Particularités écologiques de la théorie neutraliste & pistes de recherche associées.

Franck Jabot

Laboratoire d'Ingénierie pour les Systèmes Complexes (LISC)

Cemagref Clermont-Ferrand

16 juin 2011 – Rencontre de la chaire MMB

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Summary

Introduction

Phylogenetic information

Functional traits

Ecological networks

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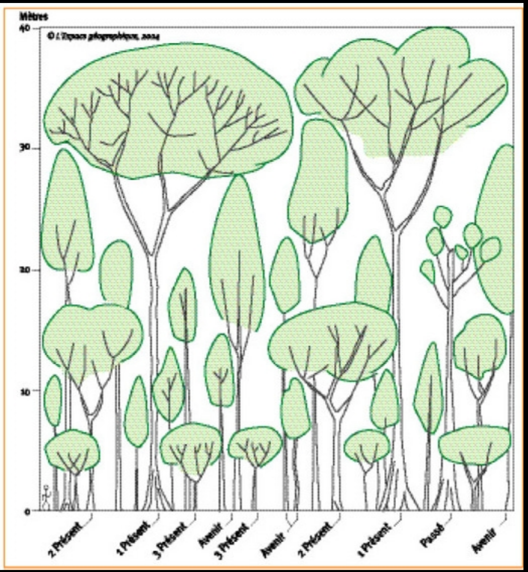
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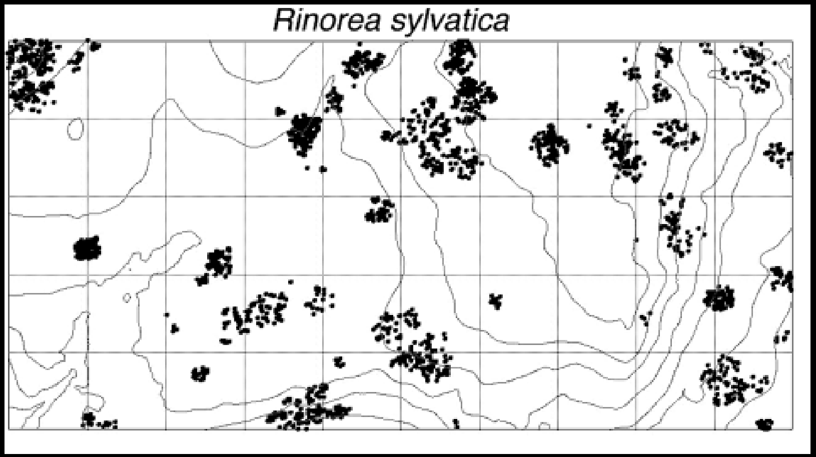
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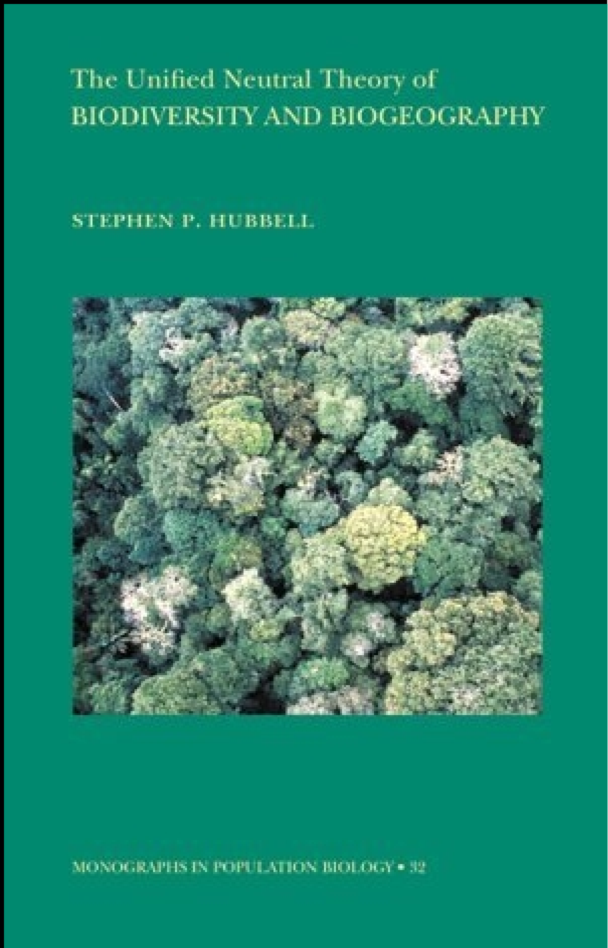
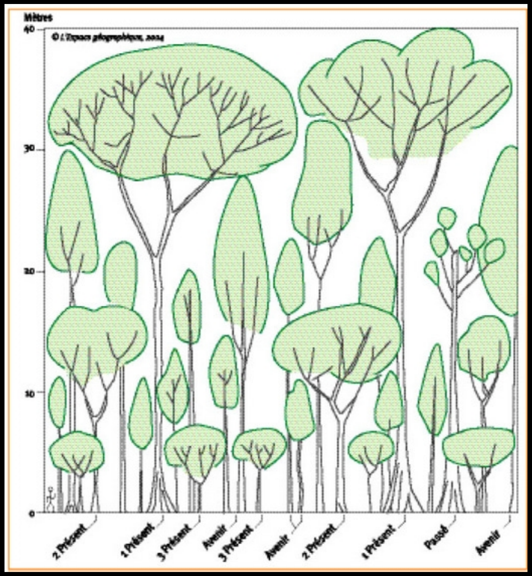
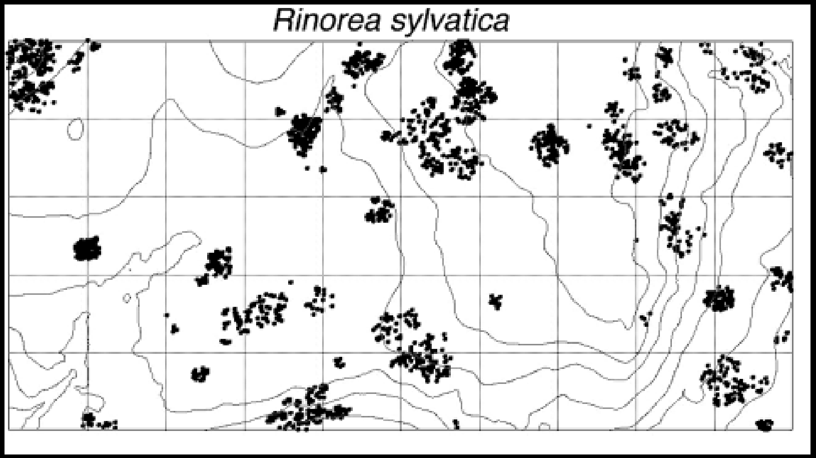
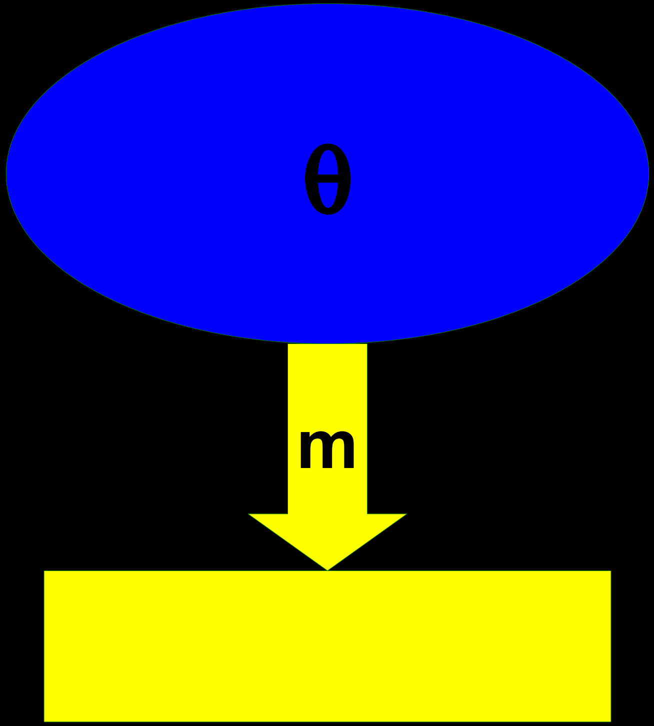
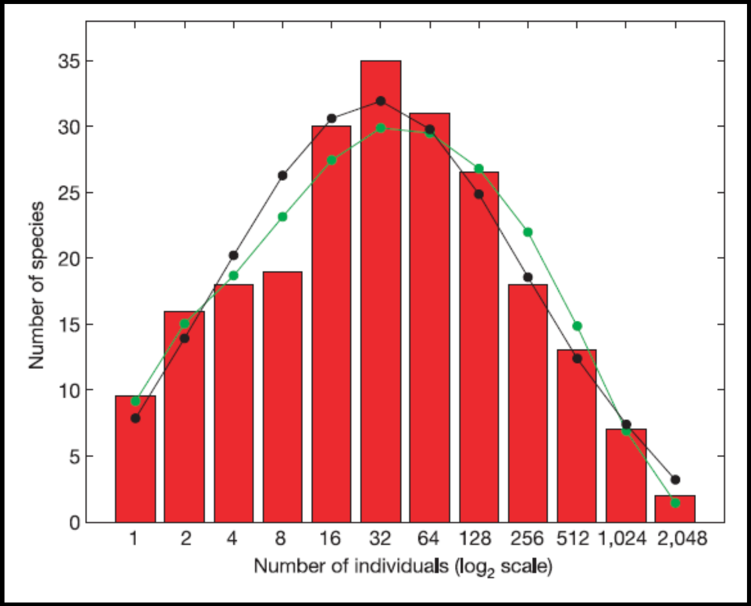

The Unified Neutral Theory of
BIODIVERSITY AND BIOGEOGRAPHY
STEPHEN P. HUBBELL
MONOGRAPHS IN POPULATION BIOLOGY • 32

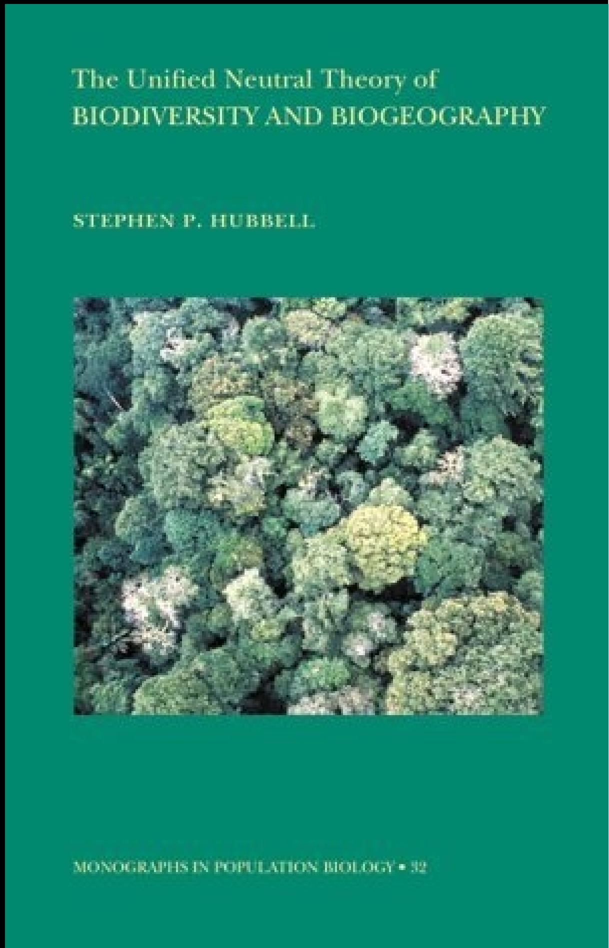








Volkov et al. Nature 2003



Dispersal limitation is widespread in nature

Dispersal limitation is widespread in nature

Are plant populations seed-limited? A review of seed sowing experiments

Lindsay A. Turnbull, Michael J. Crawley and Mark Rees

Turnbull, L. A., Crawley, M. J. and Rees, M. 2000. Are plant populations seed-limited? A review of seed sowing experiments. – Oikos 88: 225–238.

Ecology Letters, (2008) **11**: 960–968 doi: 10.1111/j.1461-0248.2008.01196.x

LETTER

Experimental evidence for extreme dispersal limitation in tropical forest birds

R. P. Moore,[1]* W. D. Robinson,[1] I. J. Lovette[2] and T. R. Robinson[1]
[1]*Department of Fisheries and Wildlife, Oregon State University, 104 Nash Hall, Corvallis, OR 97331, USA*
[2]*Evolutionary Biology Program, Cornell Laboratory of Ornithology, 159 Sapsucker Woods Road, Ithaca, NY 14850, USA*
**Correspondence: E-mail: randy.moore@oregonstate.edu*

Abstract
Movements of organisms between habitat remnants can affect metapopulation structure, community assembly dynamics, gene flow and conservation strategy. In the tropical landscapes that support the majority of global biodiversity and where forest fragmentation is accelerating, there is particular urgency to understand how dispersal across habitats mediates the demography, distribution and differentiation of organisms. By employing unique dispersal challenge experiments coupled with exhaustive inventories of birds in a Panamanian lacustrine archipelago, we show that the ability to fly even short distances (< 100 m) between habitat fragments varies dramatically and consistently among species of forest birds, and that this variation correlates strongly with species' extinction histories and current distributions across the archipelago. This extreme variation in flight capability indicates that species' persistence in isolated forest remnants will be differentially mediated by their respective dispersal abilities, and that corridors connecting such fragments will be essential for the maintenance of avian diversity in fragmented tropical landscapes.

