

Motivation  
oooooooo

Questions  
o

Theory  
oooooooo

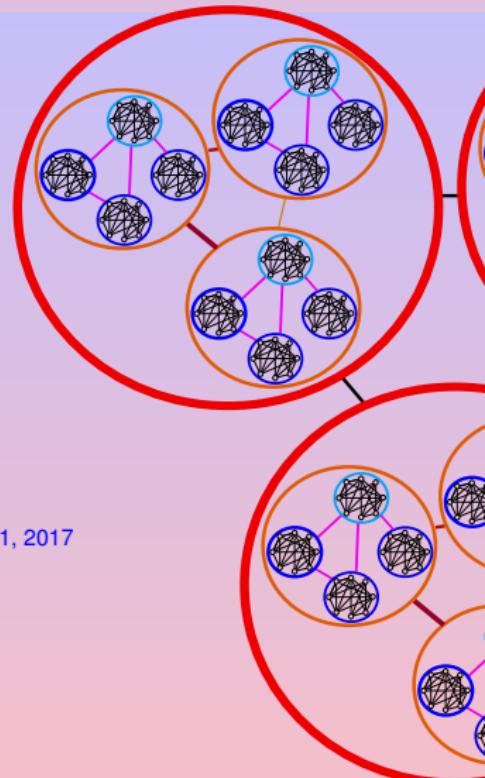
Results  
oo

Outlook  
oo

Carlos J. Melián  
ETH-EAWAG, Switzerland

# The Stability and Complexity of Eco-evolutionary Networks in Meta-Ecosystems

*2<sup>nd</sup>* Weaver symposium, EEZA, CSIC, and University Almería, Nov 27 - Dec 1, 2017



Motivation  
●○○○○○

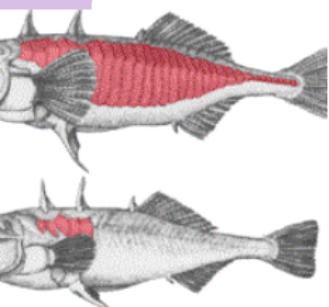
Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I



L

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

LO

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

Lor

Motivation  
●○○○○○○

Questions  
○

Theory  
○○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

Lore

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

Lorem

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder**

Evolutionary networks – model system I

Lorem i

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder**

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

Placeholder for content

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

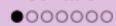
Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder**

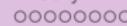
Motivation



Questions



Theory



Results



Outlook



## Evolutionary networks – model system I

**Placeholder**

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder**  
Lorem ipsum

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder text**

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder content**

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder content**  
Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusamus et iusto odio dignissim qui blandit praesent luptatum zzril delenit diam.

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder content**

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder text: Lorem ipsum dolor**

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

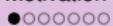
Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder content**

Motivation



Questions



Theory



Results



Outlook



## Evolutionary networks – model system I

**Lorem ipsum dolor S**

Motivation  
●○○○○○○

Questions  
○

Theory  
○○○○○○○○

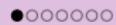
Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder text: Lorem ipsum dolor sit**

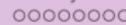
Motivation



Questions



Theory



Results



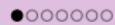
Outlook



## Evolutionary networks – model system I

**Placeholder text: Lorem ipsum dolor sit**

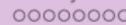
Motivation



Questions



Theory



Results



Outlook



## Evolutionary networks – model system I

**Placeholder text: Lorem ipsum dolor sit**

## Motivation

●○○○○○○

## Questions

○

## Theory

○○○○○○○○

## Results

○○

## Outlook

○○

# Evolutionary networks – model system I

**Lorem ipsum dolor sit  
a**

## Motivation

●○○○○○○

## Questions

○

## Theory

○○○○○○○○

## Results

○○

## Outlook

○○

# Evolutionary networks – model system I

**Lorem ipsum dolor sit  
am**

## Motivation

●○○○○○○

## Questions

○

## Theory

○○○○○○○○

## Results

○○

## Outlook

○○

# Evolutionary networks – model system I

**Lorem ipsum dolor sit  
am**e****

## Motivation

●○○○○○○

## Questions

○

## Theory

○○○○○○○○

## Results

○○

## Outlook

○○

### Evolutionary networks – model system I

**Lorem ipsum dolor sit  
  amet,**

## Evolutionary networks – model system I

*Lorem ipsum dolor sit  
amet,*

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

Placeholder text:  
Lorem ipsum dolor sit  
amet, **C**

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder text:  
Lorem ipsum dolor sit  
amet, c**O****

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

Placeholder text:  
Lorem ipsum dolor sit  
amet, co**n**

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Lorem ipsum dolor sit  
amet, con**S****

## Motivation

●○○○○○○

## Questions

○

## Theory

○○○○○○○○

## Results

○○

## Outlook

○○

# Evolutionary networks – model system I

**Lorem ipsum dolor sit  
amet, conse**

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Conse**C****

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder text for the main content area.**  
Lorem ipsum dolor sit amet, consectetur

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder text for the main content area.**  
Lorem ipsum dolor sit amet, consectetur

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder text for the main content area.**  
Lorem ipsum dolor sit amet, consectetur

## Motivation

●○○○○○○

## Questions

○

## Theory

○○○○○○○○

## Results

○○

## Outlook

○○

### Evolutionary networks – model system I

**Lorem ipsum dolor sit  
amet, consectetur**U****

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder text:  
Lorem ipsum dolor sit  
amet, consectetur**

## Motivation

●○○○○○○

## Questions

○

## Theory

○○○○○○○○

## Results

○○

## Outlook

○○

### Evolutionary networks – model system I

**Placeholder text for the main content area.**  
Lorem ipsum dolor sit  
amet, consectetur

## Motivation

●○○○○○○

## Questions

○

## Theory

○○○○○○○○

## Results

○○

## Outlook

○○

# Evolutionary networks – model system I

Lorem ipsum dolor sit  
amet, consectetur **a**

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder text for the main content area.**  
Lorem ipsum dolor sit amet, consectetur ad

