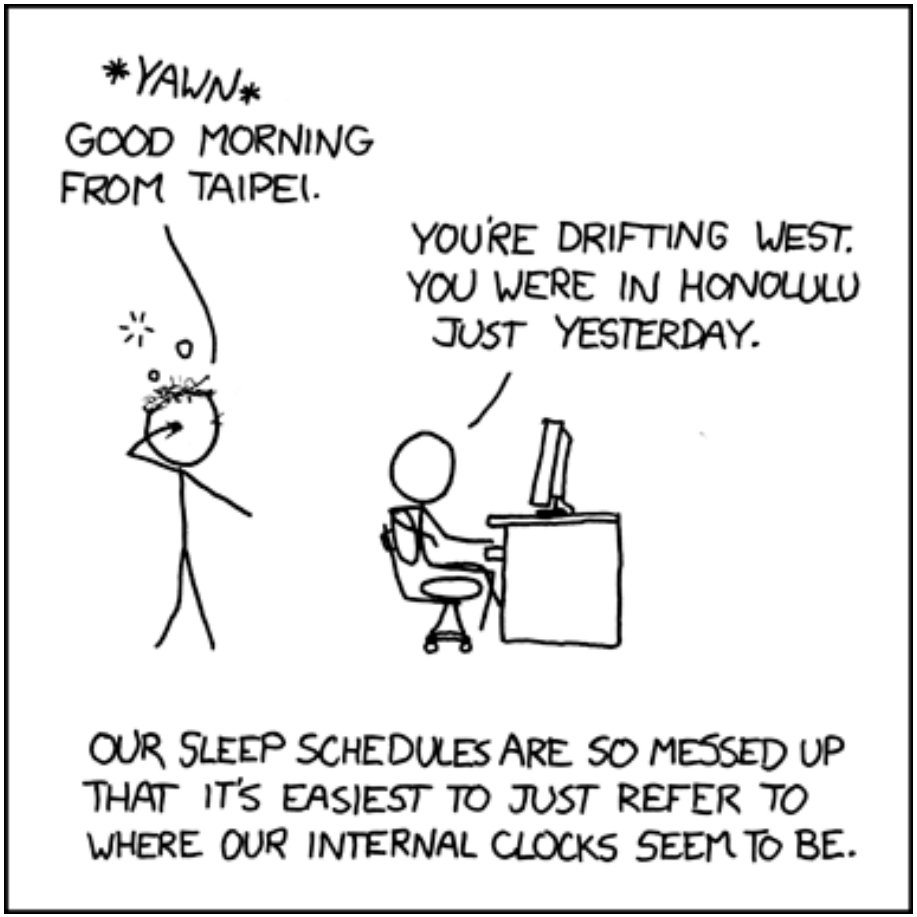
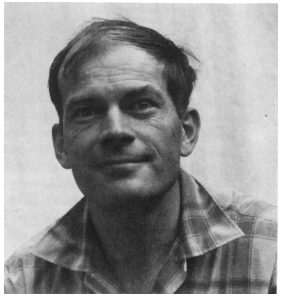
Deriva e Dispersão



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?

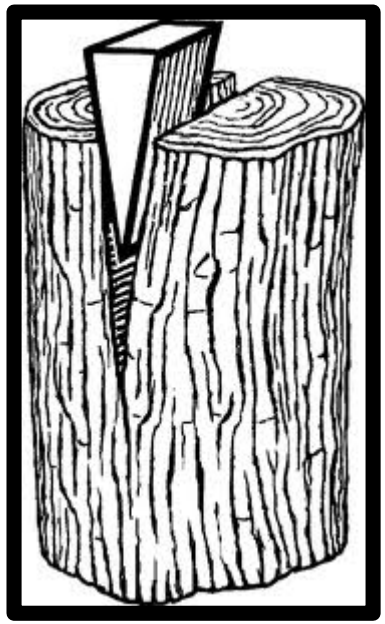
Respostas: Nicho



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

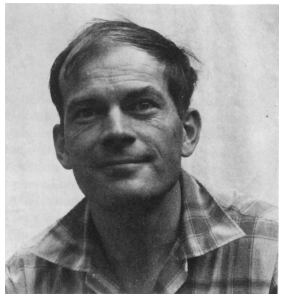
As cunhas de Darwin

"*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: (...)*"



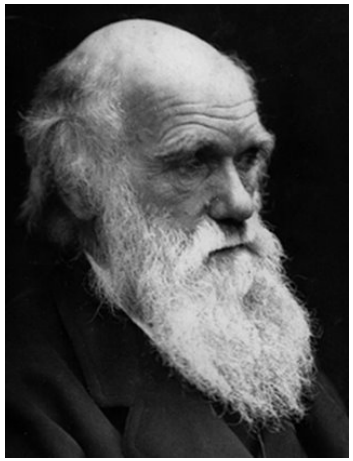
Lotka

Volterra



MacArthur

Hutchinson

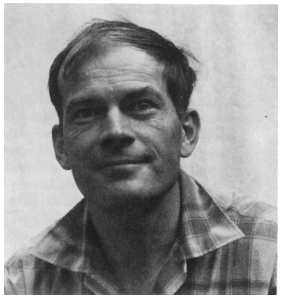


http://edhui.wordpress.com/2009/02/07/darwin/

Matemática de sistemas dinâmicos

$$\frac{dN_1}{dt} = rN_1\frac{K_1 - N_1 - \alpha N_2}{K_1}$$

Velocidade



Robert MacArthur
1930-1972

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.

Robert Whittaker
1920-1980

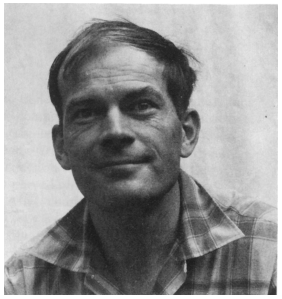
"Articles by Hutchinson (1957) and MacArthur (1957) offered promise of a new area of a different kind of ecology, one of **an orderly, formal system of mathematical relationships** by which diversities and the importance-value relations of species should become **predictable**."

Whittaker (1972) Evolution and measurement of species diversity. Taxon, 213-251.

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 essses 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.*"



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.

