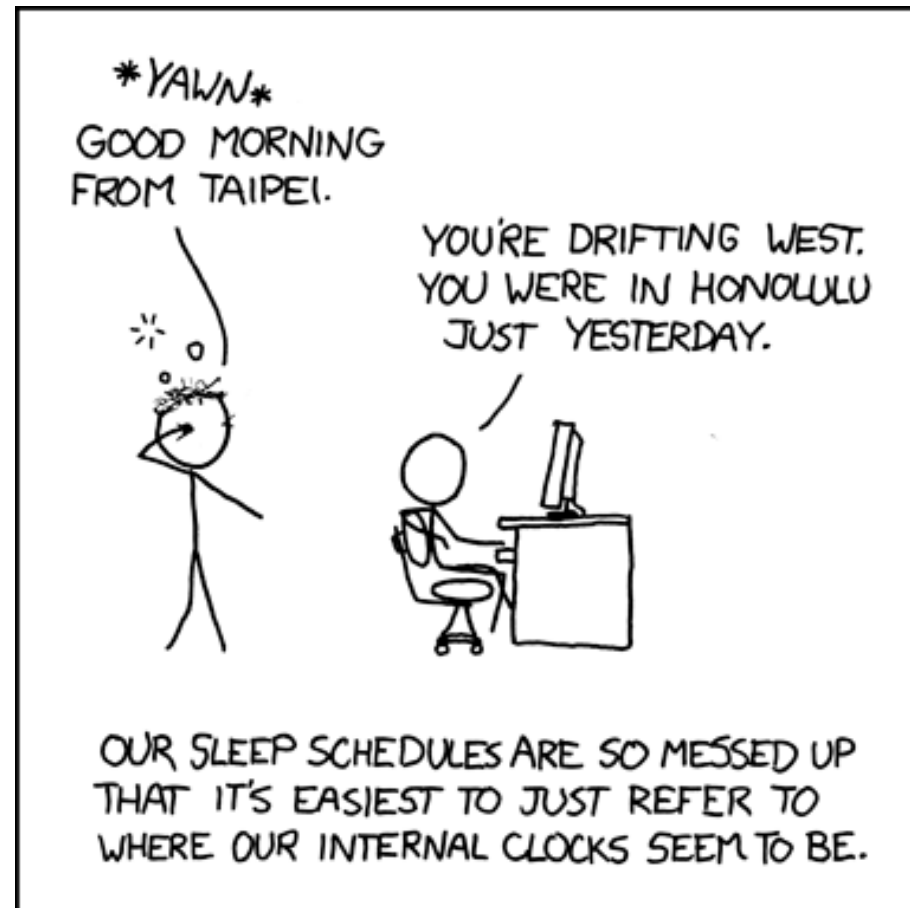


Deriva e Dispersão

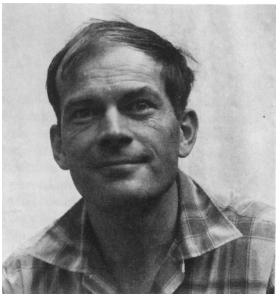


A perguntas essenciais

- Riqueza
 - Por que algumas comunidades têm mais espécies do que outras?
- Composição
 - Por que comunidades têm conjuntos diferentes de espécies?
- Abundância
 - Por que as espécies nas comunidades têm tamanhos populacionais diferentes?

Respostas: Nicho

- Riqueza
 - Saturação em pontos diferentes
- Composição
 - Interações determinam: exclusão de espécies similares, coexistência mediada por predação, etc
- Abundância
 - Tamanhos populacionais regulados por interações



As cunhas de Darwin

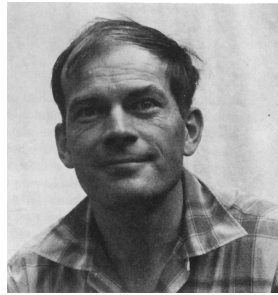
“Nature may be compared to a surface covered with ten-thousand sharp wedges, many of the same shape & many of different shapes representing different species, all packed closely together & all driven in by incessant blows: (...)”



Lotka



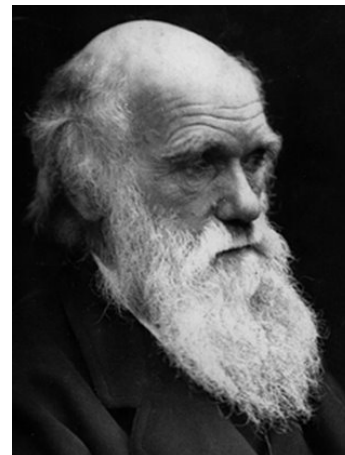
Volterra



MacArthur



Hutchinson



<http://edhui.wordpress.com/2009/02/07/darwin/>

As cunhas de Darwin

“(...) the blows being far severer at one time than at another; sometimes a wedge of one form & sometimes another being struck; the one driven deeply in forcing out others; with the jar and shock often transmitted very far to other wedges in many lines of direction: beneath the surface we may suppose that there lies a hard layer, fluctuating in its level, & which may represent the minimum amount of food required by each living being, & which layer will be impenetrable by the sharpest wedge.”

EDOs ou ODEs

$$\frac{dN_1}{dt} = r N_1 \frac{K_1 - N_1 - \alpha N_2}{K_1}$$



Velocidade

Lotka-Volterra generalizada

$$\frac{dN_1}{dt} = r N_1 \frac{K_1 - N_1 - \alpha_{12} N_2 - \alpha_{13} N_3 - \dots}{K_1}$$

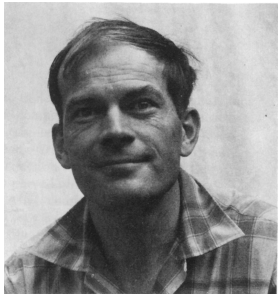
$$\frac{dN_i}{dt} = r N_i \left(1 - \sum \alpha_{ij} N_j \right)$$

Determinismo: demônio de Laplace



Marquês Pierre-Simon Laplace
(1749-1827)

*“Se houvesse um intelecto que num dado momento conhecesse todas as forças que colocam a natureza em movimento, e todas as posições de seus elementos, e que também fosse vasto o suficiente para submeter esses dados à análise, **ele poderia abranger numa única fórmula** os movimentos dos maiores corpos celestes e do mais ínfimo átomo, e para ele nada seria incerto, e passado e futuro seriam o mesmo que o presente a seus olhos.”*

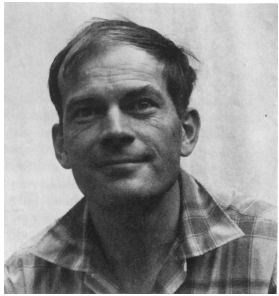


1963a (M. Rosenzweig and R. H. MacArthur). Graphical representation of stability conditions of predator-prey interactions. *Amer. Natur.* 97: 209-223.

1964d (with R. Levins). Competition habitat selection and character displacement in a patchy environment. *Proc. Nat. Acad. Sci. USA* 51: 1207-1210.

1966c (with E. R. Pianka). On optimal use of a patchy environment. *Amer. Natur.* 100: 603-609.

1967a (with R. Levins). The limiting similarity, convergence and divergence of coexisting species. *Amer. Natur.* 101: 377-385.



MacArthur, R. H. (1958). Population ecology of some warblers of northeastern coniferous forests. *Ecology*, 39(4), 599-619.

1963a (M. Rosenzweig and R. H. MacArthur). Graphical representation of stability conditions of predator-prey interactions. *Amer. Natur.* 97: 209-223.

1963b (with E. O. Wilson). An equilibrium theory of insular zoogeography. *Evolution* 17: 373-387.

1964d (with R. Levins). Competition habitat selection and character displacement in a patchy environment. *Proc. Nat. Acad. Sci. USA* 51: 1207-1210.

1966c (with E. R. Pianka). On optimal use of a patchy environment. *Amer. Natur.* 100: 603-609.