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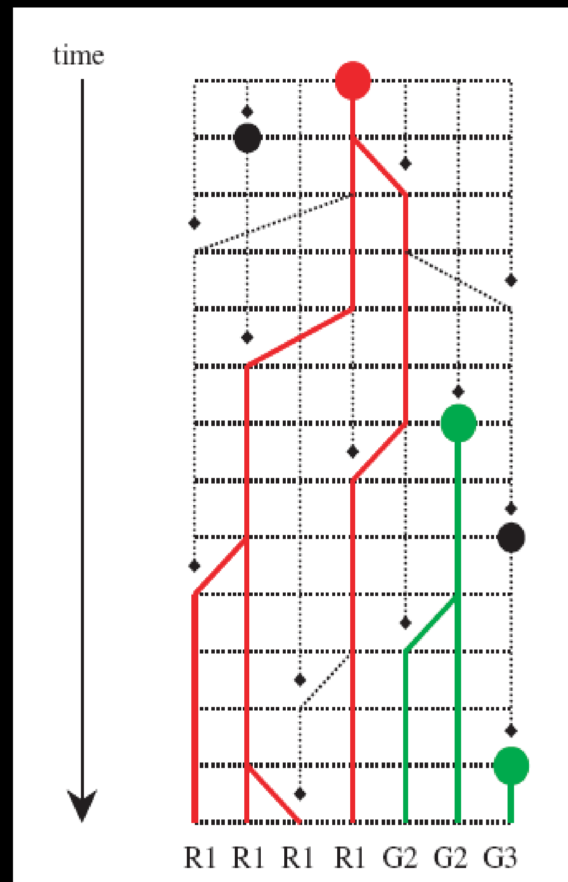
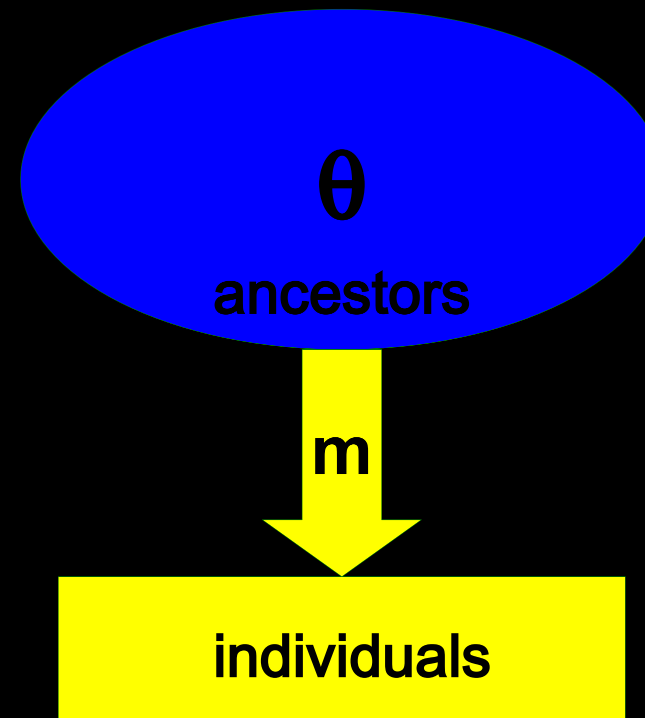
Neutral theory and coalescent

Neutral theory and coalescent

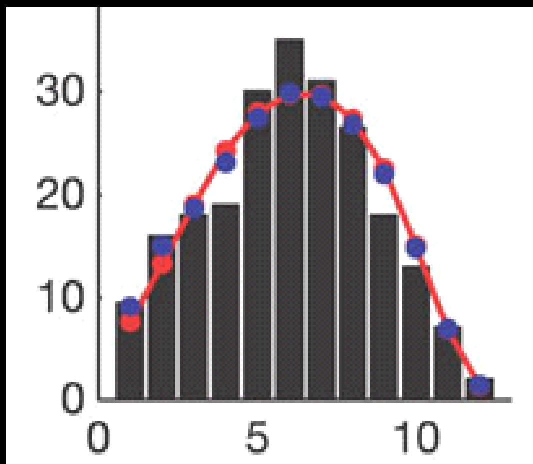


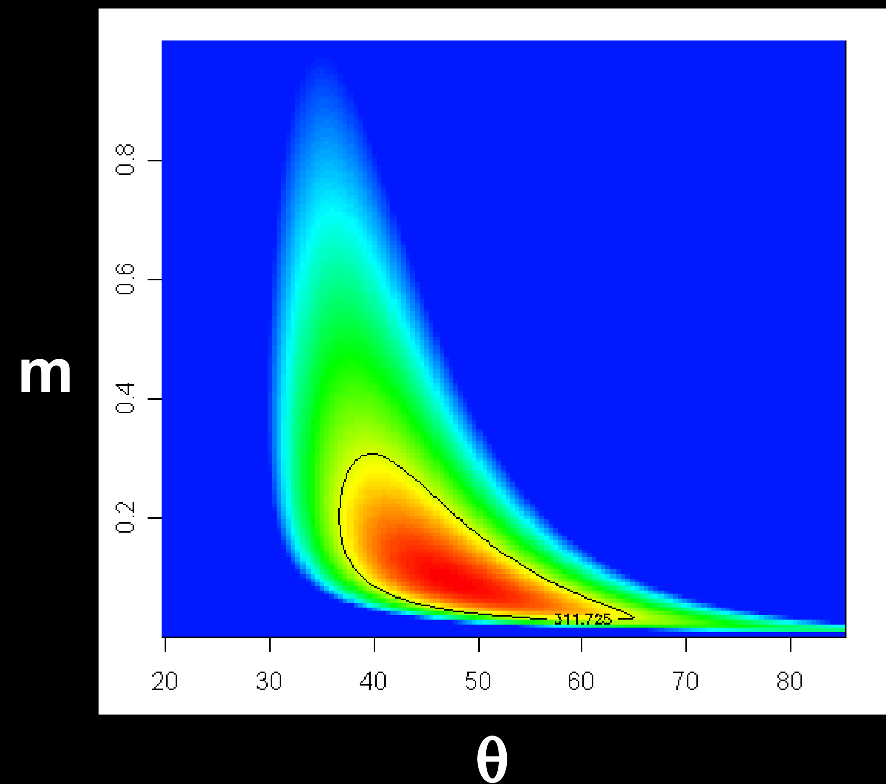


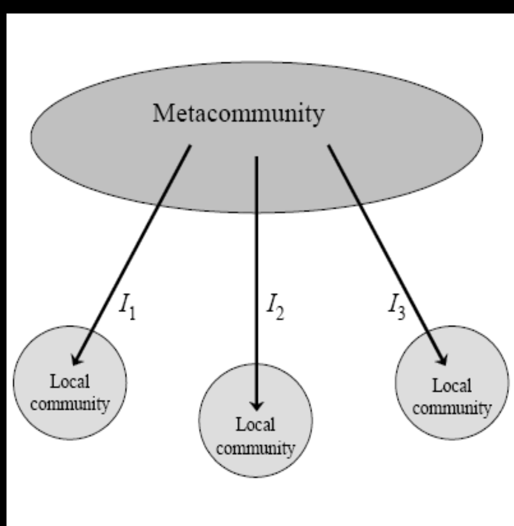
Etienne Ecol. Lett. 2005

$$P[D|\theta, m, J] = \frac{J!}{\prod_{i=1}^{S} n_i \prod_{j=1}^{J} \Phi_j!} \frac{\theta^S}{(I)_J} \sum_{A=S}^{J} K(D,A) \frac{I^A}{(\theta)_A}$$

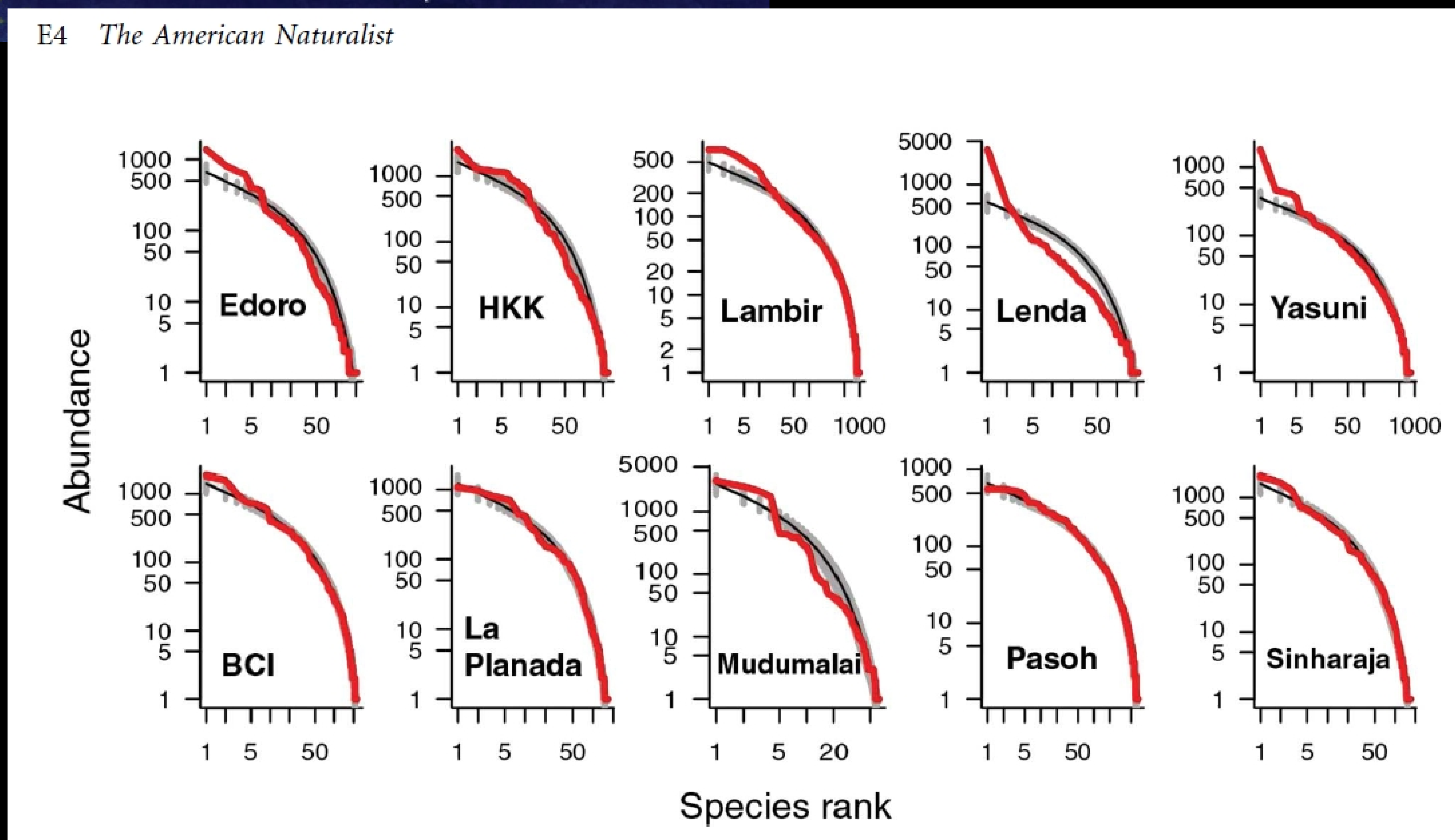
Neutral theory and coalescent







TeTame, Jabot et al. Oikos 2008



Jabot & Chave Am. Nat. *in press*

Neutral theory in ecology

$\neq$

Population genetics with one locus

Summary

Introduction

Phylogenetic information

Functional traits

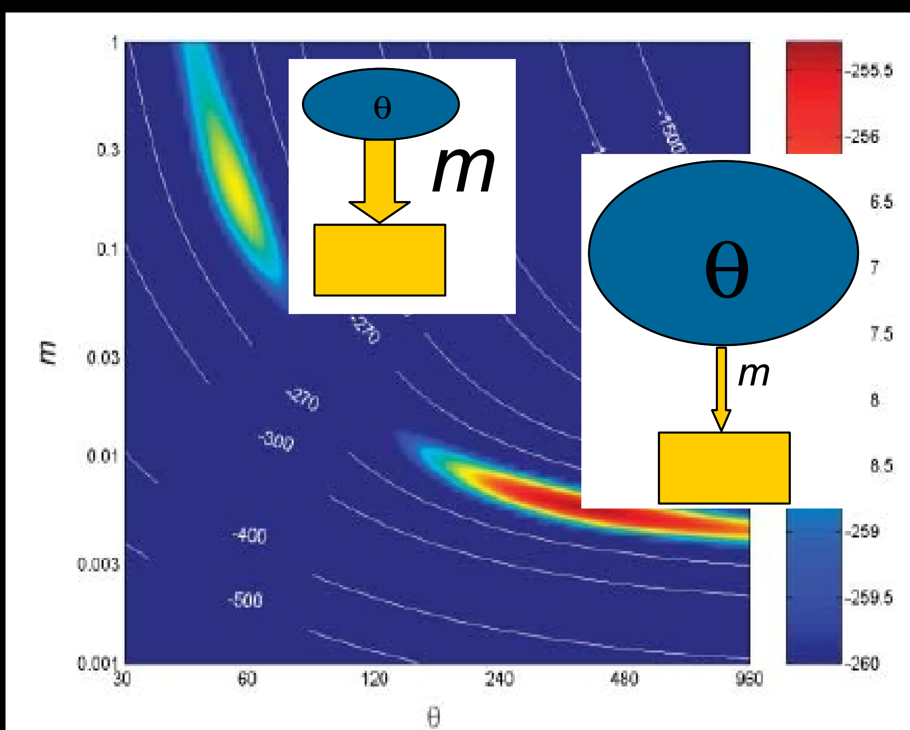
Ecological networks

Phylogenetic information and neutral parameter inference

Science 2005

Neutral Ecological Theory Reveals Isolation and Rapid Speciation in a Biodiversity Hot Spot

