

群落系统发育学研究进展



中国科学院植物研究所
INSTITUTE OF BOTANY, THE CHINESE ACADEMY OF SCIENCES

米湘成 裴男才 马克平

一、生物多样性格局与群落生态学范式

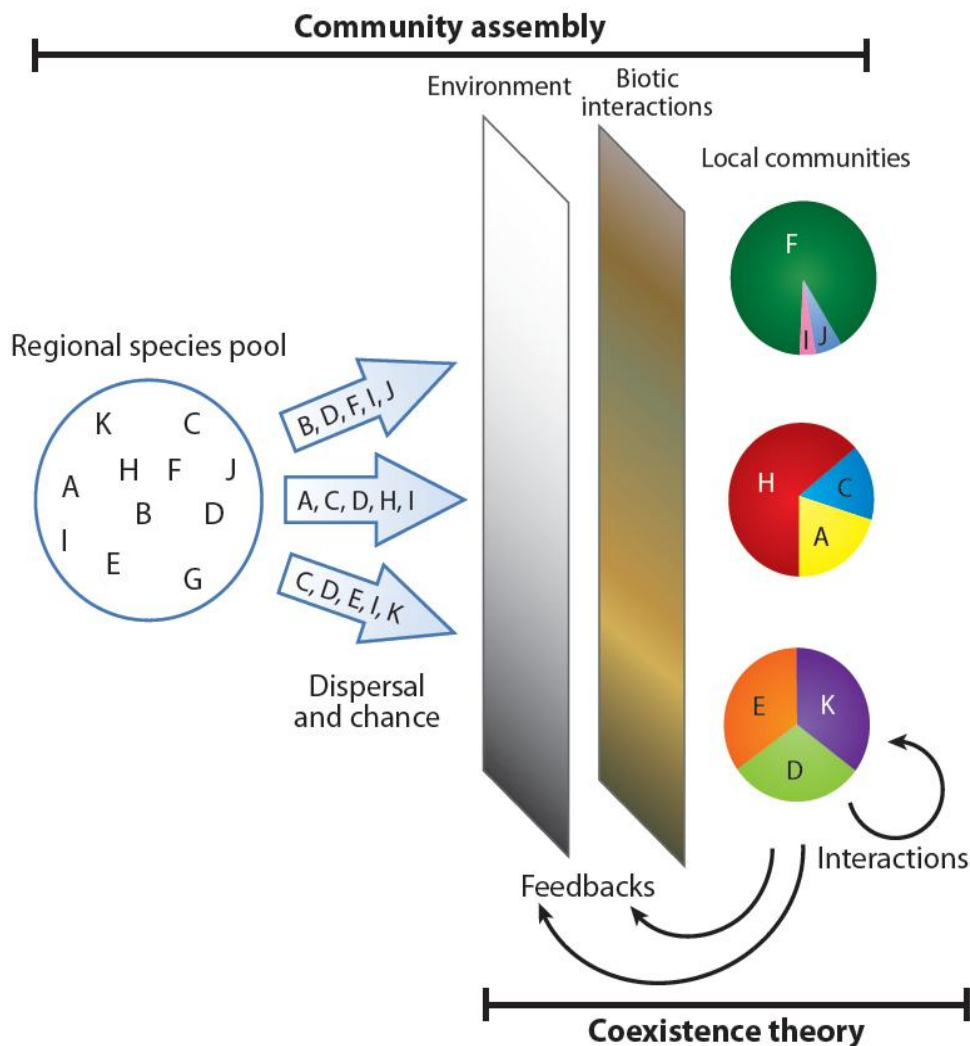
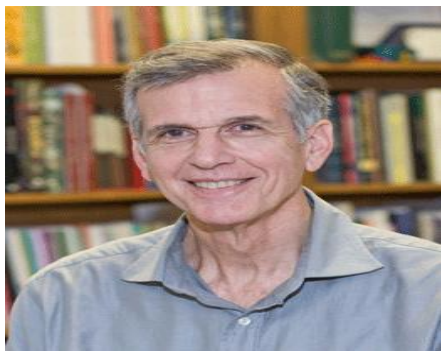
1. 生态位理论



