COMMUNITY ECOLOGY: AN HISTORICAL OVERVIEW

Raphaël Boulay

ANT-ECOLOGY.EU

- IMPACT OF INVASIVE ANTS
- ADAPTATION TO ARID ENVIRONMENTS
- EFFECT OF ANTRHOPIC DISTURBANCES ON ANT FUNCTIONAL, TAXONOMIC AND PHYLOGENETIC DIVERSITY
- PHYLOGEOGRAPHY OF DESERT ANTS

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Institut de Recherche sur la Biologie de l'Insecte

Estación Biológica Doñana CSIC

CHARLES DARWIN'S ENTANGLED BANK

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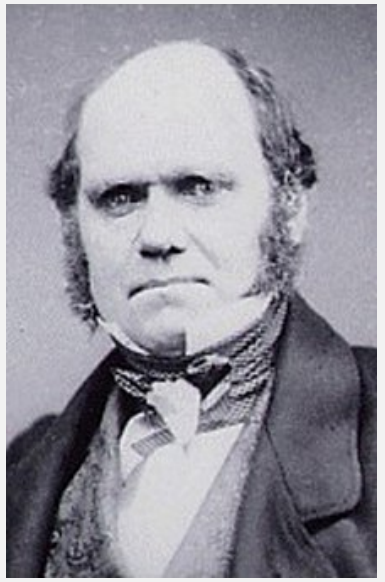
"*It is interesting to contemplate an entangled bank clothed with many plants of many kinds with birds singing on the bushes, with various insects flitting about and with worms crawling through the damp earth and to reflect that these elaborately constructed forms so different from each other and dependent on each other and so complex a manner have all been produced by laws acting around us.*"



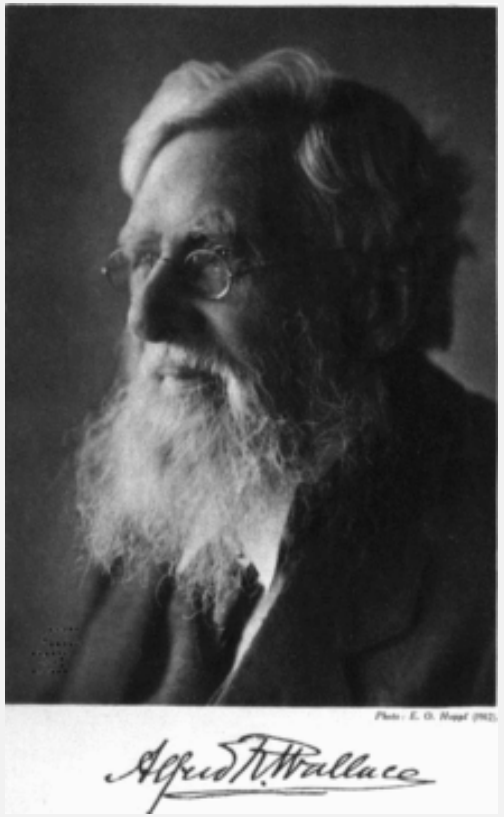
Charles Darwin,
(1809 – 1882)

SOME CENTRAL QUESTIONS IN ECOLOGY AND EVOLUTIONARY SCIENCES

- What are species? How are they formed?
- What determines their distribution?
- What factors limit their number in a community?
- What are the respective roles of micro vs macroecological processes in shaping local species assemblages?
- What is the role of biotic interactions in shaping biodiversity?
- How do communities evolve?

THE WALLACE EFFECT

Hybrids are less fit and are eliminated by natural selection.



Alfred Russel Wallace,
(1823 – 1913)

THE WALLACE LINE

Species spatial distribution can be explained by geography and the history of continental shelves.

WALLACE PREOCCUPATION FOR CONSERVATION

"Future ages will certainly look back upon us as people so immersed in the pursuit of wealth to be blind to higher considerations. They will consider us with having culpably allowed the destruction of some of those records of Creation which we had on our planet to preserve; and while professing to regard every living thing as the direct handiwork and best evidence of a Creator, yet, with a strange inconsistency, seeing many of them perish irrecoverably from the face of the earth, uncared for and unknown."

THEODOSIUS DOBZHANSKY'S THEORY OF REPRODUCTIVE ISOLATION

Dobzhansky applies theories of genetics to natural populations to explain species formation.

Formalized the Wallace effect as pre-zygotic reinforcement.

Explained the evolution of mimetism.

T. Dobzhansky 1900 - 1975

ERNST MAYR' BIOLOGICAL SPECIES CONCEPT

Enrst Mayr
(1904 – 2005)

An ornithologist who described a great number of bird species and reported their distribution.

Defined the biological species concept.

Underlined the role of allopatry in species formation.

Sister species have allopatric distributions.

See Coyne and Orr (2004)

http://darwiniana.org/mayrspecies.htm

THE LOTKA-VOLTERRA EQUATIONS FOR COMPETITIVE SPECIES

The influence of population dynamic modelling: the population size of *n* competing species tends towards an unstable equilibrium state.

