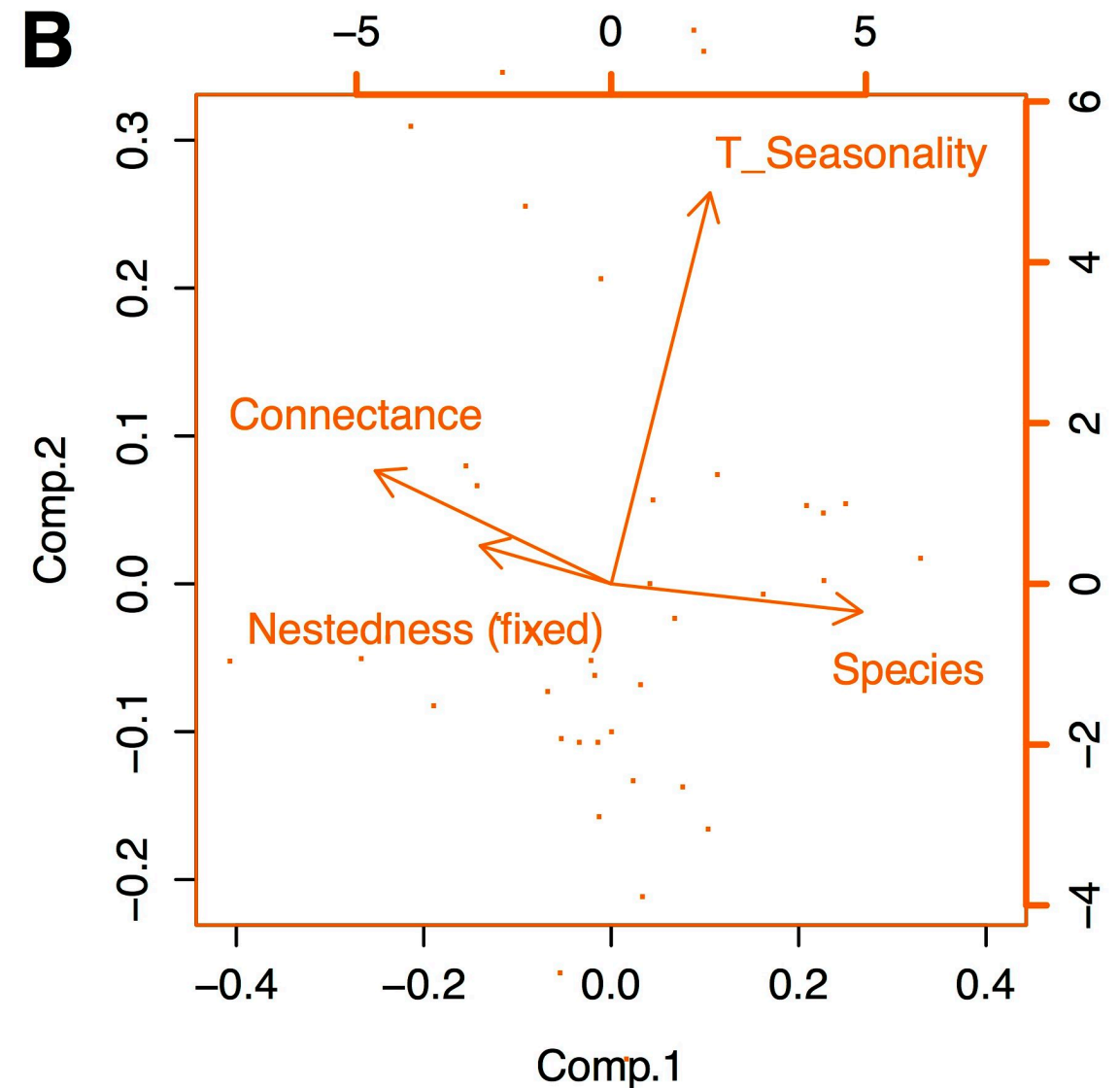
HYPOTHESIS ON ENVIRONMENTAL UNCERTAINTY VS STRUCTURAL STABILITY



STATISTICAL ANALYSIS ON NESTEDNESS AND SEASONALITY



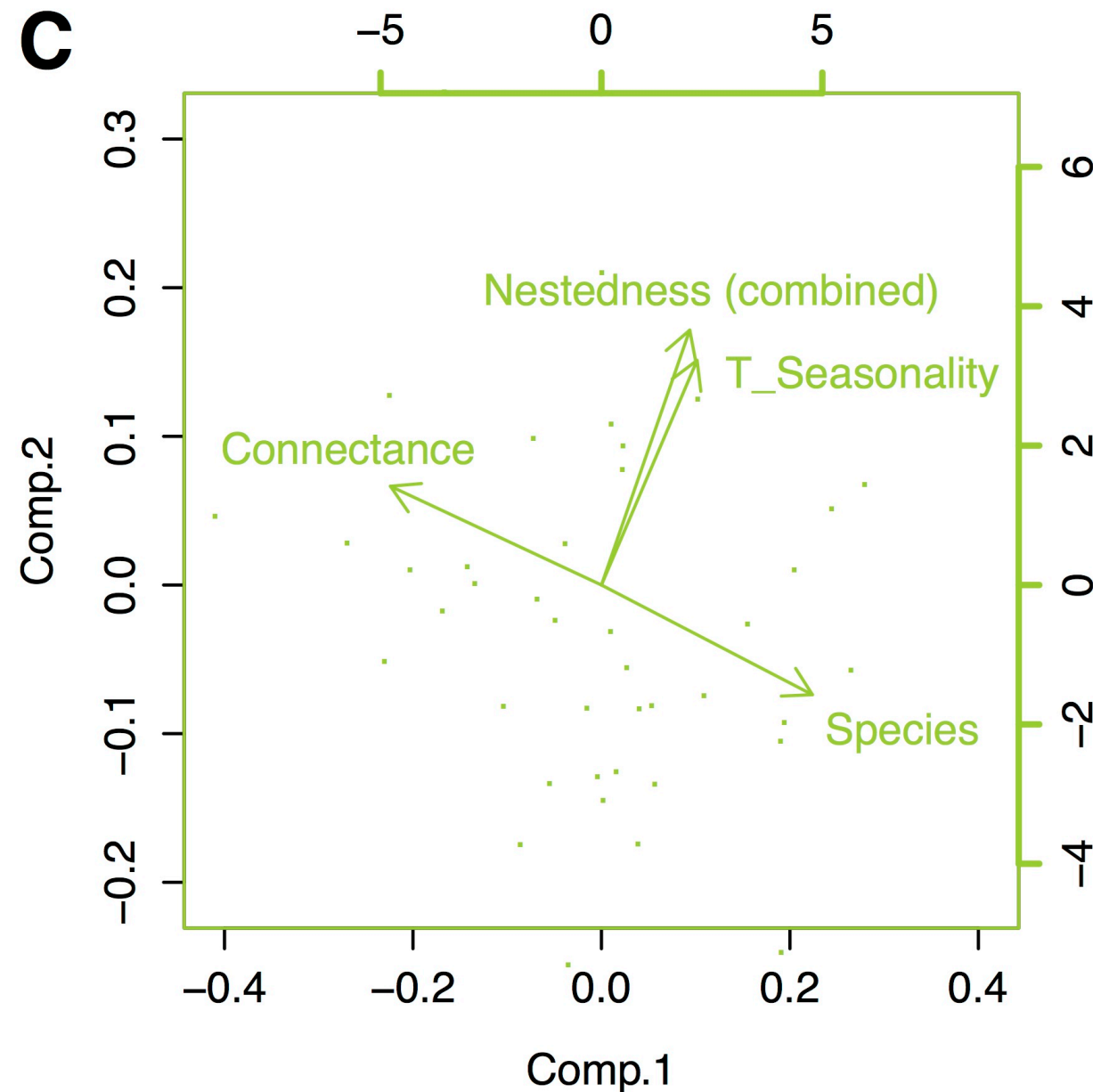
z-score of probabilistic null model



z-score of fixed null model

Data source: *web-of-life.es* & *WorldClim*
Song et al., *J. Animal Ecology*, In Press

STATISTICAL ANALYSIS ON NESTEDNESS AND SEASONALITY



combined NODF

Data source: web-of-life.es & WorldClim

Song et al., *J. Animal Ecology*, In Press

TAKE-HOME MESSAGE

- In line with theory on structural stability of species coexistence in mutualistic systems, we show that higher levels of nestedness are associated with highly changing or seasonal environments.
- We show that the previous lack of agreement on this relationship came from an extended practice of using standardize measures of nestedness (z-scores) that cannot be compared across different networks.

COLLABORATORS



Saavedra S



Rohr R