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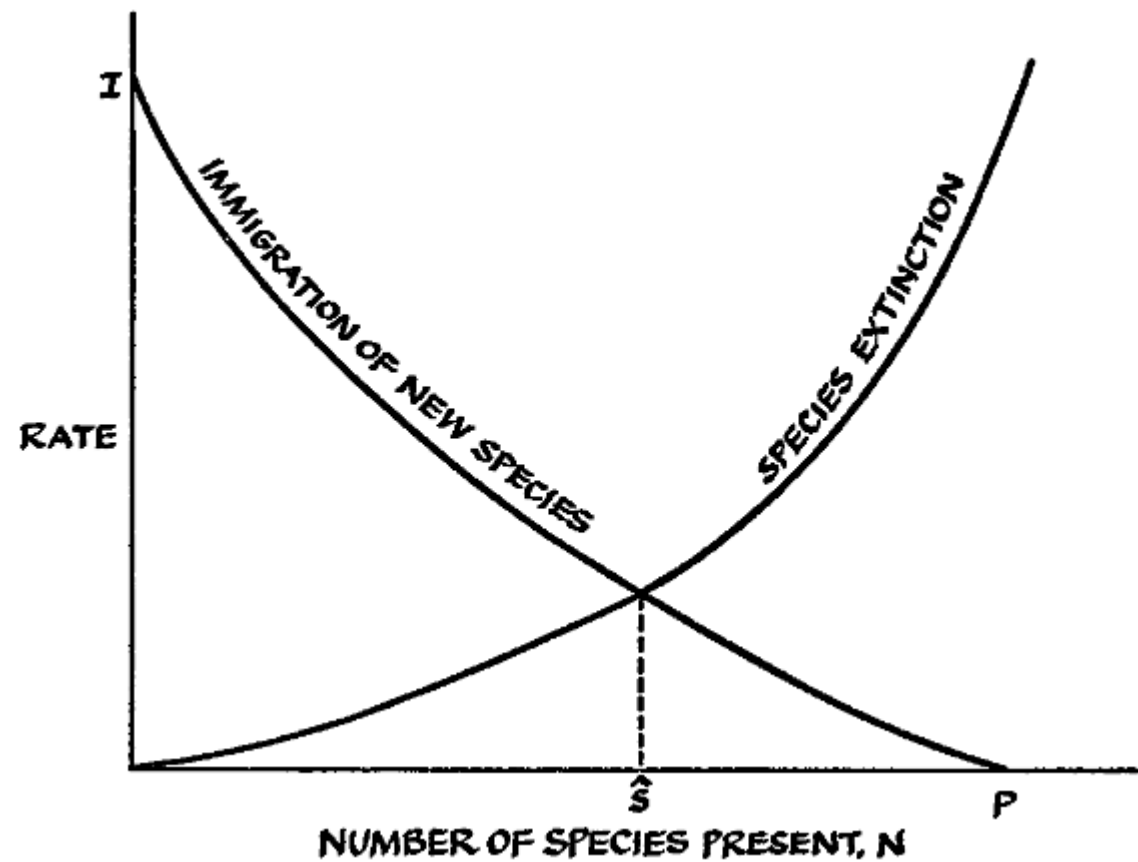
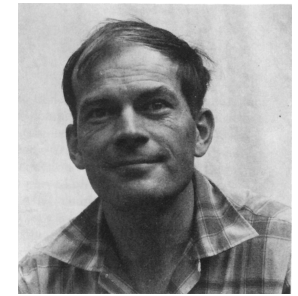
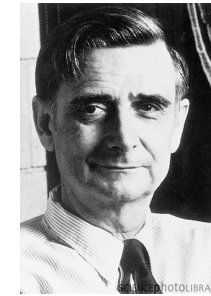
THE THEORY OF Island Biogeography

ROBERT H. MACARTHUR AND

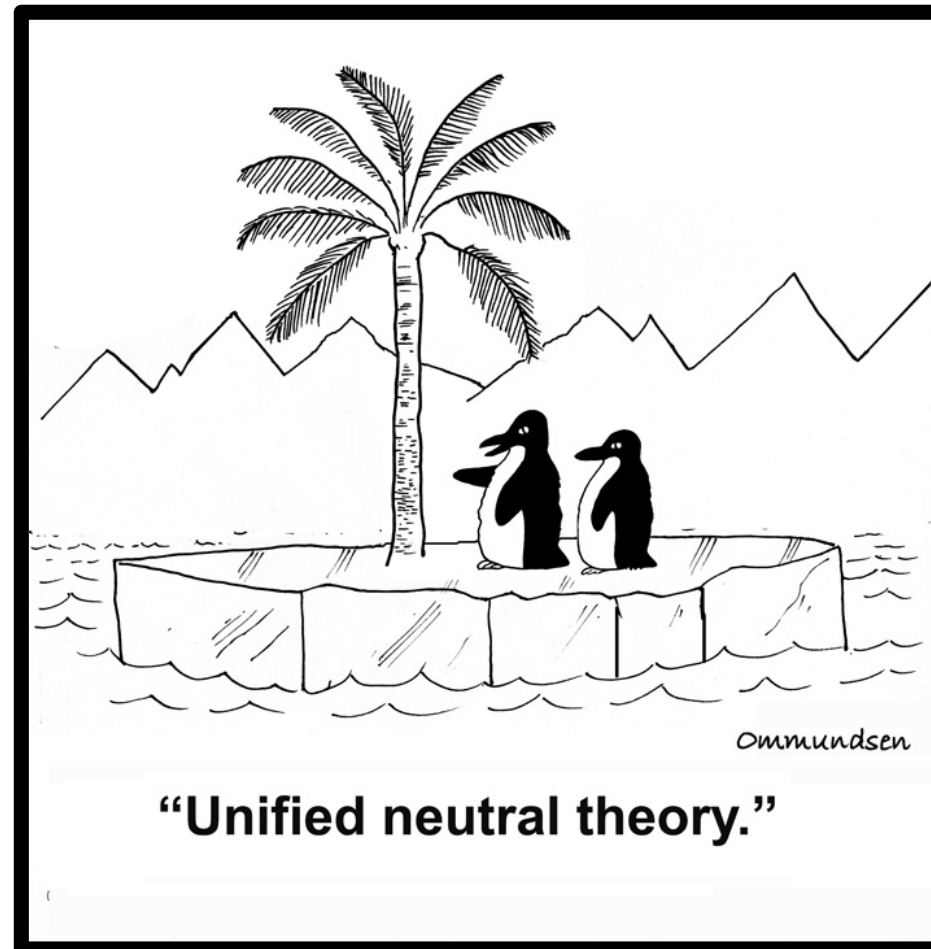
EDWARD O. WILSON

PRINCETON, NEW JERSEY
PRINCETON UNIVERSITY PRESS

1967

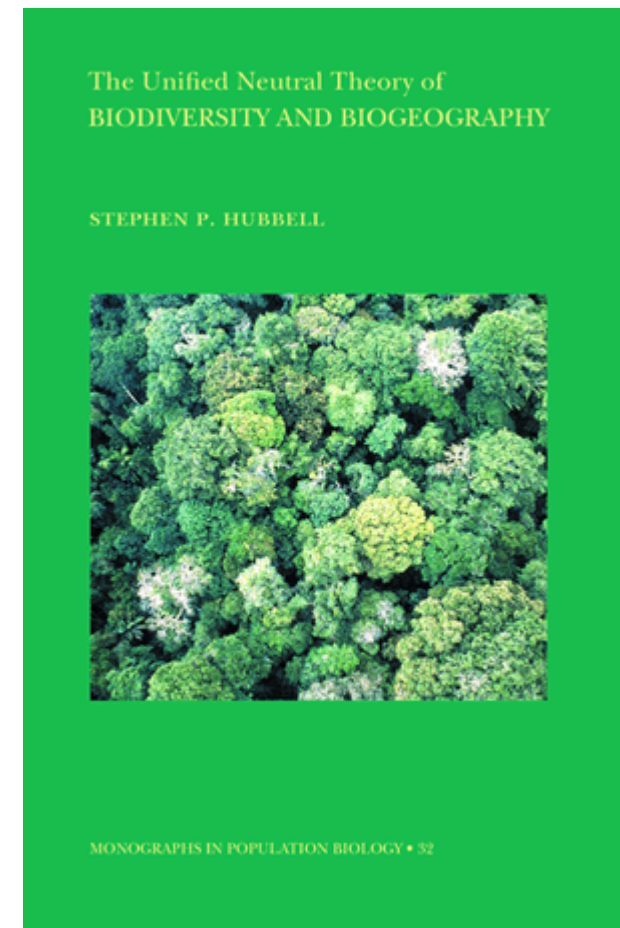
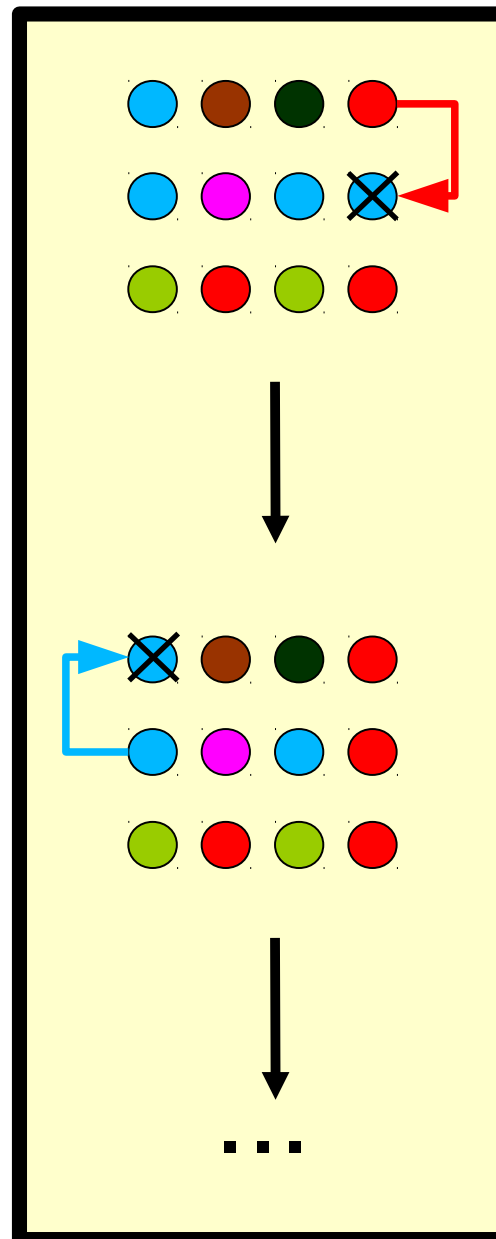