Alfred James Lotka
(1880 – 1949)

Vito Volterra
(1880 – 1940)

Interspecific competition: Lotka-Volterra Model

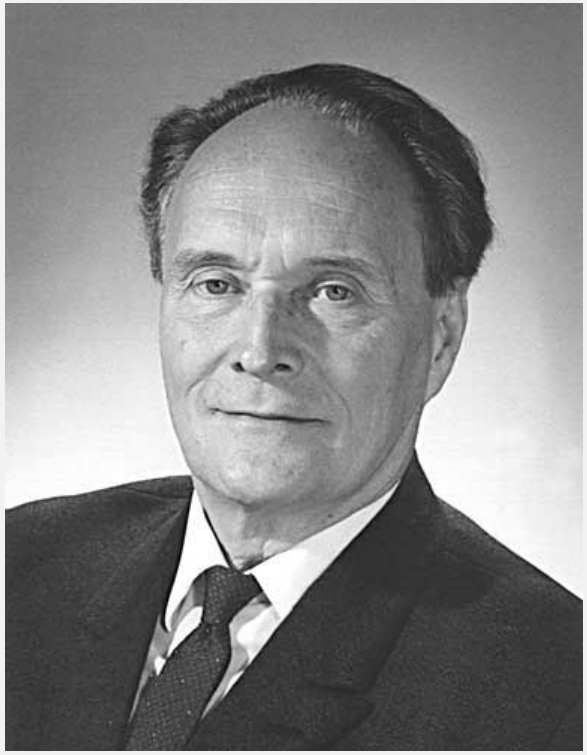
Species 1: $$\frac{dN_1}{dt} = r_1 N_1 \left(\frac{K_1 - N_1 - \alpha N_2}{K_1} \right)$$

Species 2: $$\frac{dN_2}{dt} = r_2 N_2 \left(\frac{K_2 - N_2 - \beta N_1}{K_2} \right)$$

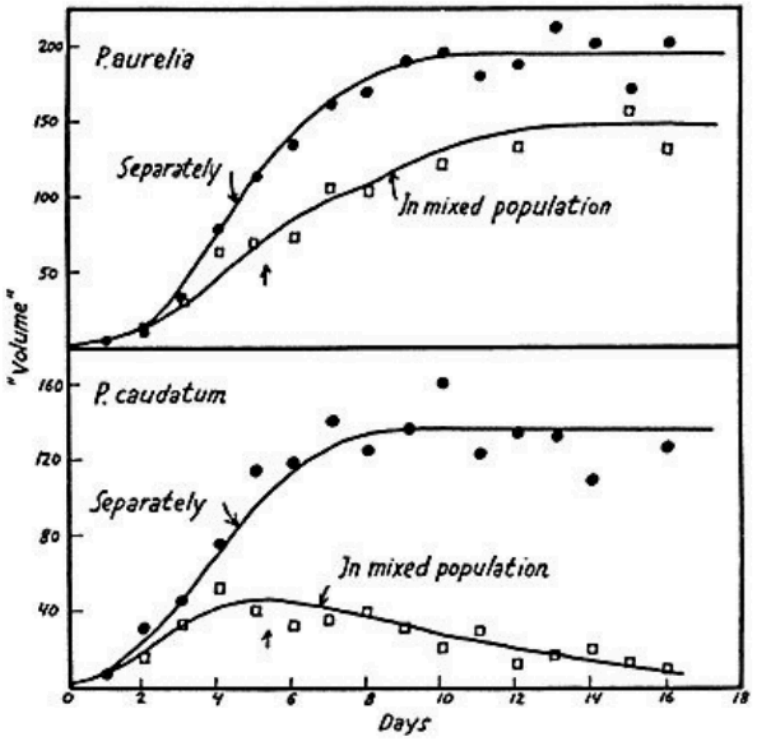
Competition coefficients:

- α : the effect an individual of species 2 has on the population growth of species 1
- β : the effect an individual of species 1 has on the population growth of species 2