2. 中性理论



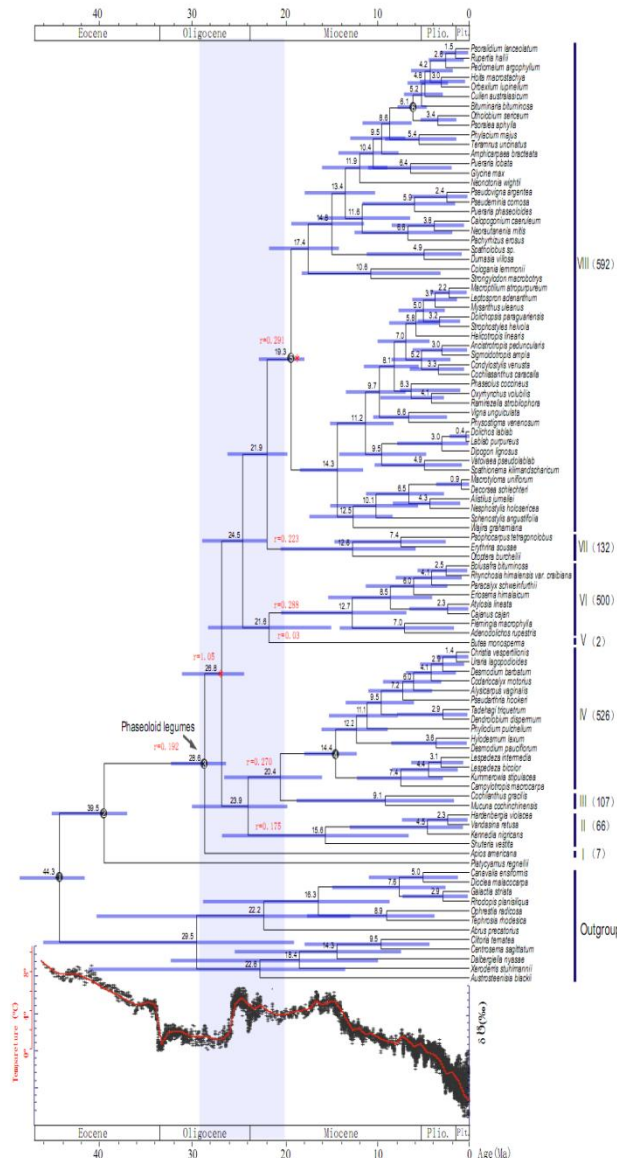
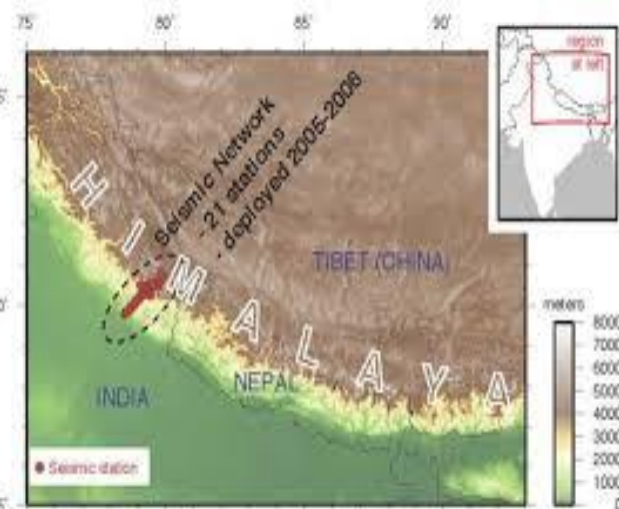
3. 种库理论