Efeitos da deriva: as coisas mais estranhas são por acaso

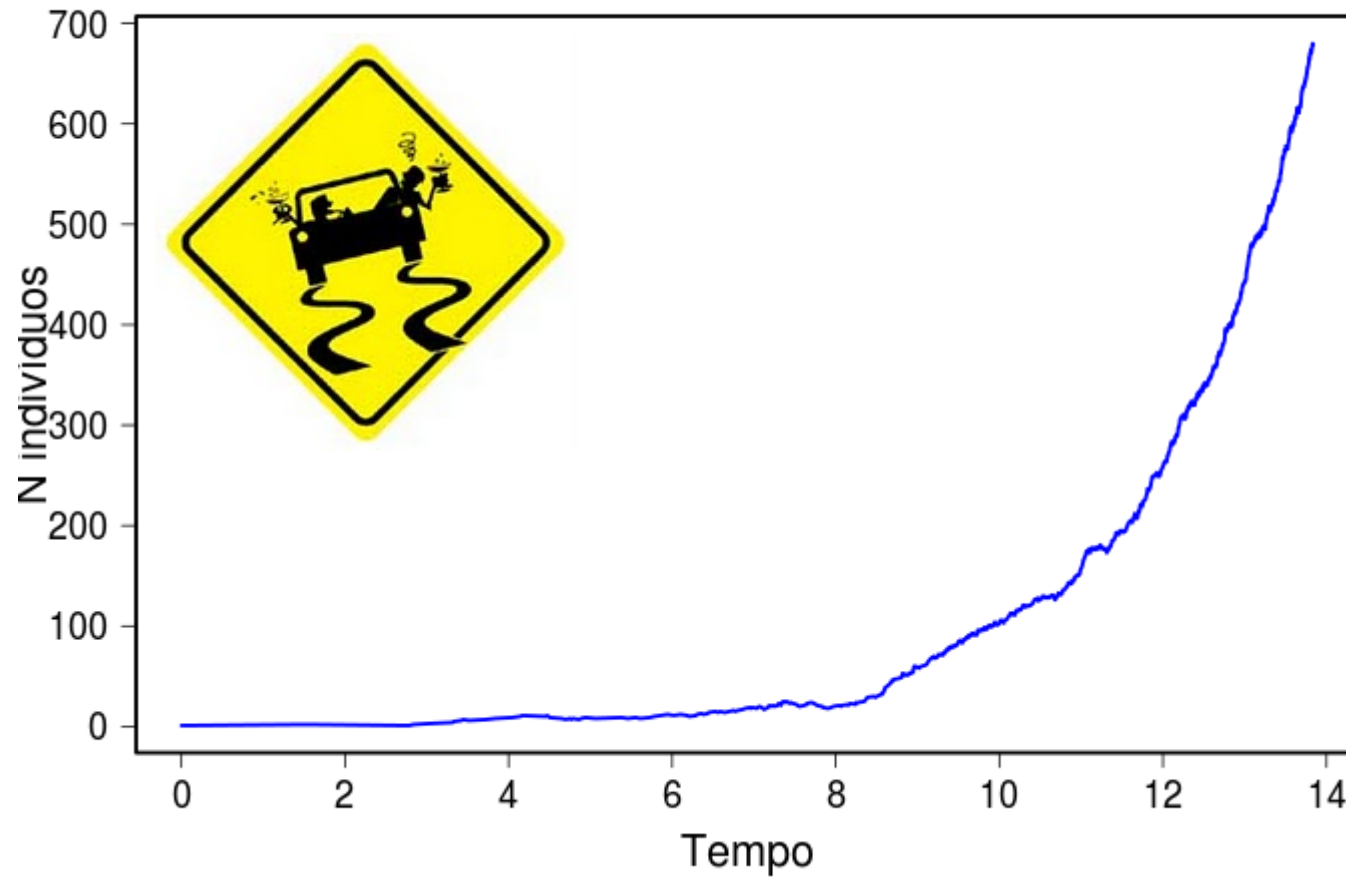


UNTB

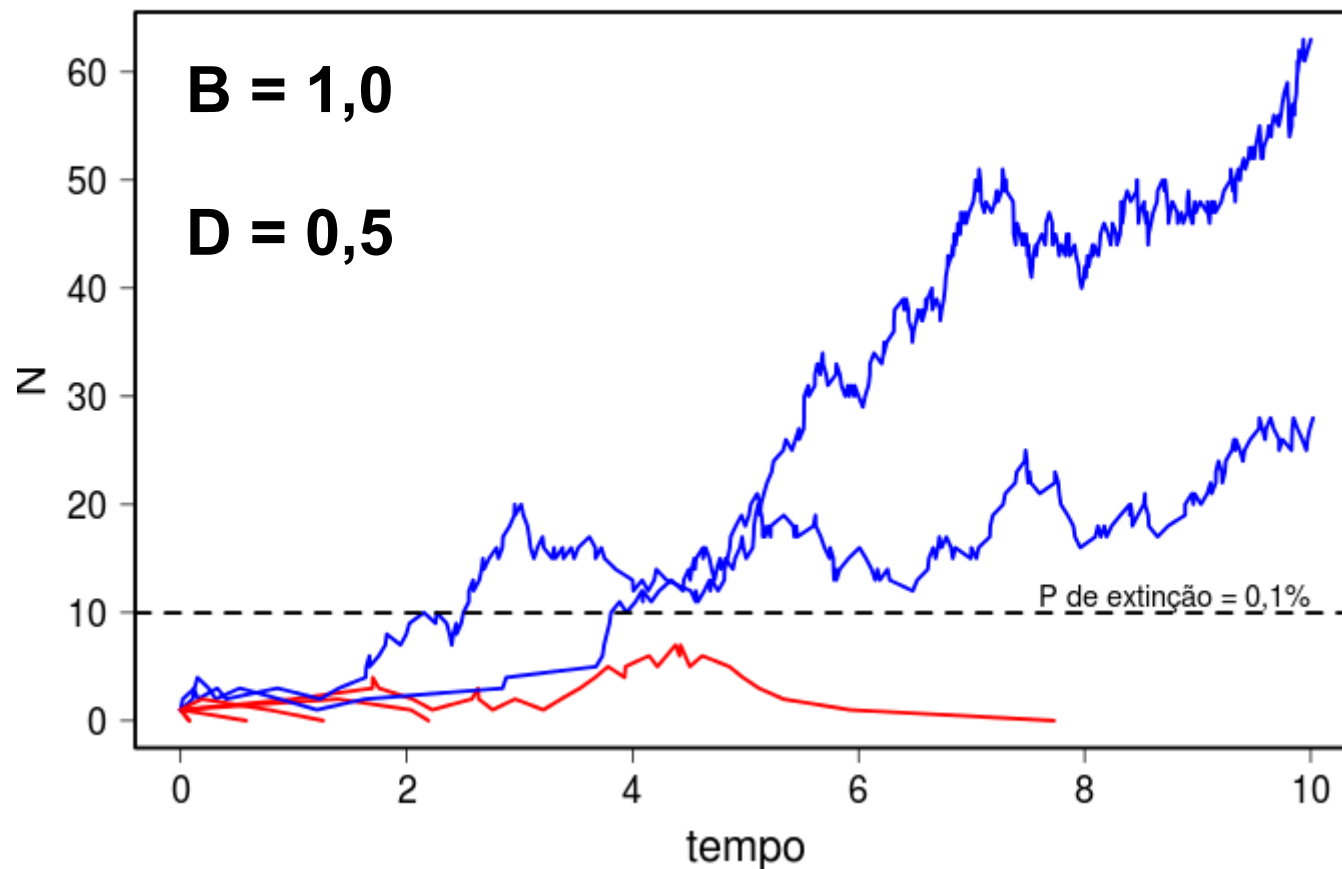
- Neutralidade
- Estocasticidade



Dinâmicas estocásticas

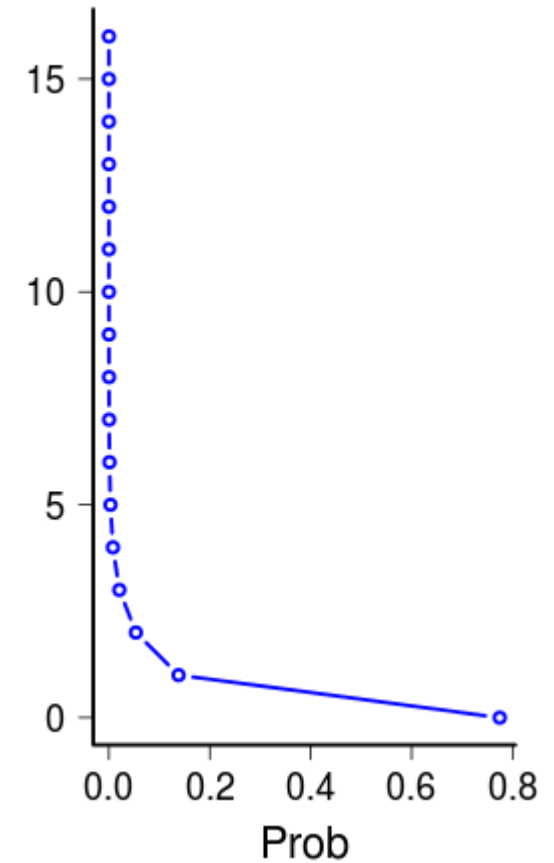
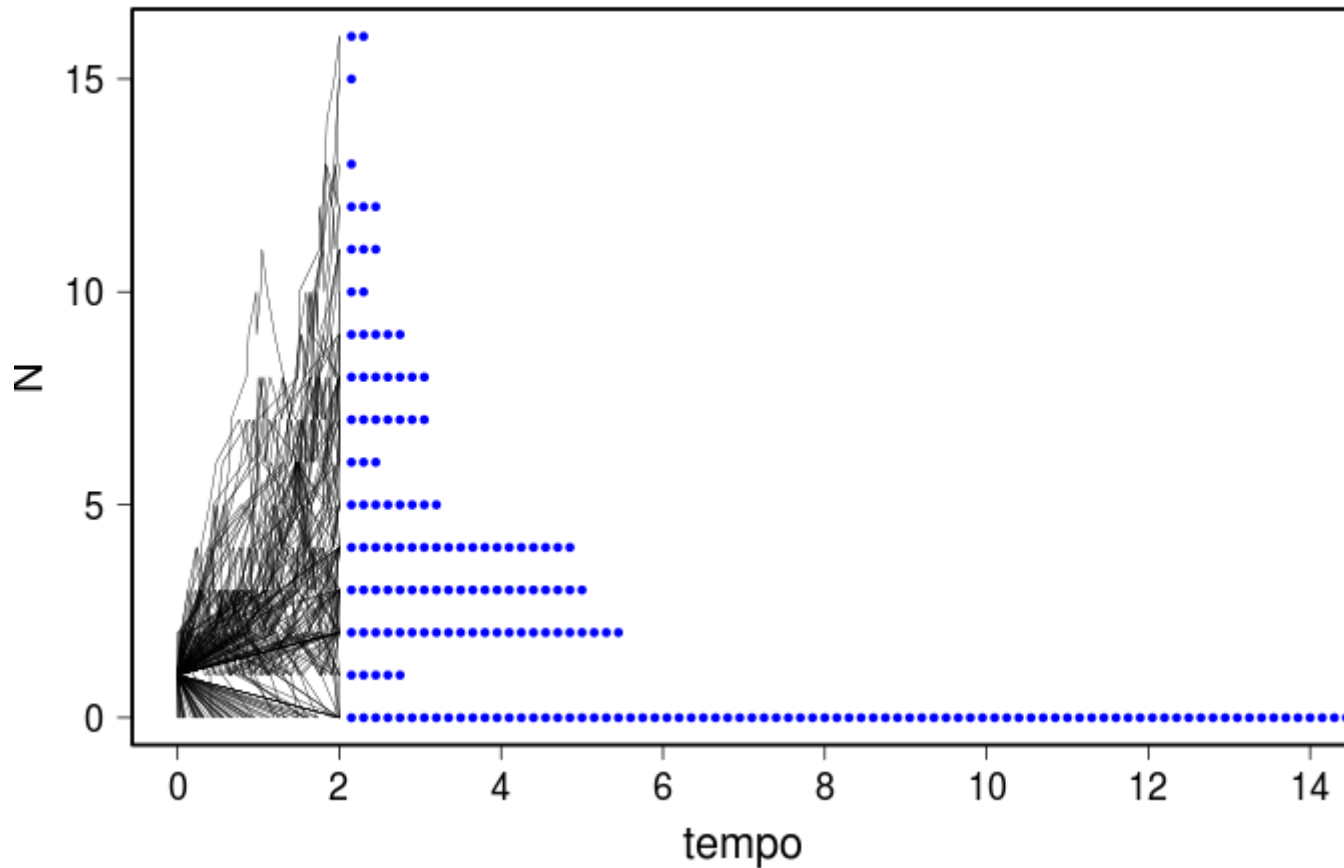


Dançando à beira do abismo



Probabilidade de extinção sempre maior que zero!

Generalizando para muitas spp



SADs