GEORGY GAUSE'S PRINCIPLE OF COMPETITIVE EXCLUSION



Georgiĭ Frant͡sėvich Gauze, 1910 - 1986

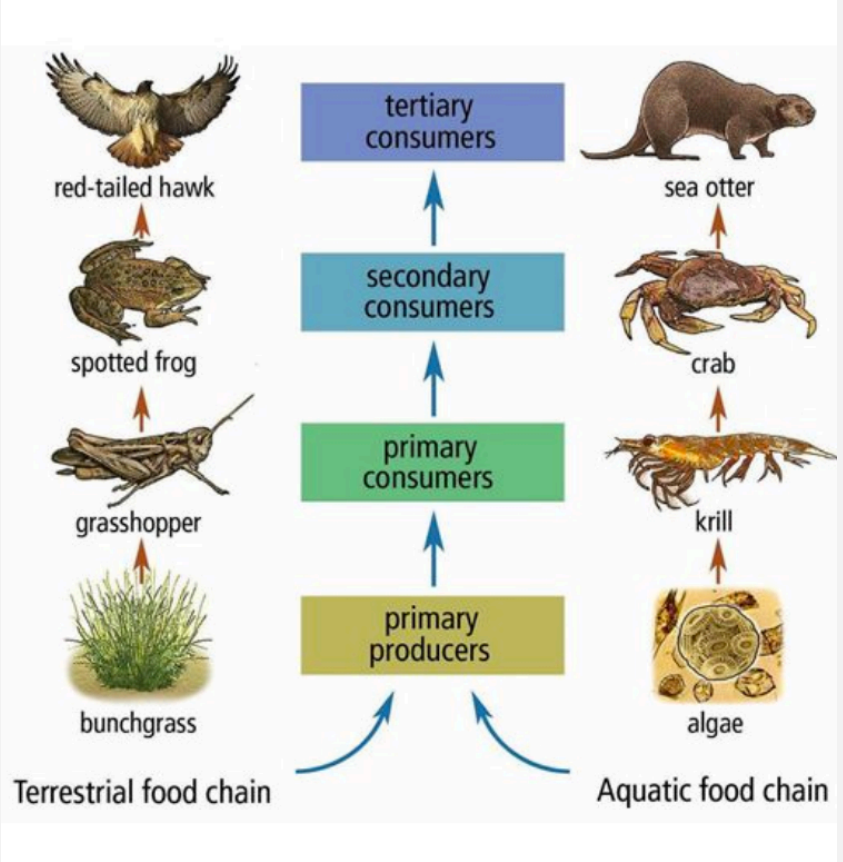


CHARLES ELTON'S ECOLOGICAL NICHE

Charles Elton (1901 – 1991)

CHARLES ELTON'S ECOLOGICAL NICHE

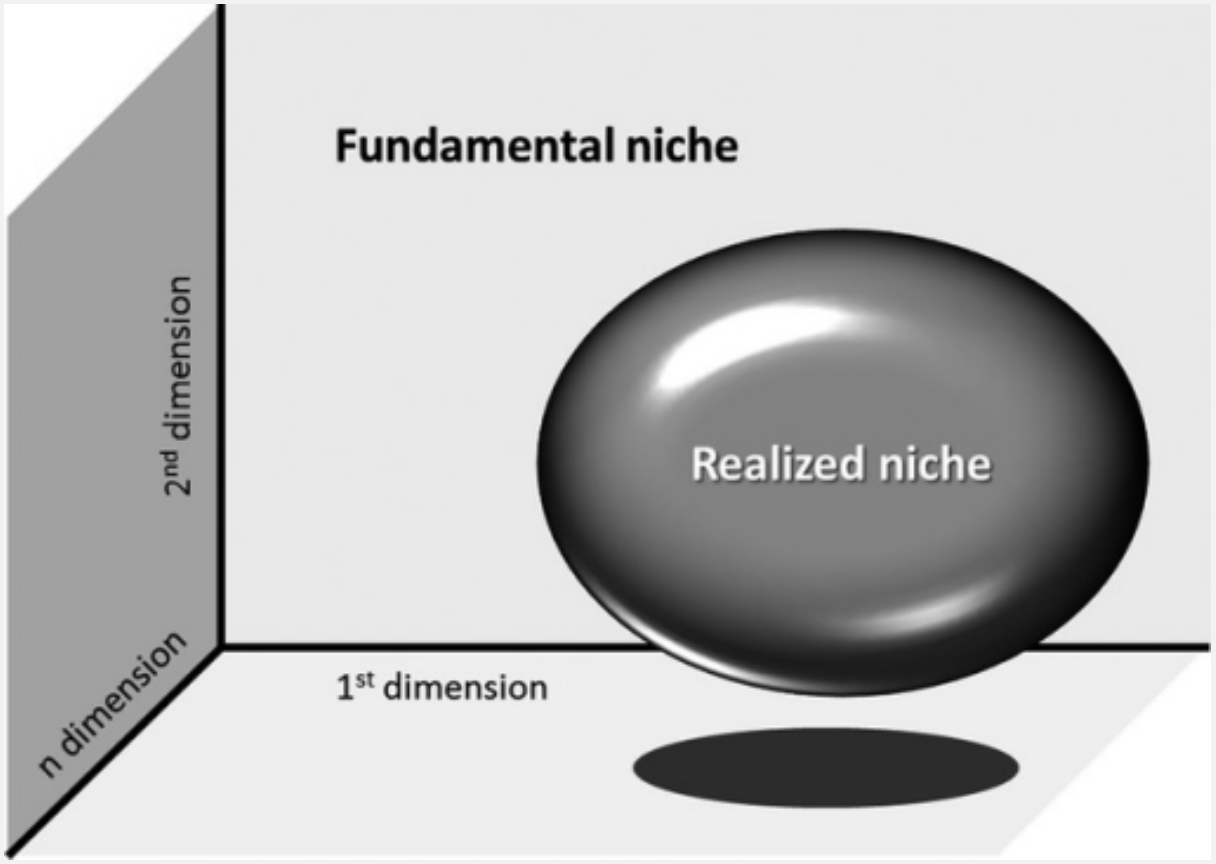
- Species co-exist because they occupy different niches.
- The place occupied by a species in an ecosystem – mostly defined by its trophic position.