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

THE THEORY OF

Island Biogeography

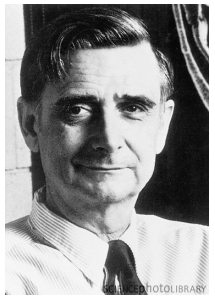
ROBERT H. MAC ARTHUR AND

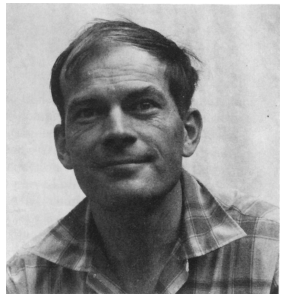
EDWARD O. WILSON

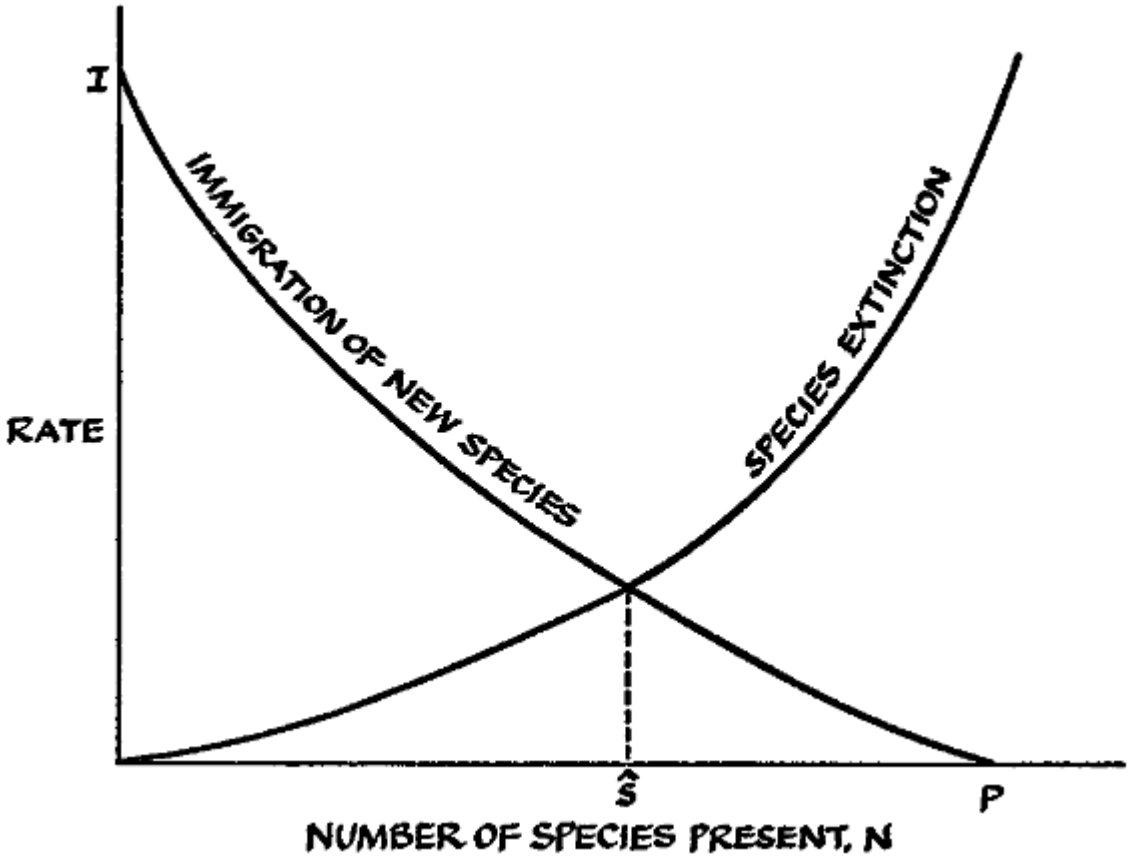
PRINCETON, NEW JERSEY

PRINCETON UNIVERSITY PRESS

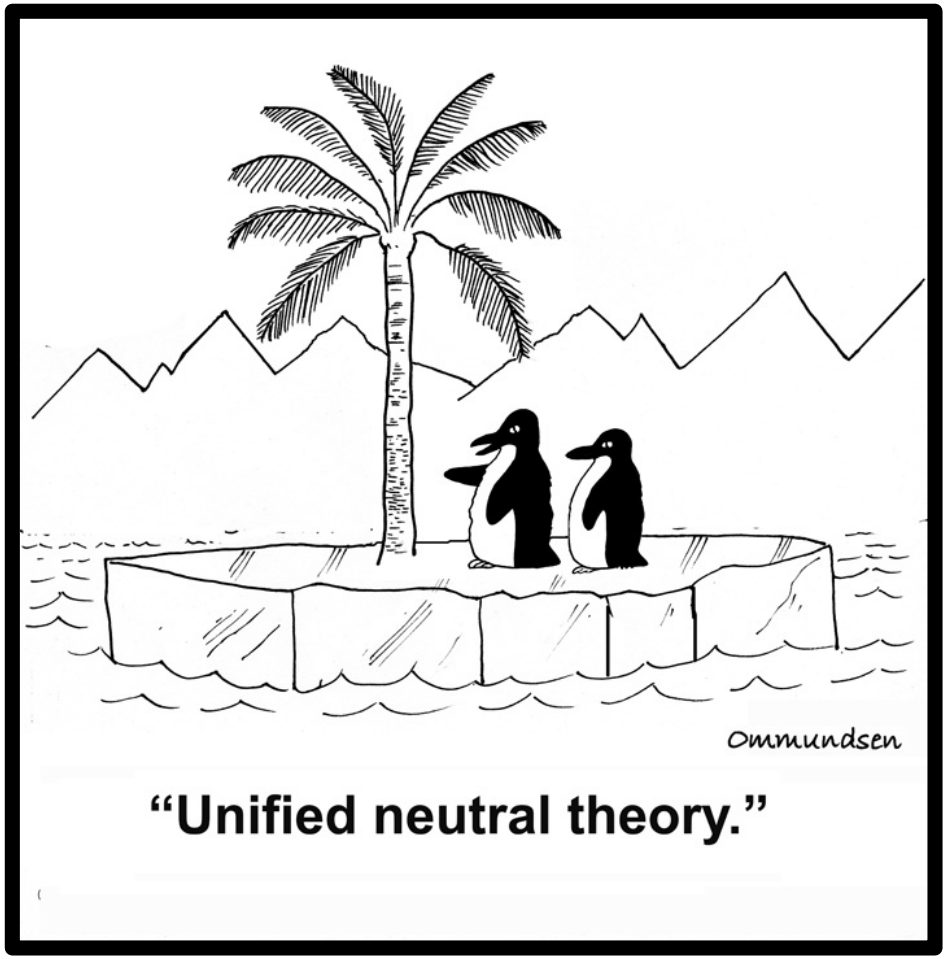
1967





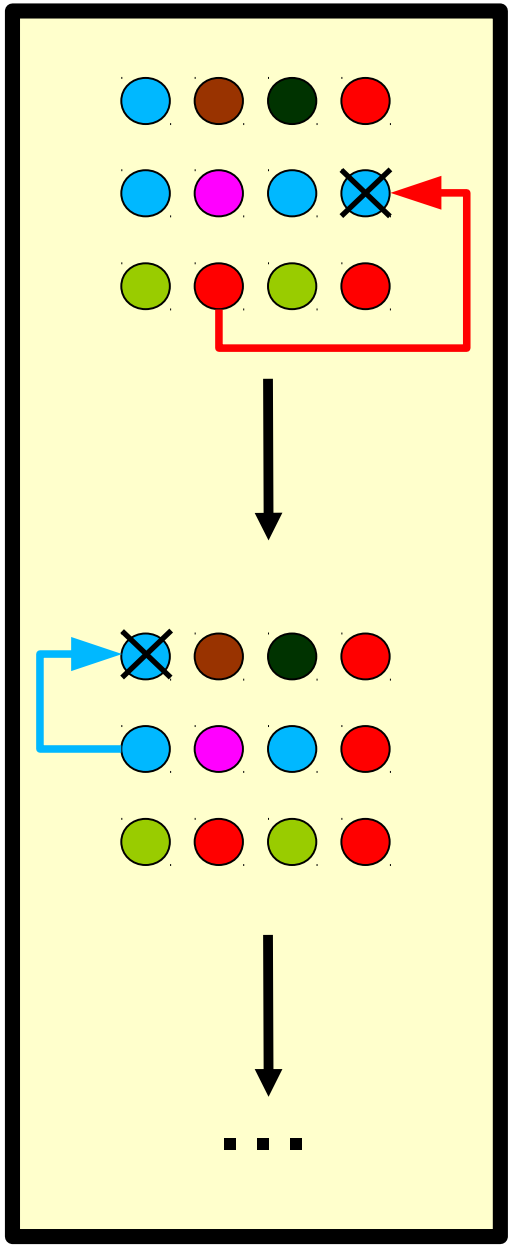


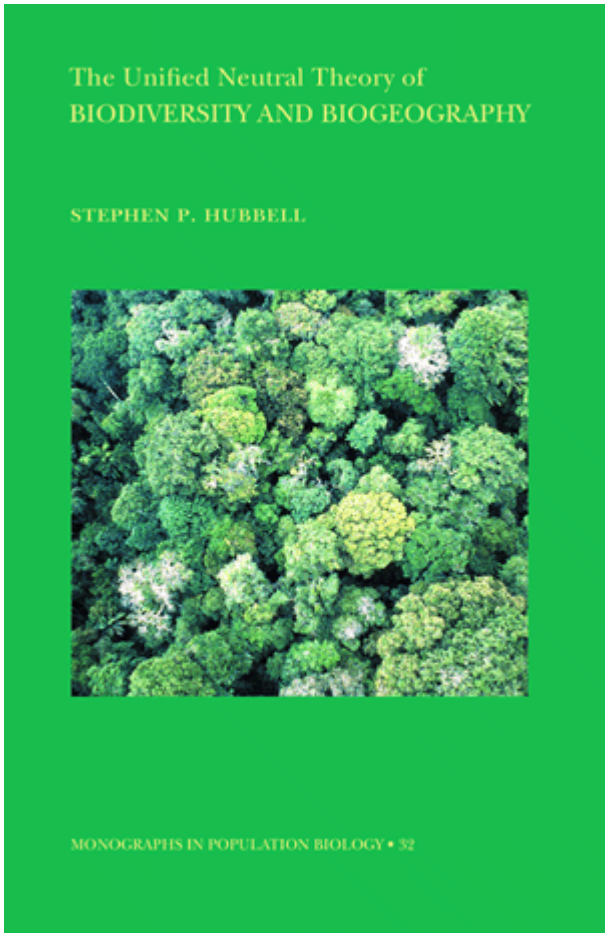
Efeitos da deriva:
as coisas mais estranhas são por acaso

