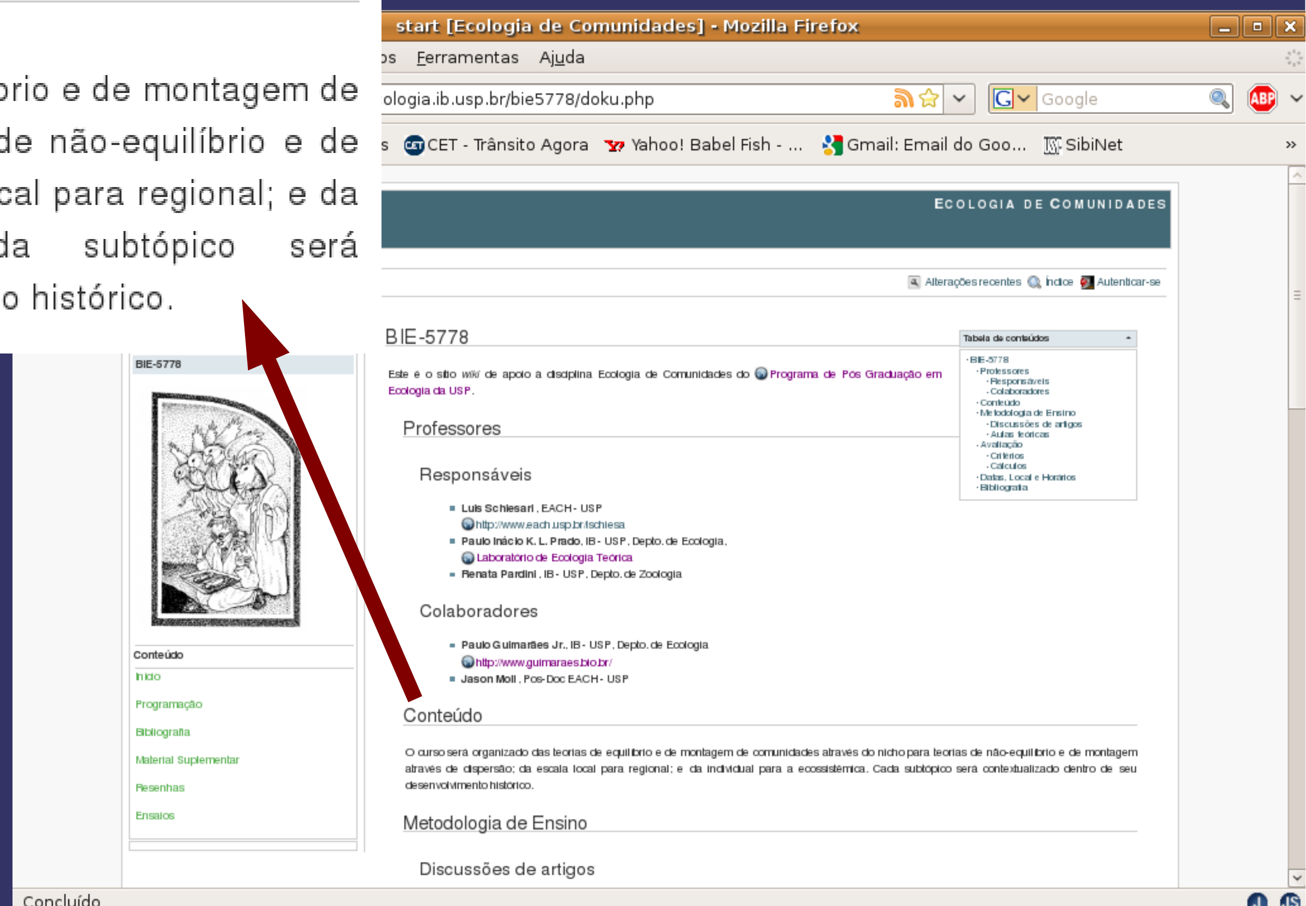
Escalas Locais e Regionais em Ecologia de Comunidades

A história oficial e algumas reflexões

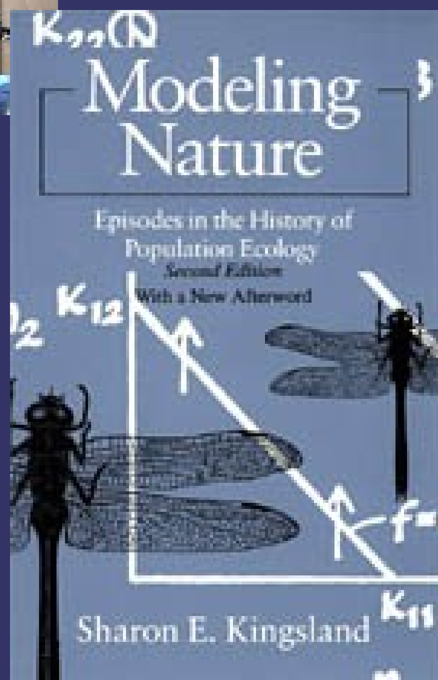
Escalas, História e Equilíbrio em Ecologia de Comunidades

Conteúdo

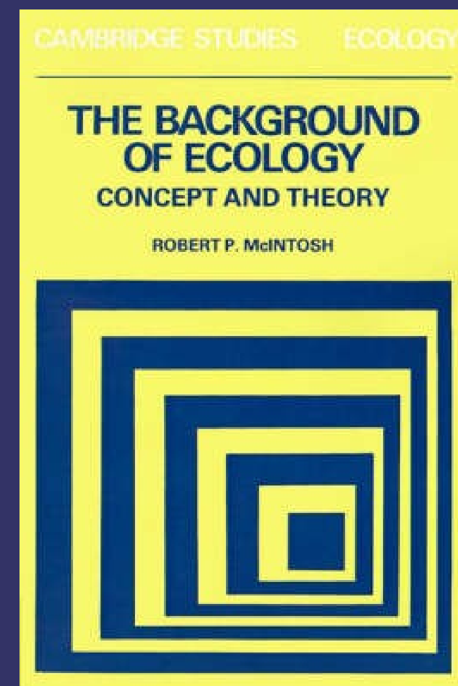
O curso será organizado das teorias de equilíbrio e de montagem de comunidades através do nicho para teorias de não-equilíbrio e de montagem através de dispersão; da escala local para regional; e da individual para a ecossistêmica. Cada subtópico será contextualizado dentro de seu desenvolvimento histórico.