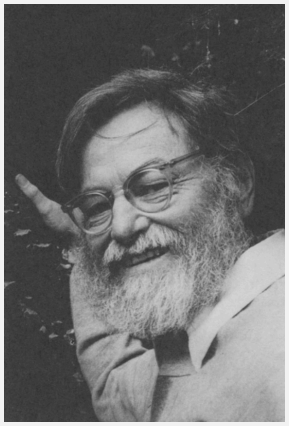
GEORGE EVELYN HUTCHINSON: THE HYPER-VOLUME CONCEPT OF NICHE

Hutchinson (1903 – 1991)

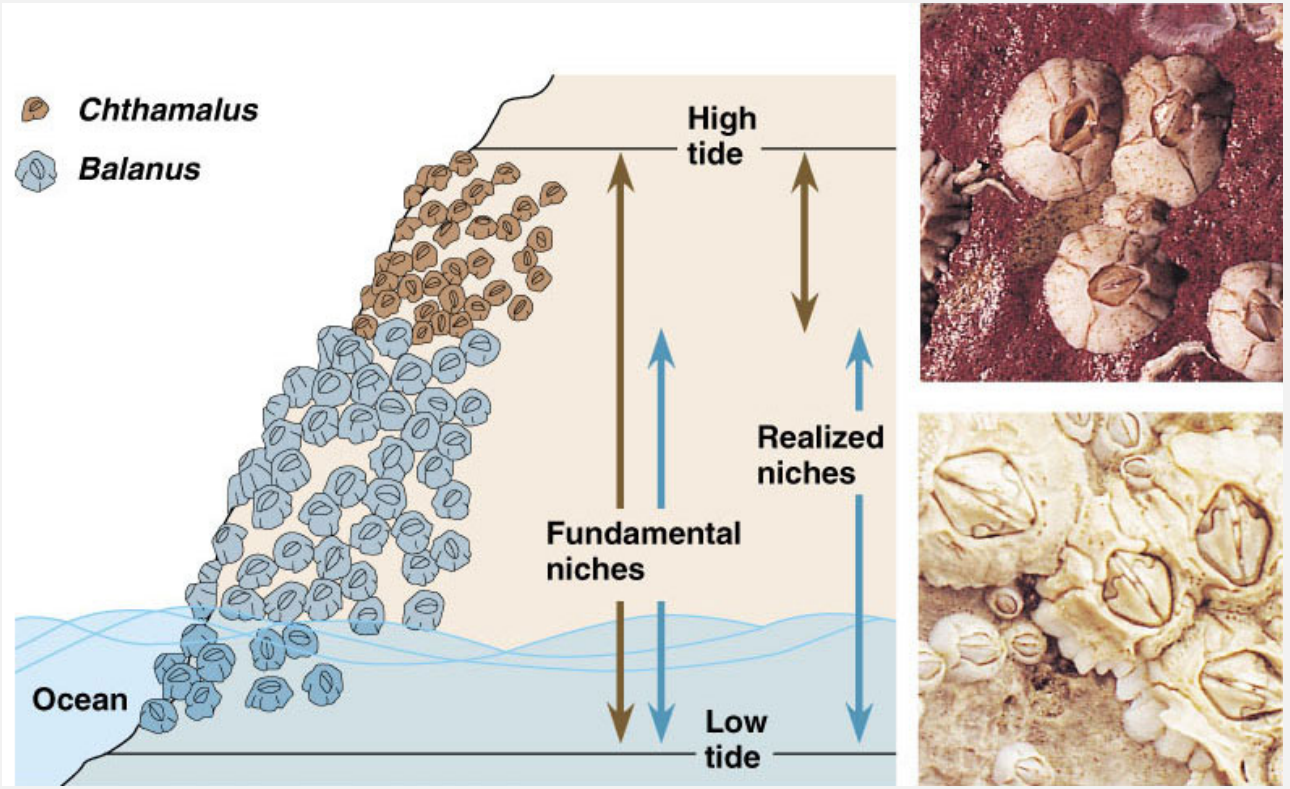
GEORGE EVELYN HUTCHINSON: THE HYPER-VOLUME CONCEPT OF NICHE



JOSEPH H. CONNELL STUDY ON BARNACLES NICHE PARTITIONNING



J.H. Connell
(1923 -)