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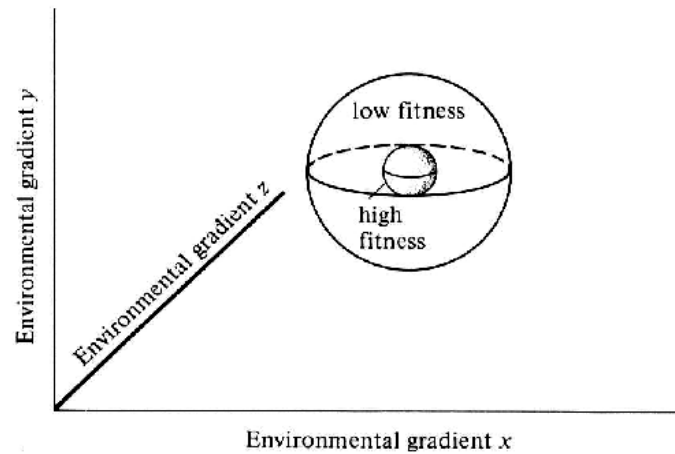
Figure 1 consists of three vertically stacked graphs, labeled (a), (b), and (c). Each graph plots 'Species richness' on the y-axis against 'Time' on the x-axis. Two curves are shown in each graph: a solid line for 'tropics' and a dashed line for 'temperate'.

- (a)** The solid line (tropics) rises steeply and then levels off at a higher value than the dashed line (temperate). The text 'species carrying capacity, $K_{\text{trop}} > K_{\text{temp}}$ ' is to the right.
- (b)** The solid line (tropics) rises more steeply than the dashed line (temperate). The text 'diversification rate, $\lambda - \mu_{\text{trop}} > \lambda - \mu_{\text{temp}}$ ' is to the right.
- (c)** The solid line (tropics) rises more steeply than the dashed line (temperate). An arrow points to the x-axis at the point where the dashed line reaches the same richness as the solid line. The text 'time for diversification, $T_{\text{trop}} > T_{\text{temp}}$ ' is to the right.