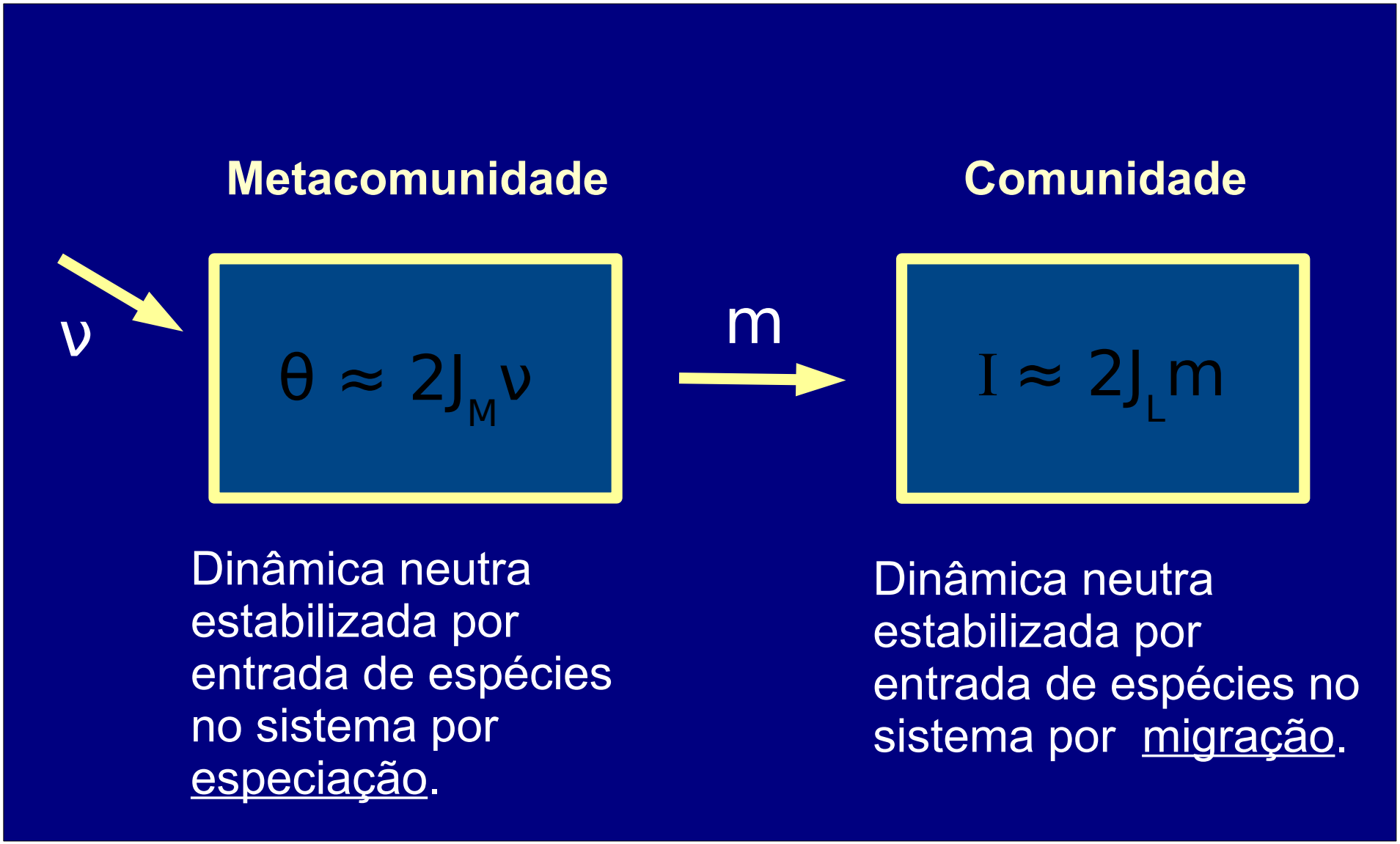


UNTB

- Neutralidade
- Estocasticidade






Metacomunidade
Comunidade
ν
θ ≈ 2J_M ν
m
I ≈ 2J_L m
Dinâmica neutra estabilizada por entrada de espécies no sistema por especiação.
Dinâmica neutra estabilizada por entrada de espécies no sistema por migração.

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

Alonso et al 2004

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

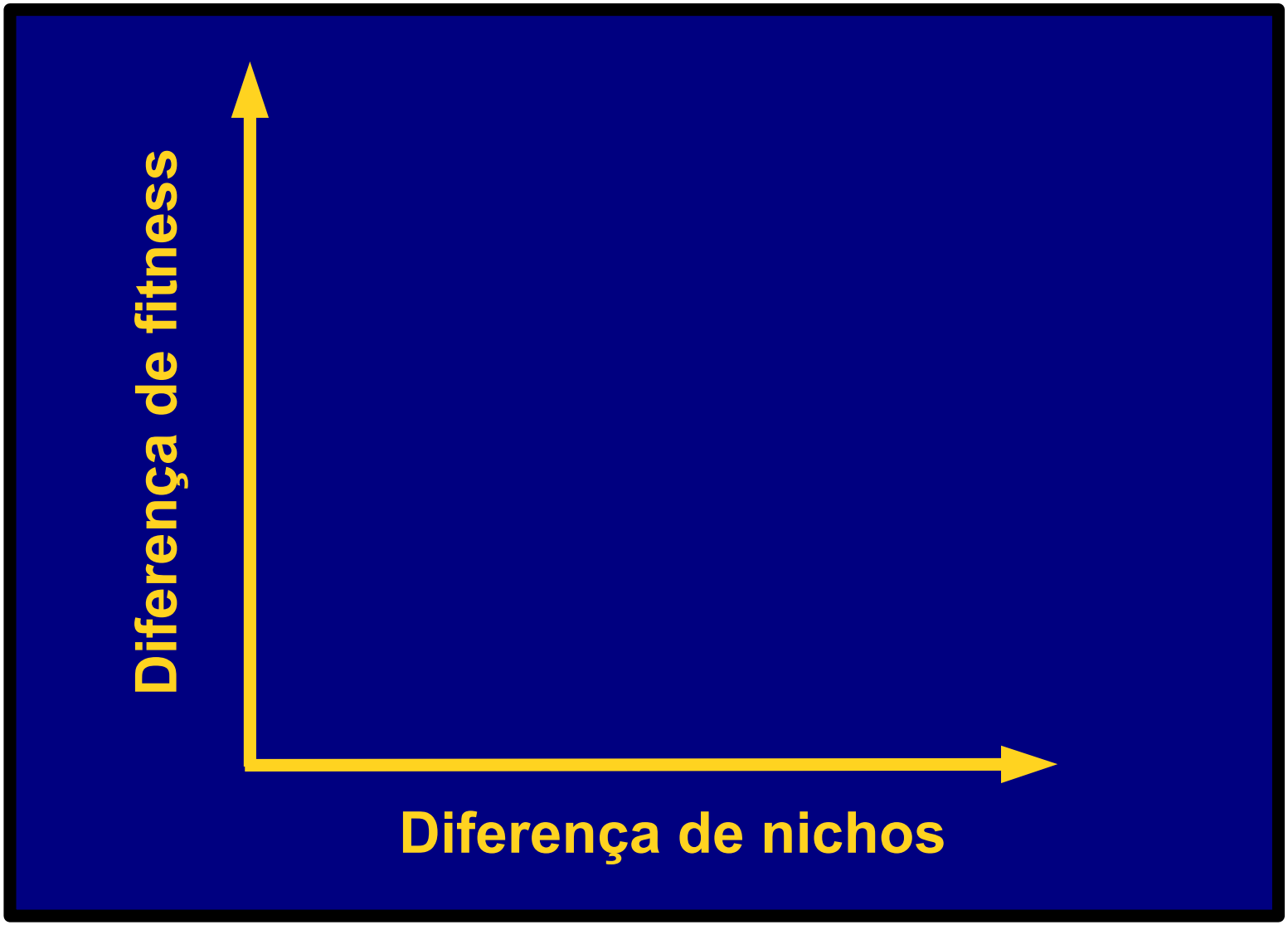
Finally, if my chief conclusion is correct, and if the neutral or nearly neutral mutation is being produced in each generation at a much higher rate than has been considered before, then we must recognize the great importance of random genetic drift due to finite population number[23] in forming the genetic structure of biological populations. The significance of random genetic drift has

Motoo Kimura
1924 - 1994

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

Teoria moderna da coexistência

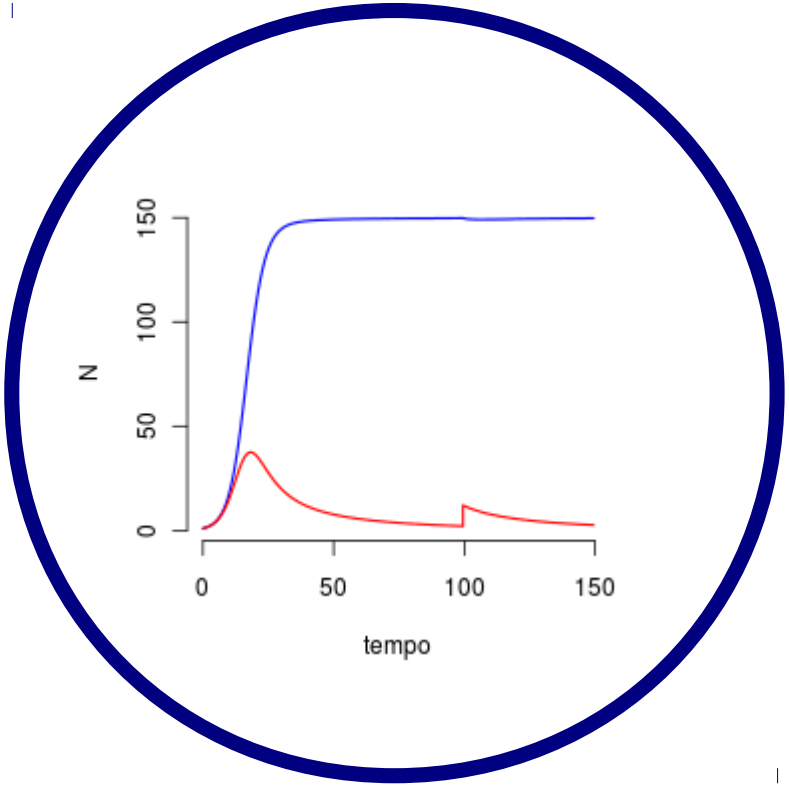


Adler et al. 2007 Ecol. Letters

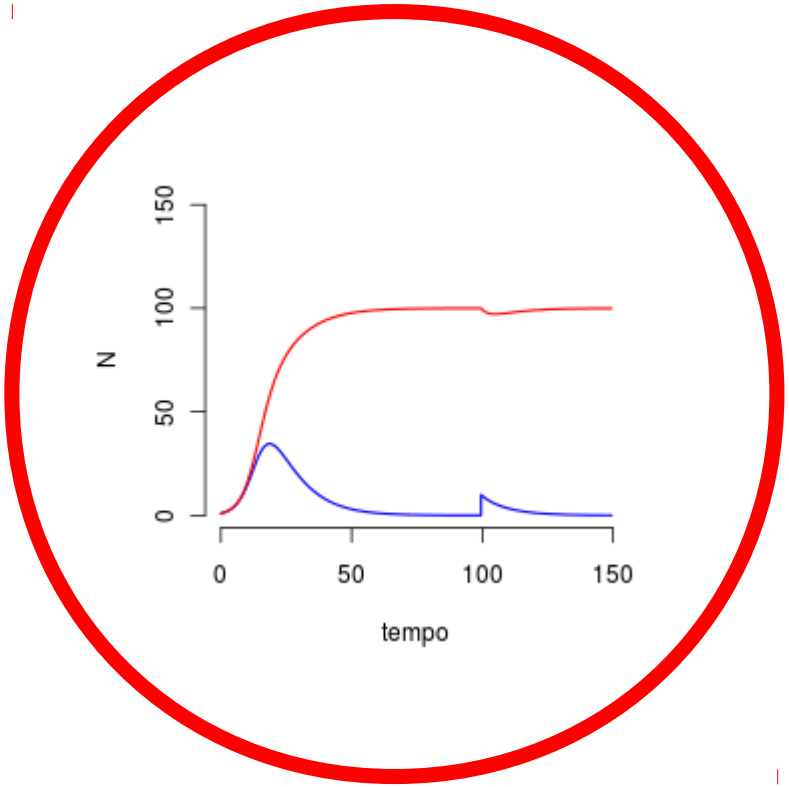
Dispersão:
no espaço as coisas são diferentes