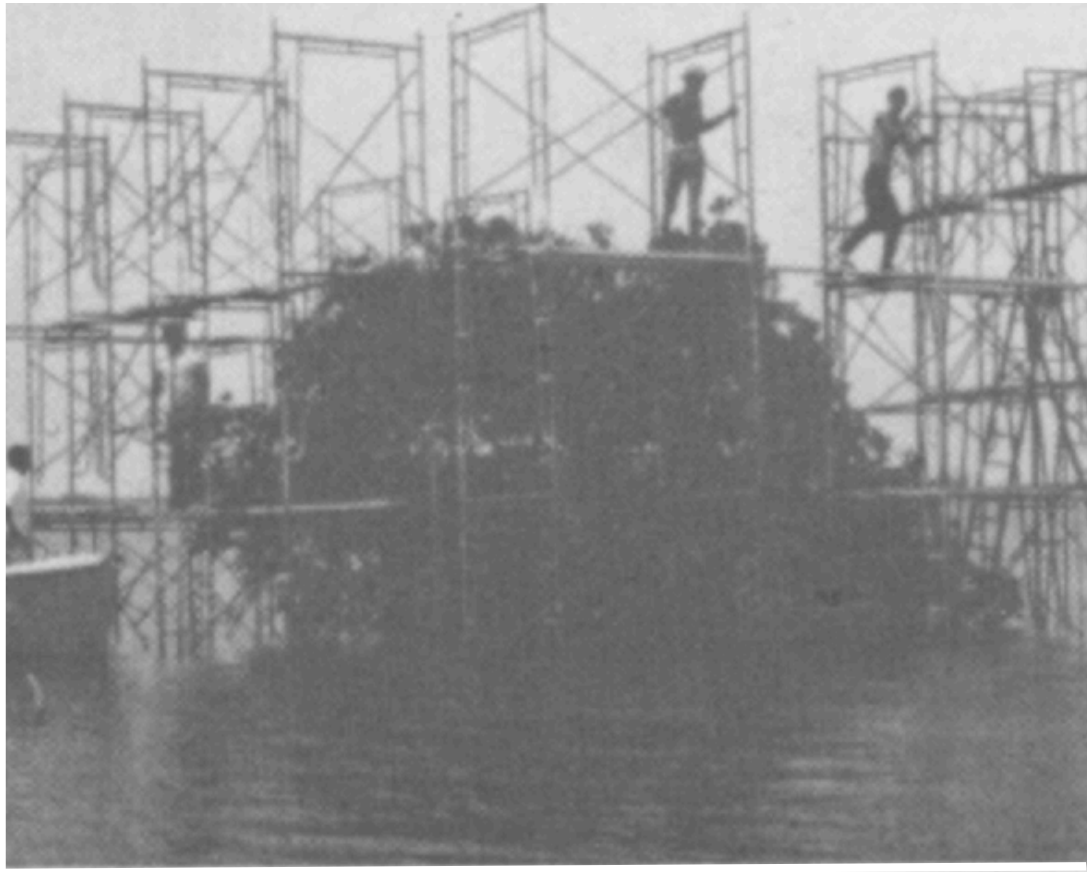
HAIRSTON'S STUDY ON SALAMANDERS

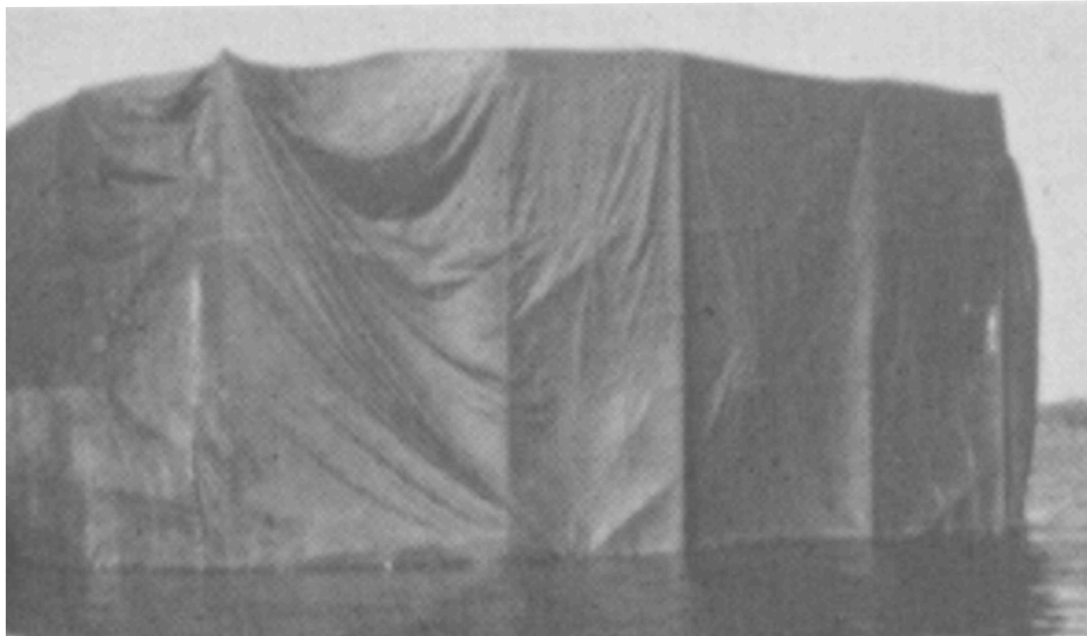
Nelson George Hairston, Sr. (1917 – 2008)