A HISTÓRIA



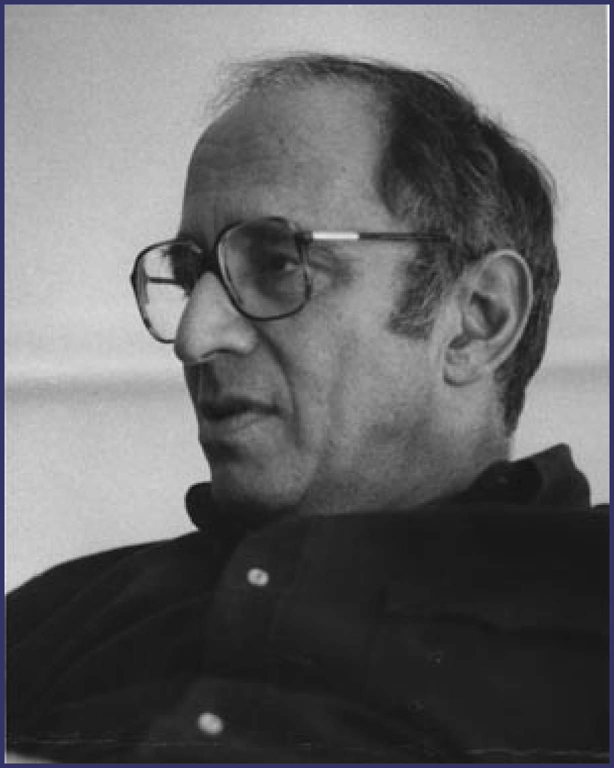
Chigago Univ. Press, 1995



Cambridge Univ. Press, 1986

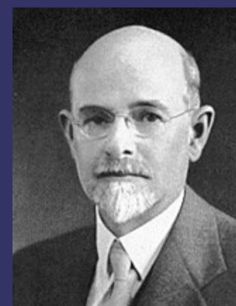
Paradigmas e Revoluções Científicas

Estátua de Louis Agassiz
em Standford,
após terremoto de 1906



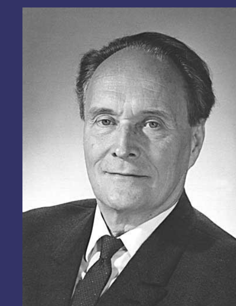
Thomas Kuhn
1922 - 1996

Homenagem a Santa Rosália: Nasce um Paradigma


Grinell

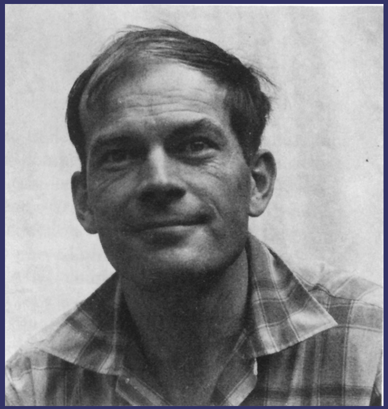

Lotka


Volterra


Gause


George E. Hutchinson
1903-1991

- Competição como principal força estruturadora.
- Diferenças de nicho mediam coexistência.
- Leis e princípios que geram modelos matemáticos, derivados da dinâmica clássica.
- Sistemas saturados e em equilíbrio.



Robert MacArthur
1930-1972

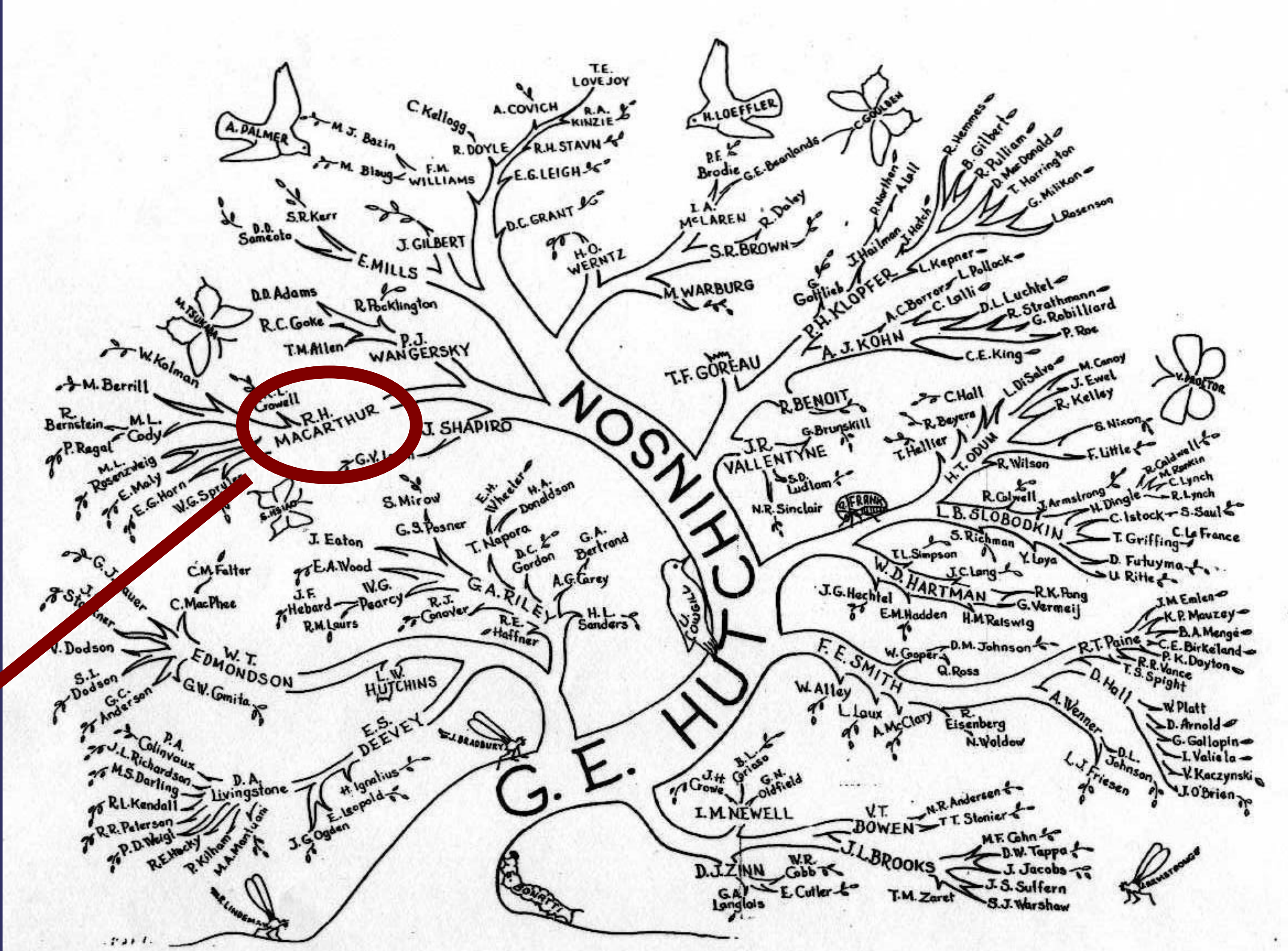
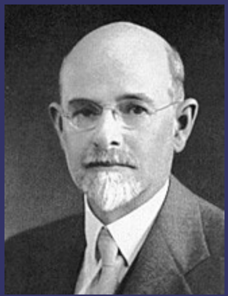


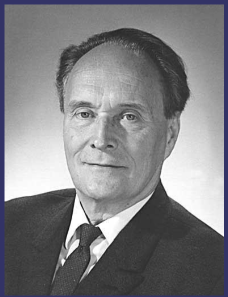
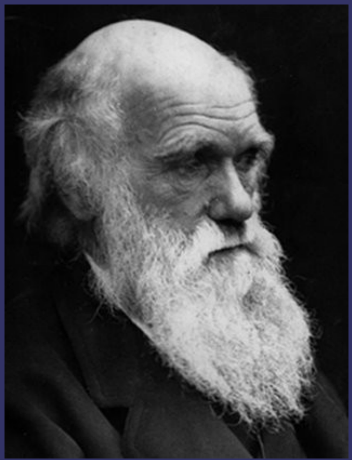
Fig. 9. Phylogenetic tree of intellectual descendants of G. E. Hutchinson, restricted to those possessing doctoral degrees. Main branches and capitalized names represent Hutchinson's own doctoral students. Secondary branches and twigs with lower-case names indicate second- and third-generation students. Terminal leaves indicate completed degrees, their absence means Ph.D. expected in 1971. The attendant fauna represent people who have done postdoctoral work with Hutchinson; their particular character and disposition were dictated by aesthetic considerations alone.

Kohn 1971. Limnology and Oceanography, Vol. 16

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: 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.”




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

"Eclipse da História"*

Articles

Community Diversity: Relative Roles of Local and Regional Processes

ROBERT E. RICKLEFS

The species richness (diversity) of local plant and animal assemblages—biological communities—balances regional processes of species formation and geographic dispersal, which add species to communities, against local processes of predation, competitive exclusion, adaptation, and stochastic variation, which may promote local extinction. During the past three decades, ecologists have sought to explain differences in local diversity by the influence of the physical environment on local interactions among species, interactions that are generally believed to limit the number of coexisting species. But diversity of the biological community often fails to converge under similar physical conditions, and local diversity bears a demonstrable dependence upon regional diversity. These observations suggest that regional and historical processes, as well as unique events and circumstances, profoundly influence local community structure. Ecologists must broaden their concepts of community processes and incorporate data from systematics, biogeography, and paleontology into analyses of ecological patterns and tests of community theory.

INTEREST IN NATURAL DIVERSITY HAS RISEN IN THE PUBLIC conscience recently with concern over the imminent extinction of thousands of species as a result of pollution and habitat destruction (*1*). Ecologists are unable to calculate the consequences of this havoc for natural resources of use to mankind and for the intrinsic stability of natural systems. But many consider these consequences to be potentially disastrous (*2*). If we are to predict change in system function after depauperization, we need to understand processes responsible for generating and maintaining diversity in biological communities. Indeed, the diversity issue may have two faces: Can one comprehend the ruin of natural systems without understanding how they are built?