Andrew M. Latimer,[1*] John A. Silander Jr.,[1] Richard M. Cowling[2]

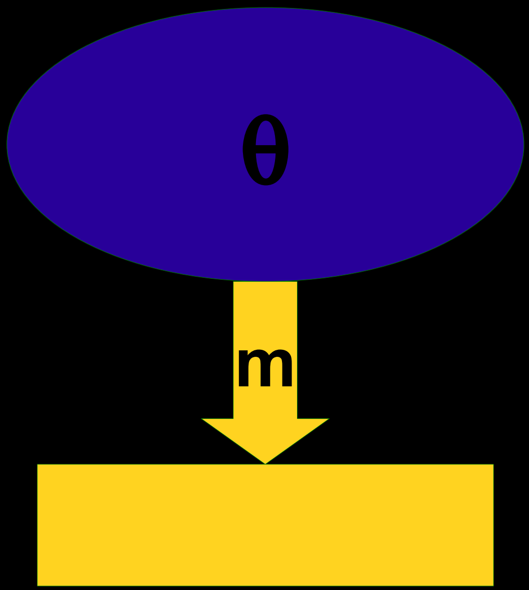


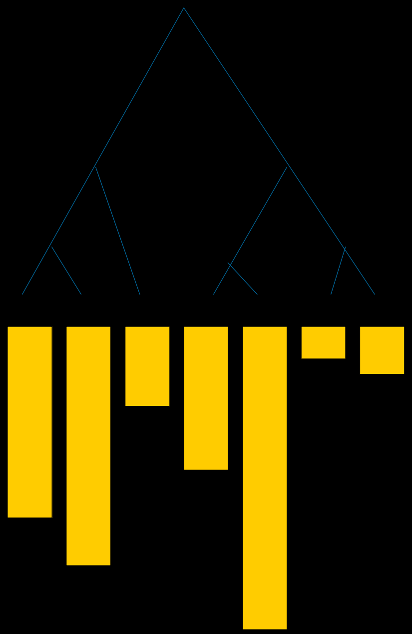
Science 2006

Comment on "Neutral Ecological Theory Reveals Isolation and Rapid Speciation in a Biodiversity Hot Spot"

Rampal S. Etienne,[1*] Andrew M. Latimer,[2] John A. Silander Jr.,[2] Richard M. Cowling[3]

Hubbell's model produces a species phylogeny





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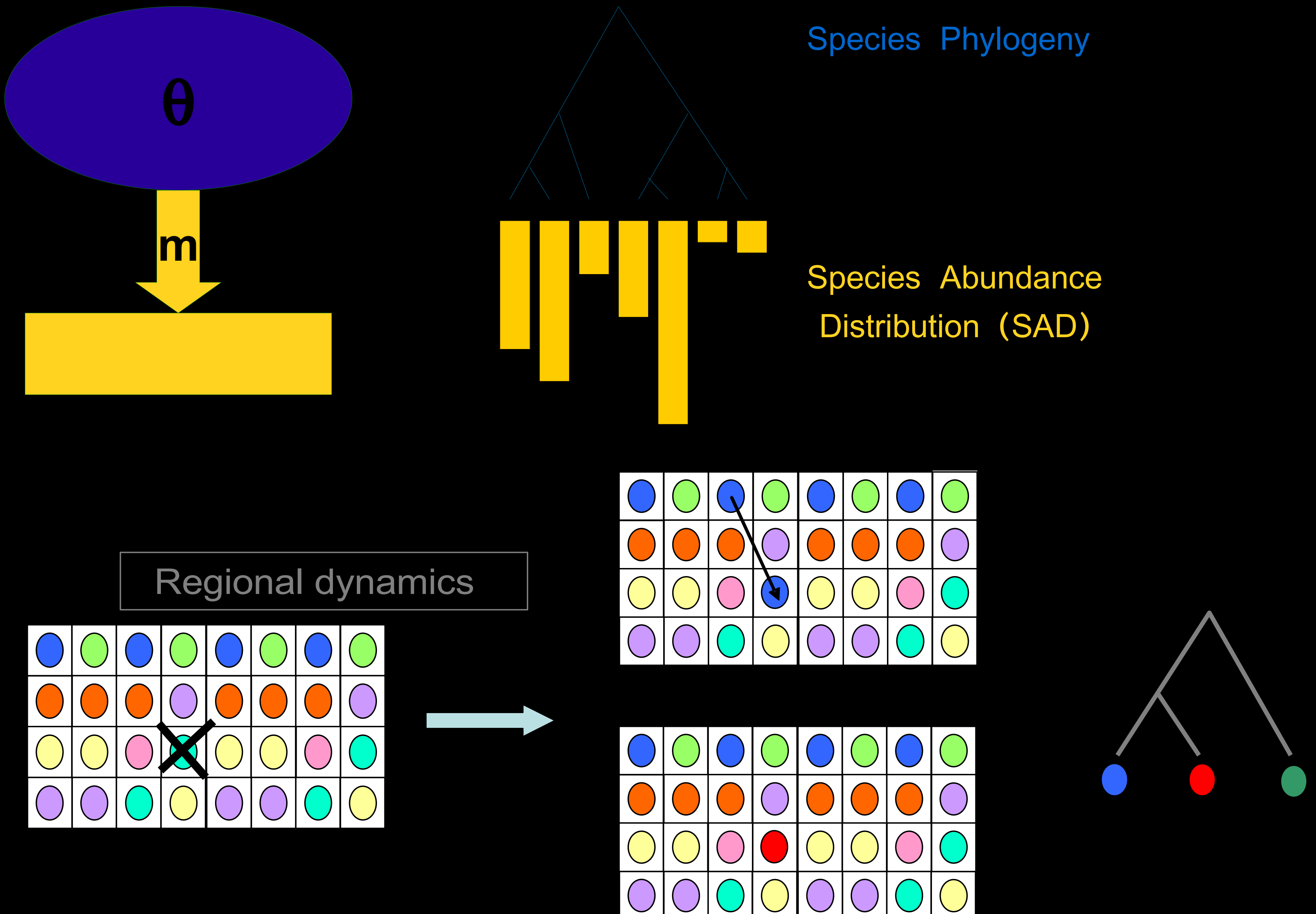
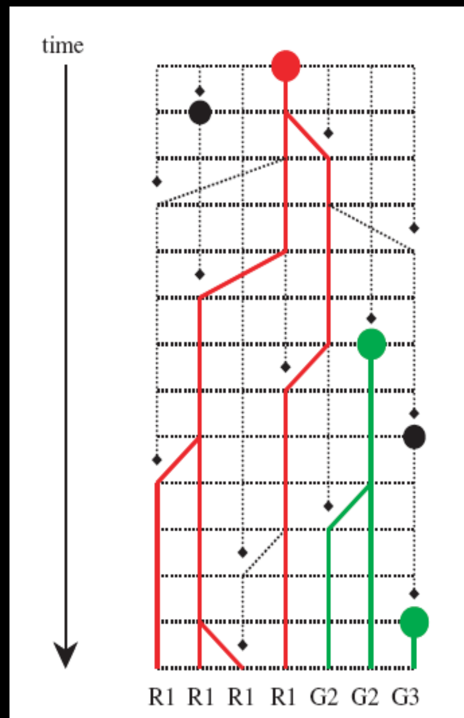
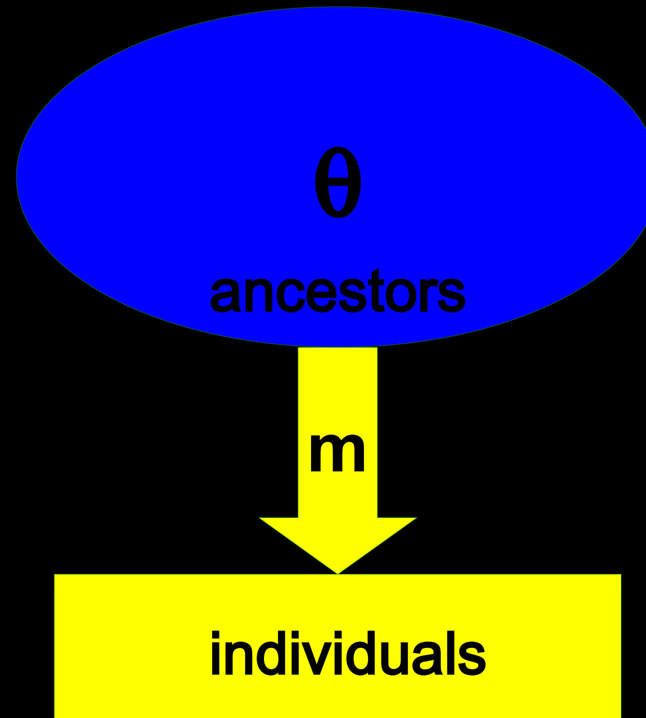


A sampling theory for {SAD & Phylogeny} ?





<u>Ewens 1972</u>:

P(set A ancestors with $d_1,..d_A$ descendants | J individuals)

P(set S species with $a_1,..a_S$ ancestors | A ancestors)

Etienne → P(SAD)= $\sum_{\text{set A}}$ P(set A...) $*$ P(set S...)

→ succeeds in factorizing the sum

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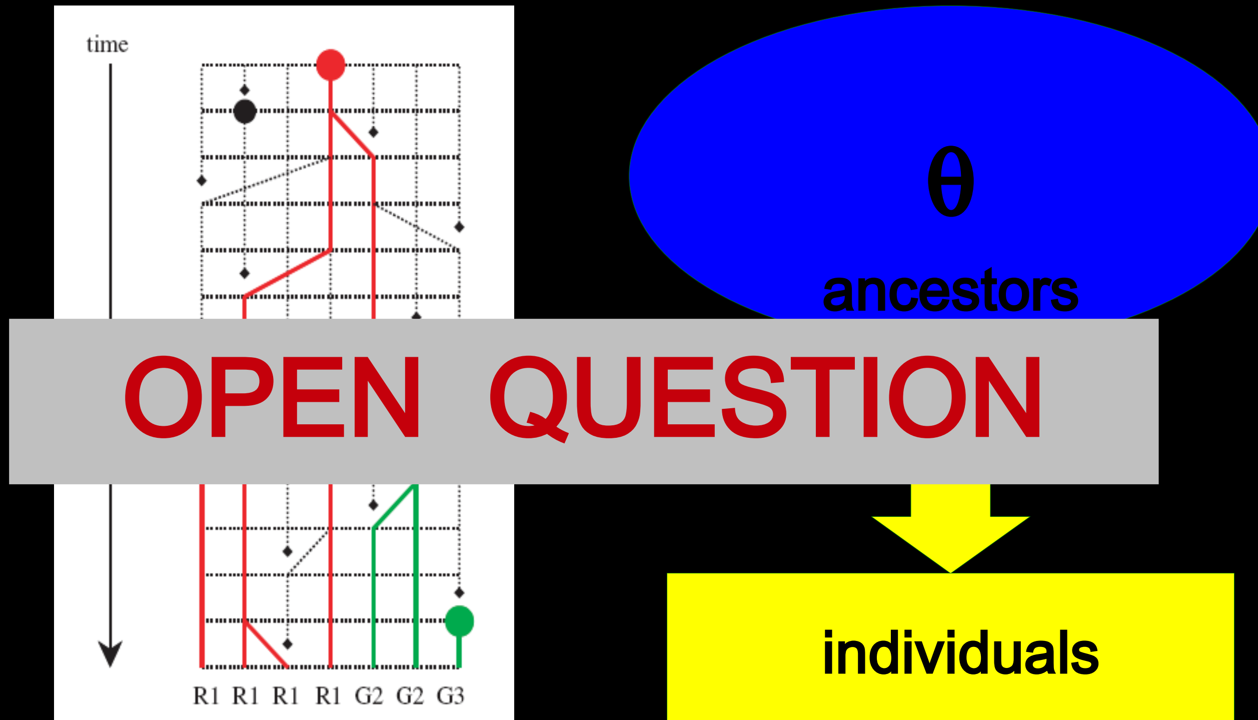