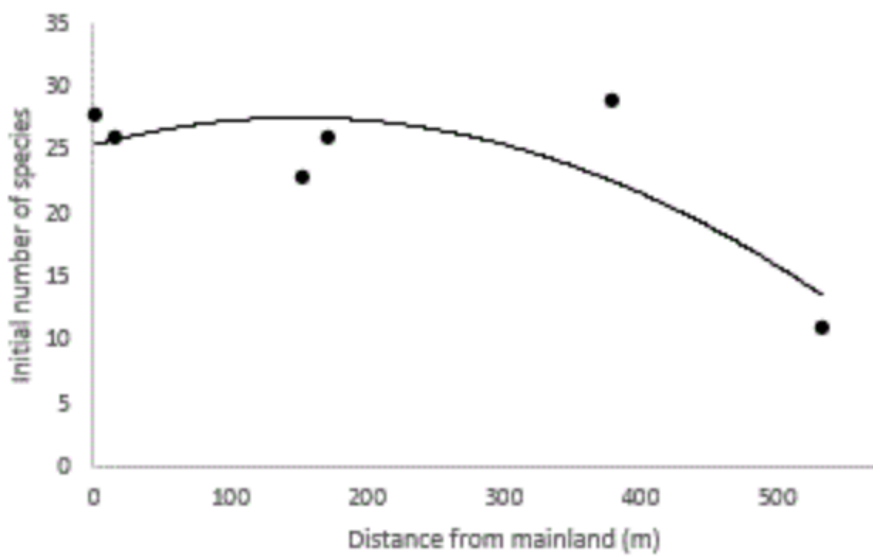
ROBERT HELMER MAC ARTHUR & EDWARD WILSON: THE THEORY OF ISLAND BIOGEOGRAPHY

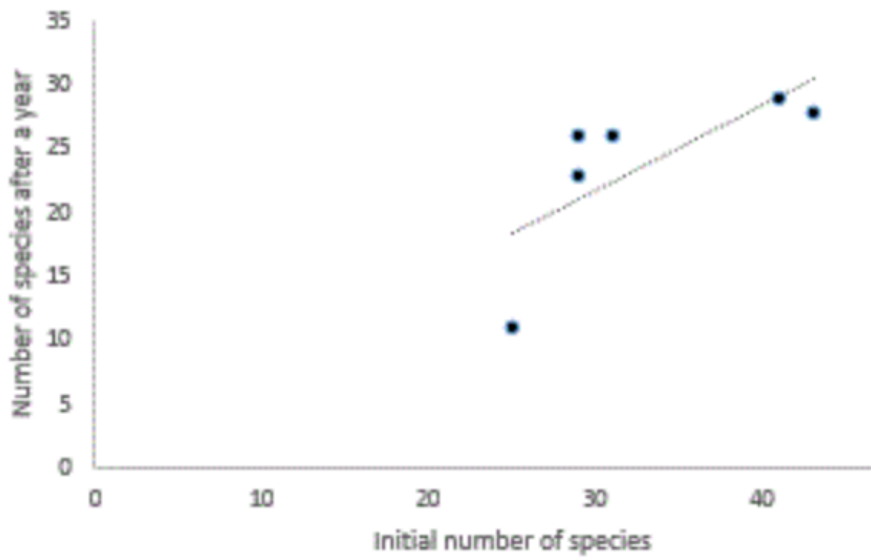
- Species richness is depends on island size and distance from continent.
- Community composition depends on extinction and colonization.
- Mac Arthur also points at competition as a main structuring force of communities.
- Develops the concept of Niche Partitionning.

SIMBERLOFF AND WILSON EXPERIMENTAL DEMONSTRATION OF MAC ARTHUR THEORY (1969)









MAIN RESULTS

JARED DIAMONDS' ASSEMBLY RULES (1975)

a. If one considers all the combinations that can be formed from a group of related species, only certain ones of these combinations exist in nature.

b. Permissible combinations resist invaders that would transform them into forbidden combinations.

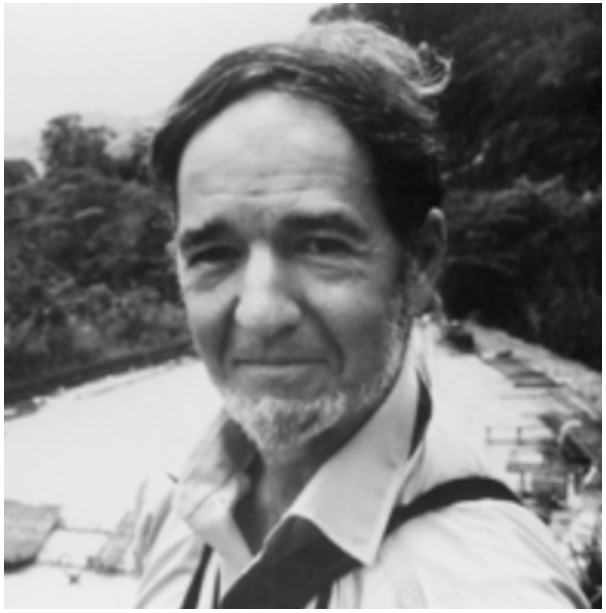
c. A combination that is stable on a large or species-rich island may be unstable on a small or species-poor island.

d. On a small or species-poor island, a combination may resist invaders that would be incorporated on a larger or more species-rich island.

e. Some pairs of species never coexist, either by themselves or as part of a larger combination.

f. Some pairs of species that form an unstable combination by themselves may form part of a stable larger combination.

g. Conversely, some combinations that are composed entirely of stable subcombinations are themselves unstable.

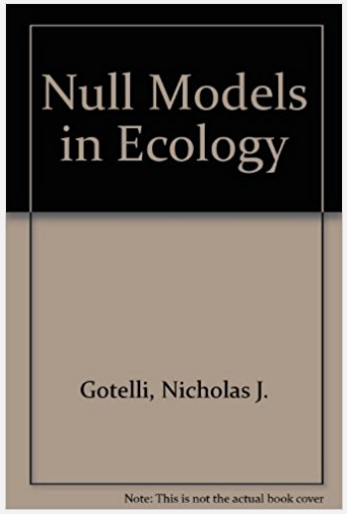


ED CONNOR & DAN SIMBERLOFF'S CRITICS OF DIAMOND'S RULES

- Rule c: Basically a statement that species-rich islands contain more combinations than species- poor islands, which seem inevitable. Therefore, Rule c is trivial.
- Rule b: The evidence for "resistance" is weak; rule then states only that permissible combinations occur and forbidden combinations do not. Therefore, Rule b is a tautology.
- Rule d: A combination of Rules b and c; therefore, Rule d is a trivial tautology.
- Rule f: Because there are no islands that contain just a pair of species, pairs cannot occur by themselves. Therefore, Rule f is untestable.
- Rules a, e, and g: Use null model analysis to show that "there is nothing about the absence of certain species pairs or trios...that would not be expected were the birds not randomly distributed over the islands...Since there are so many possible sets of species, it is to be expected that a few sets are not found on any island; this does not imply that such sets are actively forbidden by any deterministic forces."