Teorema da perturbação

Mancha 1



Mancha 2

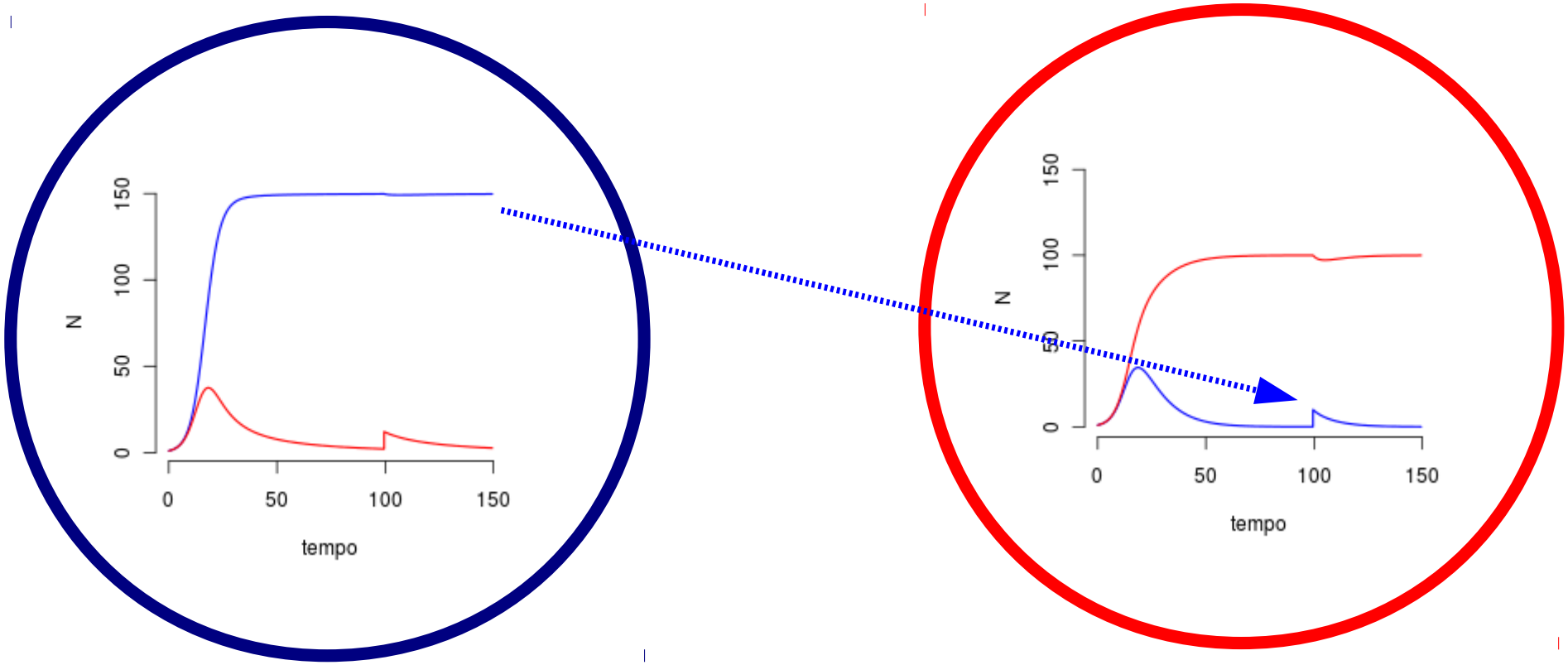


Amarasekare 2000, Biol J Linn Soc

Teorema da perturbação

Mancha 1

Mancha 2

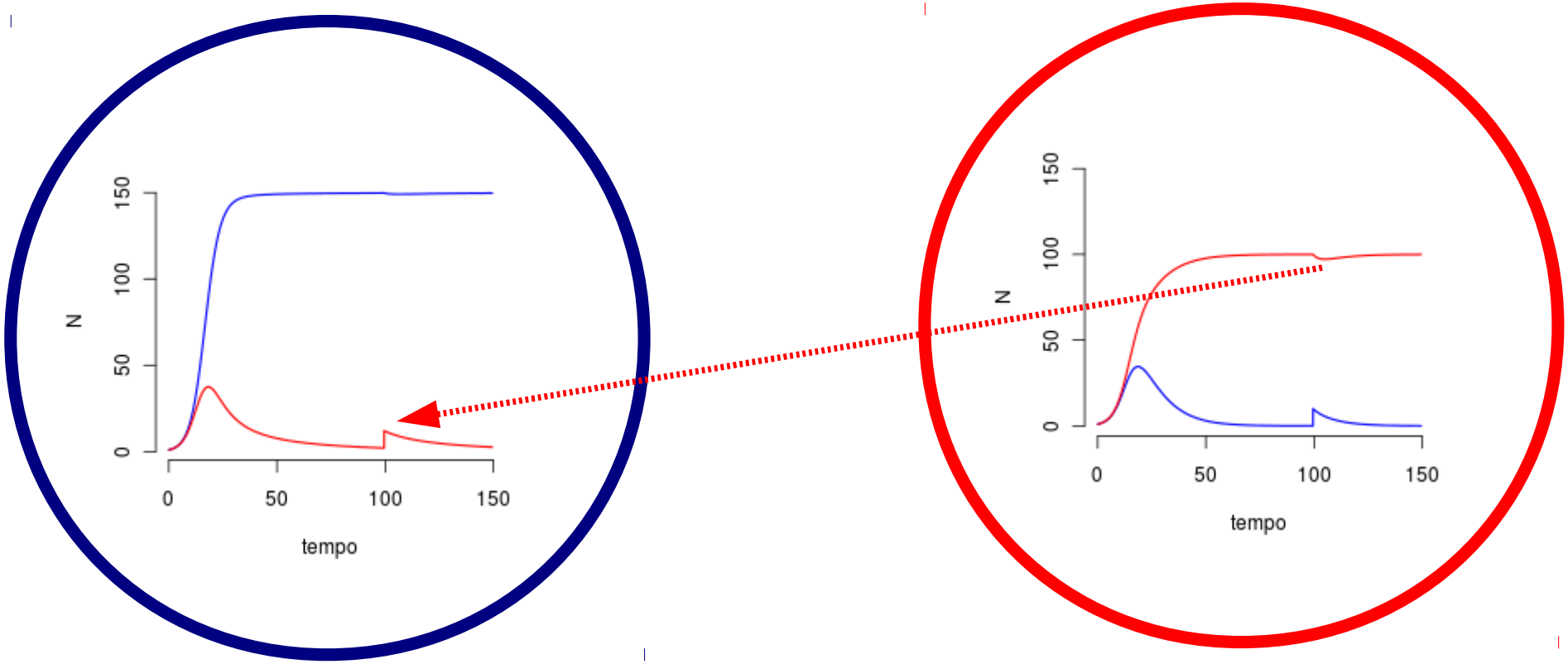


Amarasekare 2000, Biol J Linn Soc

Teorema da perturbação

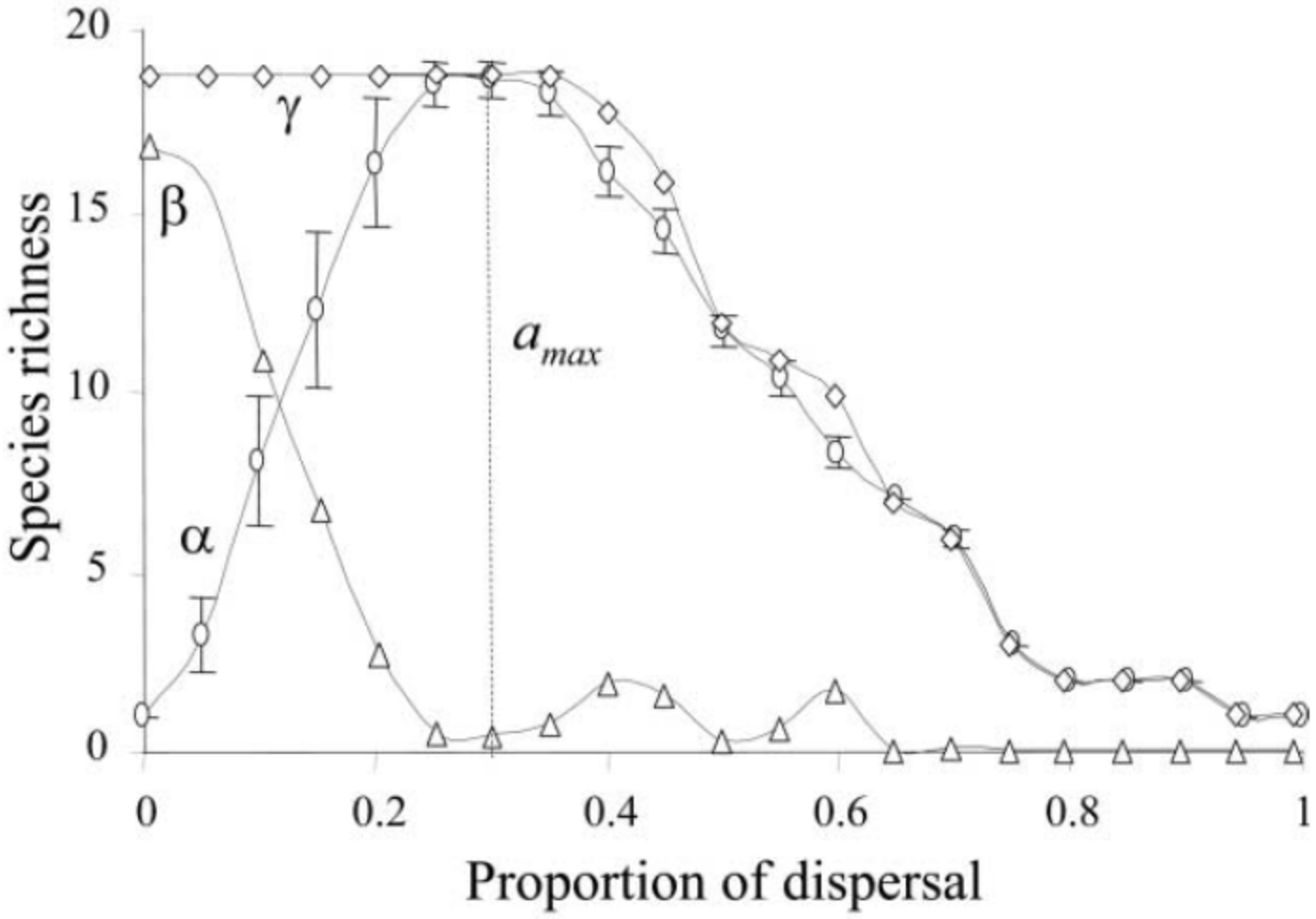
Mancha 1

Mancha 2



Amarasekare 2000, Biol J Linn Soc

Mass-effects