Motomura 1932

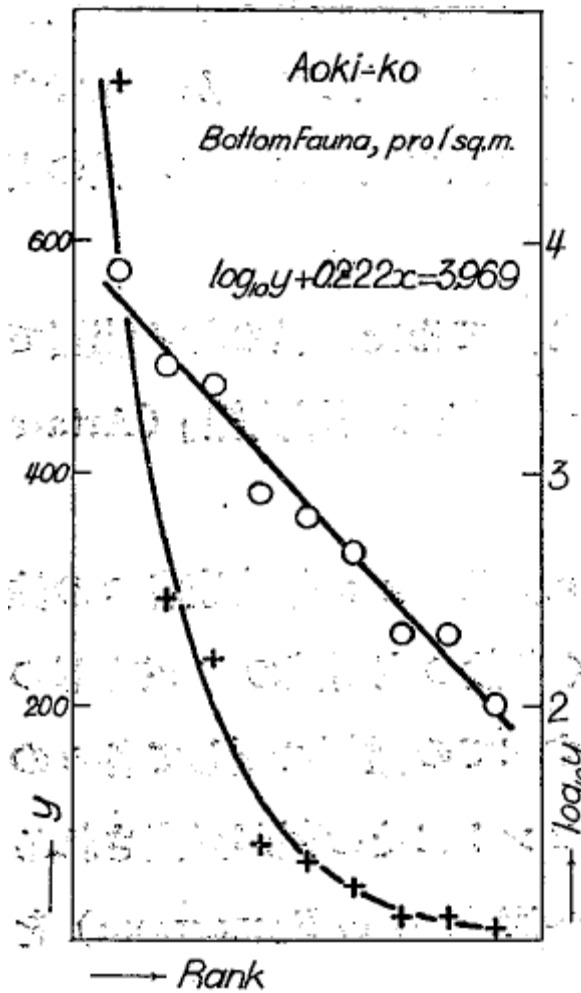
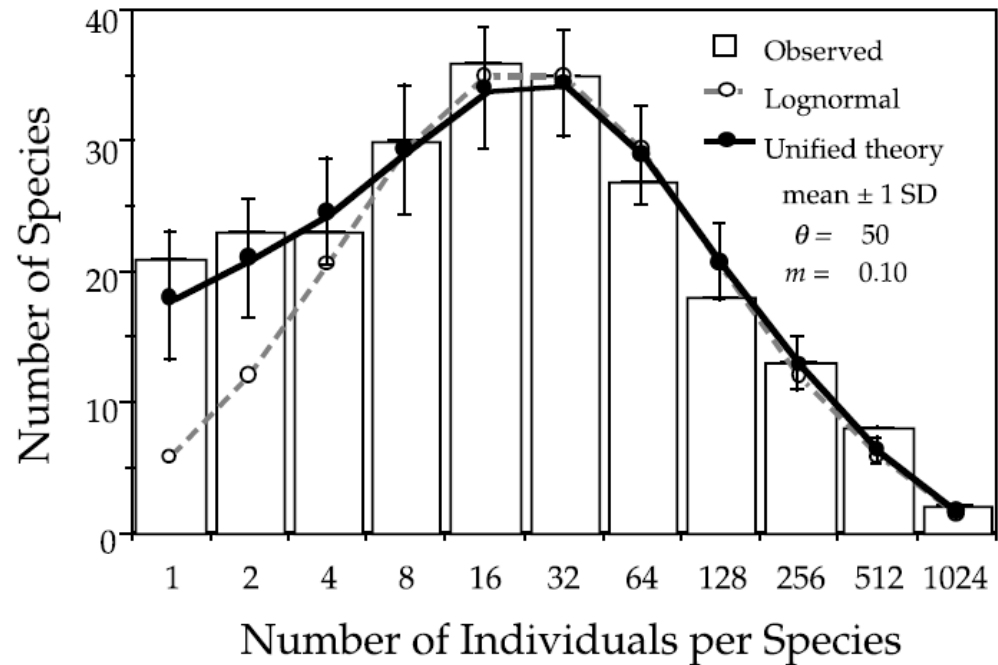


Fig. 1



Hubbell 2001

Teoria neutra da evolução

Evolutionary Rate at the Molecular Level

by

MOTOO KIMURA

National Institute of Genetics,
Mishima, Japan

Calculating the rate of evolution in terms of nucleotide substitutions seems to give a value so high that many of the mutations involved must be neutral ones.