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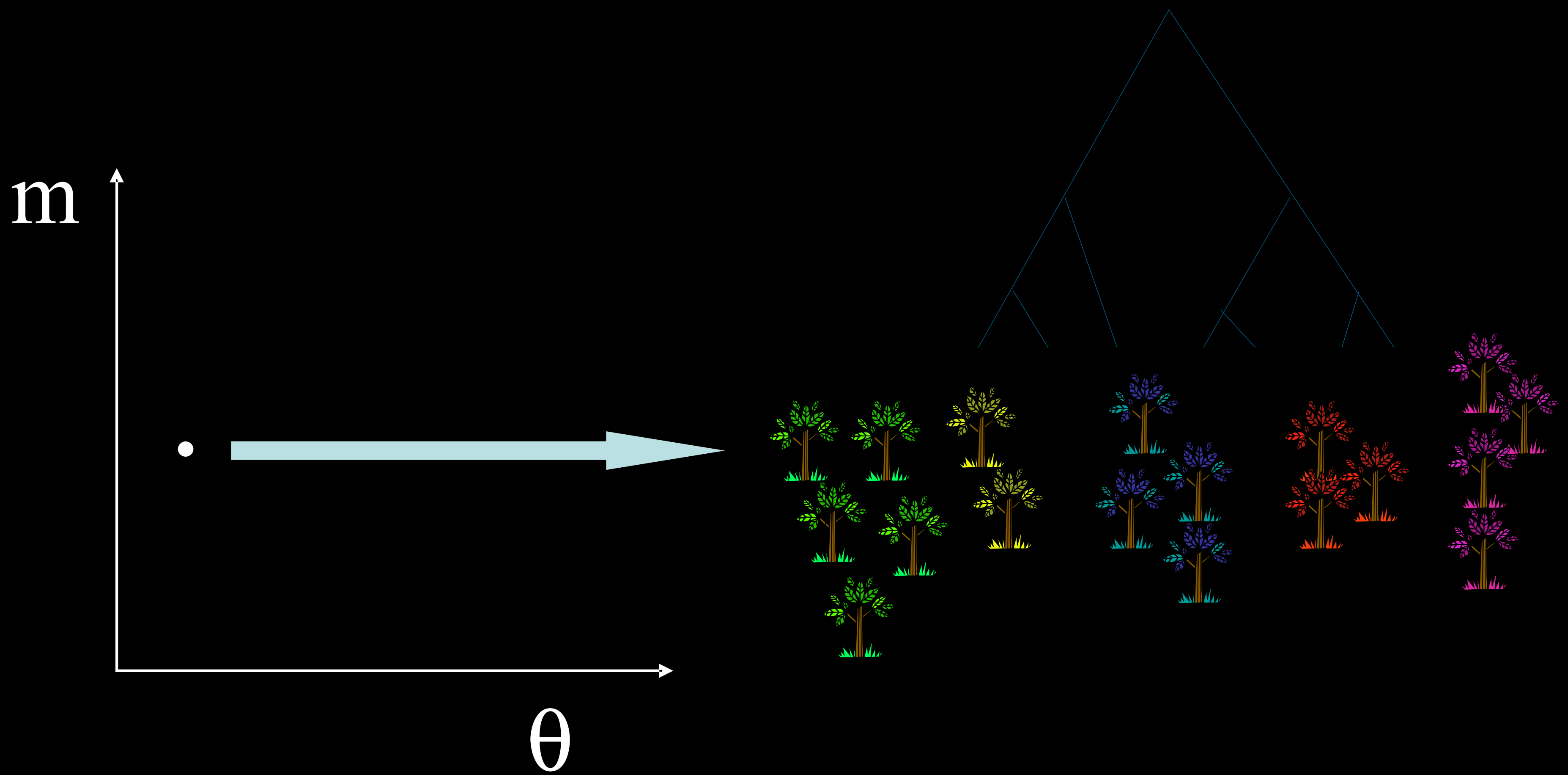

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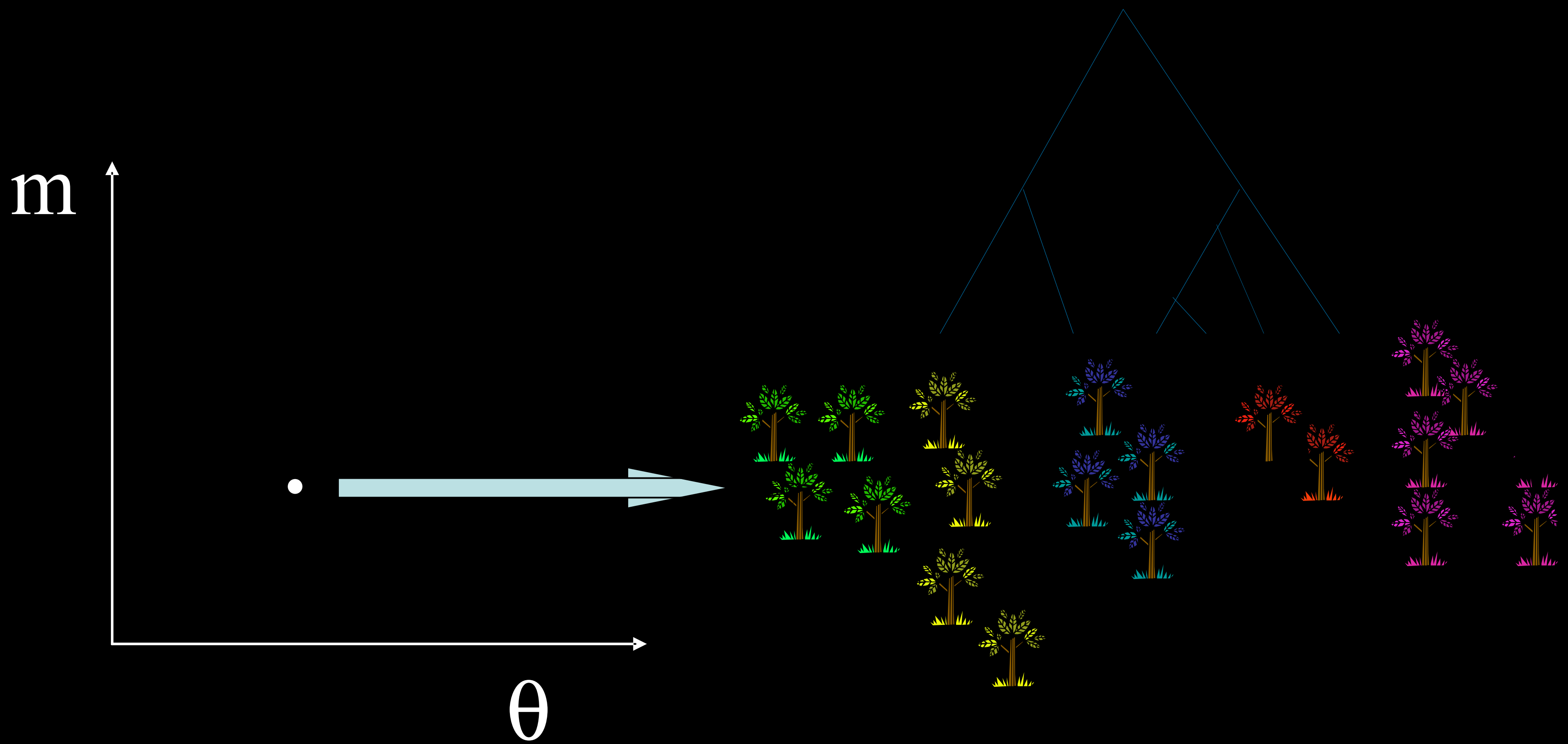

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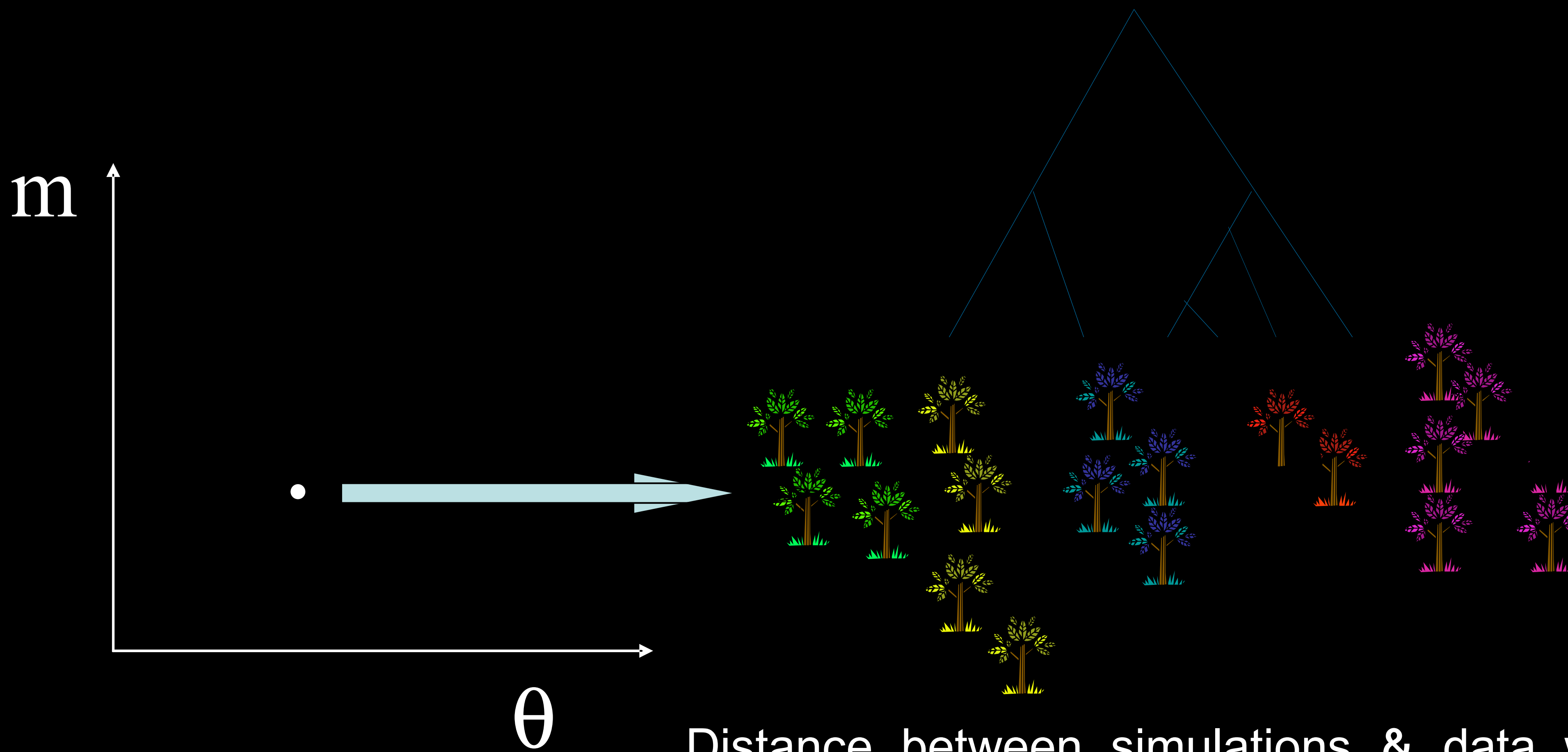
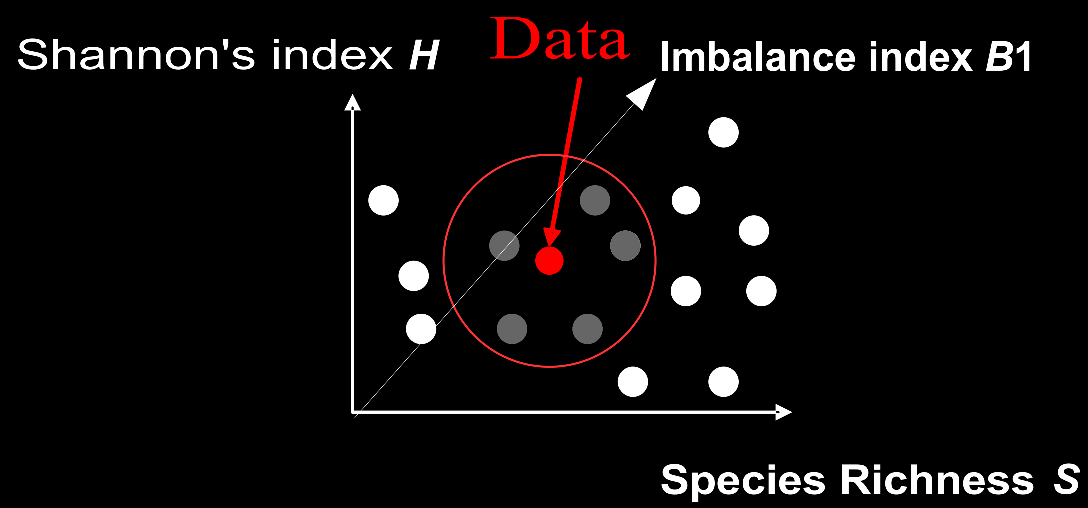


Distance between simulations & data with summary statistics:

- species richness S
- Shannon's index H
- phylogenetic imbalance index B_1

Approximate Bayesian Computation (ABC)