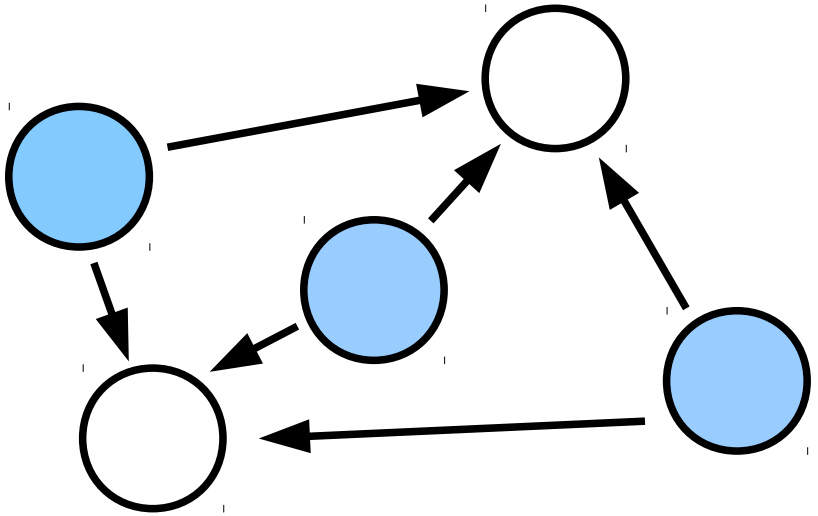
Mouquet & Loureau 2003 Am. Nat.

Richard Levins
1930 - 2016

Metapopulações

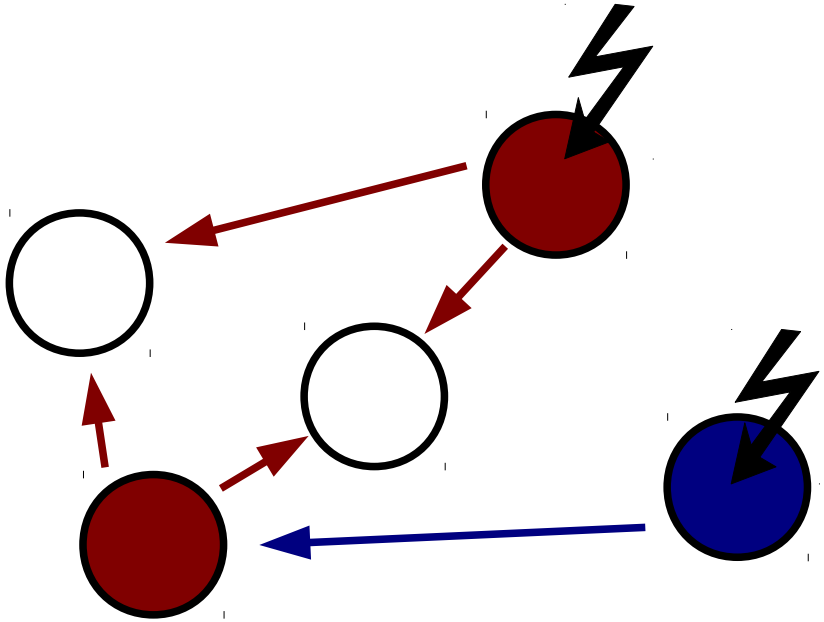
$$\frac{df}{dt} = i f(1-f) - p_e f$$

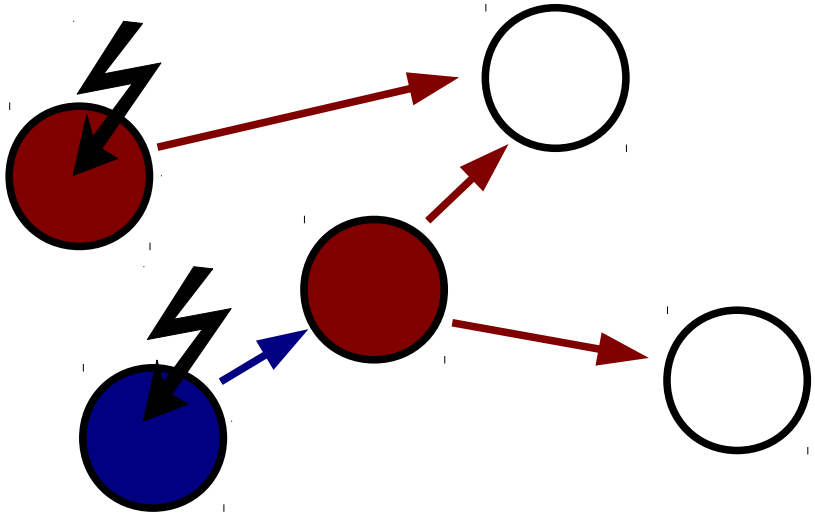
$$\hat{f} = 1 - \frac{p_e}{i}$$



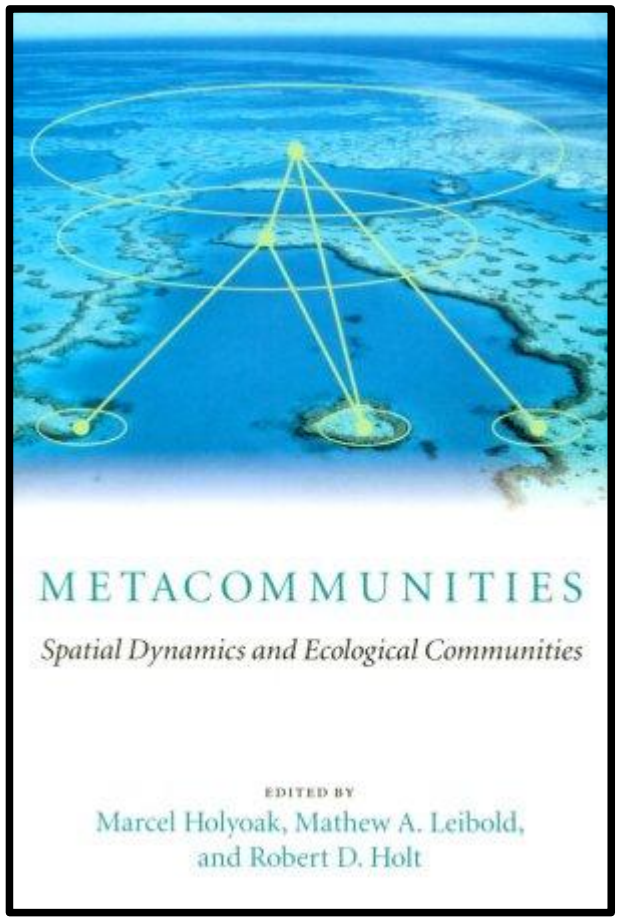
- Infinitas manchas iguais
- Populações chegam a K imediatamente
- Colonização não afeta dinâmicas locais