NATURE, VOL. 217. FEBRUARY 17. 1968

Finally, if my chief conclusion is correct, and if the neutral or nearly neutral mutation is being produced in each generation at a much higher rate than has been considered before, then we must recognize the great importance of random genetic drift due to finite population number²³ in forming the genetic structure of biological populations. The significance of random genetic drift has



Motoo Kimura
1924 - 1994

Sobre o ombro de gigantes

Table I. Analogies between community ecology and population genetics

| Property | Community ecology | Population genetics |
|---|----------------------------------|----------------------------------|
| System (size) | Metacommunity (J_M) | Population (N) |
| Subsystem | Local community | Deme |
| Neutral system unit | Individual organism | Individual gene |
| Diversity unit | Species | Allele |
| Stochastic process | Ecological drift | Genetic drift |
| Generator of diversity | Speciation (at rate ν) | Mutation (at rate μ) |
| Fundamental diversity number | $\theta \approx 2J_M\nu$ | $\theta \approx 4N\mu$ |
| Fundamental dispersal number | $I \approx 2J_L m$ | $\theta \approx 4Nm$ |
| Relative abundance distribution, $\Phi(x)$ | $\theta x^{-1} (1-x)^{\theta-1}$ | $\theta x^{-1} (1-x)^{\theta-1}$ |
| Time to common ancestor (in small θ approximation) | $-J_M x (1-x)^{-1} \log(x)$ | $-N x (1-x)^{-1} \log(x)$ |
| Dispersal | Immigration | Migration |

Mesmas perguntas, outras respostas

- Riqueza
 - Balanço entre extinção estocástica e migração/especiação
- Composição
 - Divergência ao acaso (deriva de comunidades)
- Abundância
 - Flutuação estocástica dos tamanhos populacionais

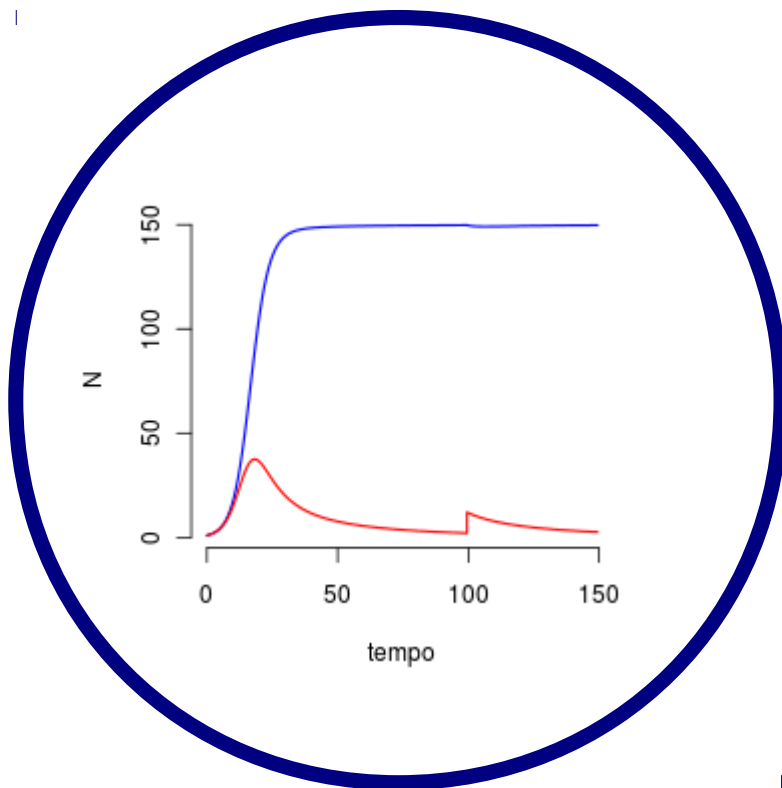
Dispersão:

no espaço as coisas são diferentes

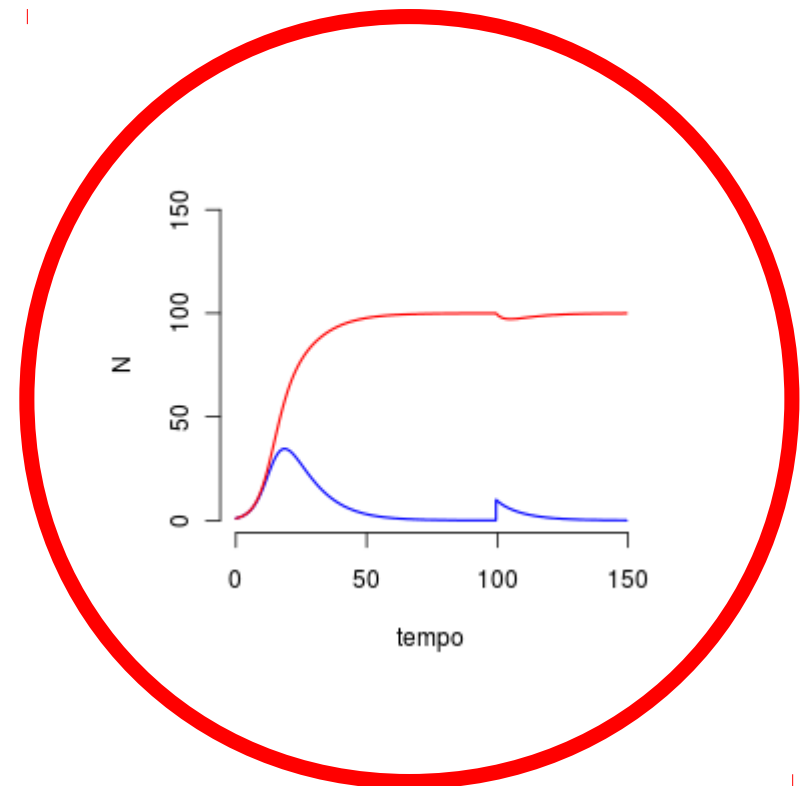


Teorema da perturbação

Mancha 1



Mancha 2

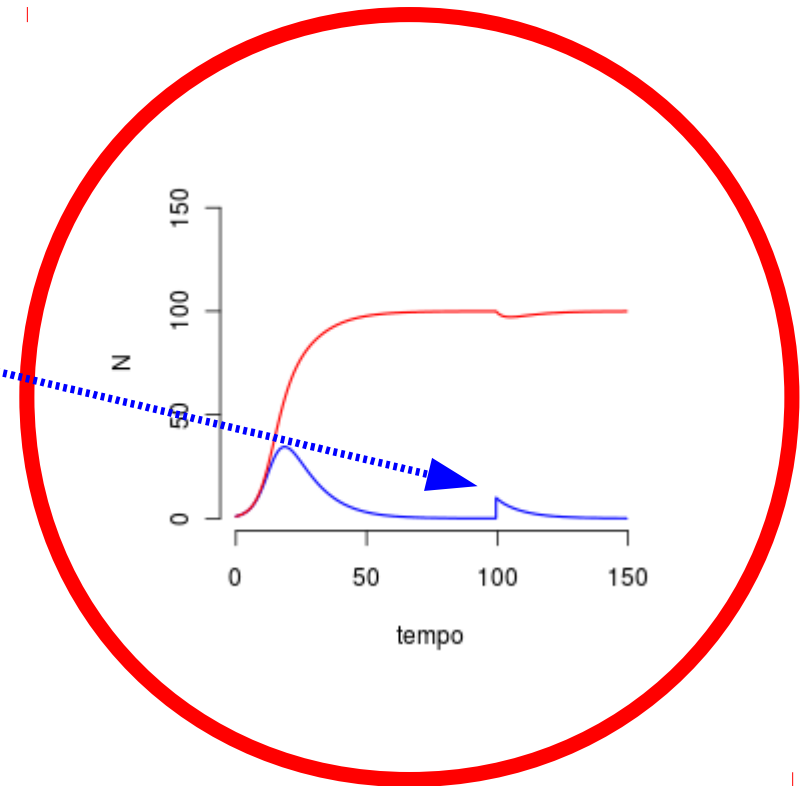
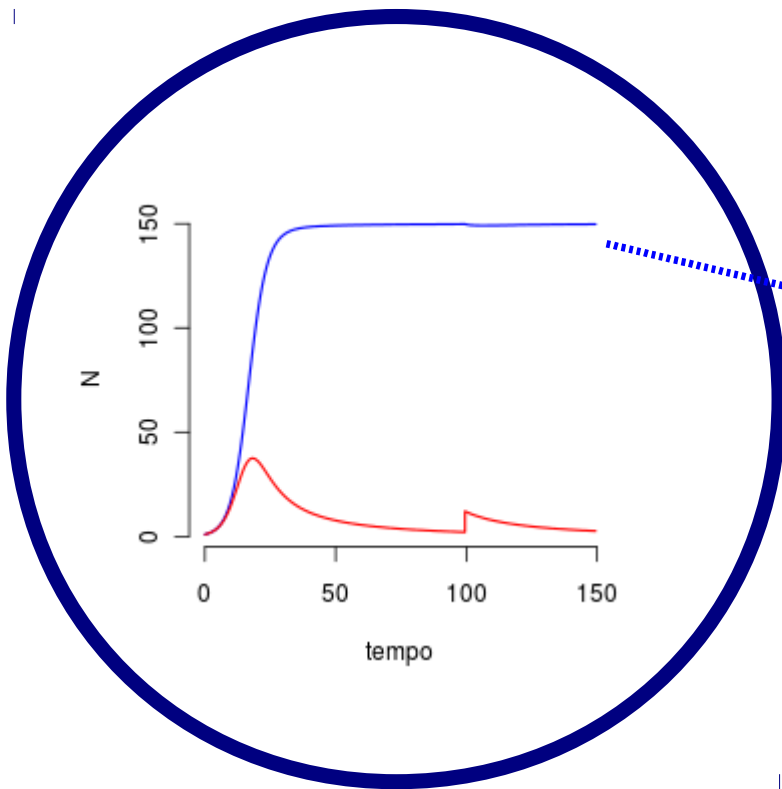