Present-day ecological investigations are largely founded on the premise that local diversity—the number of species living in a small, ecologically homogeneous area—is the deterministic outcome of local processes within the biological community. As a general rule, community diversity parallels variation in local physical conditions. For example, on all continents, diversity tends to decrease with increasing distance north or south from the equator (*3*). But whether such patterns are mediated by competition between species, predation and disease, or patchworks of natural disturbances is intensely debated without any sign of resolution soon (*4, 5*).

Competition has been advocated strongly (*6–8*) because coexistence requires that each species has some corner on a limited resource market. If coexistence were precluded when ecological similarity exceeded some limit, or if a species could not persist when its ecological niche were reduced below some minimum viable size, the number of species in a community would be determined in a manner analogous to the packing of balls in a box. Accordingly, one would expect to find regular spacing between the positions of species within ecological space. Equivocal evidence for such spacing (*9*) has prevented the "competition hypothesis" from completely sweeping the discipline.

Predation is ubiquitous. The fact that predators can manipulate the dynamic relations between competing prey species has attracted many to the position that predation may influence diversity (*10*). Disturbances to the uniform fabric of the community caused by storms, erosion, predation, and natural deaths of individuals increase the heterogeneity of the environment and increase the amount of ecological space available (*11*). Disturbance itself, by interrupting the return of systems to equilibrium, may retard competitive exclusion and thereby promote diversity (*12*).

Almost certainly, these local factors influence local diversity. But a larger issue for ecologists is the degree to which they can explain local diversity solely by local processes, without considering the matrix of processes on larger spatial and temporal scales within which the community is imbedded. Ecologists are beginning to realize that local diversity bears the imprint of such global processes as dispersal and species production and of unique historical circumstance. These processes pose a challenge to community ecologists to expand the geographical and historical scope of their concepts and investigations.

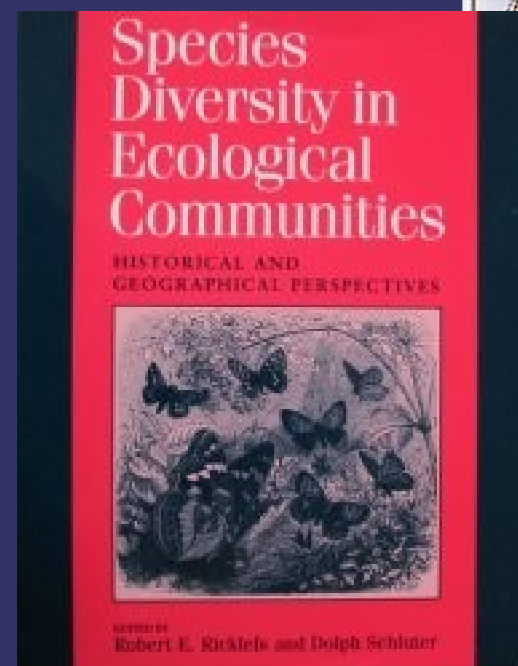
Testing Predictions of Local-Process Theories

Regardless of the underlying mechanism, hypotheses that relate local diversity deterministically to local conditions make common predictions of (i) community convergence, (ii) resistance of the community to invasion, and (iii) independence of local and regional diversity. In two areas having different histories of biological development but similar physical conditions, adaptations of individuals and attributes of community structure and function should conform to limits imposed by local conditions. Although plant and animal form and function commonly converge in similar environments (*13*), accumulating counterexamples dispel belief that species diversity similarly converges (*14, 15*). Two examples will illustrate this important point. First, throughout the tropics, the boundary separating marine and terrestrial environments supports a mangrove-type vegetation consisting of species of trees uniquely (and convergently) adapted to the immersion of their roots in salt water. In the New World tropics and western Africa, mangrove communi-

The author is a professor in the Department of Biology, University of Pennsylvania, Philadelphia, PA 19104.