Colonização x Competição





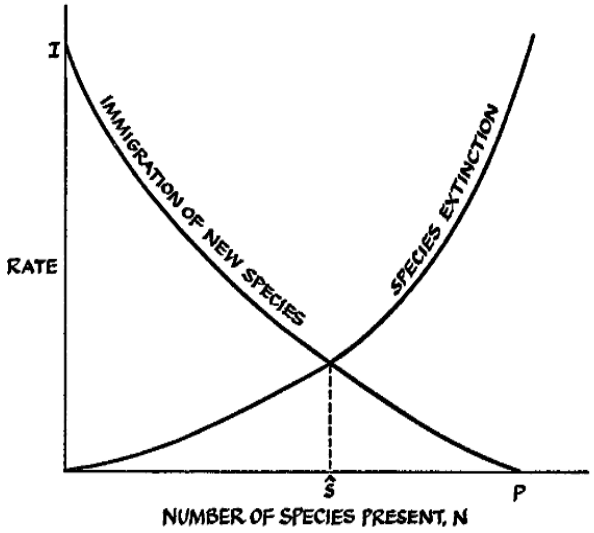
O conceito de metacomunidades

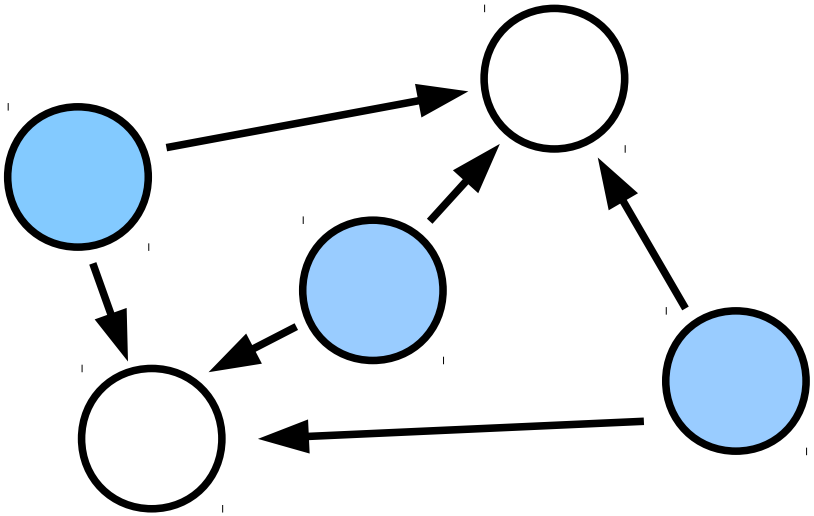


- Patch dynamics
- Mass effects
- Species sorting
- Neutral dynamics

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

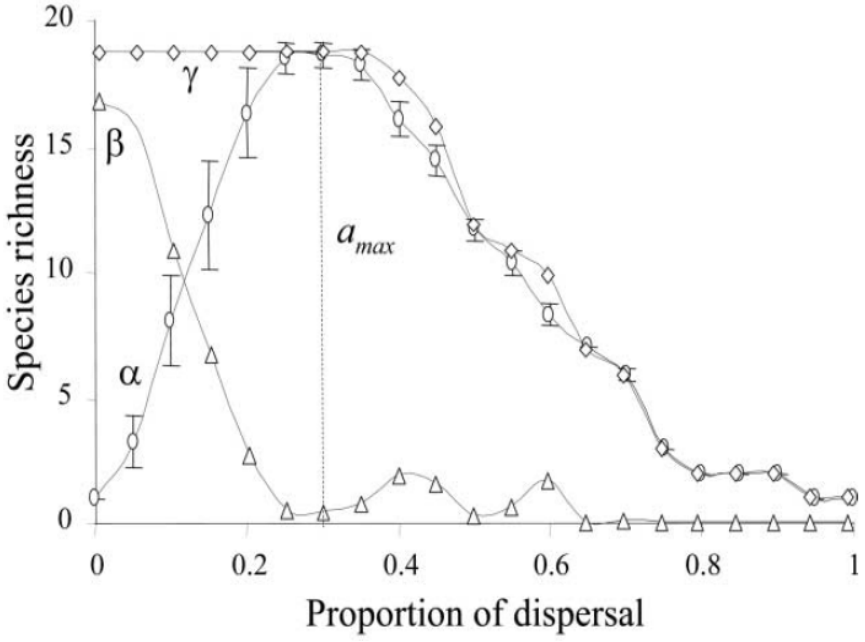
O conceito de metacomunidades





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

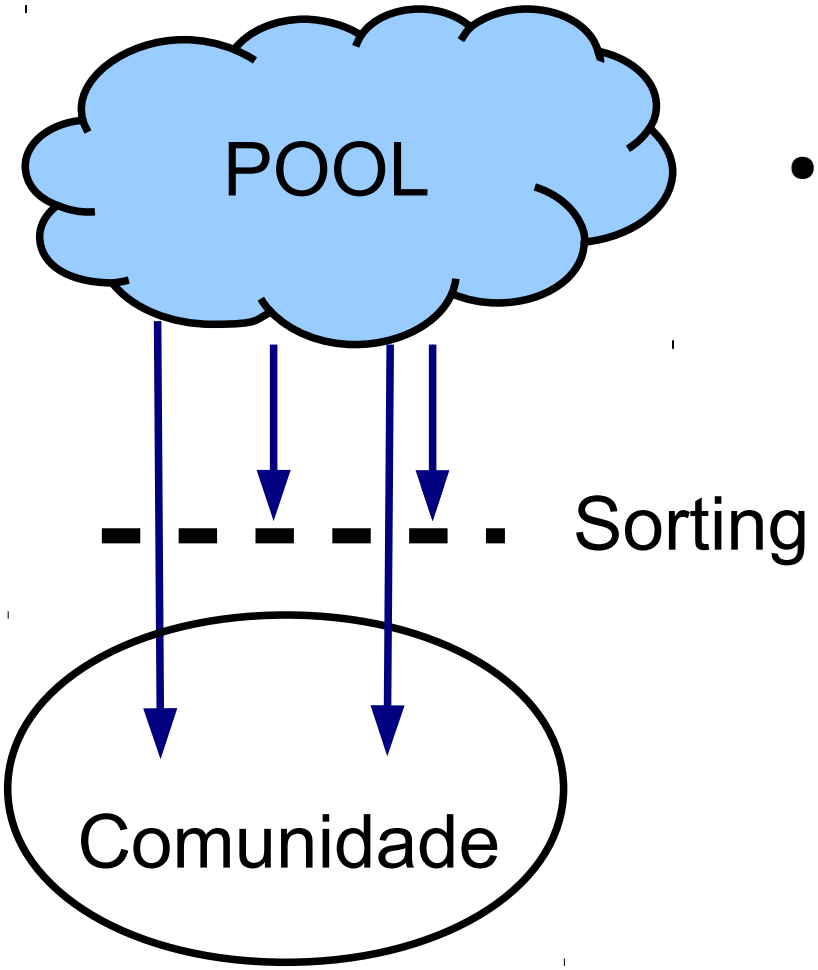
O conceito de metacomunidades



Mass effects:

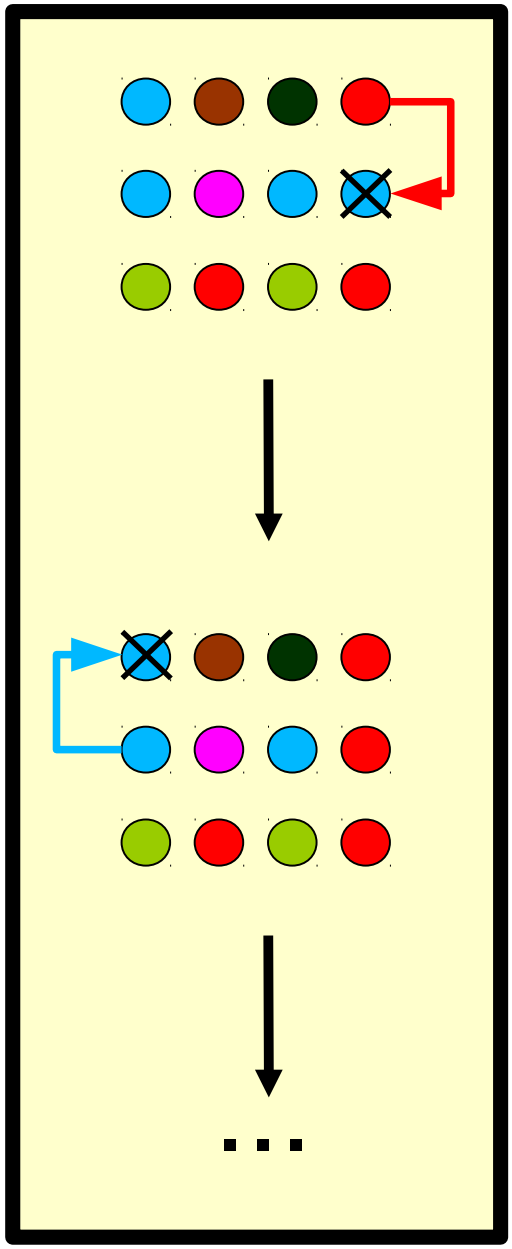
- Migração na mesma escala de tempo da demografia local mantendo dinâmicas source-sink
- Ex: teorema da perturbação

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:
  - Comunidades governadas por limitação à dispersão e deriva
  - 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

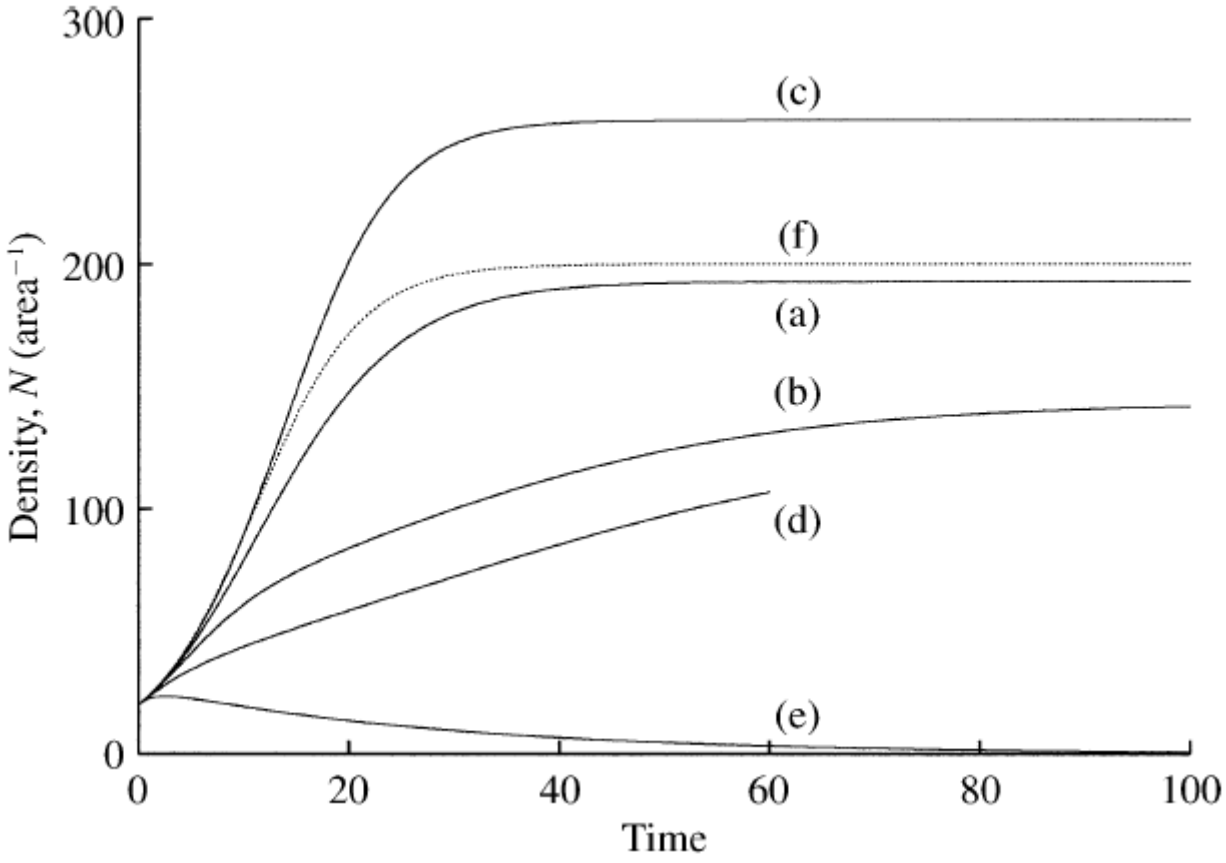
- Abundância
  - Balanço entre dinâmica local e influxo de migrantes.
  - Deriva nas abundâncias locais.