NICK GOTELLI: THE EMERGENCE OF NULL MODELS IN ECOLOGY

"A null model is a pattern-generating model that is based on randomization of ecological data…Certain elements of the data are held constant and others are allowed to vary stochastically…The randomization is designed to produce a pattern that would be expected in the absence of a particular ecological mechanism"

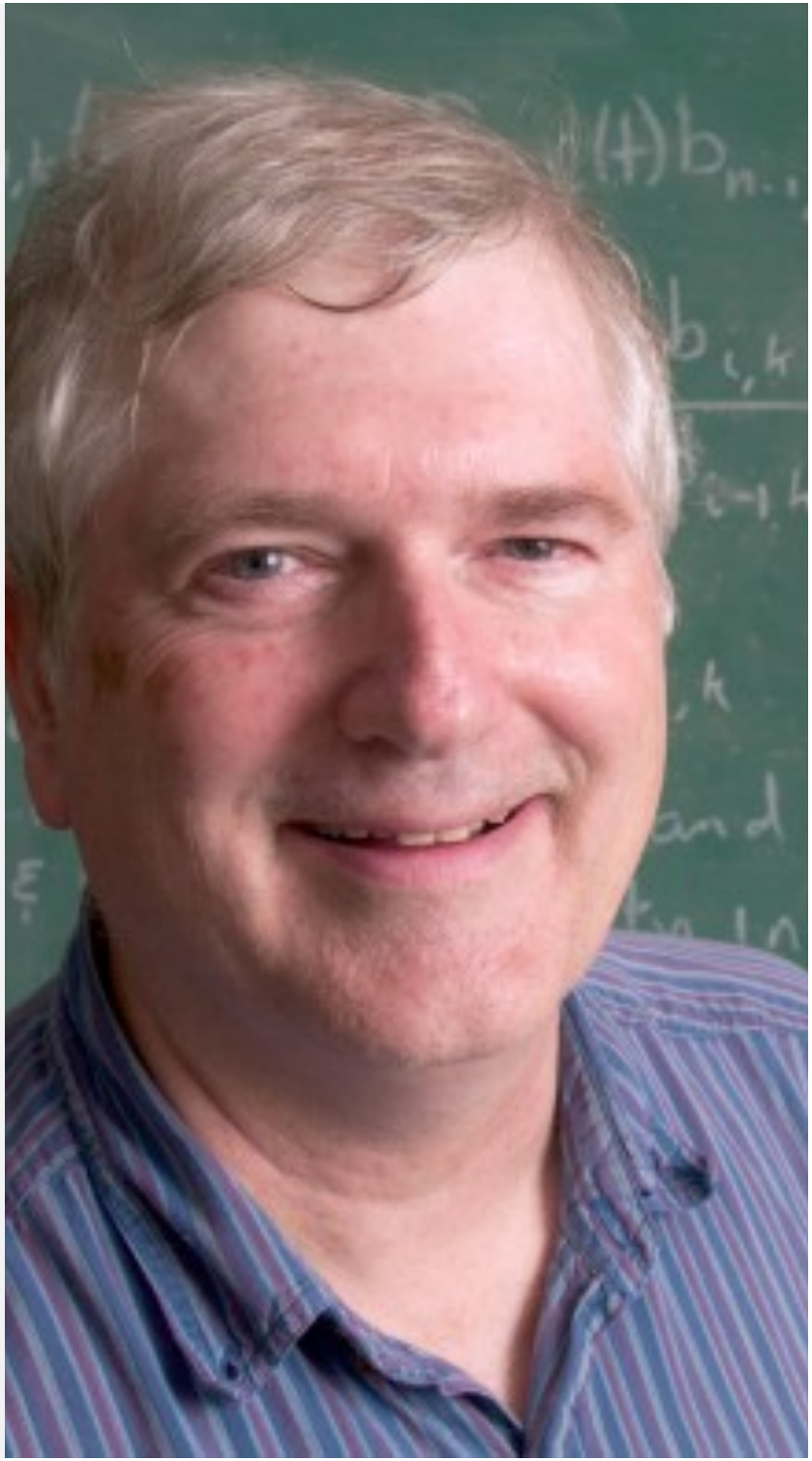


DANIEL JANZEN HYPOTHESIS OF TROPICAL TREE DIVERSITY

- Density-dependent seed predators prevent germination near the mother tree.

STEPHEN HUBBELL'S NEUTRAL THEORY

- Works on dry forest of Costa Rica:
- Species composition depends on stochastics events rather than on competition.
- A Null Model of Mac Arthur & Wilson theory.