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder text for the main content area.**  
Lorem ipsum dolor sit amet, consectetur adi

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder text for the main content area.**  
Lorem ipsum dolor sit amet, consectetur adip**p**

## Evolutionary networks – model system I

**L**orem ipsum dolor sit  
amet, consectetur  
adip*i*

## Evolutionary networks – model system I

**Lorem ipsum dolor sit  
amet, consectetur  
adipi**S****

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**L**orem ipsum dolor sit  
amet, consectetur  
adipis**C**

## Evolutionary networks – model system I

**Lore**m ipsum dolor sit  
amet, consectetur  
adipisci

## Evolutionary networks – model system I

**Lorem ipsum dolor sit  
amet, consectetur  
adipiscin**

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder text:  
Lorem ipsum dolor sit  
amet, consectetur  
adipiscing**

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

*Placeholder text for the main content area.*  
Lorem ipsum dolor sit  
amet, consectetur  
adipiscing

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder text**  
Lorem ipsum dolor sit  
amet, consectetur  
adipiscing **e**

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder text for the main content area.**  
Lorem ipsum dolor sit  
amet, consectetur  
adipiscing el

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Placeholder text**  
Lorem ipsum dolor sit  
amet, consectetur  
adipiscing eli

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Lorem ipsum dolor sit  
amet, consectetur  
adipiscing elit,**

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

*Lorem ipsum dolor sit  
amet, consectetur  
adipiscing elit,*

Motivation  
●○○○○○○

Questions  
○

Theory  
○○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

*Placeholder text for the main content area.*  
Lorem ipsum dolor sit  
amet, consectetur  
adipiscing elit, **S**

Motivation  
●○○○○○

Questions  
○

Theory  
○○○○○○○

Results  
○○

Outlook  
○○

## Evolutionary networks – model system I

**Lore**m ipsum dolor sit  
amet, consectetur  
adipiscing elit, s**e**

## Evolutionary networks – model system I

**Lore**m ipsum dolor sit  
amet, consectetur  
adipiscing elit, sed

## Evolutionary networks – model system I

*Lorem ipsum dolor sit  
amet, consectetur  
adipiscing elit, sed*

## Evolutionary networks – model system I

*Placeholder text for the main content area.*  
Lorem ipsum dolor sit  
amet, consectetur  
adipiscing elit, sed **d**

## Evolutionary networks – model system I

**Placeholder text for the main content area.**  
Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed d**o**

## Evolutionary networks – model system I

*Lorem ipsum dolor sit  
amet, consectetur  
adipiscing elit, sed do*

## Evolutionary networks – model system I

**L**orem ipsum dolor sit  
amet, consectetur  
adipiscing elit, sed do  
**e**

## Evolutionary networks – model system I

**L**orem ipsum dolor sit  
amet, consectetur  
adipiscing elit, sed do  
ei

## Evolutionary networks – model system I

**L**orem ipsum dolor sit  
amet, consectetur  
adipiscing elit, sed do  
ei**U**

## Evolutionary networks – model system I

**L**orem ipsum dolor sit  
amet, consectetur  
adipiscing elit, sed do  
eius**S**

## Evolutionary networks – model system I

*Placeholder text for the first slide content.*  
Lorem ipsum dolor sit  
amet, consectetur  
adipiscing elit, sed do  
eius**m**

## Evolutionary networks – model system I

**LOREM IPSUM DOLOR SIT  
AMET, CONSECTETUR  
ADIPISCING ELIT, SED DO  
EIUSM**○****

## Evolutionary networks – model system I

**L**orem ipsum dolor sit  
amet, consectetur  
adipiscing elit, sed do  
eiusmod**d**

## Evolutionary networks – model system I

*Lorem ipsum dolor sit  
amet, consectetur  
adipiscing elit, sed do  
eiusmod*

## Evolutionary networks – model system I

**L**orem ipsum dolor sit  
amet, consectetur  
adipiscing elit, sed do  
eiusmod **t**

## Evolutionary networks – model system I

**Placeholder text for the main content area.**  
Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

## Evolutionary networks – model system I

**L**orem ipsum dolor sit  
amet, consectetur  
adipiscing elit, sed do  
eiusmod te**m**

## Evolutionary networks – model system I

*Placeholder text for the first slide content.*  
Lorem ipsum dolor sit  
amet, consectetur  
adipiscing elit, sed do  
eiusmod temp**p**

## Evolutionary networks – model system I

**Placeholder text for the first slide content.**  
Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor

## Evolutionary networks – model system I

**Placeholder text for the first slide content.**  
Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor

## Evolutionary networks – model system I

*Lorem ipsum dolor sit  
amet, consectetur  
adipiscing elit, sed do  
eiusmod tempor*

## Evolutionary networks – model system I

*Lorem ipsum dolor sit  
 amet, consectetur  
 adipiscing elit, sed do  
 eiusmod tempor i*

## Evolutionary networks – model system I

**Placeholder text for the first slide content.**  
Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor in

## Evolutionary networks – model system I

**L**orem ipsum dolor sit  
amet, consectetur  
adipiscing elit, sed do  
eiusmod tempor in**C**

## Evolutionary networks – model system I

*Placeholder text for the first slide content.*  
Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor inci

## Evolutionary networks – model system I

**L**orem ipsum dolor sit  
amet, consectetur  
adipiscing elit, sed do  
eiusmod tempor incid**d**

## Evolutionary networks – model system I

*Placeholder text for the first slide content.*  
Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt

## Evolutionary networks – model system I

Lorem ipsum dolor sit  
amet, consectetur  
adipiscing elit, sed do  
eiusmod tempor  
incidi**d**

Evolutionary networks – model system I

**U**nd die anderen waren enttäuscht.  
Sie erwarteten eine längere  
Reise, aber sie war zu Ende.  
Sie waren müde und hungrig.  
Sie waren enttäuscht.