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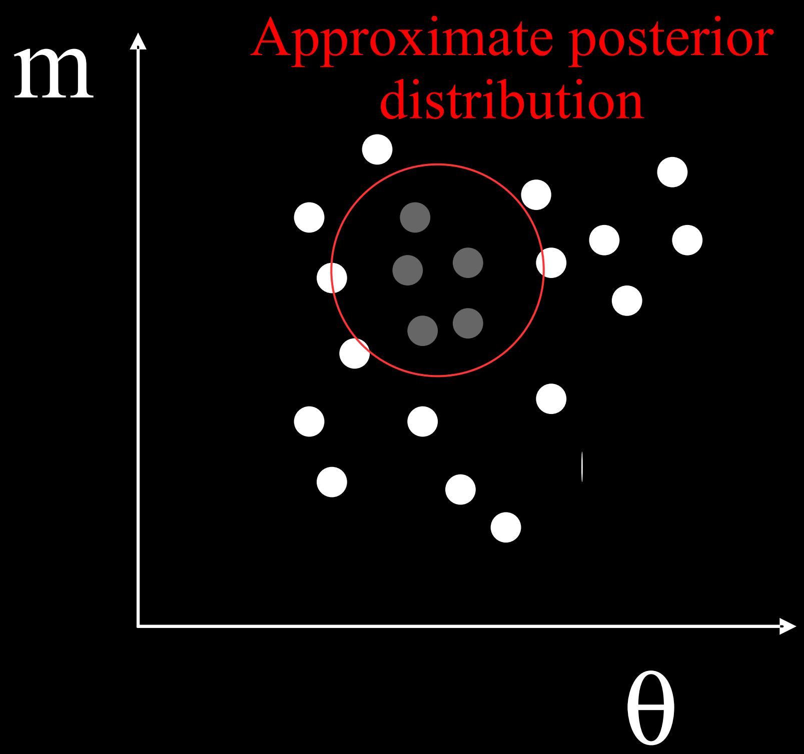
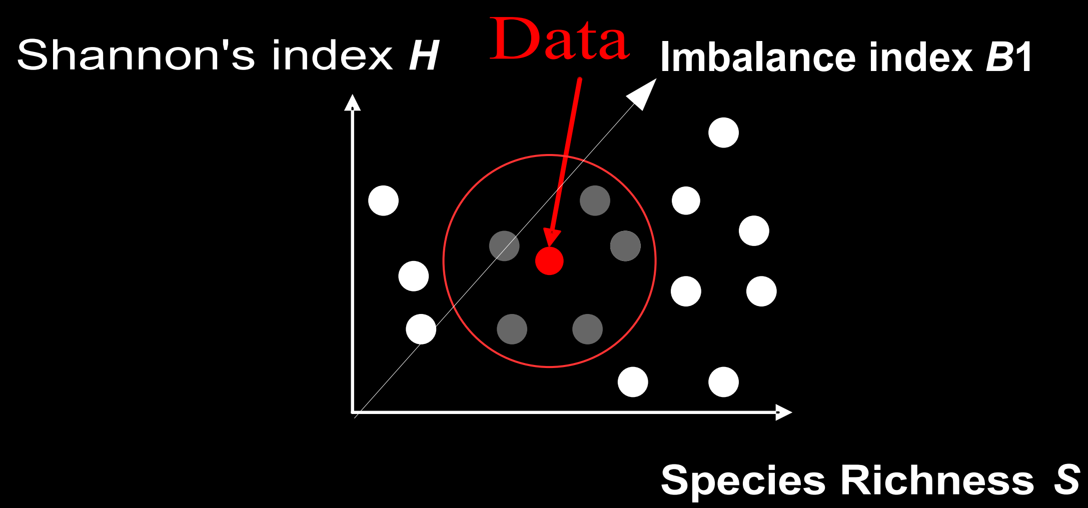
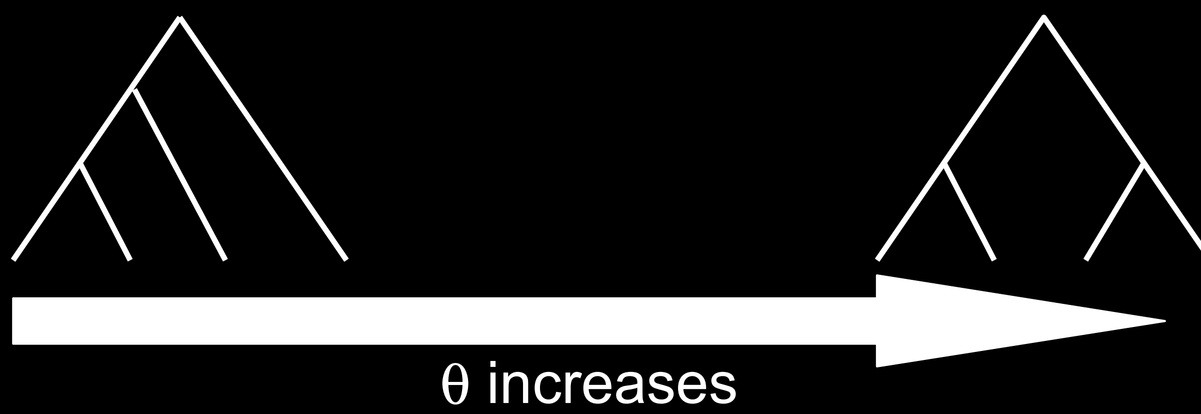


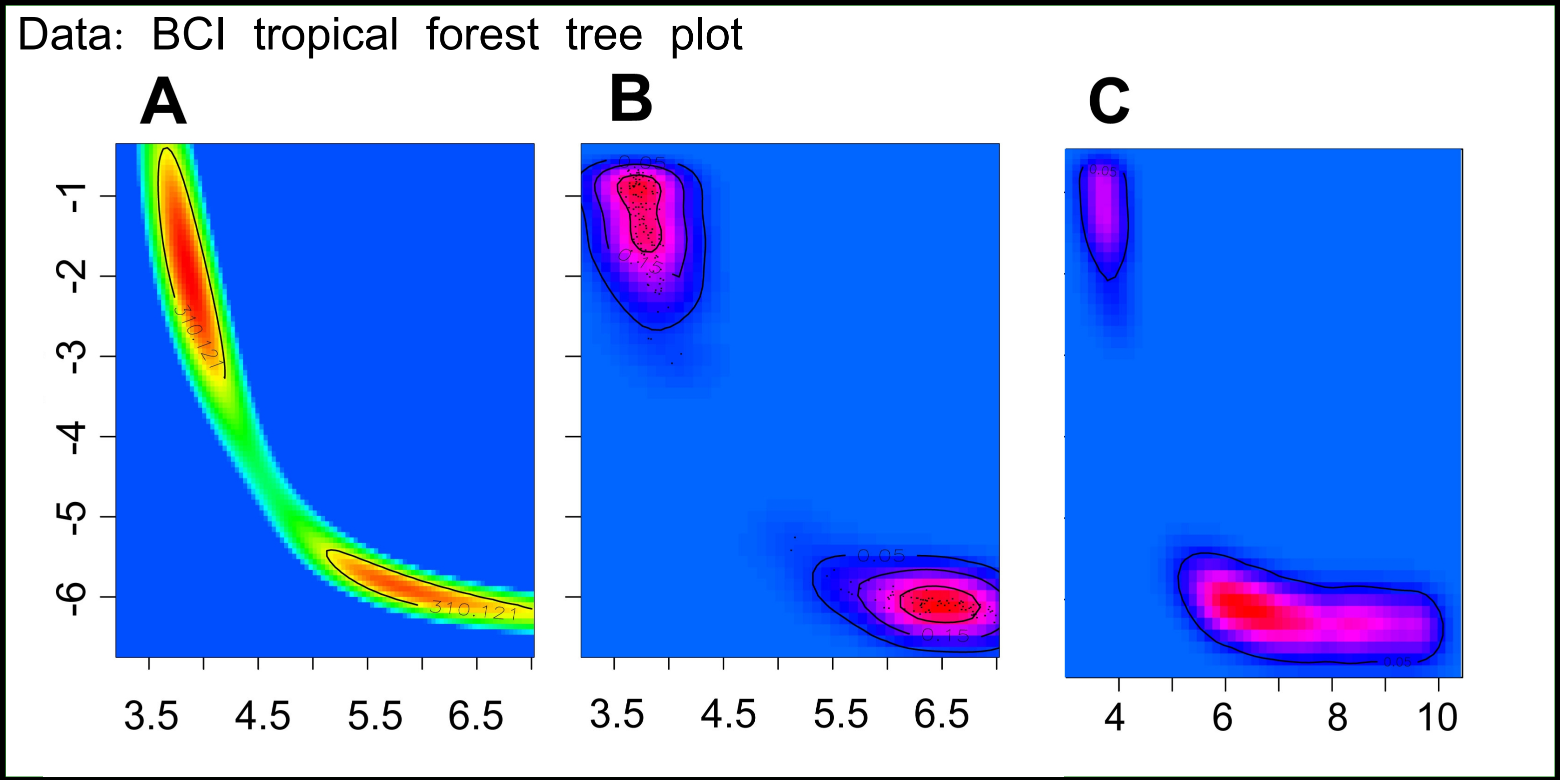


Distance between simulations & data with summary statistics:

- species richness *S*
- Shannon's index *H*
- phylogenetic imbalance index B_1

Why B_1 ?





Exact likelihood based on SAD

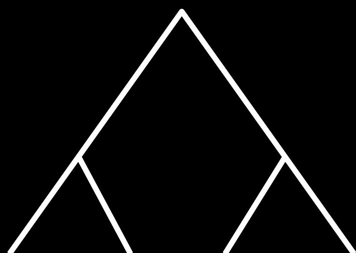
Approximate likelihood based on S & H

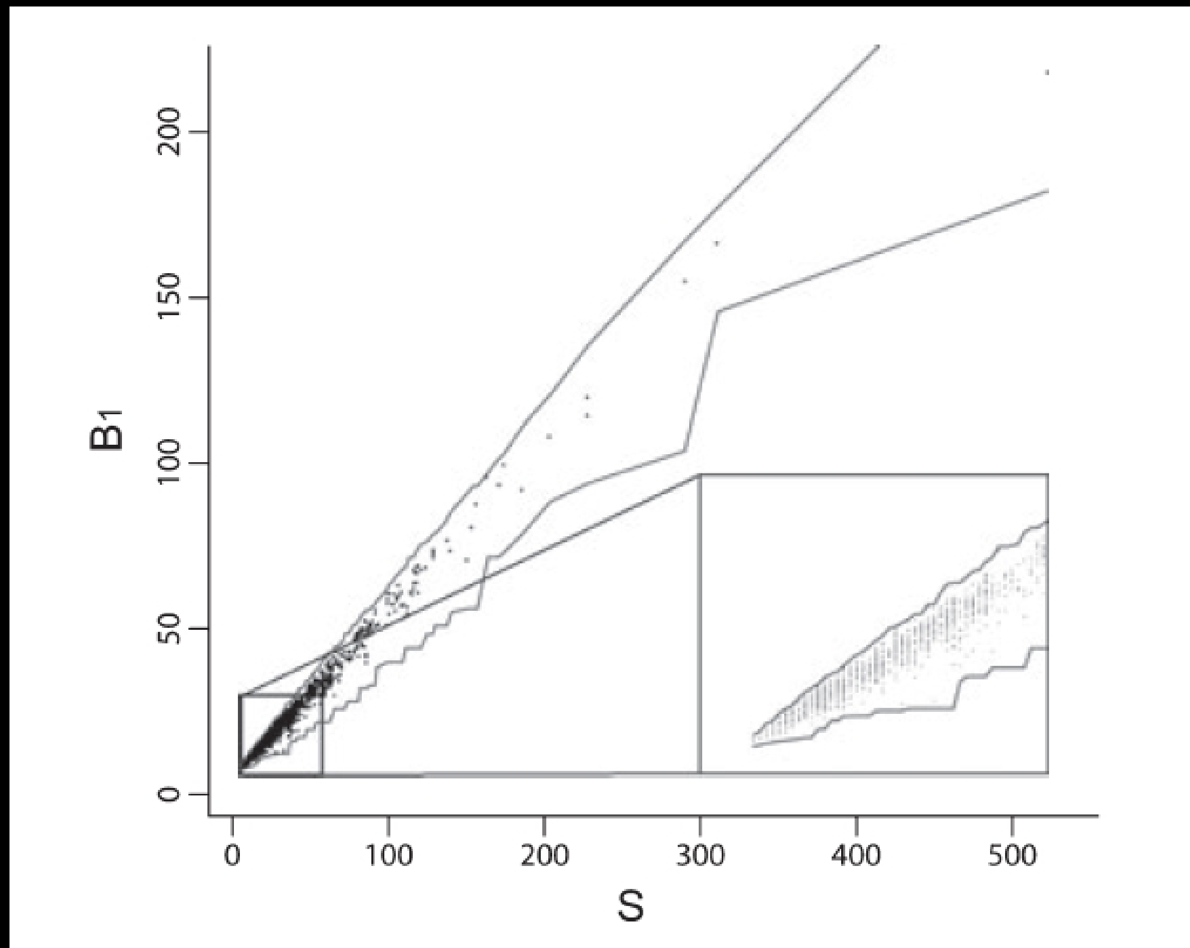
Approximate likelihood based on S, H & B1

Jabot & Chave Ecol. Lett. 2009

Data: 2000 published phylogenetic trees

Source: www.treebase.org





Jabot & Chave Ecol. Lett. 2009

Neutral theory in ecology

$\neq$

Population genetics with one locus

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What is a functional trait ?

What is a functional trait ?