Science, 1987

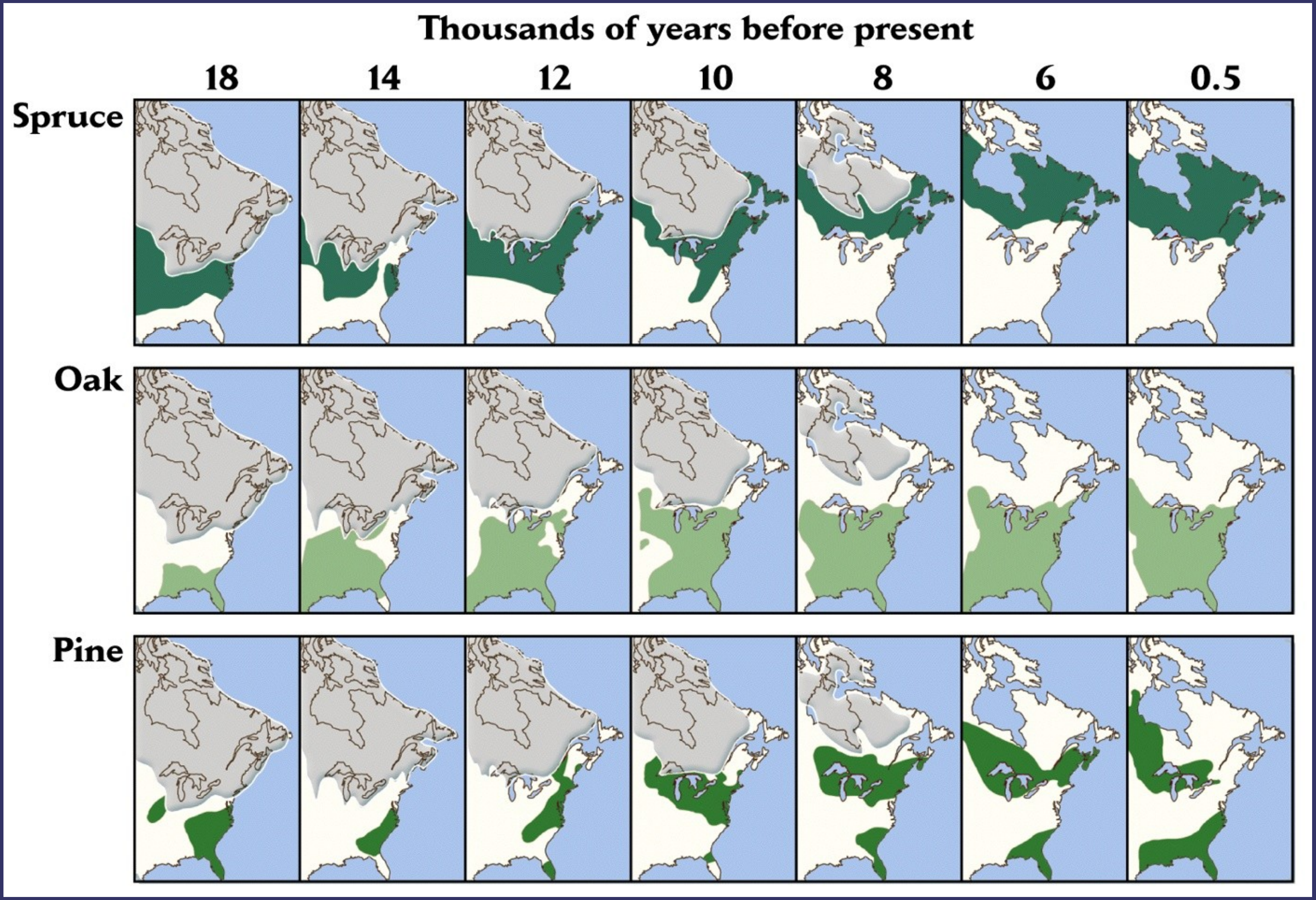
Robert Ricklefs



1993

* Expressão de Kingsland, 1986

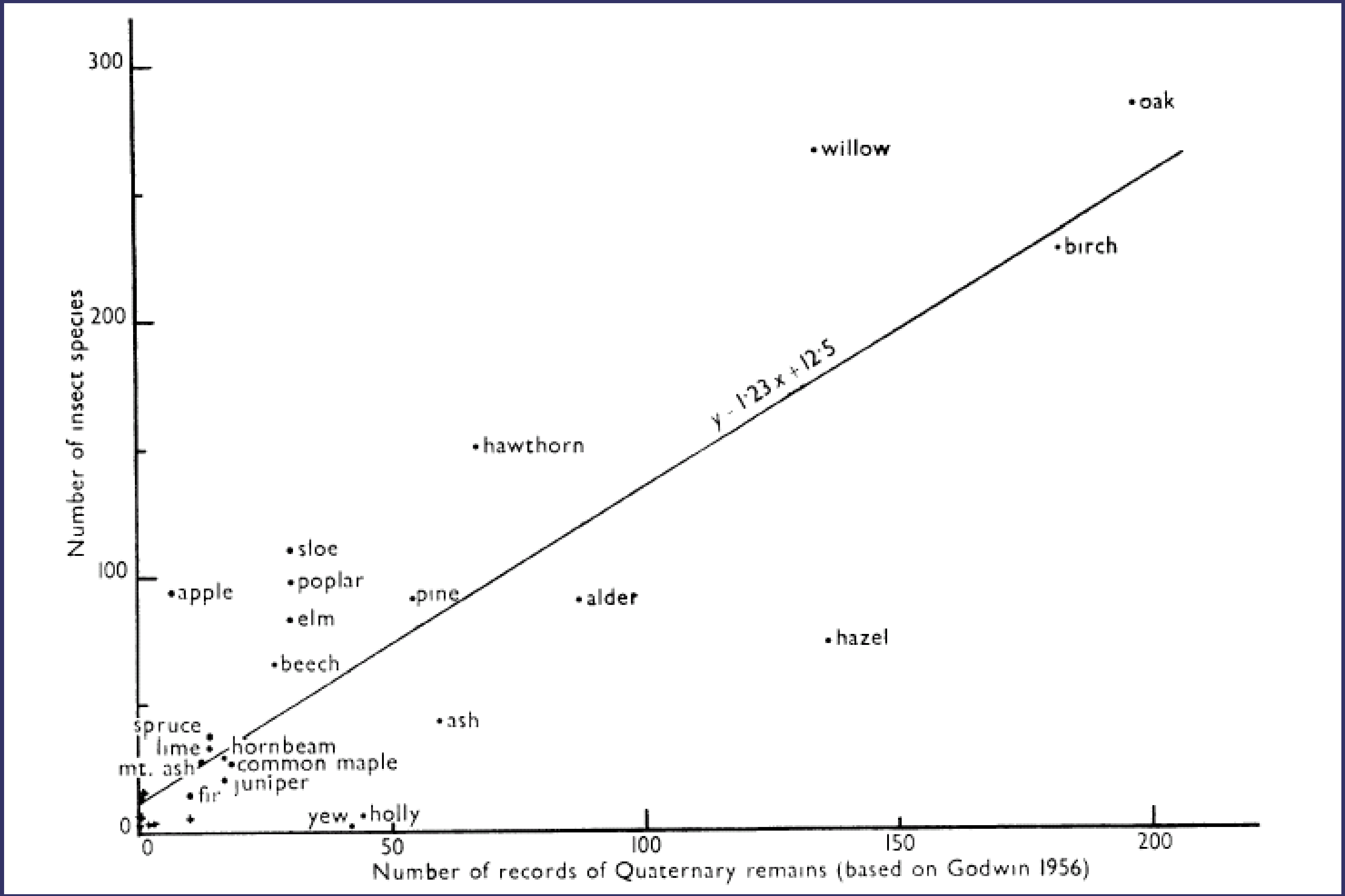
O Papel da História

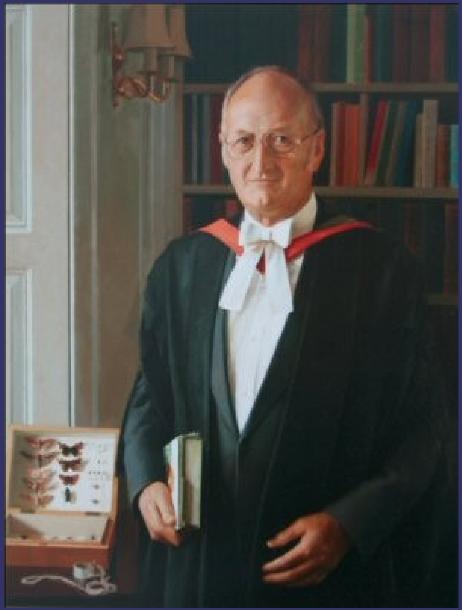


Distribuição geográfica de três espécies de árvores na costa leste da América do Norte, nos últimos 18 mil anos.

Jacobson et al. 1987, apud Ricklefs 2003.

A Contribuição da Interação Inseto - Planta



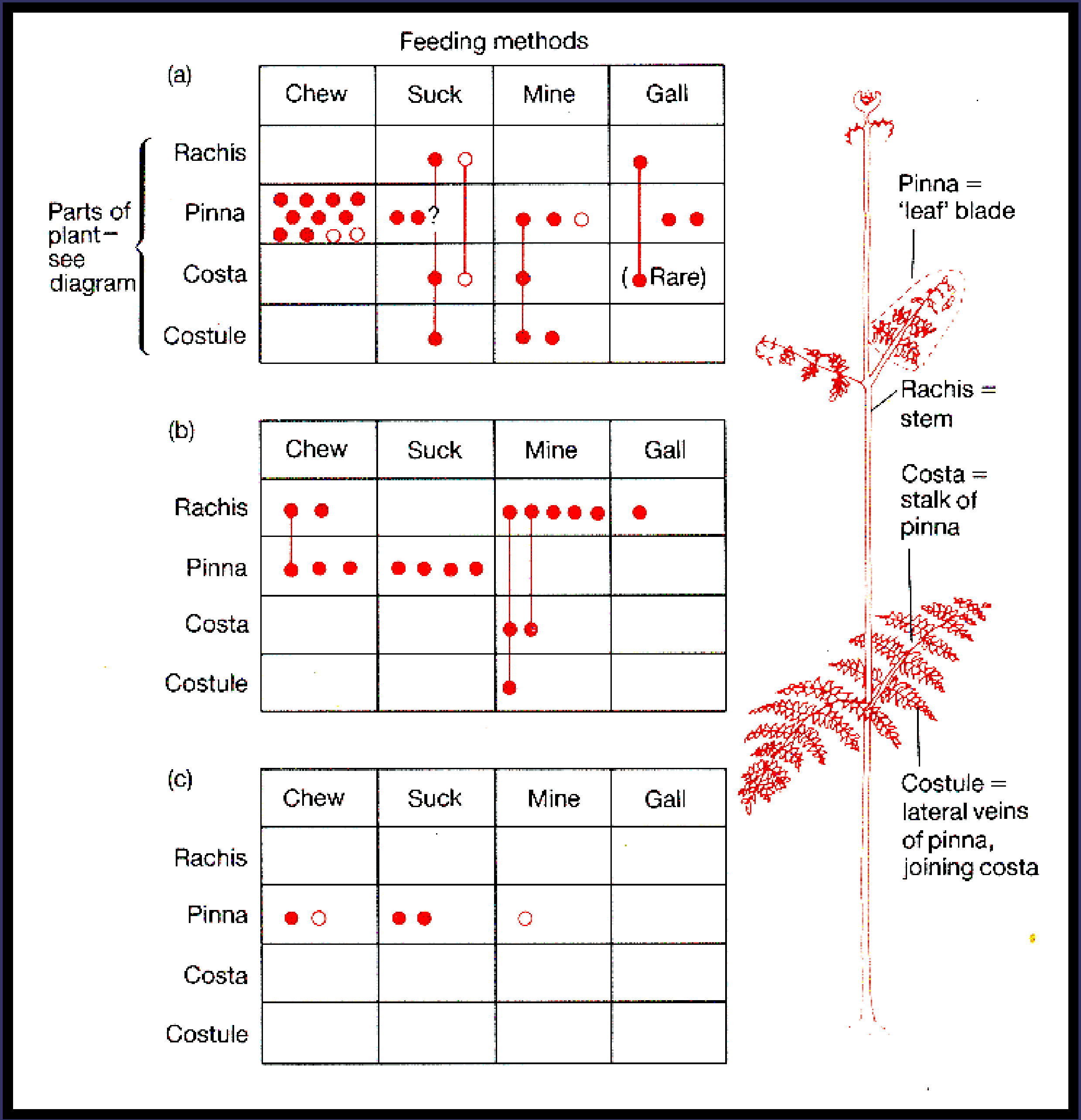


Sir T. R.Southwood, FRS
1931-2005

N de espécies de insetos herbívoros em árvores nas Ilhas Britânicas em função da frequência das espécies de árvores no registro fóssil quaternário.