## Evolutionary networks – model system I

**L**orem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididuntut**n**

## Evolutionary networks – model system I

**L**orem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt**t**

## Evolutionary networks – model system I

*Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt*

## Evolutionary networks – model system I

*Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt* **U**

## Evolutionary networks – model system I

**L**orem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut

## Evolutionary networks – model system I

*Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut*

## Evolutionary networks – model system I

*Lorem ipsum dolor sit  
amet, consectetur  
adipiscing elit, sed do  
eiusmod tempor  
incididunt ut* █

## Evolutionary networks – model system I

*Placeholder text for the first slide of the model system I section.*  
Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut **la**

## Evolutionary networks – model system I

*Placeholder text for the first slide of the model system I section.*  
Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut lab**b**

## Evolutionary networks – model system I

**L**orem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut lab**O**

## Evolutionary networks – model system I

**L**orem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore

Evolutionary networks – model system I

## Evolutionary networks – model system I

*Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore*

## Evolutionary networks – model system I

*Lore* ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore **e**

## Evolutionary networks – model system I

**L**orem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et

## Evolutionary networks – model system I

*Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et*

## Evolutionary networks – model system I

**L**orem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et **d**

## Evolutionary networks – model system I

**L**orem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

## Evolutionary networks – model system I

**L**orem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore

## Evolutionary networks – model system I

**L**orem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore

## Evolutionary networks – model system I

**L**orem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore

## Evolutionary networks – model system I

**L**orem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore**e**

## Evolutionary networks – model system I

*Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore*

## Evolutionary networks – model system I

**L**orem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore **m**

## Evolutionary networks – model system I

**L**orem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore m**a**

## Evolutionary networks – model system I

**L**orem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.

## Evolutionary networks – model system I

**L**orem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.

## Evolutionary networks – model system I

**L**orem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna

## Evolutionary networks – model system I

*Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna*

## Evolutionary networks – model system I

*Placeholder text for the first slide content.*  
Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna **a**

## Evolutionary networks – model system I

**L**orem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.

## Evolutionary networks – model system I

**L**orem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.

## Evolutionary networks – model system I

**L**orem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua

## Evolutionary networks – model system I

**L**orem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliquaU

## Evolutionary networks – model system I

Lorem ipsum dolor sit  
amet, consectetur  
adipiscing elit, sed do  
eiusmod tempor  
incididunt ut labore et  
dolore magna aliqua**a.**

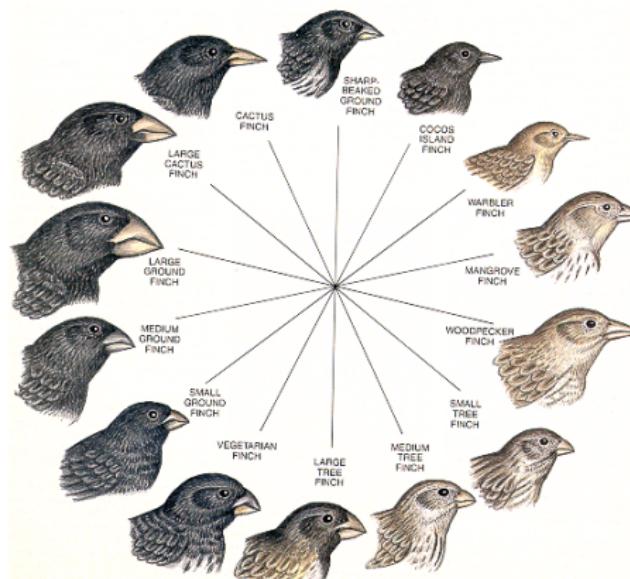
## Evolutionary networks – model system I

*Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.*

## Evolutionary networks – model system I

*Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.*

## Evolutionary networks – model system II



## Evolutionary networks – model system III



L. TANGANYIKA



L. MALAWI

Stiassny, M. J., and Meyer, A. (1999). Cichlids of the Rift Lakes. *Scientific American*, 64-69.

# Distribution of traits – structural stability

Pere Alberch  
Genetica 84: 5-11, 1991

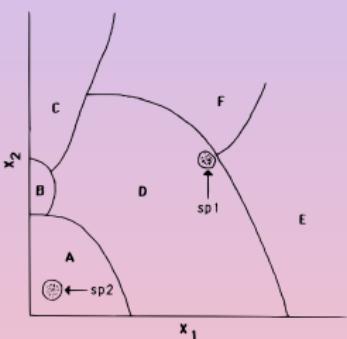
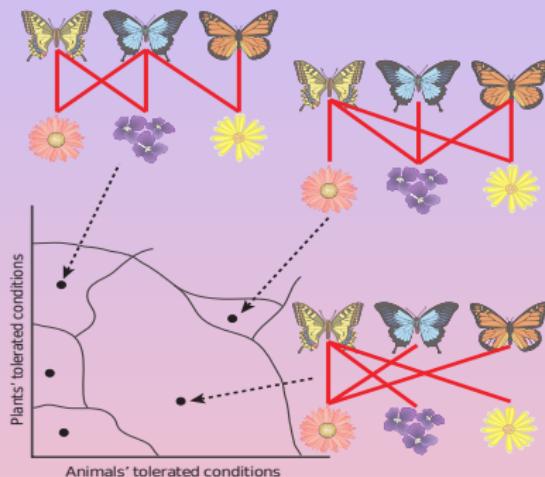


Fig. 3. Parameter Space.

and the phenotype can be mathematically stated as:

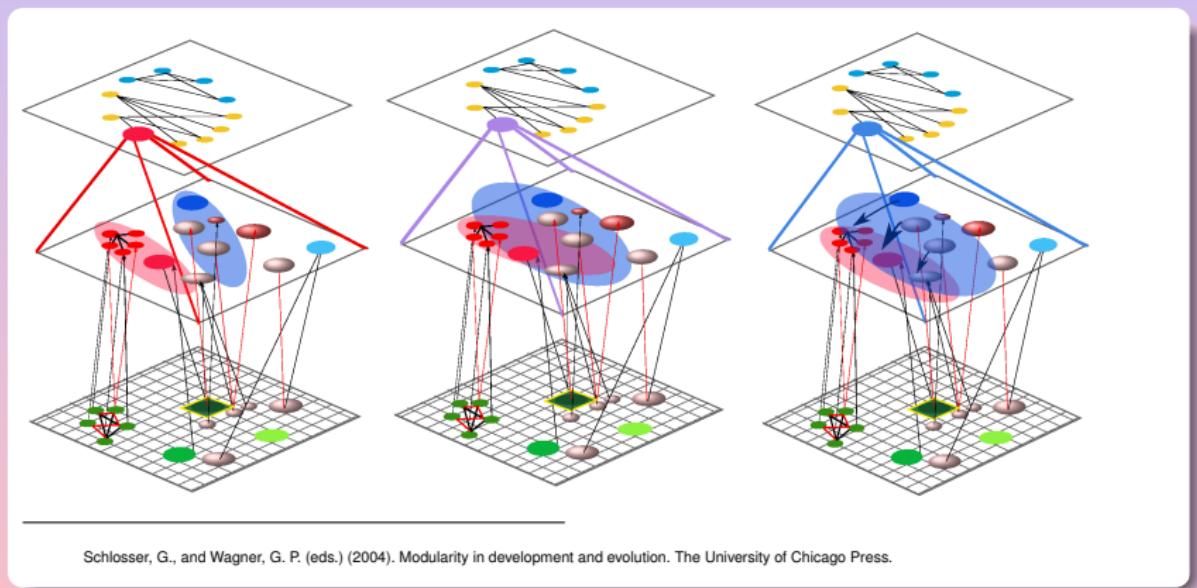
$$dP/dt = f(P, x)$$

7



Rudolf P. Rohr, Serguei Saavedra, Jordi Bascompte  
(2014). DOI: 10.1126/science.1253497

# GIN underlying complex traits



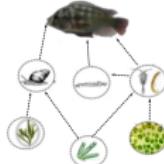
Schlosser, G., and Wagner, G. P. (eds.) (2004). Modularity in development and evolution. The University of Chicago Press.

# Remove?

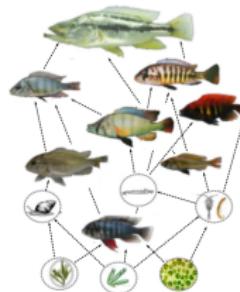
(a)



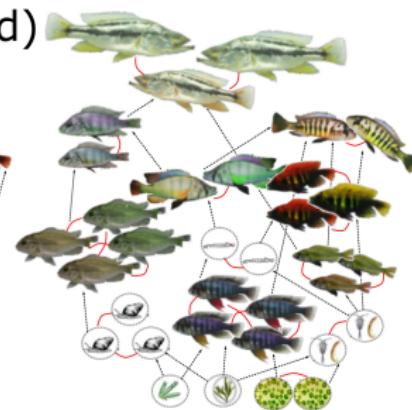
(b)



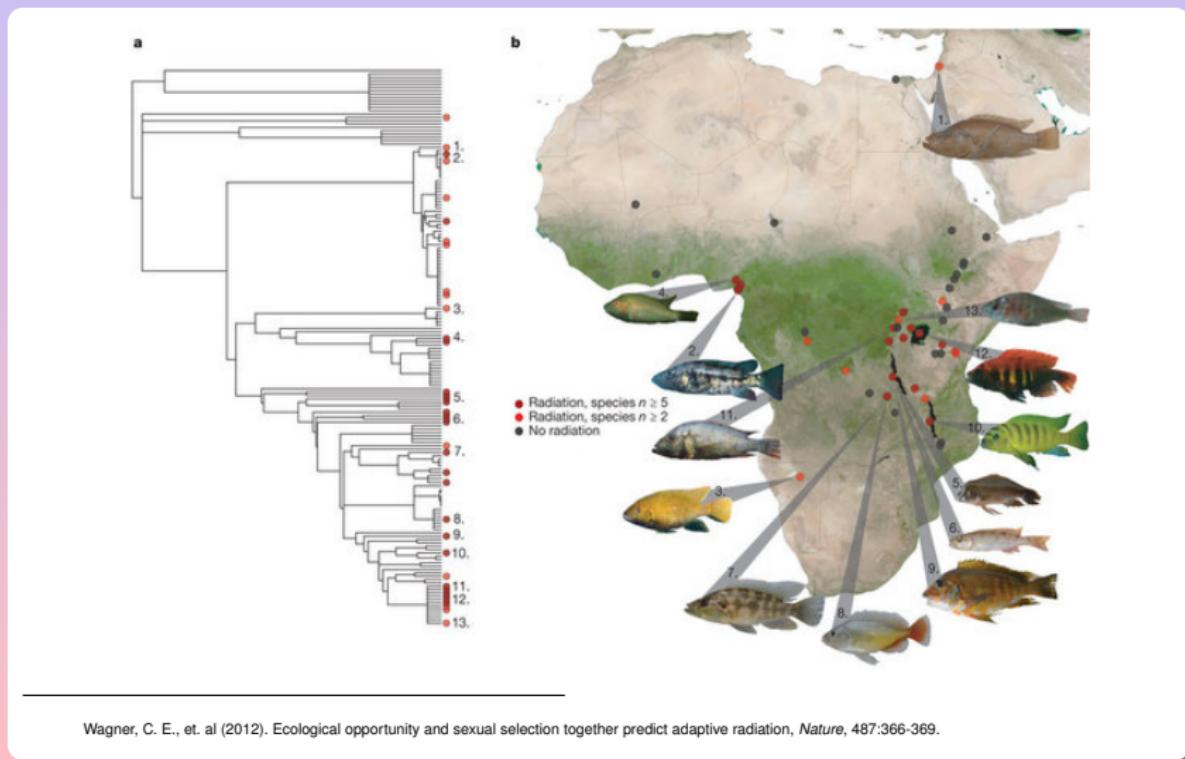
(c)



(d)



# Remove?



# Questions

- ▶ How do gene interaction networks underlying complex interaction traits affect ecological networks?