Evelyn Hutchinson



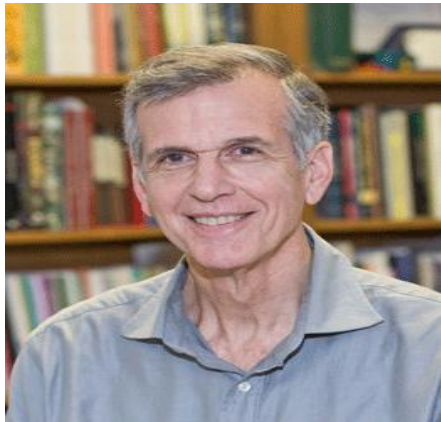
VOL. 172, NO. 6 THE AMERICAN NATURALIST DECEMBER 2008



中国科学院植物研究所
INSTITUTE OF BOTANY, THE CHINESE ACADEMY OF SCIENCES

Disintegration of the Ecological Community

American Society of Naturalists Sewall Wright Award Winner Address*



Robert E Ricklefs

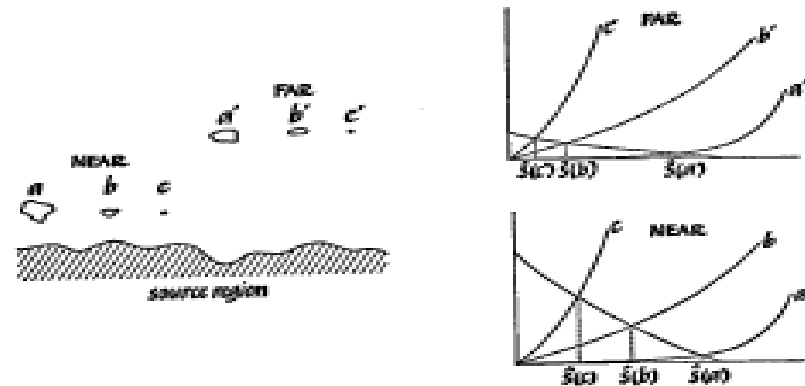
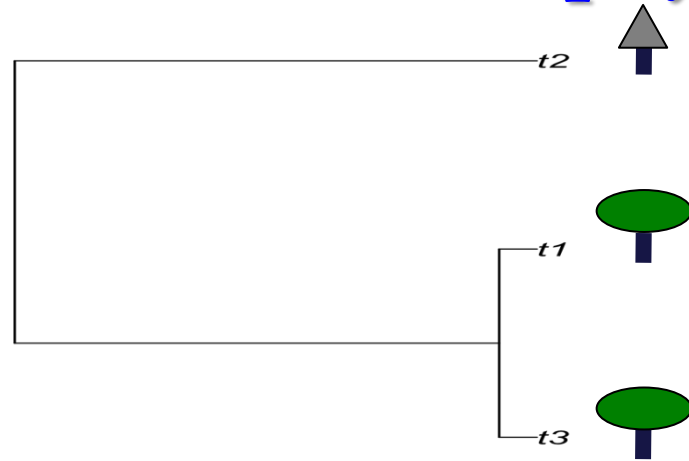


FIGURE 12. Diagram contrasting near and far archipelagos within which island area varies. The number of species increases with area more rapidly on the far archipelago. In this case the scale of the abscissa is in absolute number of species; the relationship becomes more nearly universal when the scale is made logarithmic.

群落谱系学提供的新见解

系统发育保守性(phylogenetic conservatism)



亲缘关系相近的物种
具有相似的生态位

nature

Vol 458|9 April 2009|doi:10.1038/nature07764

LETTERS

Phylogenetic biome conservatism on a global scale

Michael D. Crisp¹, Mary T. K. Arroyo², Lyn G. Cook³, Maria A. Gandolfo⁴, Gregory J. Jordan⁵, Matt S. McGlone⁶, Peter H. Weston⁷, Mark Westoby⁸, Peter Wilf⁹ & H. Peter Linder¹⁰

LETTERS

Ecological interactions are evolutionarily conserved across the entire tree of life