Southwood 1960 J. Anim. Ecol.

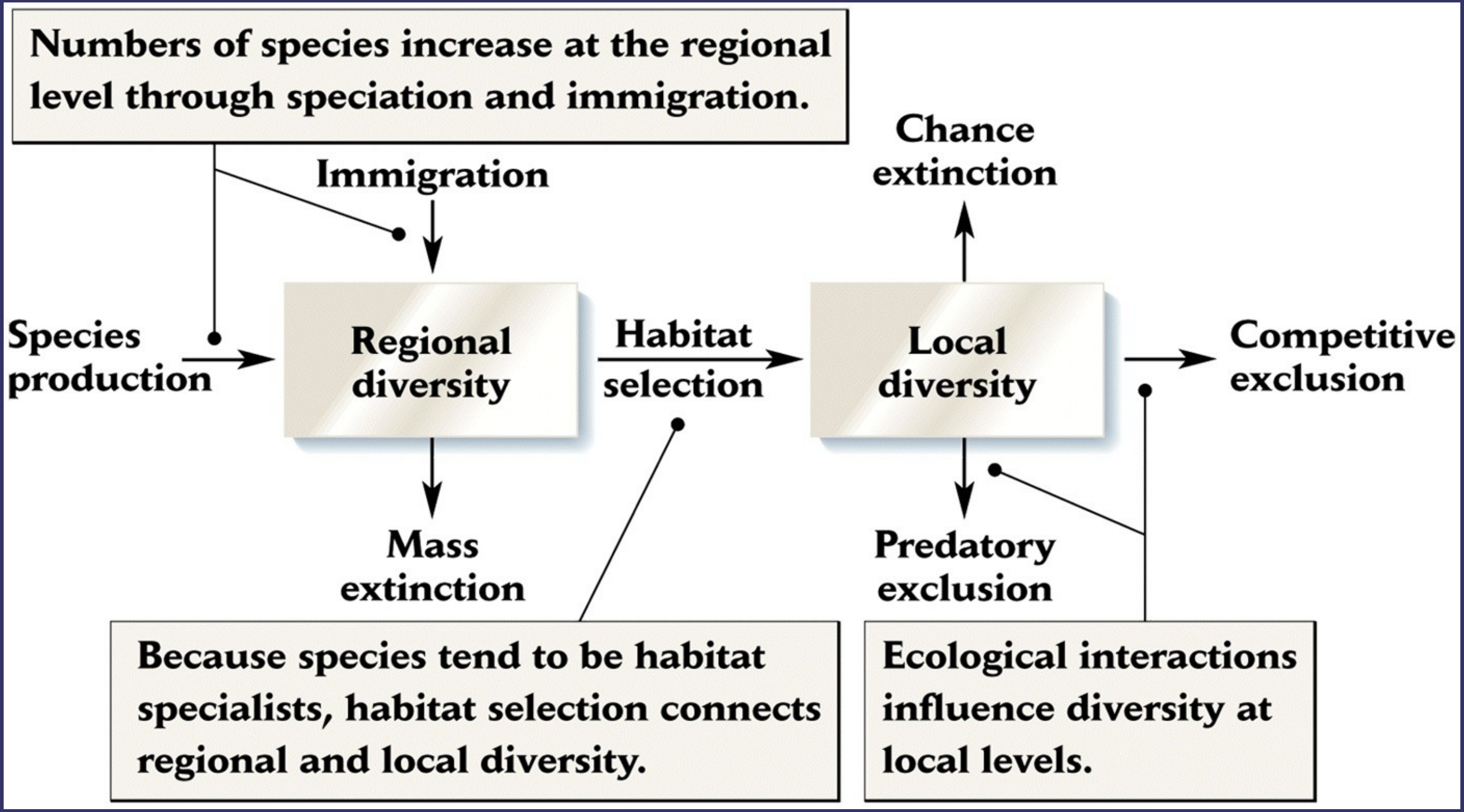
Pteridum e os Nichos Vagos de Lawton



Pteridium anqulinum L..
Scandinavian Ferns .
Øllgaard & Tind, Rhodos, 1993

Lawton 1984 J. Anim. Ecol.

O Modelo Conceitual de Ricklefs *et al.*



Ricklefs, 2003

O Eclipse da Escala Local?

VOL. 172, NO. 6 THE AMERICAN NATURALIST DECEMBER 2008

Disintegration of the Ecological Community

American Society of Naturalists Sewall Wright Award Winner Address*

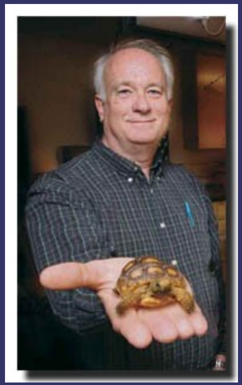
Robert E. Ricklefs†

" I suggest that the distributions of species within a region reveal more about the processes that generate diversity patterns than does the co-occurrence of species at any given point. **The local community is an epiphenomenon that has relatively little explanatory power in ecology and evolutionary biology.**"

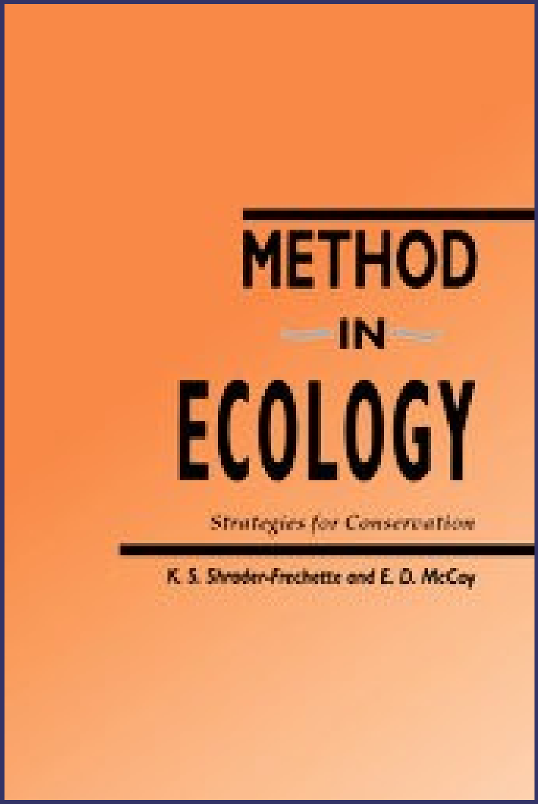
Ecologia = Estudos de Caso?

" When we wish to apply ecology to promote conservation or preservation our knowledge of particular taxa is more important than knowledge of general theory."

Kristin Shrader-Frechette



Earl McCoy



Cambridge Univ. Press, 1993

Algumas Considerações sobre Irreversibilidade, História e Evolução

$$\frac{dN}{dt} = r \cdot N\left(1 - \frac{N}{K}\right)$$

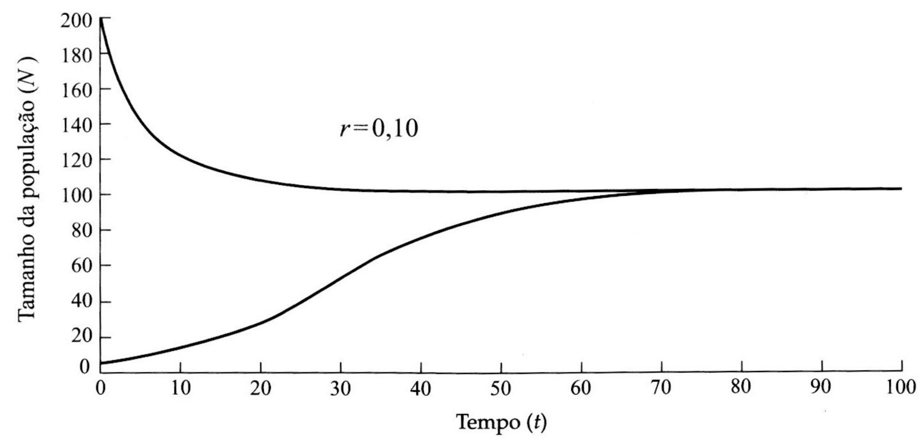


Figura 2.2 Curva de crescimento logístico. Quando o crescimento começa abaixo da capacidade de suporte, a trajetória de *N* em função do tempo descreve uma típica curva em forma de S. Acima da capacidade de suporte, a curva cai rapidamente para o equilíbrio. Neste exemplo, *K* = 100, e o tamanho inicial da população é 5 ou 200.