Idea:

species having similar traits should have similar ecologies

Examples:

Small seeds → ruderal strategies

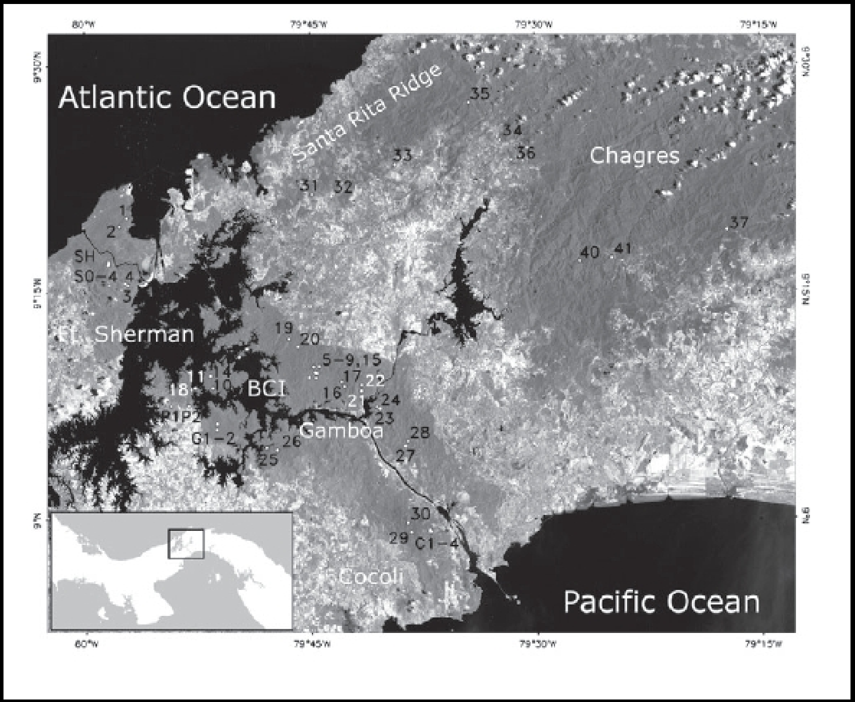
Thick and waxy leaves → drought tolerant

(Grime 2001, Westoby et al. 2002)

Trait-based assembly rules

Keddy J. Veg. Sci. 1992

A starting example: Engelbrecht et al. Nature 2007



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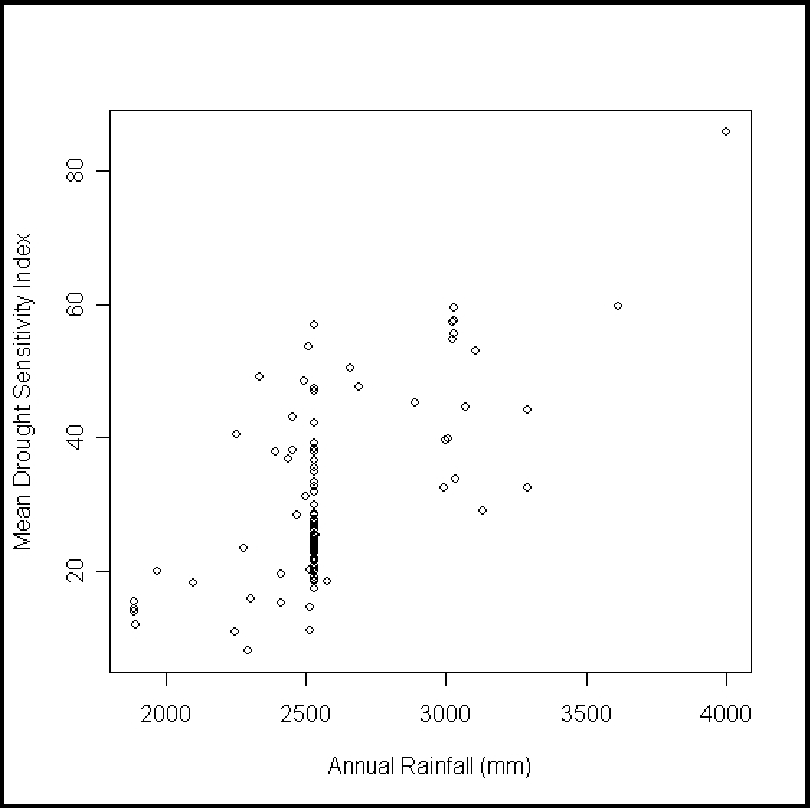
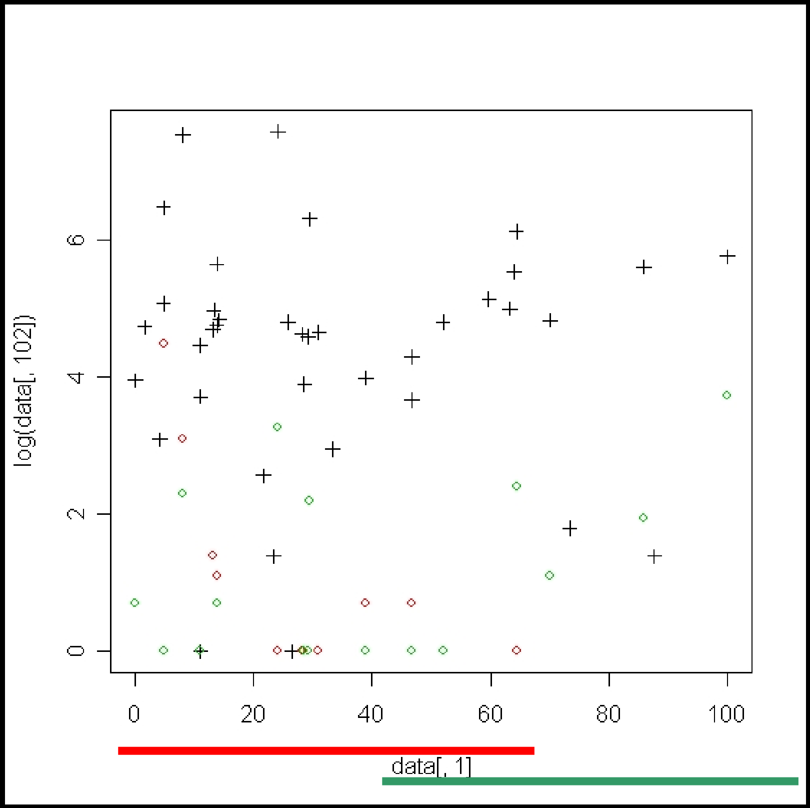
Average Drought Sensitivity



Rainfall

Log Abundance



Drought Sensitivity

Trait-based assembly rules
Keddy J. Veg. Sci. 1992

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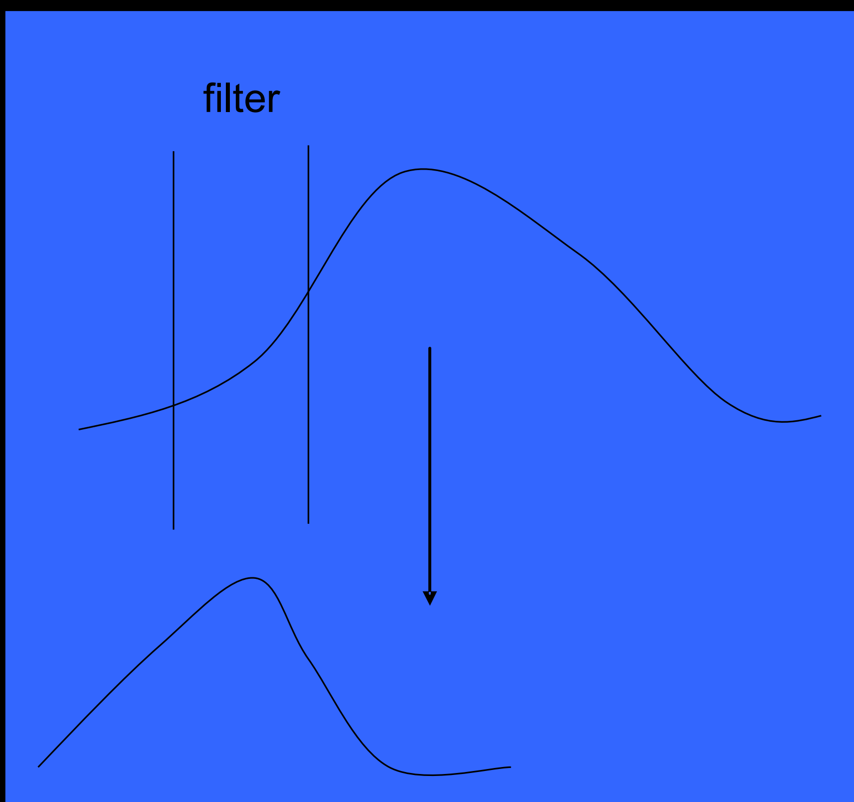

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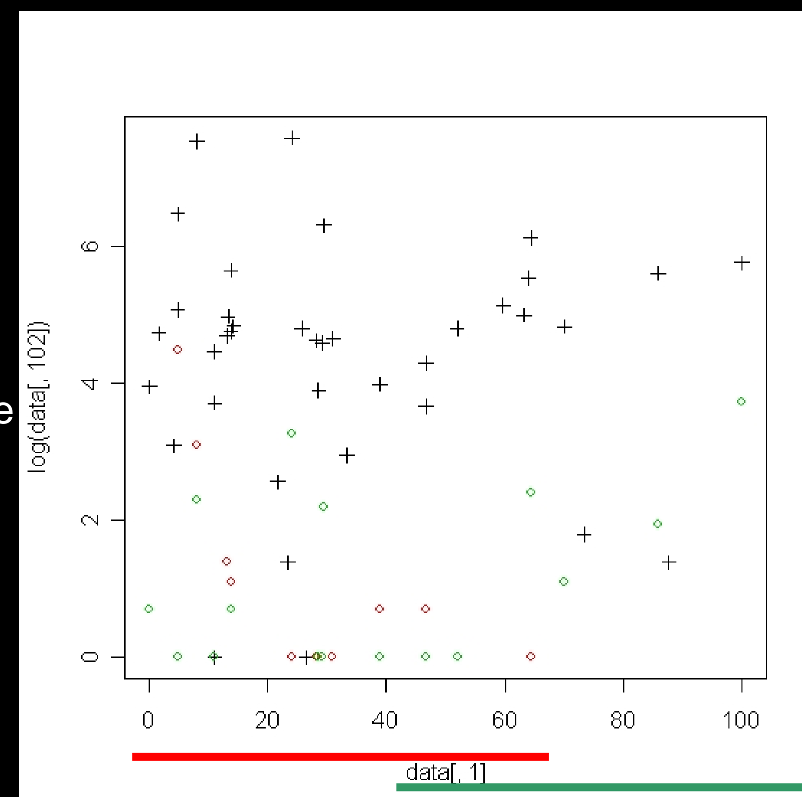
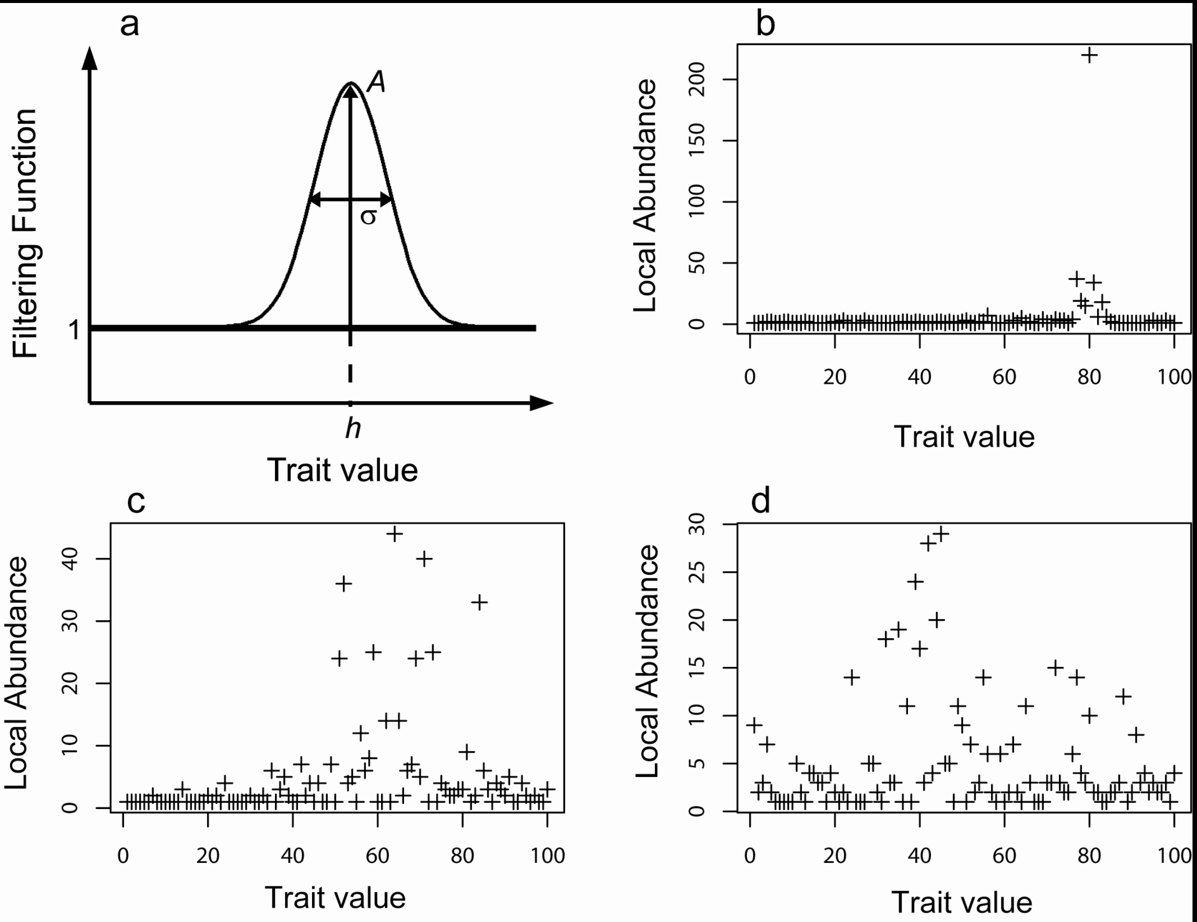