# Questions

- ▶ How do gene interaction networks underlying complex interaction traits affect ecological networks?
- ▶ How does trait variance affect interaction strength and the stability of species-rich meta-ecosystems?

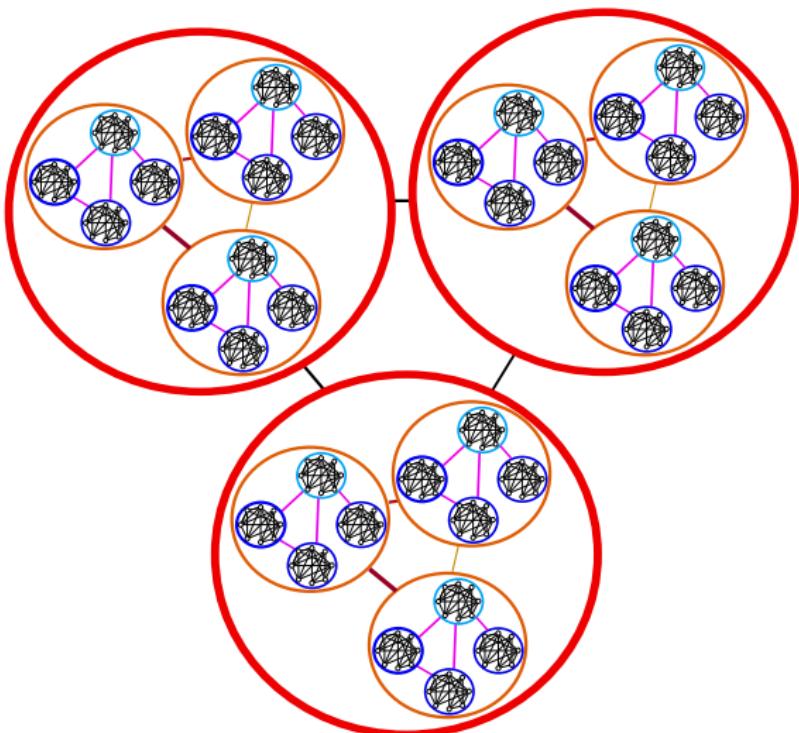
Motivation  
○○○○○○○

Questions  
○

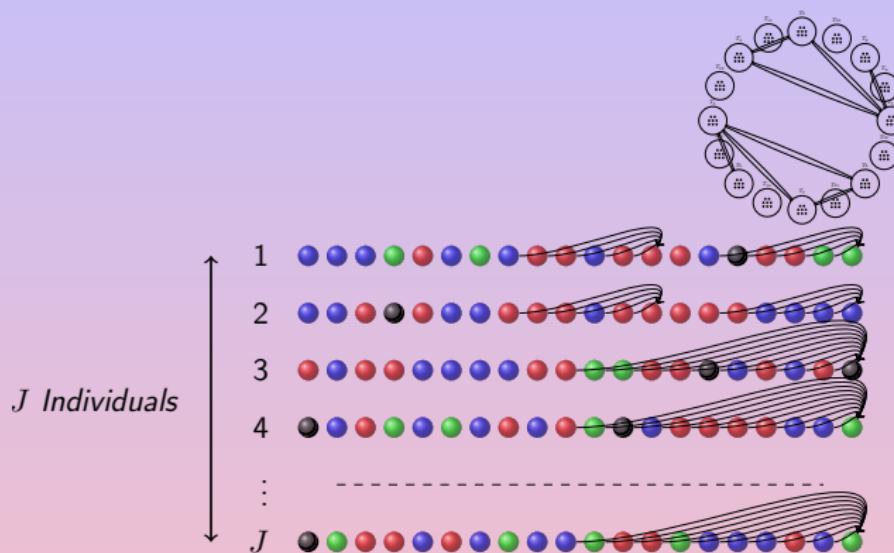
Theory  
●○○○○○○○

Results  
○○

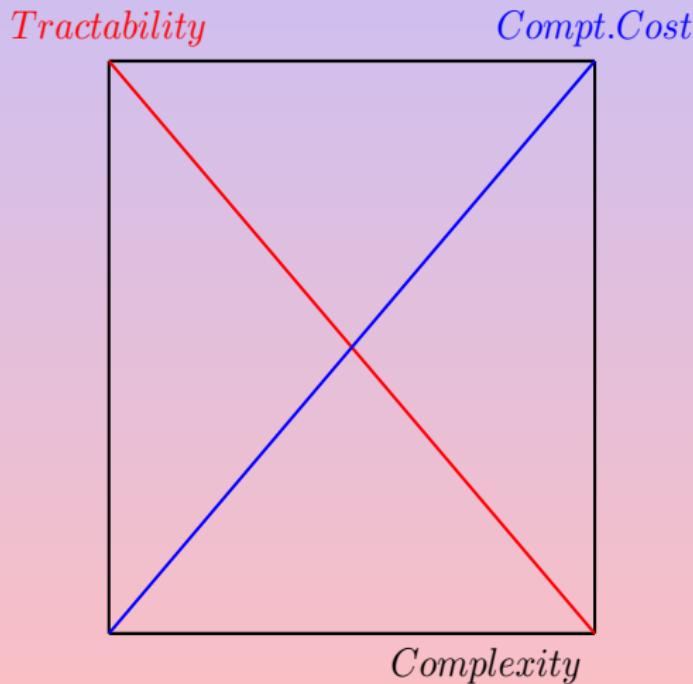
Outlook  
○○



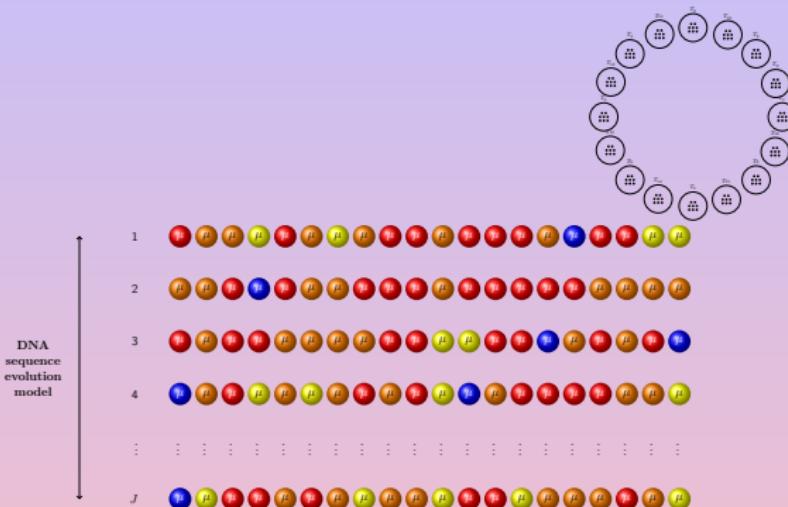
Population size,  $\mathcal{J}$ , Genome size,  $\mathcal{L}$ , and mutation rate,  $\mu$

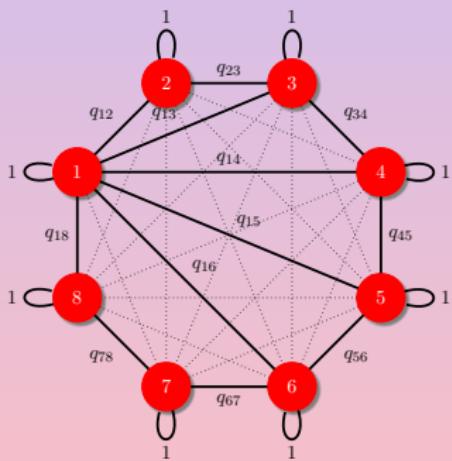


# Tractability and replicability

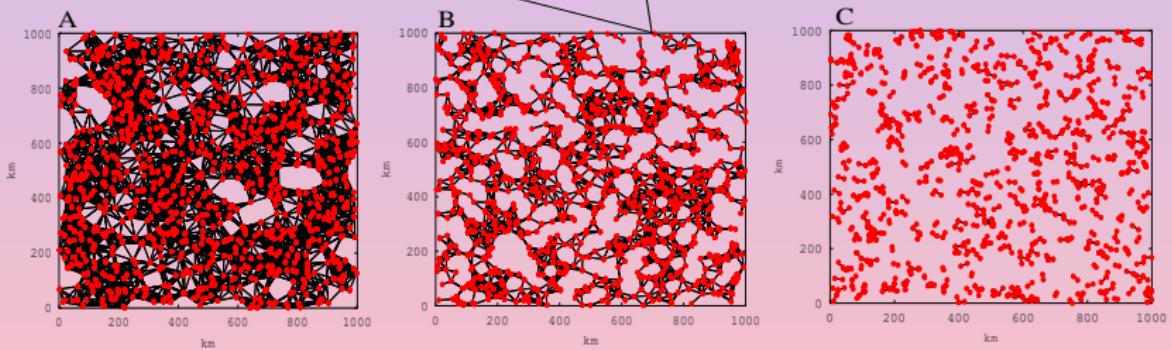
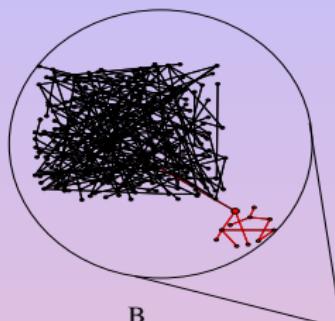


Population size,  $\mathcal{J}$ , Genome size,  $\mathcal{L}$ , and mutation rate,  $\mu$



Genomes in a mating graph (threshold,  $\mathcal{Q}_{min}$ );  $Q = [q_{ij}]$  and  $q_{ij} > \mathcal{Q}_{min}$ 