Amarasekare 2000, Biol J Linn Soc

Teorema da perturbação

Mancha 1

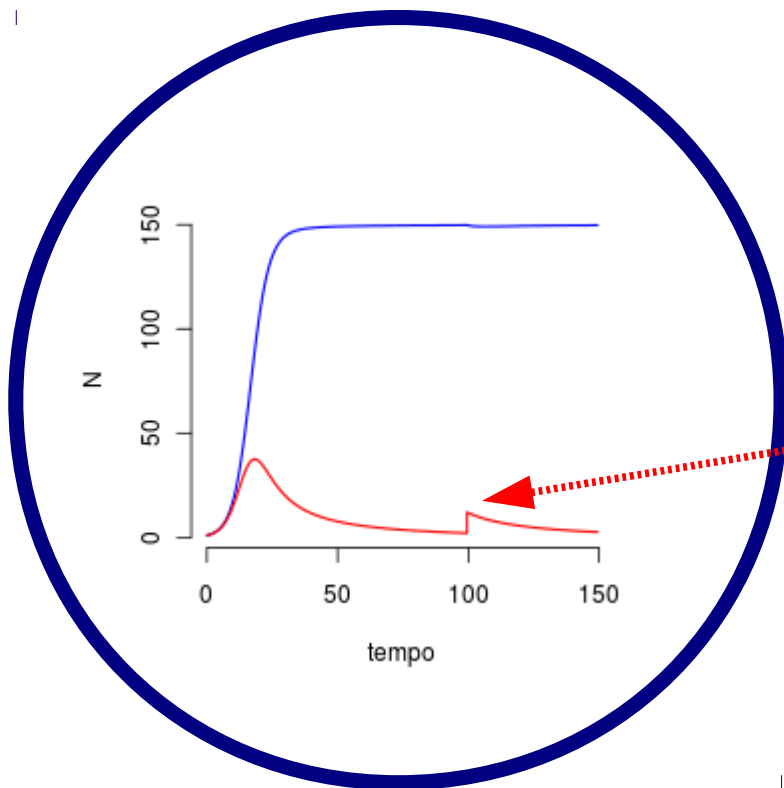
Mancha 2



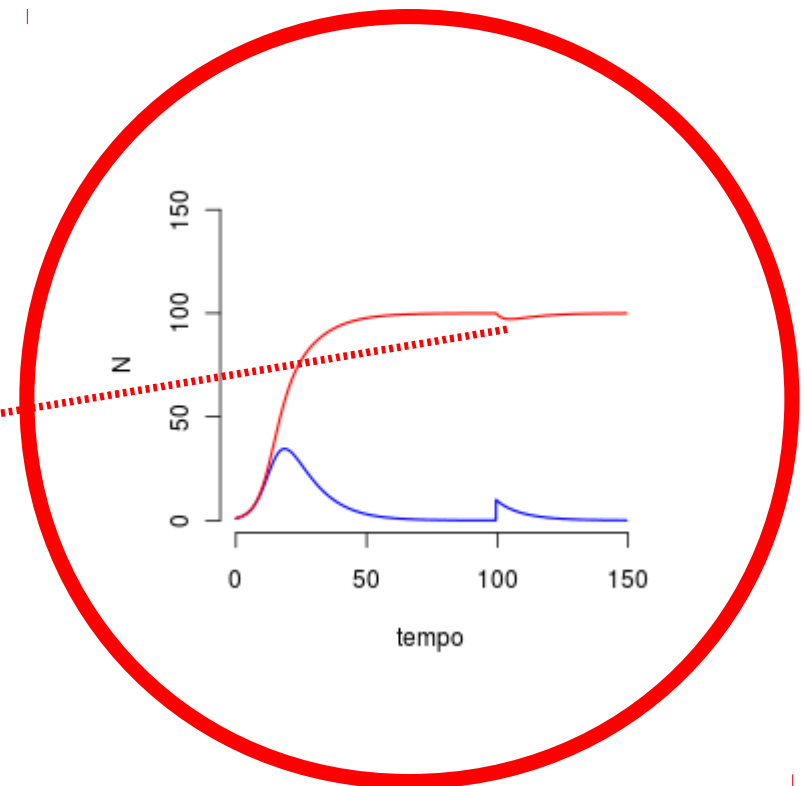
Amarasekare 2000, Biol J Linn Soc

Teorema da perturbação

Mancha 1

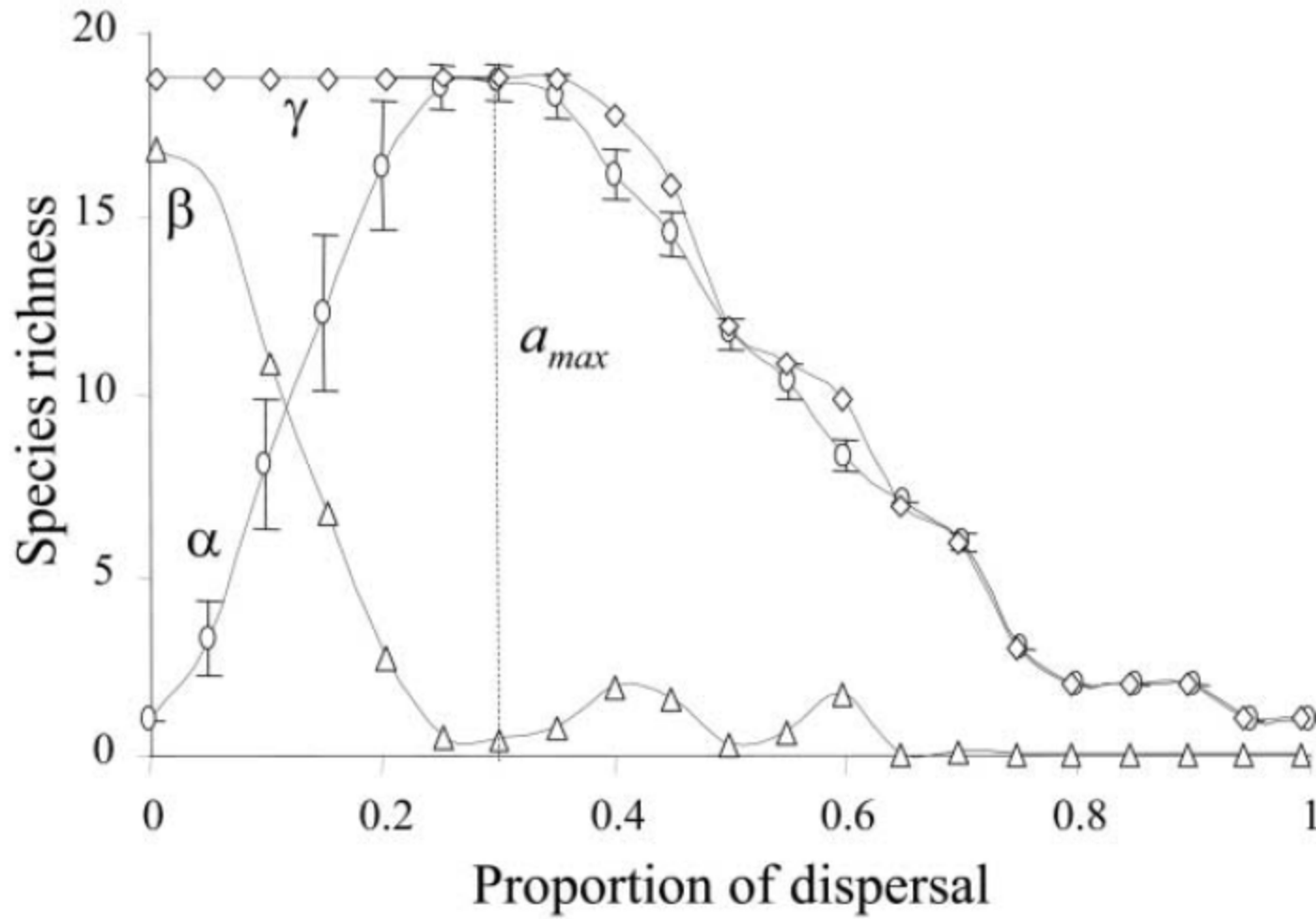


Mancha 2

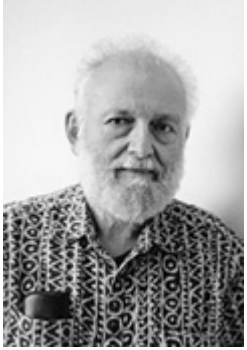


Amarasekare 2000, Biol J Linn Soc

Mass-effects



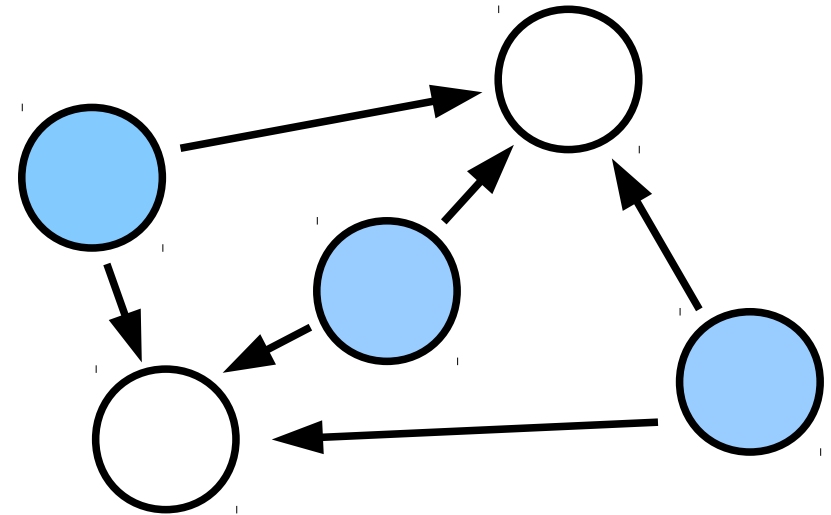
Mouquet & Loureau 2003 Am. Nat.



Metapopulações

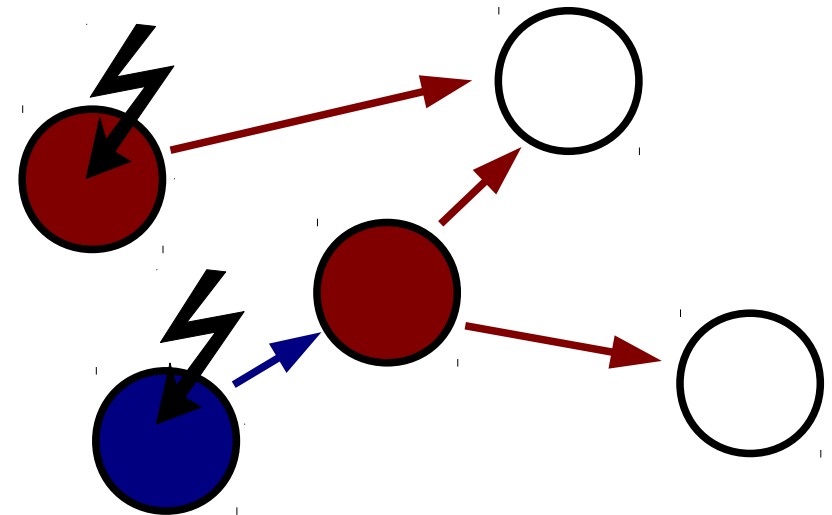
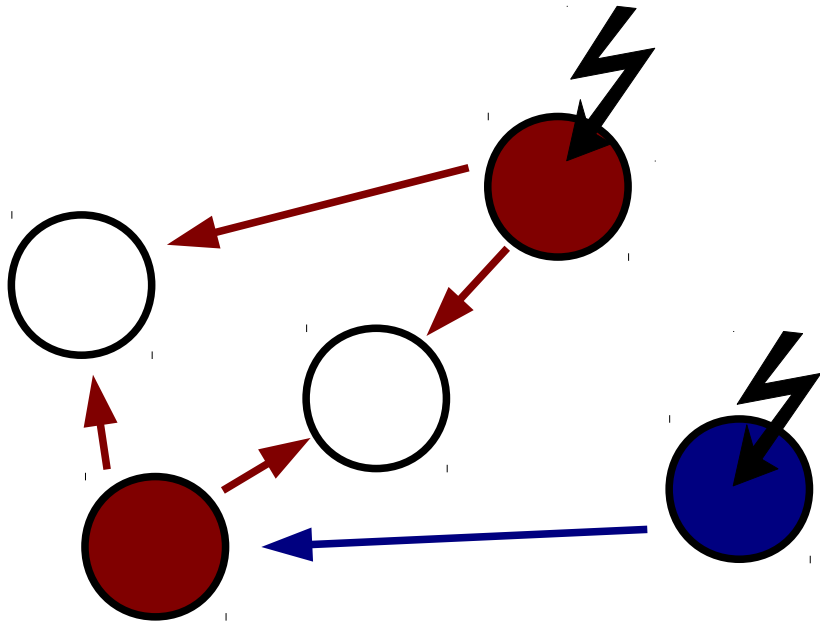
$$\frac{df}{dt} = i f (1 - f) - p_e f$$