Espaço Explícito: Equações de Reação-difusão

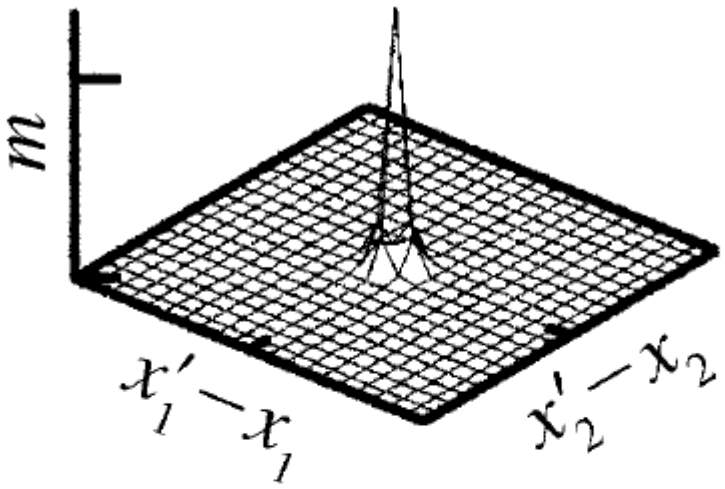
Ecology, 84(1), 2003, pp. 252–262

POPULATION GROWTH IN SPACE AND TIME: SPATIAL LOGISTIC EQUATIONS

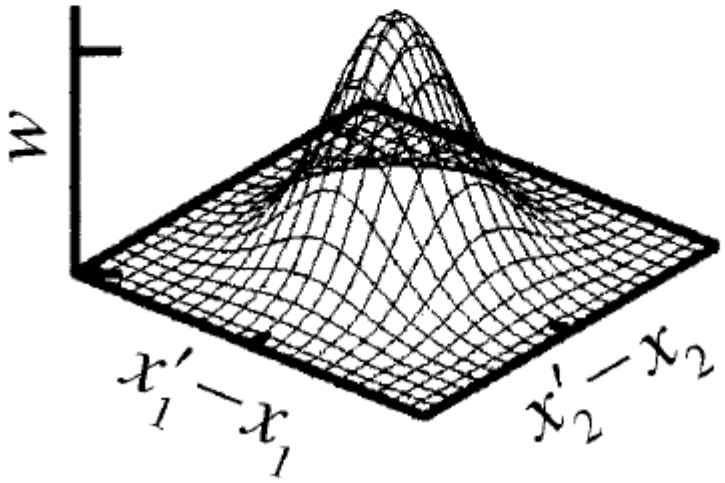
RICHARD LAW,[1,4] DAVID J. MURRELL,[2] AND ULF DIECKMANN[3]