Drought Sensitivity

Selection in population genetics = Environmental filtering in ecology

BUT

Traits give additional info on « selection values » among species



Jabot JTB 2010

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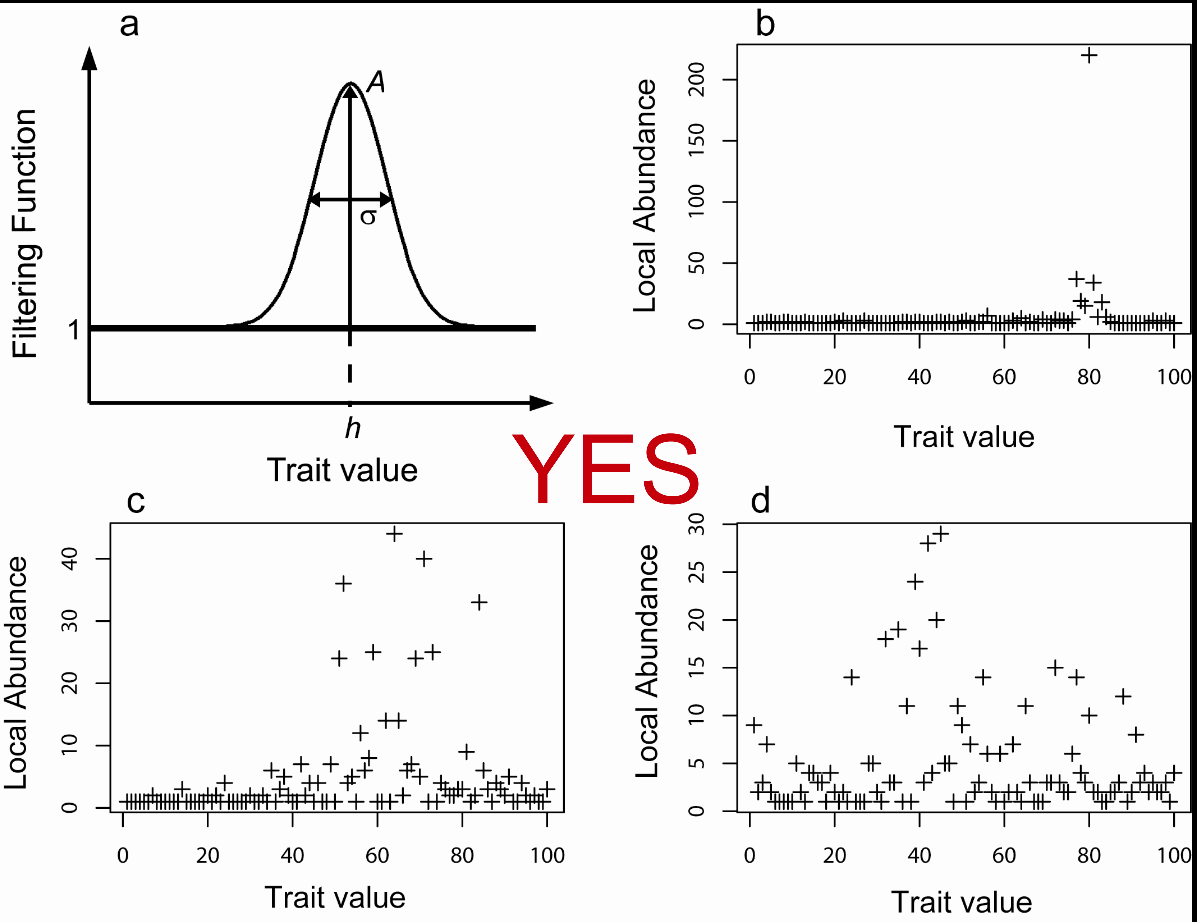
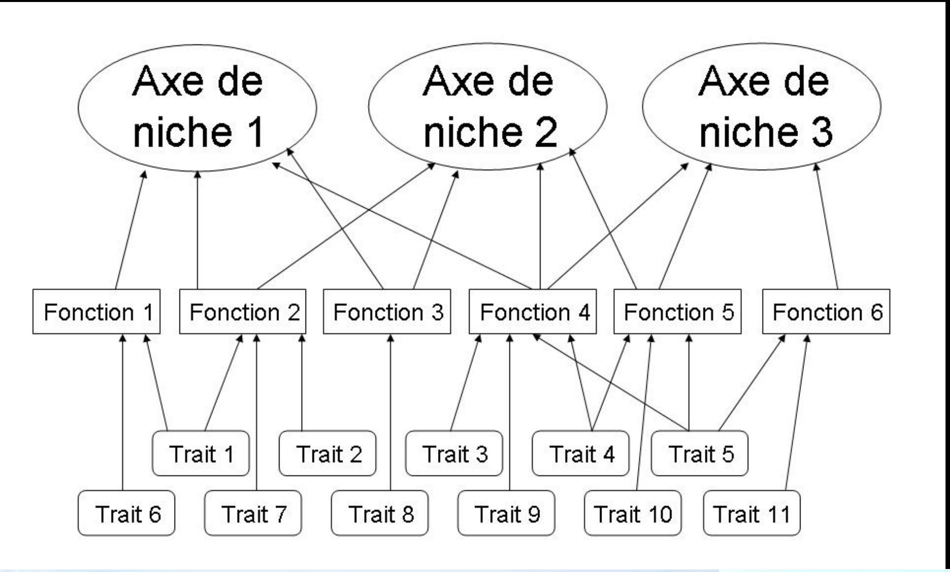
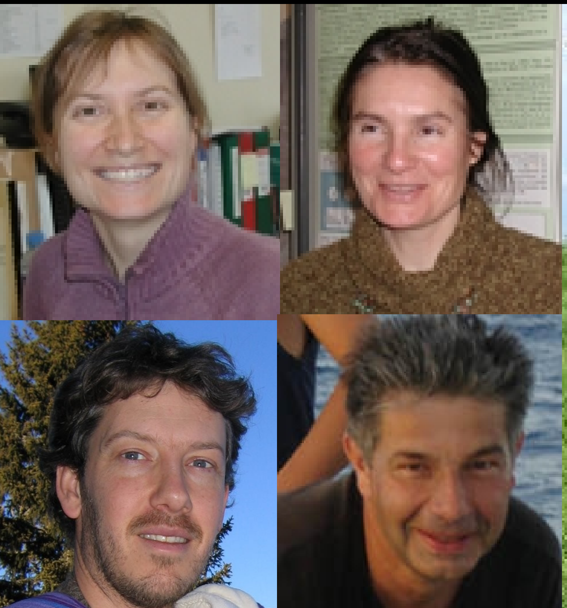


YES

Jabot JTB 2010

Challenge: integrating multiple traits in ecologically-relevant measures





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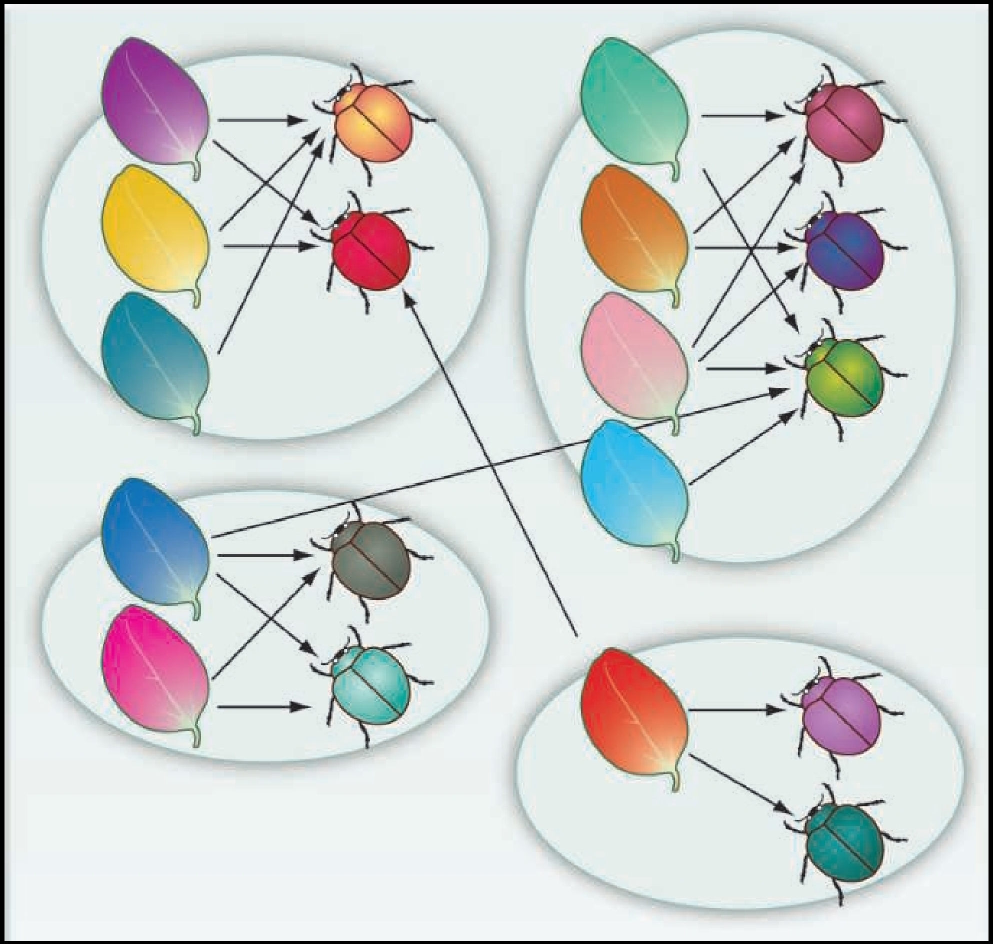
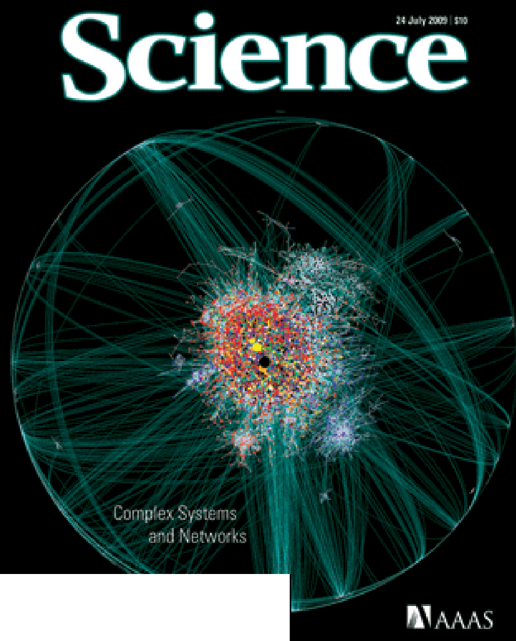
The field of network ecology



Bascompte Science 2010

The field of network ecology



Plant-Animal Mutualistic Networks: The Architecture of Biodiversity

Jordi Bascompte and Pedro Jordano

Integrative Ecology Group, Estación Biológica de Doñana, CSIC, E-41080 Sevilla, Spain; email: bascompte@ebd.csic.es, jordano@ebd.csic.es

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The nested assembly of plant–animal mutualistic networks

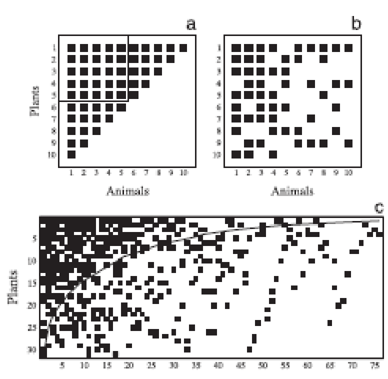
Jordi Bascompte[†‡], Pedro Jordano[†], Carlos J. Melián[†], and Jens M. Olesen[§]

[†]Integrative Ecology Group, Estación Biológica de Doñana, Consejo Superior de Investigaciones Científicas, Apartado 1056, E-41080 Sevilla, Spain; and [§]Department of Ecology and Genetics, University of Aarhus, Ny Munkegade, Building 540, DK-8000 Aarhus, Denmark

Communicated by Mary Arroyo, Universidad de Chile, Santiago, Chile, June 11, 2003 (received for review December 18, 2002)

Most studies of plant–animal mutualisms involve a small number of species. There is almost no information on the structural organization of species-rich mutualistic networks despite its potential importance for the maintenance of diversity. Here we analyze 52 mutualistic networks and show that they are highly nested; that is, the more specialist species interact only with proper subsets of those species interacting with the more generalists. This assembly pattern generates highly asymmetrical interactions and organizes the community cohesively around a central core of interactions. Thus, mutualistic networks are neither randomly assembled nor organized in compartments arising from tight, parallel specialization. Furthermore, nestedness increases with the complexity (number of interactions) of the network: for a given number of species, communities with more interactions are significantly more nested. Our results indicate a nonrandom pattern of community organization that may be relevant for our understanding of the organization and persistence of biodiversity.