$$Q = \begin{bmatrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 \\ 1 & 1 & q_{12} & q_{13} & q_{14} & q_{15} & q_{16} & 0 & q_{18} \\ 2 & q_{21} & 1 & q_{23} & 0 & 0 & 0 & 0 & 0 \\ 3 & q_{31} & q_{32} & 1 & q_{34} & 0 & 0 & 0 & 0 \\ 4 & q_{41} & 0 & q_{43} & 1 & q_{45} & 0 & 0 & 0 \\ 5 & q_{51} & 0 & 0 & q_{54} & 1 & q_{56} & 0 & 0 \\ 6 & q_{61} & 0 & 0 & 0 & q_{65} & 1 & q_{67} & 0 \\ 7 & 0 & 0 & 0 & 0 & 0 & q_{76} & 1 & q_{78} \\ 8 & q_{81} & 0 & 0 & 0 & 0 & 0 & q_{87} & 1 \end{bmatrix}$$

Genomes in the landscape (threshold,  $D_{max}$ );  $D = [d_{ij}]$  and  $d_{ij} \leq D_{max}$ 

# Gene flow, ( $\mathcal{M}$ )

Symmetric gene flow

$$m_{ij}^k = \frac{\mathcal{M}}{d_{ij}} \quad (1)$$

Centripetal gene flow

$$m_{ij}^k = \begin{cases} \frac{\mathcal{M}}{d_{ij}} & \text{if } \sum_{l=1}^S d_{il} \leq \sum_{l=1}^S d_{jl}, \\ 0 & \text{if } \sum_{l=1}^S d_{il} > \sum_{l=1}^S d_{jl} \end{cases} \quad (2)$$

Centrifugal gene flow

$$m_{ij}^k = \begin{cases} \frac{\mathcal{M}}{d_{ij}} & \text{if } \sum_{l=1}^S d_{il} \geq \sum_{l=1}^S d_{jl}, \\ 0 & \text{if } \sum_{l=1}^S d_{il} < \sum_{l=1}^S d_{jl} \end{cases} \quad (3)$$