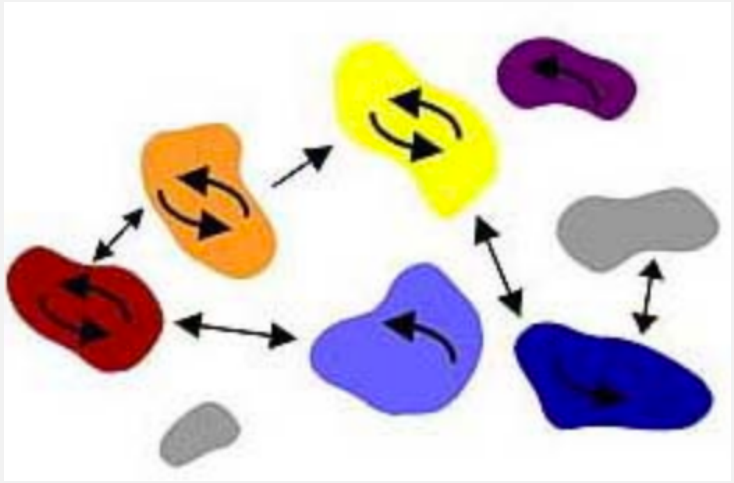


Response variable	Regression parameters			Overall r^2	Overall F value
	Intercept	Species diversity	Functional diversity		
Productivity	81.1***	−0.19NS	20.0***	0.09	14.0***
Plant % N	1.24***	−0.0003NS	−0.072***	0.11	17.15***
Plant total N	104.3***	−0.193NS	12.06*	0.02	3.61*
Soil NH_4	1.07***	0.003NS	−0.082**	0.04	5.60**
Soil NO_3	0.37***	0.001NS	−0.041***	0.09	13.4***
Light penetration	0.75***	0.0001NS	−0.040***	0.11	18.3***

DAVID TILMAN'S FUNCTIONAL DIVERSITY

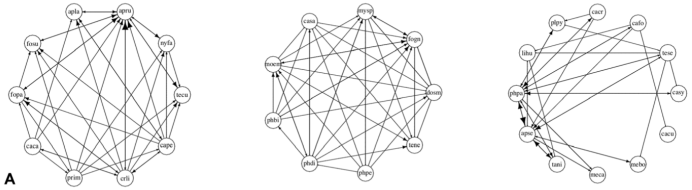
Functional diversity and composition is more important for ecosystem functioning than species composition

JOHN THOMPSON GEOGRAPHIC MOSAIC THEORY OF COEVOLUTION



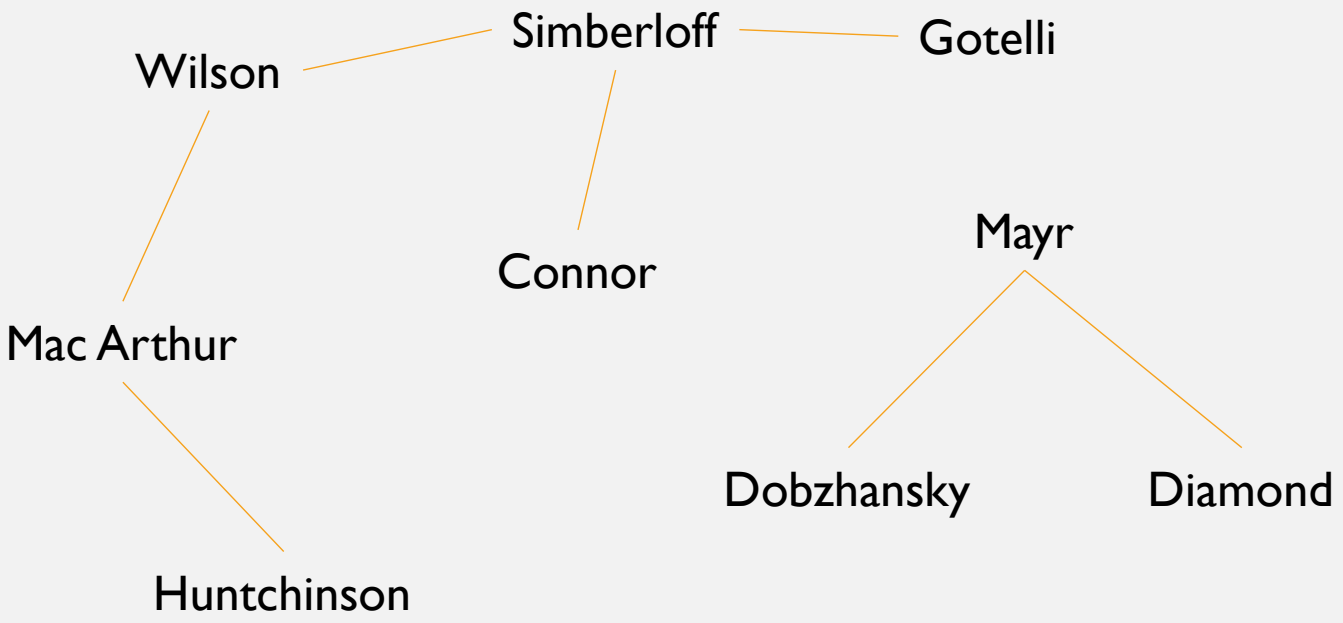
COEVOLUTION DEPENDS ON PARTNERS IDENTITY

- Where squirrels are present, cones are heavey, widder and contain few seeds.
- Where crossbills are present, cones are larger, with heavey-sick scales and more seeds



JORDI BASCOMPTE: COMMUNITIES ARE STRUCTURED IN NETWROKS OF INTERACTING SPECIES

SCIENCE ALSO IS ORGANIZED IN WEB: ALL DEPENDS ON YOUR PROFESSIONAL NETWORK



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