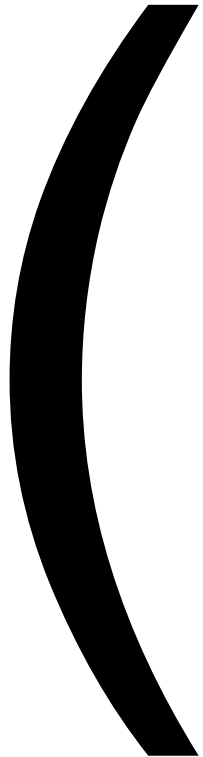
$$\hat{f} = 1 - \frac{p_e}{i}$$



- Infinitas manchas iguais
- Populações chegam a K imediatamente
- Colonização não afeta dinâmicas locais

Colonização x Competição



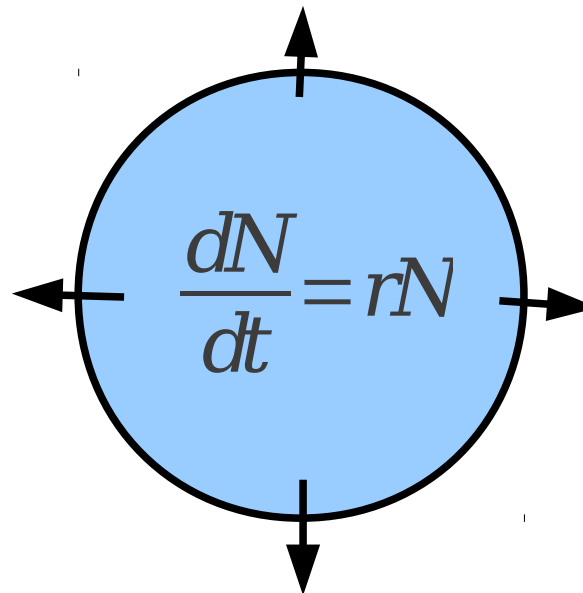


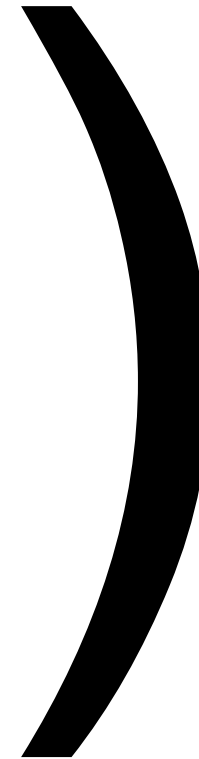
Espaço Explícito: Equações de Reação-difusão

RANDOM DISPERSAL IN THEORETICAL POPULATIONS

By J. G. SKELLAM

Biometrika, Vol. 38, No. 1/2 (Jun., 1951), pp. 196-218





O conceito de metacomunidades



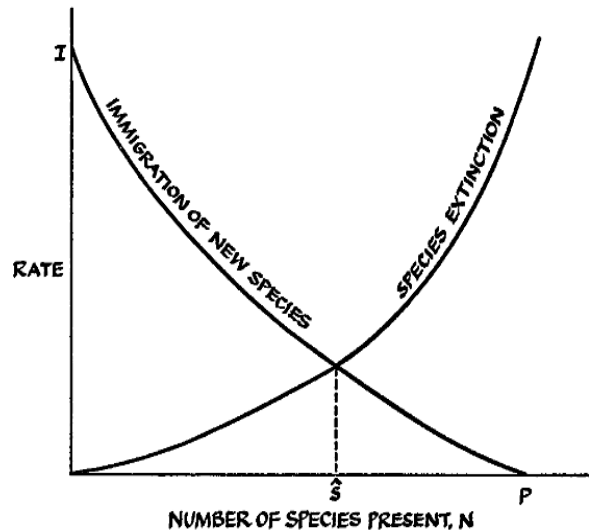
METACOMMUNITIES
Spatial Dynamics and Ecological Communities