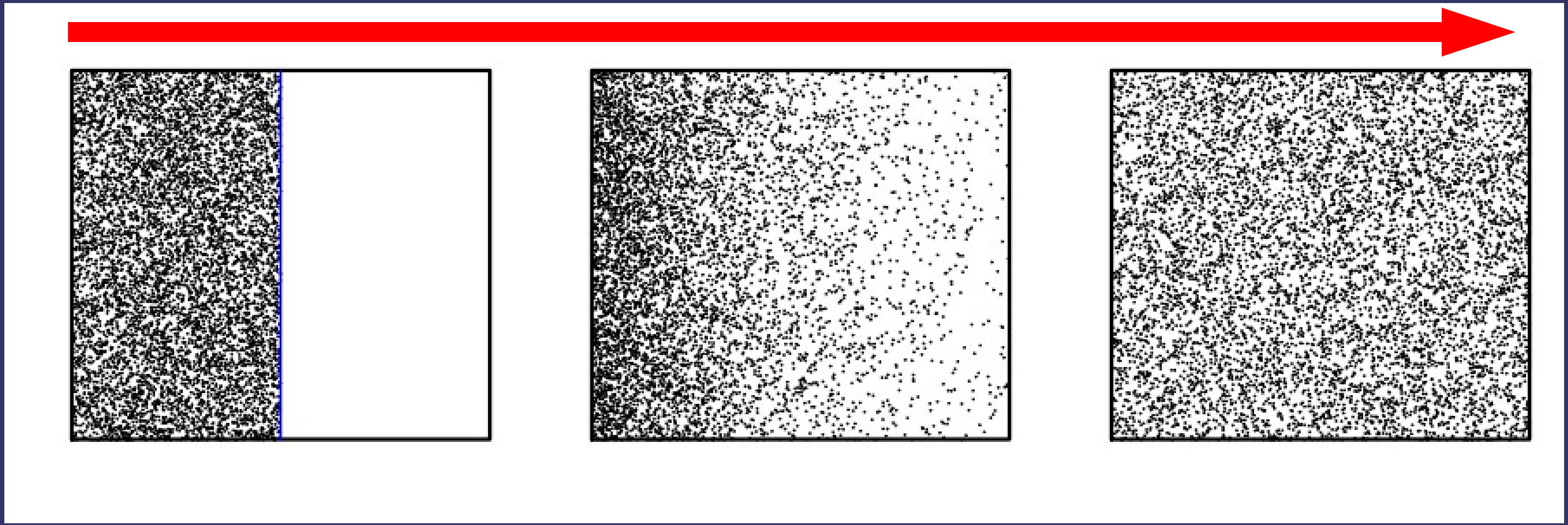
Gotelli, 2007. Ecologia. Ed. Planta

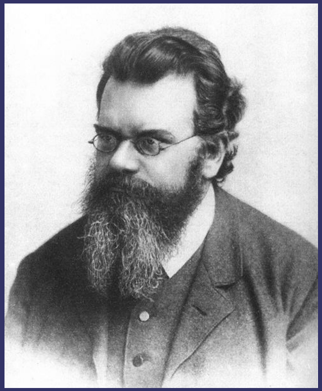
Demônio de Laplace

Marquês Pierre-Simon Laplace (1749-1827)

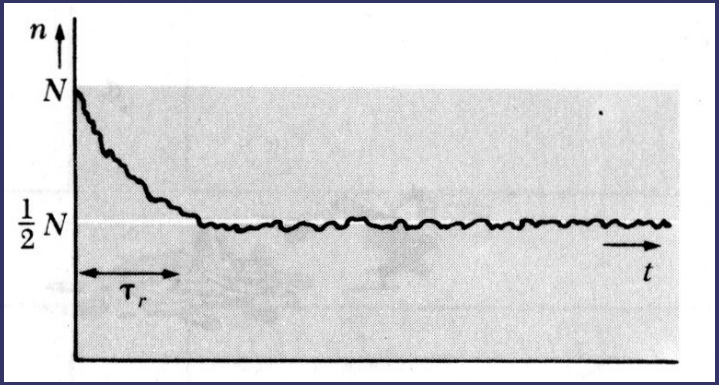
"Se houvesse um intelecto que num dado momento conhecesse todas as forças que colocam a natureza em movimento, e todas as posições de seus elementos, e que também fosse vasto o suficiente para submeter essses dados à análise, ***ele poderia abranger numa única fórmula*** *os movimentos dos maiores copros 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."*

A Seta do Tempo de Boltzmann



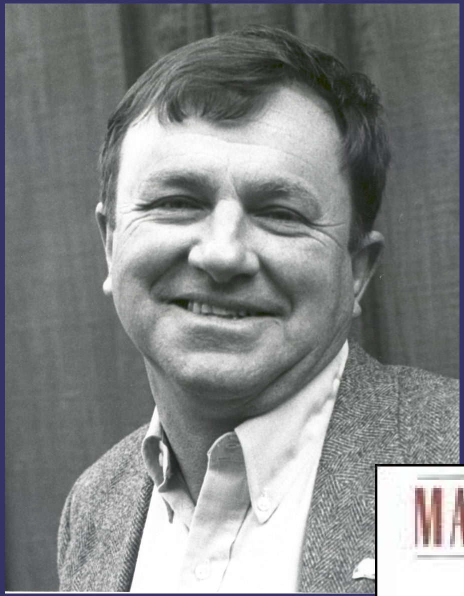


Ludwig Boltzmann
1844 - 1906

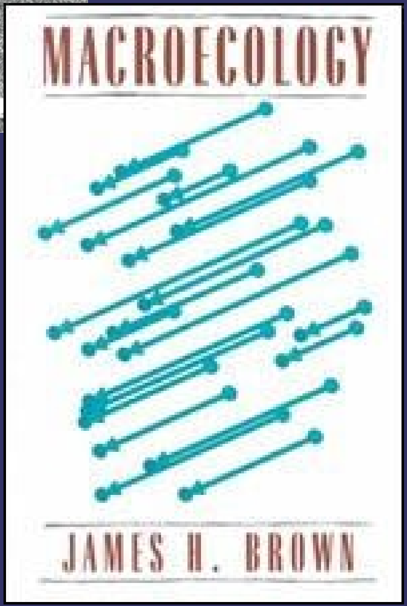


Propriedades macroscópicas do sistema evoluem para seu estado mais provável.