Studies of plant–animal mutualisms have traditionally focused on highly specific interactions among a few species, such as a plant and its pollinators or seed dispersers (1, 2). On the other hand, some systems seem to involve a much larger number of species, and some authors have used the term "diffuse coevolution" to describe the coevolutionary process in such communities (3–5). The approach of diffuse coevolution, however, has



PNAS PNAS PNAS
ECOLOGY

Stability of Ecological Communities and the Architecture of Mutualistic and Trophic Networks

Elisa Thébault[1,2]* and Colin Fontaine[1,3]*

Research on the relationship between the architecture of ecological networks and community stability has mainly focused on one type of interaction at a time, making difficult any comparison between different network types. We used a theoretical approach to show that the network architecture favoring stability fundamentally differs between trophic and mutualistic networks. A highly connected and nested architecture promotes community stability in mutualistic networks, whereas the stability of trophic networks is enhanced in compartmented and weakly connected architectures. These theoretical predictions are supported by a meta-analysis on the architecture of a large series of real pollination (mutualistic) and herbivory (trophic) networks. We conclude that strong variations in the stability of architectural patterns constrain ecological networks toward different architectures, depending on the type of interaction.

Which are the determinants of network structure ?

OIKOS 112: 111–121, 2006

Size constraints and flower abundance determine the number of interactions in a plant–flower visitor web

Martina Stang, Peter G. L. Klinkhamer and Eddy van der Meijden

ECOLOGY LETTERS

Ecology Letters, (2010) **13**: 442–452 doi: 10.1111/j.1461-0248.2009.01437.x

LETTER

The robustness of pollination networks to the loss of species and interactions: a quantitative approach incorporating pollinator behaviour

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LETTER

The robustness of pollination networks to the loss of species and interactions: a quantitative approach incorporating pollinator behaviour

FORUM FORUM FORUM

FORUM is intended for new ideas or new ways of interpreting existing information. It provides a chance for suggesting hypotheses and for challenging current thinking on ecological issues. A lighter prose, designed to attract readers, will be permitted. Formal research reports, albeit short, will not be accepted, and all contributions should be concise with a relatively short list of references. A summary is not required.

Degree distribution in plant–animal mutualistic networks: forbidden links or random interactions?

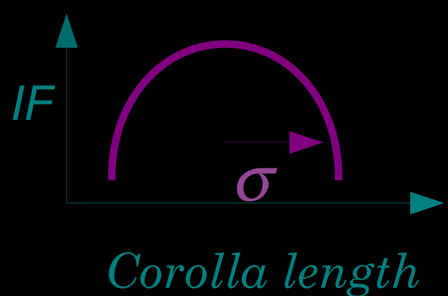
Diego P. Vázquez, National Center for Ecological Analysis and Synthesis, Univ. of California, Santa Barbara, 735 State Street, Suite 300, Santa Barbara, CA 93101, USA (vazquez@nceas.ucsb.edu).

Which are the determinants of network structure ?

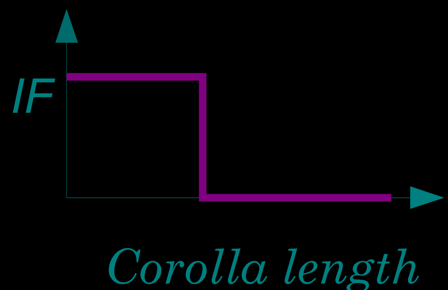
Likelihood approach to network determinants (see also Vazquez et al. Ecology 2009)

Interaction rules such as :

-matching rule (σ)



-threshold rule



$$P\left(\vec{n}_{ij}\right)=\prod_{i=1}^{S_{plants}}\prod_{j=1}^{S_{pollinators}}\left(\frac{x_j f_j\left(t_i^1, t_i^2, \ldots, t_i^t\right)}{\sum_j x_j f_j\left(t_i^1, t_i^2, \ldots, t_i^t\right)}\right)^{n_{ij}}$$

Which are the determinants of network structure ?

Preliminary results:

- missing links cannot be solely explained by random (non) sampling.

- trait-based rules explain a large part of missing links, but not all.

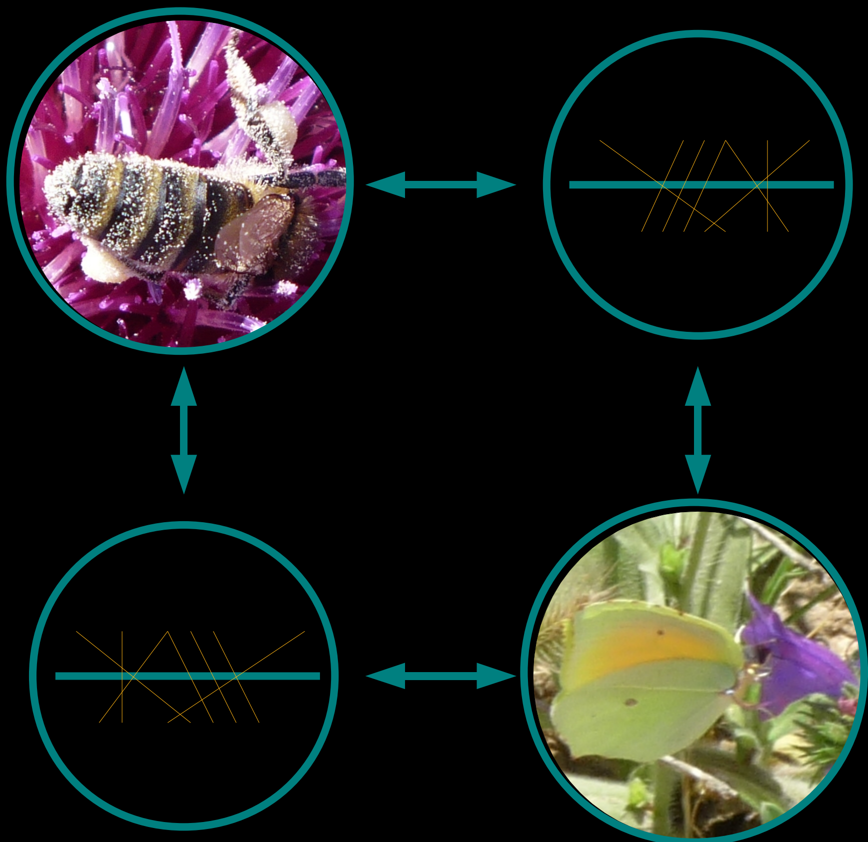
- This suggests that interactions (repulsion) among pollinators/seed dispersers act during network assembly.

Which are the determinants of network structure ?

Open questions:

- consequences for community dynamics
- adding spatial component

Methods:

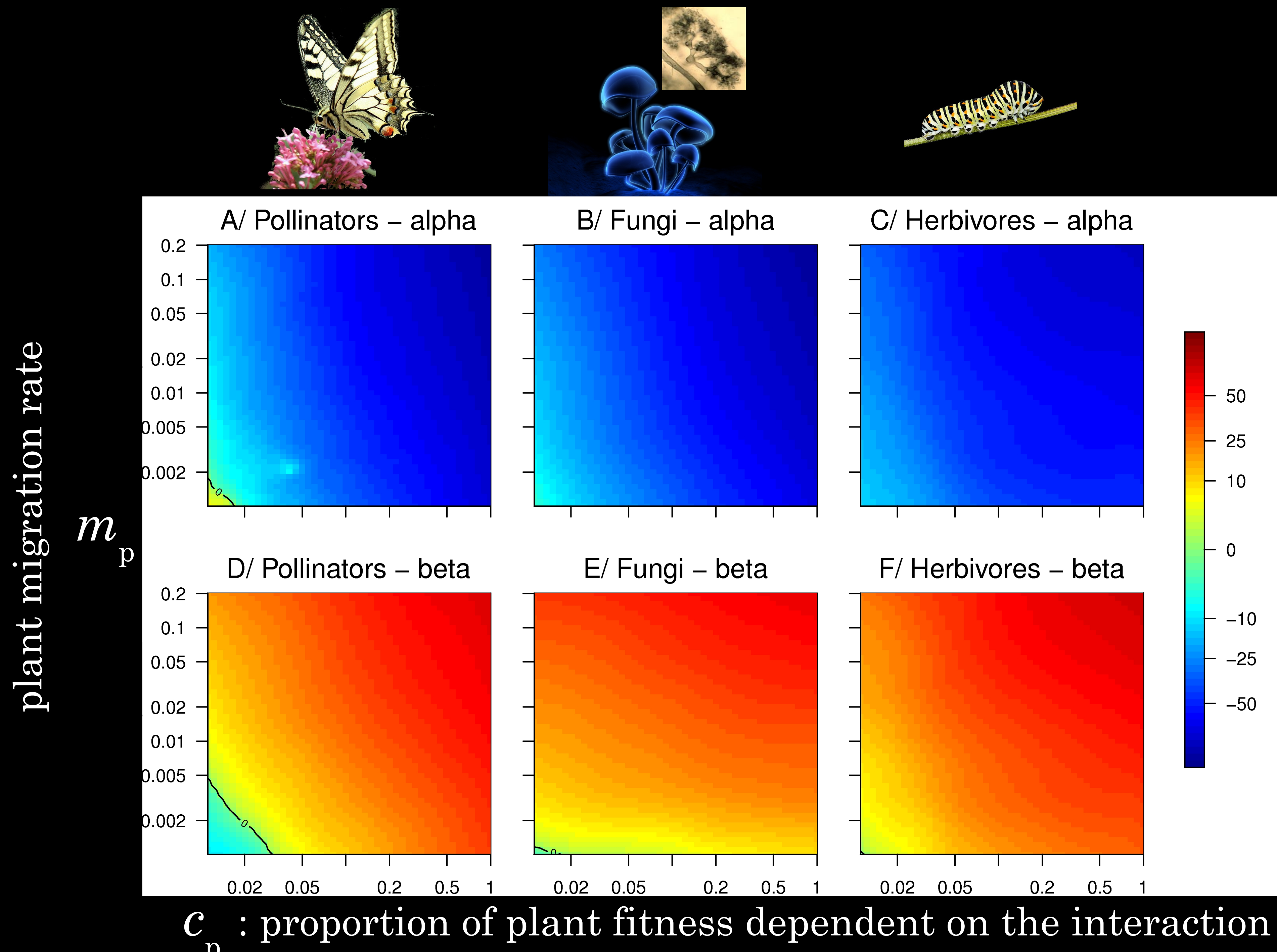


Part of the fitness dependent on the interactions

Neutral

$$f = \underbrace{1 - c_p}_{\text{Neutral}} + c_p \times \sum \text{interactions}$$

$$f = 1 - c_a + c_a \times \sum \text{interactions}$$

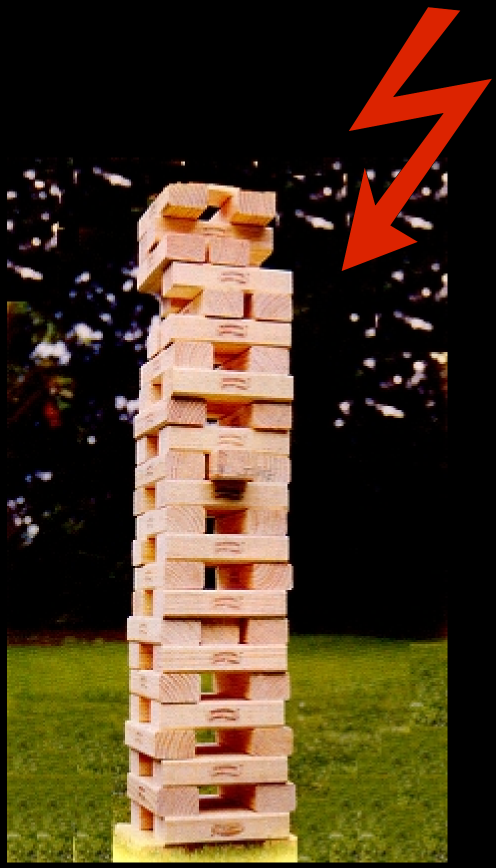


A/ Pollinators – alpha
B/ Fungi – alpha
C/ Herbivores – alpha
D/ Pollinators – beta
E/ Fungi – beta
F/ Herbivores – beta
plant migration rate
m_p
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.02
0.05
0.2
0.5
1
50
25
10
0
−10
−25
−50
c_p : proportion of plant fitness dependent on the interaction

Others areas to explore with neutral approaches

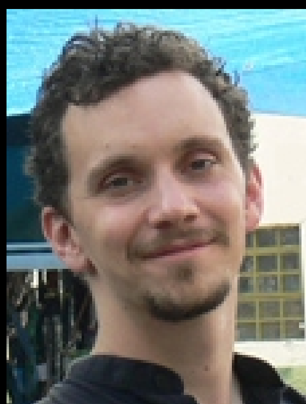
- biogeography
- temporal dynamics
- conservation

...



Merci !

Hélène Morlon et le CMAP



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