## Motivation



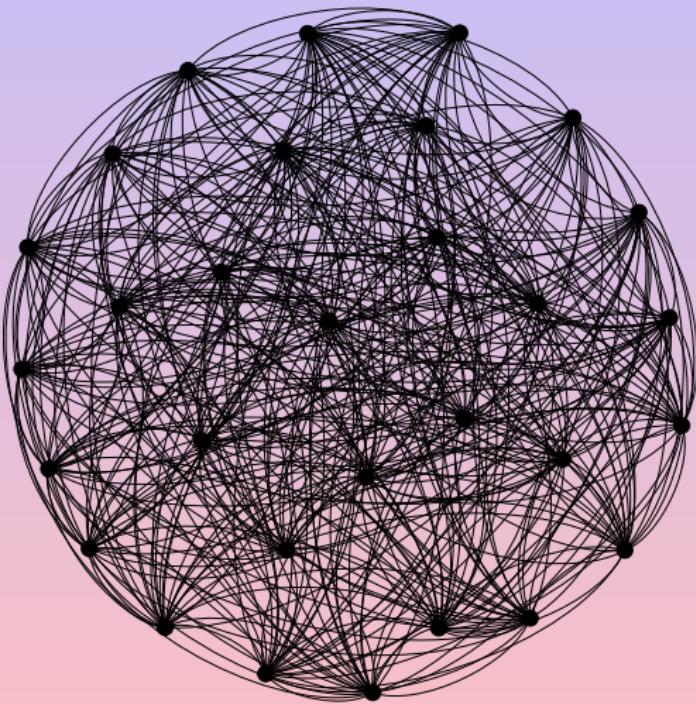
## Questions

## Theory



## Results

## Outlook



## Motivation



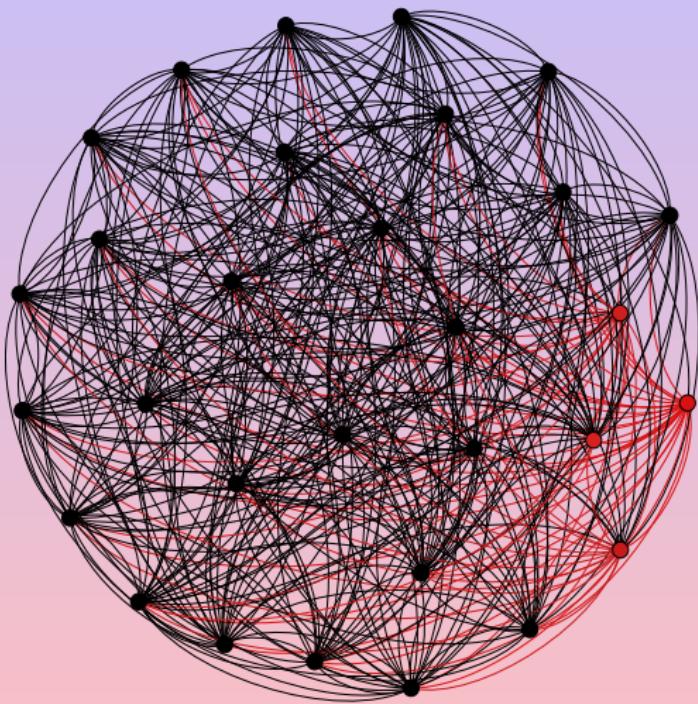
## Questions

## Theory



## Results

Outlook  
oo



## Motivation



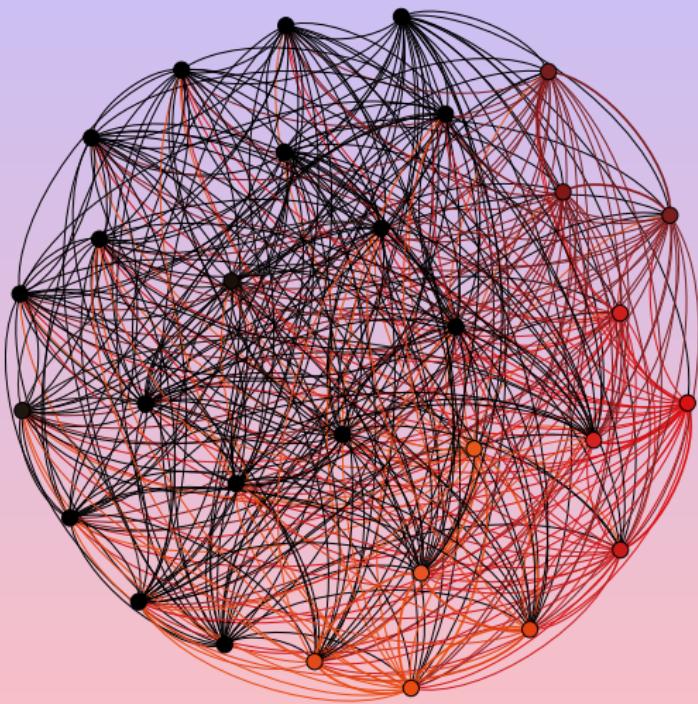
## Questions

## Theory



## Results

## Outlook



## Motivation



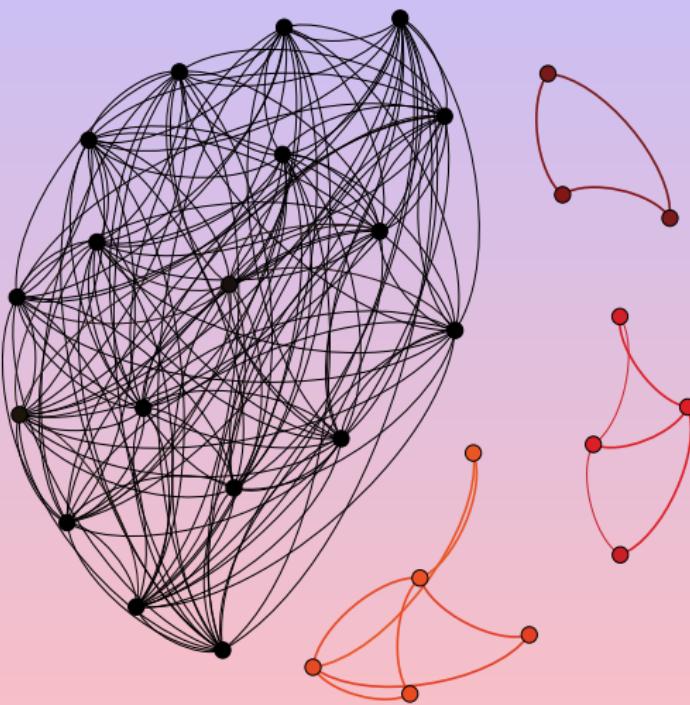
## Questions

## Theory

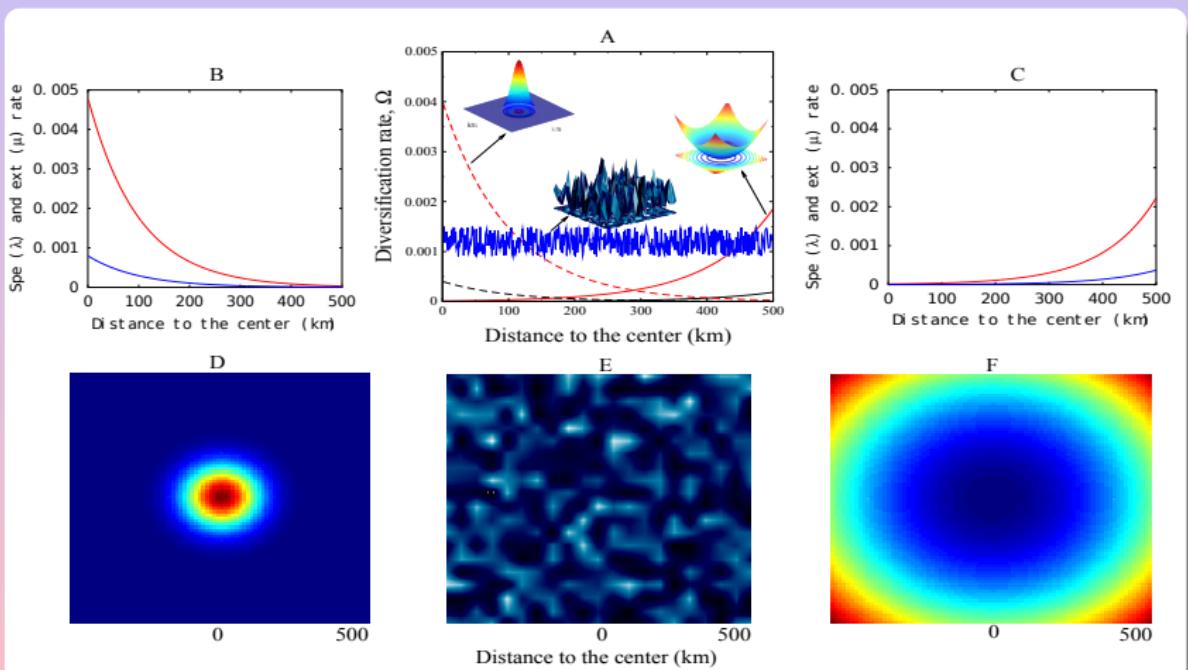


## Results

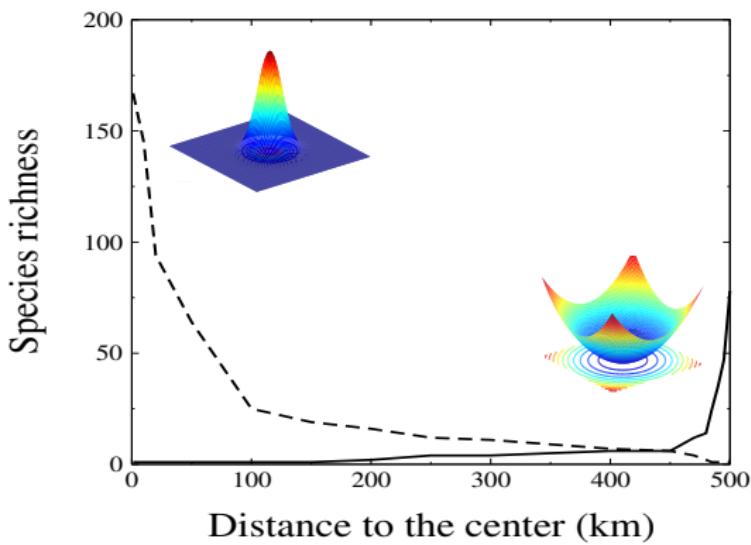
## Outlook



# Hot and cold spots ( $\mathcal{J}, \mathcal{L}, \mu, Q_{min}, D_{max}, M$ )



# Hot spots and species richness



# Outlook

- ▶ **BIG CHALLENGE:** Join complex genotype-phenotype maps to large scale biodiversity patterns using meta-ecosystem dynamic models

# Outlook

- ▶ **BIG CHALLENGE:** Join complex genotype-phenotype maps to large scale biodiversity patterns using meta-ecosystem dynamic models
- ▶ Landscape structure, the strength of assortative mating and the intensity and directionality of gene flow in structured landscapes may play a critical role to anticipate the formation of radiations

# Outlook

- ▶ **BIG CHALLENGE:** Join complex genotype-phenotype maps to large scale biodiversity patterns using meta-ecosystem dynamic models
- ▶ Landscape structure, the strength of assortative mating and the intensity and directionality of gene flow in structured landscapes may play a critical role to anticipate the formation of radiations
- ▶ Centripetal gene flow model predicts hot spots in the center of the distribution ranges of diversifying lineages

Motivation  
○○○○○○○

Questions  
○

Theory  
○○○○○○○○

Results  
○○

Outlook  
○●

# Thank you!

- ▶ Swiss National Science Foundation (SNSF)