A Atávica Inveja da Física



James Brown

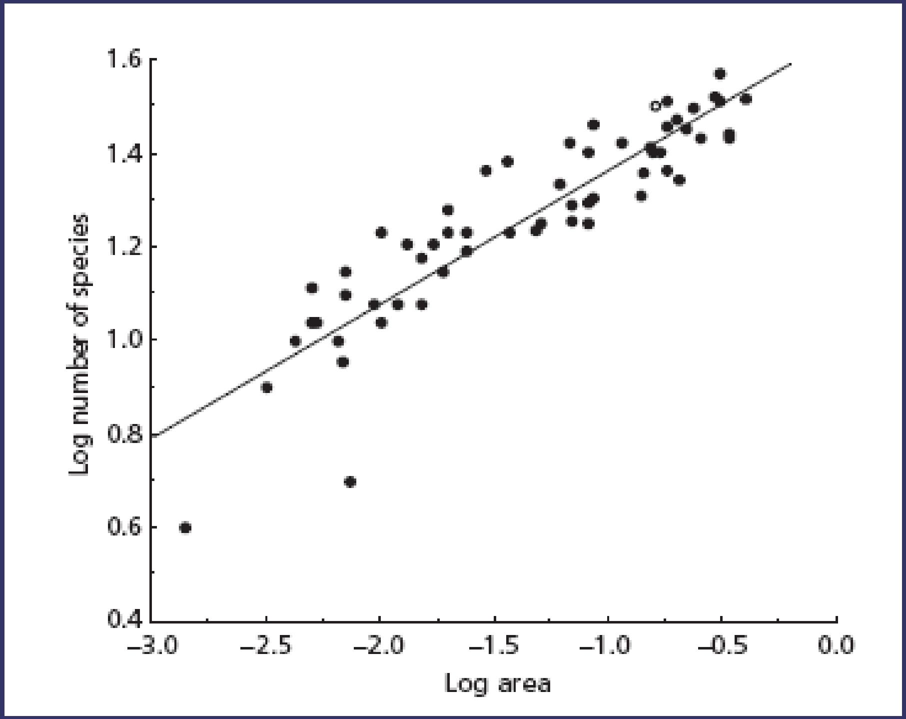


Chigago Univ. Press
1995

" Macroecology is concerned with statistical distributions of variables among large numbers of ecological 'particles'. Usually these particles are either many individual organisms within species populations, or many species within local, regional or continental biotas. [...] In order to characterize and compare these distributions, it is desirable - but not always possible - to have samples of hundreds or thousands of particles. "

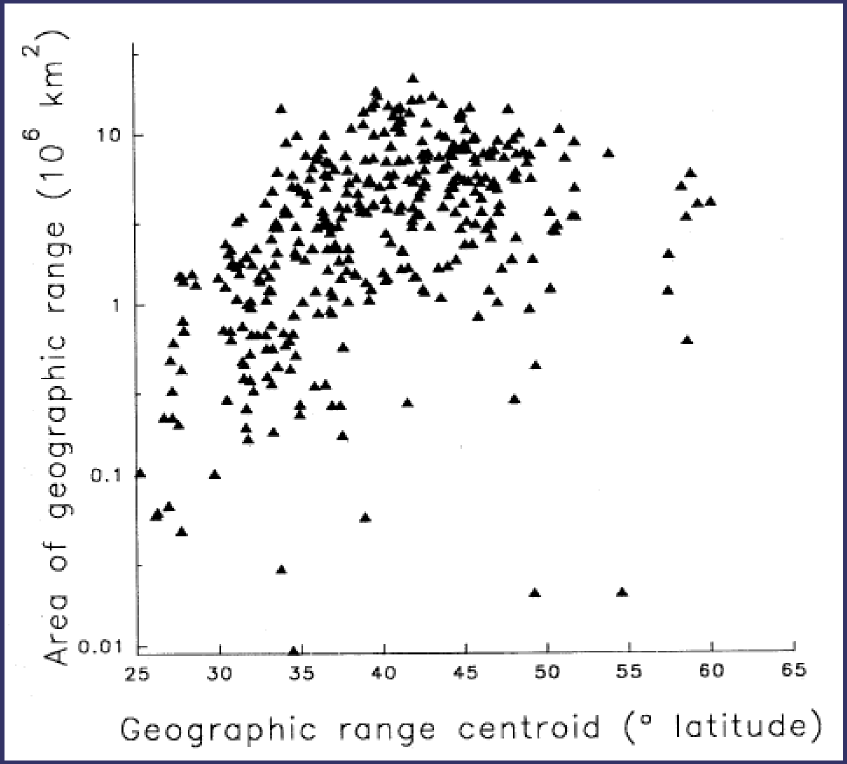
Macroecologia: Dois Exemplos

Relação Espécie x Área



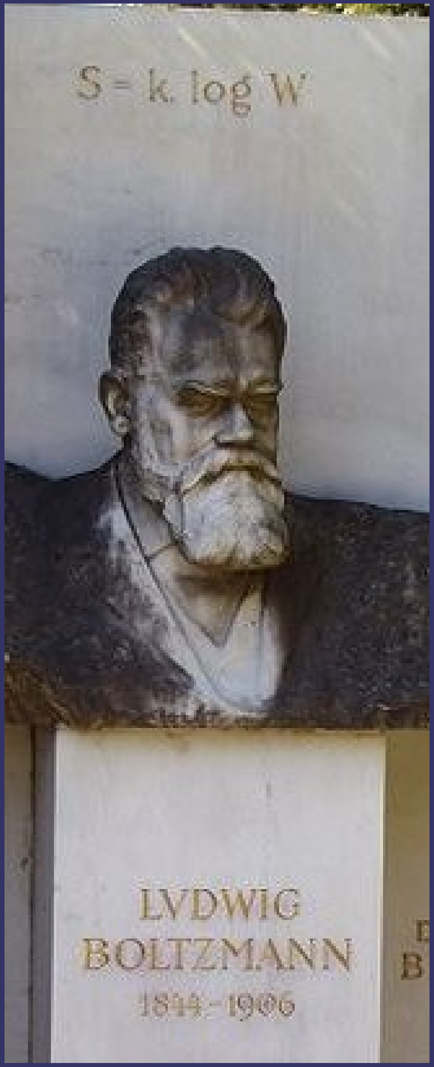
Aves em ilhas britânicas, Gaston & Blackburn 2000

Regra de Rapoport



Aves na América do Norte, Brown, 1995

Basta uma Seta do Tempo?



- A irreversibilidade é a consequência macroscópica de nossa incapacidade de descrição do nível microscópico.
- Mesmo em termos macroscópicos, o sistema segue sempre para um mesmo estado de equilíbrio (determinismo).

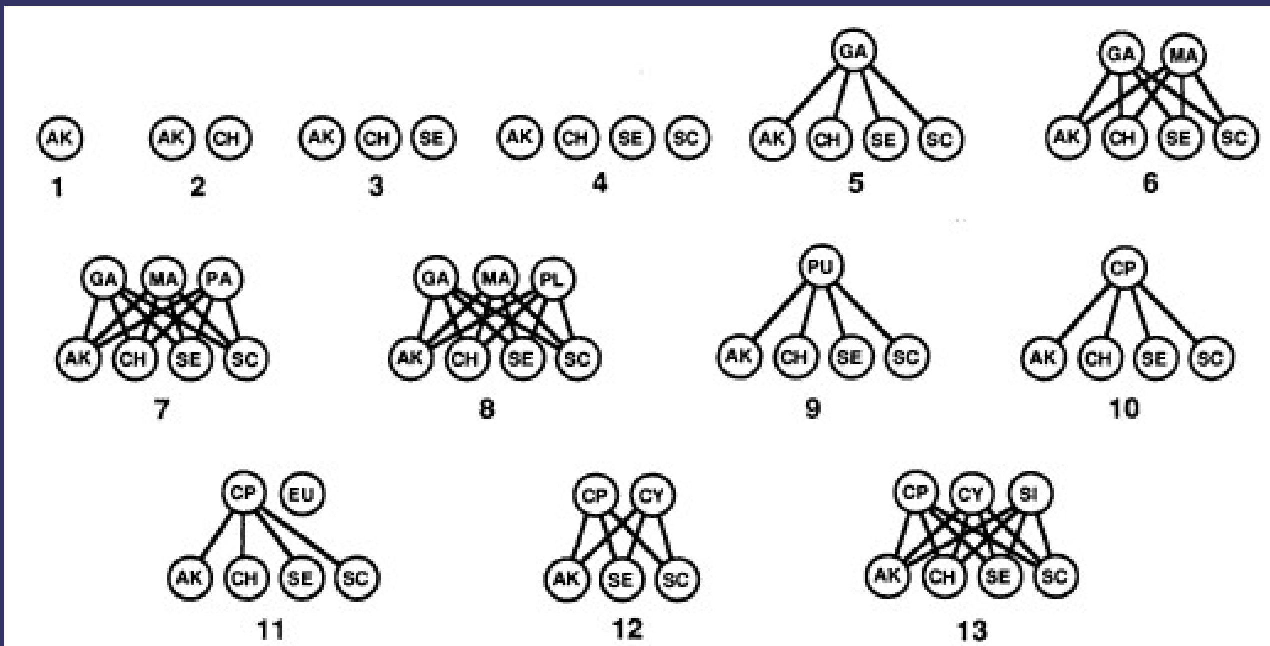
O que define história?