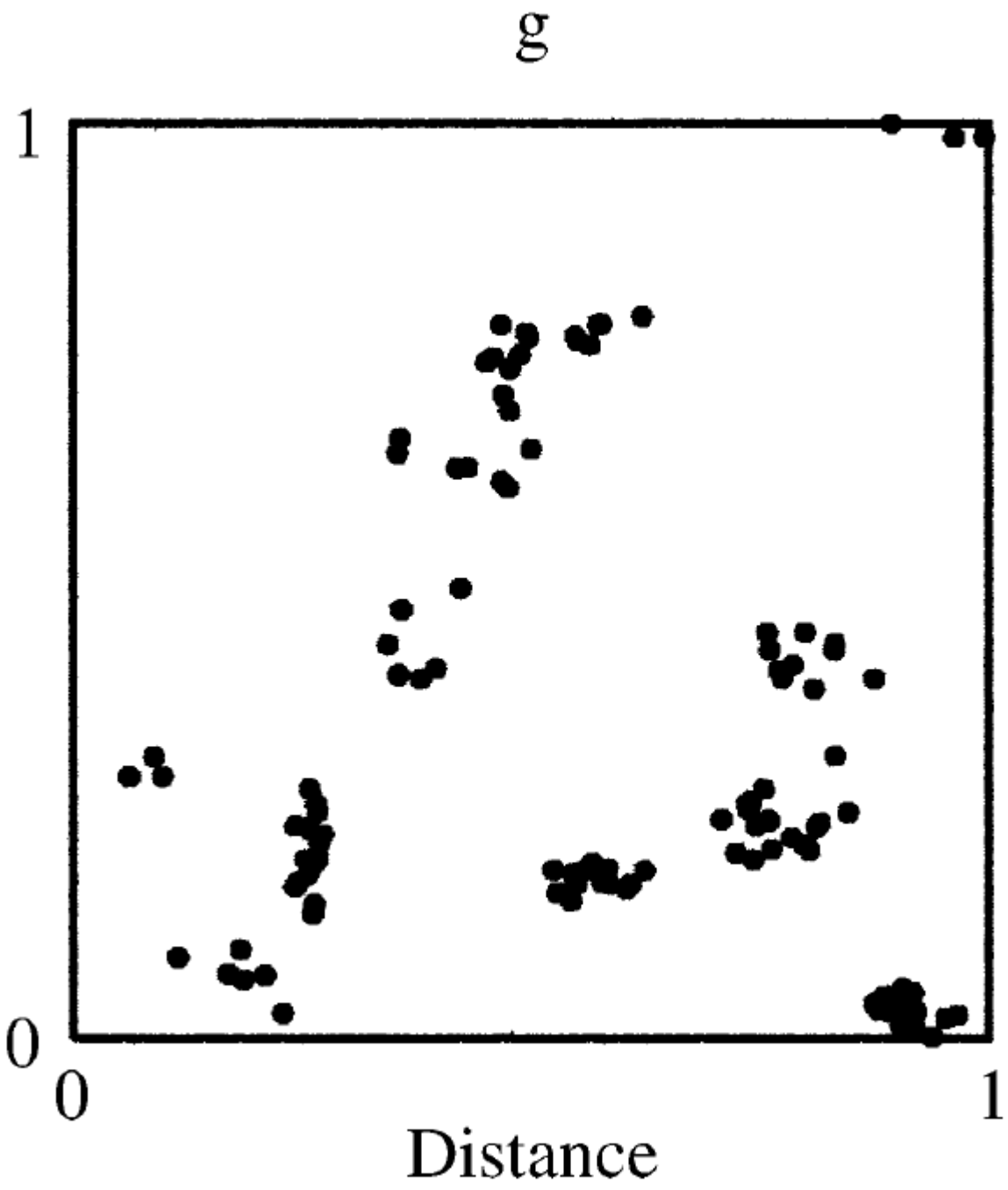


Dispersão

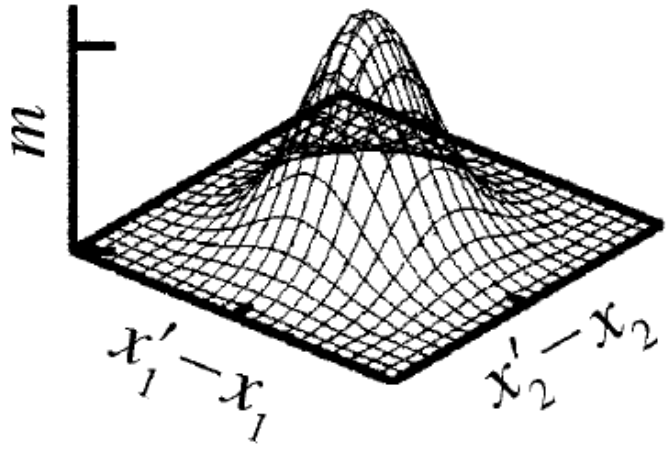


Competição

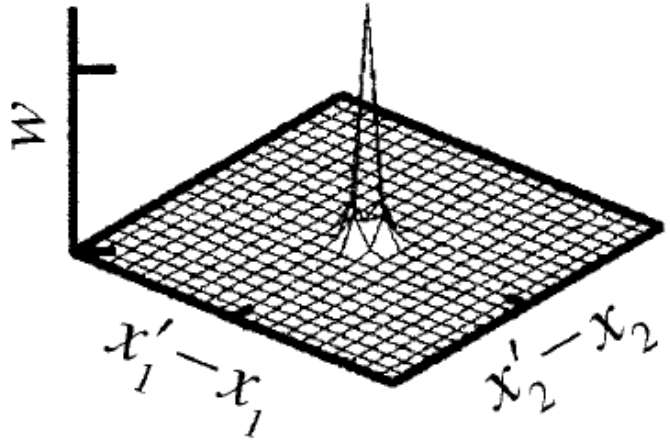


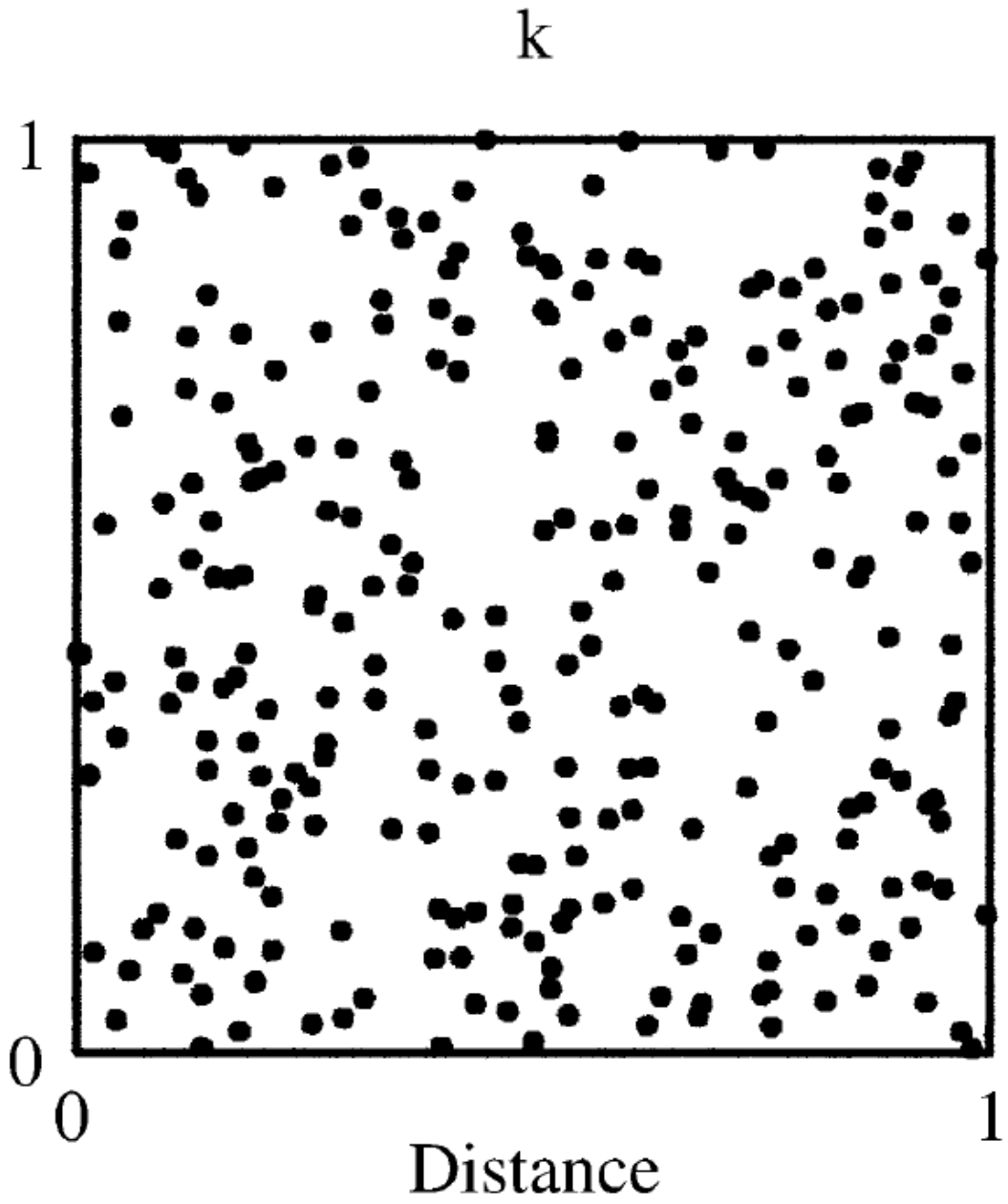


Dispersão



Competição

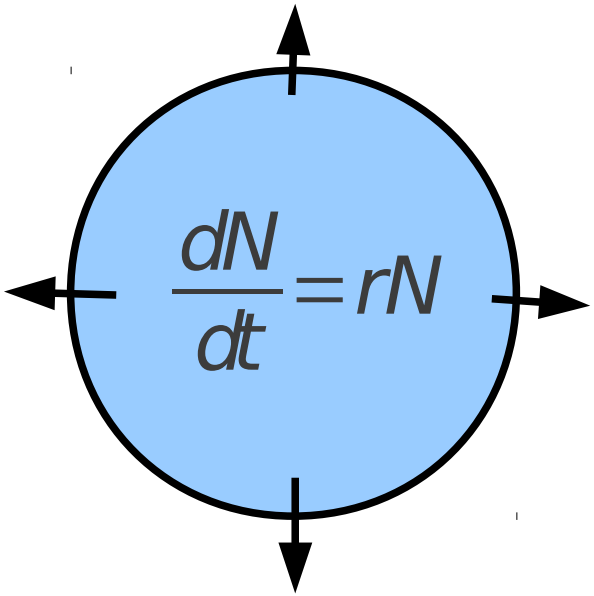




RANDOM DISPERSAL IN THEORETICAL POPULATIONS

By J. G. SKELLAM

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

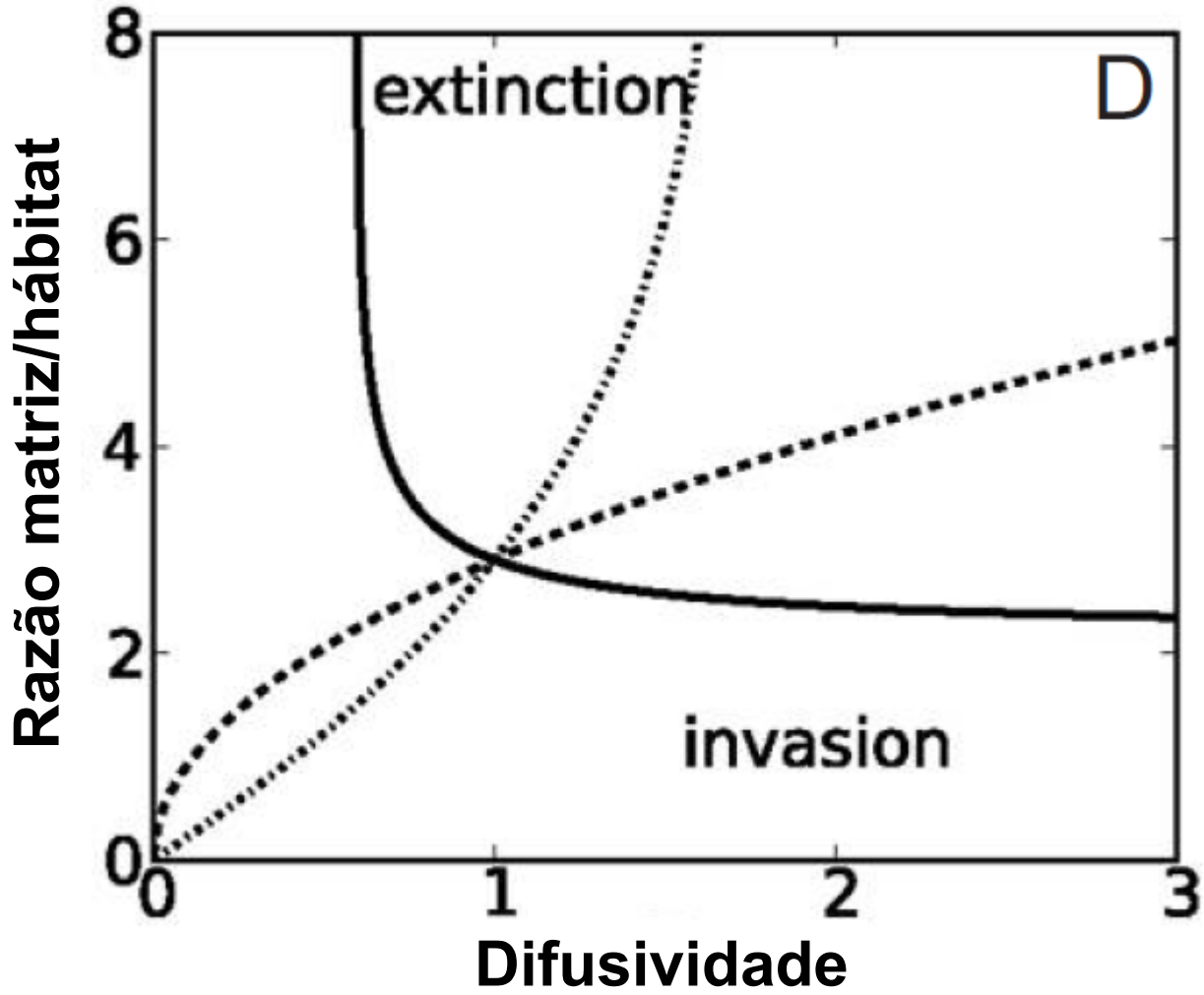


Raio crítico da área de hábitat

$$L = \pi\sqrt{\frac{D}{r}}$$

How Individual Movement Response to Habitat Edges Affects Population Persistence and Spatial Spread

Gabriel Andreguetto Maciel[1] and Frithjof Lutscher



American Naturalist 2013