EDITED BY
Marcel Holyoak, Mathew A. Leibold,
and Robert D. Holt

- Patch dynamics
- Mass effects
- Species sorting
- Neutral dynamics

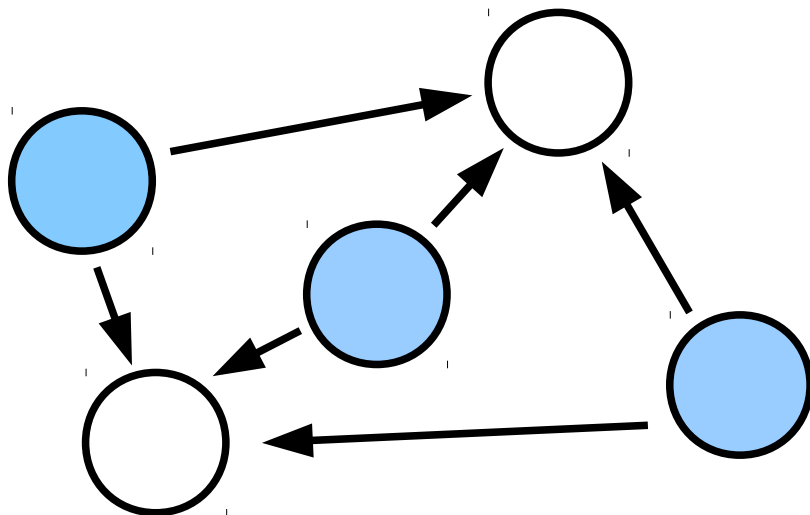
Veja também Leibold 2011
In: Scheiner & Willig (Eds) Theory in Ecology.

O conceito de metacomunidades

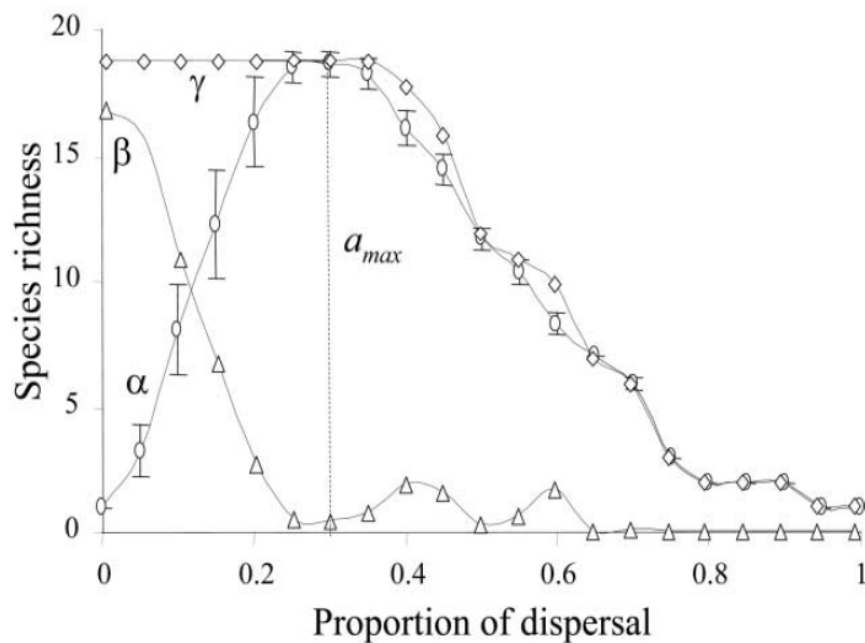


- Patch dynamics:

- balanço entre colonizações e extinções em manchas
- Ex: TBI, metapop



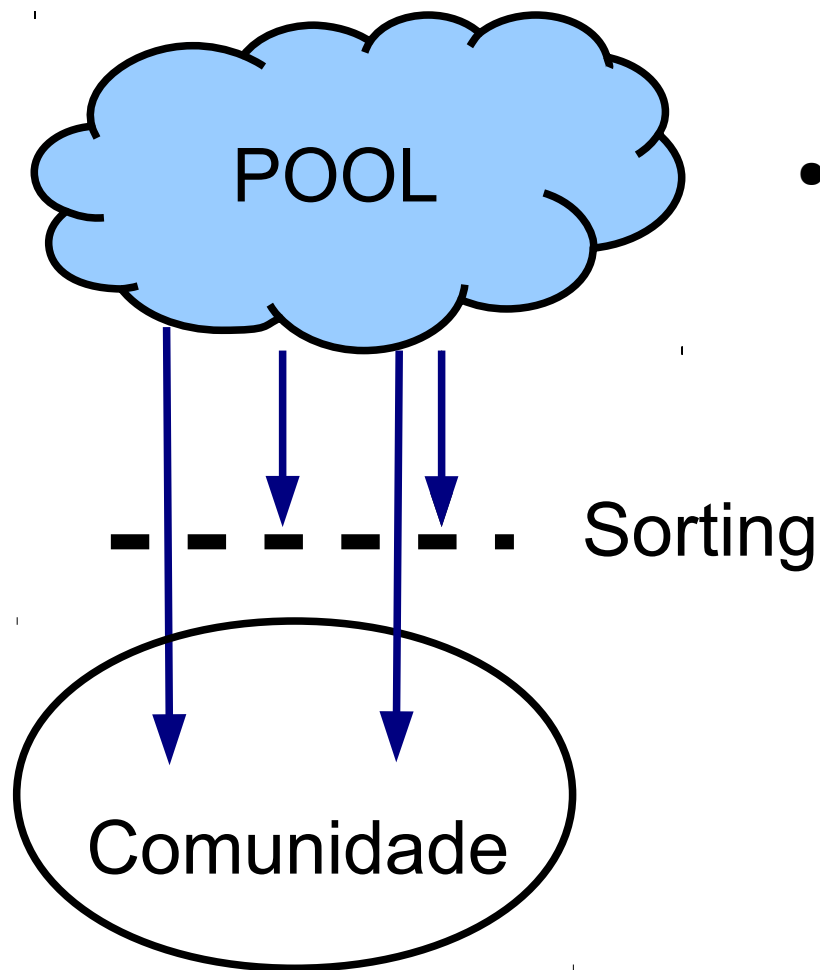
O conceito de metacomunidades



Mass effects:

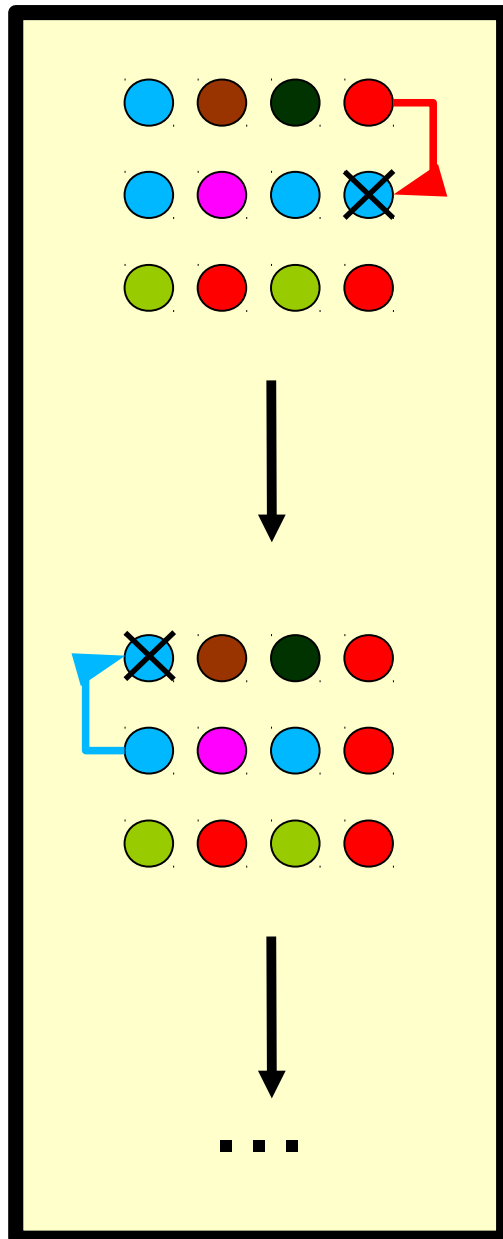
- Migração na mesma escala de tempo da demografia local mantendo dinâmicas source-sink
- Ex: teorema da perturbação

O conceito de metacomunidades



- Species sorting:
 - Migração provê colonizadores, alguns dos quais capazes de se estabelecer nas condições locais.
 - Ex: filtros ambientais, gradientes, modelos de distribuição potencial.

O conceito de metacomunidades



- Neutral dynamics:
 - Equivalência demográfica implica em deriva nas abundâncias e composições
 - Ex: UNTB

Mesmas perguntas, outras respostas

- Riqueza
 - Balanço entre migração e extinção
 - Balanço entre migração e filtros ambientais

Mesmas perguntas, outras respostas

- Composição
 - Equilíbrio dinâmico: sorteios contínuos de um mesmo pool (deriva, metapopulações)
 - Equilíbrio determinístico: source-sink, saturação de comunidades

Mesmas perguntas, outras respostas

- Abundância
 - Balanço entre dinâmica local e influxo de migrantes.
 - Deriva nas abundâncias locais.