- Além de irreversibilidade história exige:
  - **Acontecimento**: realização de um entre muitos estados possíveis.
  - **Contexto**: conjunto de condições que definem os acontecimentos possíveis, suas probabilidades, e seus efeitos no sistema.
  - **Coerência**: relações que definem o contexto como consequência de acontecimentos prévios.

Ilya Prigogine
1917-2003
Nobel em 1977

Adaptado de:
I. Prigogine & I. Stengers 1990. Entre o tempo e a eternidade. Lisboa, Gradiva

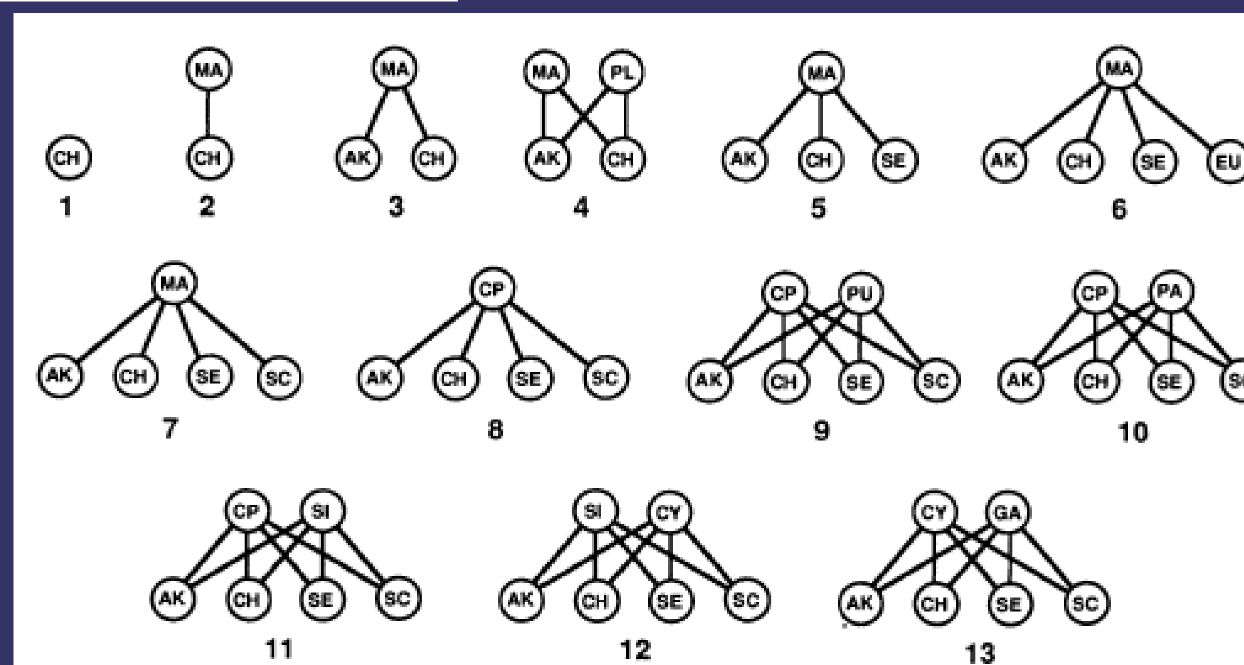
Comunidades como Sistemas Históricos



Drake, 1991. Am. Nat

AK - *Ankistrodesmus falcatus*
CH - *Chlamydomonas reinhardtii*
CP - *Cypris*
CY - *Cyclops vernalis*
EU - *Euglena gracilis*
GA - *Gammarus lacustris*

MA - *Daphnia magna*
PA - *Paramecium multimicronucleatum*
PL - *Pleuroxus truncatus*
PU - *Daphnia pulex*
SC - *Scenedesmus quadricauda*
SE - *Selenastrum bibrium*



Evolução de Sistemas Complexos

Table 1 Results of species elimination

	Elimination method	
	Random	Natural selective
Maximum no. of eliminations required for homeostasis	50	29
Mean no. of eliminations required for homeostasis	46.7	25
Fraction of sample yielding a non-trivial homeostatic system	24%	100%
Fraction of feasible systems stable	100%	100%
Largest homeostatic system resulting	4	29
Smallest (non-trivial) homeostatic system resulting	2	21
Mean ratio of connectance in homeostatic set to that in random ensemble	0.80	0.99
Fraction of eliminated species which were consumers	0.50	0.826
Maximum fraction of consumers in a homeostatic system	0.33	0.25
Minimum fraction of consumers in a homeostatic system	0.00	0.11
Mean fraction of consumers in a homeostatic system	0.20	0.165
Ratio of mean no. of eliminations to initial no. of unfeasible species	1.82	0.99
Final range of values of g	0.88–1.25	0.33–0.39

Tregonning & Roberts 1979, Science

Complexidade sem Regras

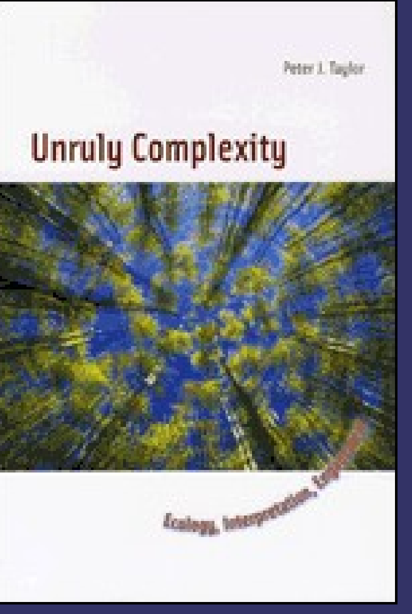
REGIONAL

↓

LOCAL

- ✓ **Não** há limites claros
- ✓ **Não** há dinâmica interna coerente
- ✗ **Há** relações simples com o contexto

Peter Taylor



Chigago Univ. Press, 2005

Embebimento: Comunidades são Situações

- **Não** há limites claros
- **Não** há dinâmica interna coerente
- **Não** há relações simples com o contexto

A escala regional é ao mesmo tempo contexto e produto da escala local.

De quem a física tem inveja?

Vol. 8, 1922 BIOLOGY: A. J. LOTKA 147

*CONTRIBUTION TO THE ENERGETICS OF EVOLUTION**

By Alfred J. Lotka

School of Hygiene and Public Health, Johns Hopkins University

Communicated, May 6, 1922

It has been pointed out by Boltzmann[1] that the fundamental object of contention in the life-struggle, in the evolution of the organic world, is available energy.[2] In accord with this observation is the principle[3] that, in the struggle for existence, the advantage must go to those organisms whose energy-capturing devices are most efficient[4] in directing available energy into channels favorable to the preservation of the species.

The first effect of natural selection thus operating upon competing

NATURAL SELECTION AS A PHYSICAL PRINCIPLE*

By Alfred J. Lotka

School of Hygiene and Public Health, Johns Hopkins University

Communicated May 6, 1922

In a paper presented concurrently with this, the principle of natural selection, or of the survival of the fittest (persistence of stable forms), is employed as an instrument for drawing certain conclusions regarding the energetics of a system in evolution.

Aside from such interest as attaches to the conclusions reached, the method itself of the argument presents a feature that deserves special note. The principle of natural selection reveals itself as capable of yielding information which the first and second laws of thermodynamics are not competent to furnish.

The two fundamental laws of thermodynamics are, of course, insufficient to determine the course of events in a physical system. They tell us that certain things cannot happen, but they do not tell us what does happen.

PNAS, 1922

Darwin Chegou Lá!

- Evolução por seleção natural:
  - **Acontecimento**: variação individual fenotípica, decorrente de genotípica.
  - **Contexto**: diferenças fenotípicas acarretam em diferentes probabilidades de reprodução e sobrevivência dos indivíduos.
  - **Coerência**: mudanças nas frequências dos genótipos na população fixam e eliminam fenótipos, o que por sua vez altera o contexto de seleção das gerações seguintes.