José M. Gómez¹, Miguel Verdú² & Francisco Perfectti³

1. 增加系统发育关系精度

Molecular Ecology Notes (2005) 5, 181–183

doi: 10.1111/j.1471-8286.2004.00829.x

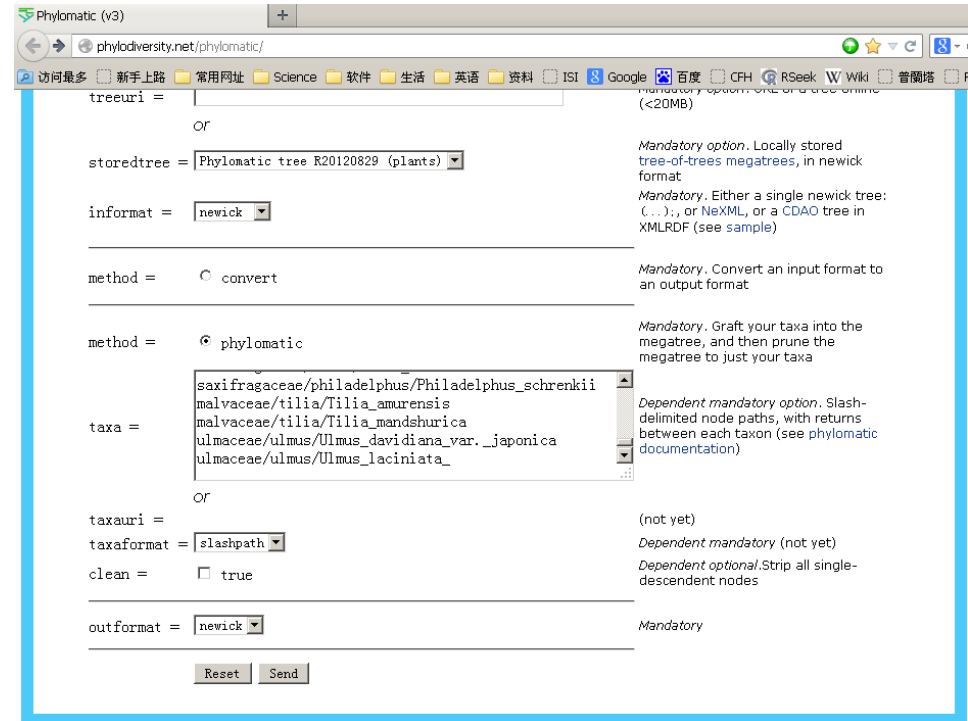
PROGRAM NOTE

Phylomatic: tree assembly for applied phylogenetics

CAMPBELL O. WEBB and MICHAEL J. DONOGHUE

Department of Ecology and Evolutionary Biology, Yale University, Box 208106, New Haven, CT 06520–8106

<http://phylodiversity.net/phyloomatic/>



The screenshot shows the Phylomatic (v3) web interface in a browser window. The URL bar shows phylodiversity.net/phyloomatic/. The interface includes several input fields and options:

- treeuri =** (empty text box)
- OR**
- storedtree =** **Phylomatic tree R20120829 (plants)** (dropdown menu)
- informat =** **newick** (dropdown menu)
- method =** ☐ **convert**
- method =** ☒ **phyloomatic**
- taxa =** **saxifragaceae/philadelphus/Philadelphus_schrenkii**
malvaceae/tilia/Tilia_amurensis
malvaceae/tilia/Tilia_mandshurica
ulmaceae/ulmus/Ulmus_davidiana_var._japonica
ulmaceae/ulmus/Ulmus_laciniata (text box with a list of taxa)
- OR**
- taxauri =** (empty text box)
- taxaformat =** **slashpath** (dropdown menu)
- clean =** ☐ **true**
- outformat =** **newick** (dropdown menu)

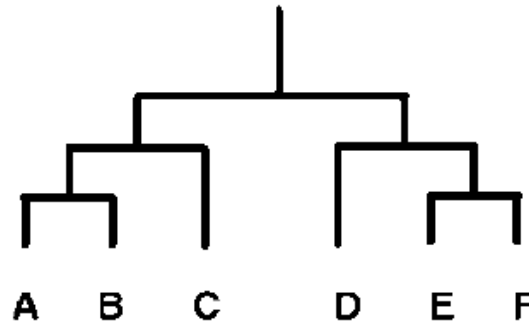
Buttons at the bottom: **Reset** and **Send**.

Help text on the right side of the form:

- Mandatory option. Locally stored tree-of-trees megatrees, in newick format**
- Mandatory. Either a single newick tree: C...), or NeXML, or a CDAO tree in XMLRDF (see sample)**
- Mandatory. Convert an input format to an output format**
- Mandatory. Graft your taxa into the megatree, and then prune the megatree to just your taxa**
- Dependent mandatory option. Slash-delimited node paths, with returns between each taxon (see phylomatic documentation)**
- (not yet)**
- Dependent mandatory (not yet)**
- Dependent optional. Strip all single-descendant nodes**
- Mandatory**

Phylogeny

Community Phylogeny



Community 1: A, B, C, D

Nodal distances:

	A	B	C	D
A		1	2	4
B			2	4
C				3

Community 2: A, B, E, F

Nodal distances:

	A	B	E	F
A		1	5	5
B			5	5
E				1

Phylogenetic Distance Matrix

MPD

MNTD

Mean *pairwise* nodal distance =
 $(1 + 2 + 4 + 2 + 4 + 3) / 6$
 = 2.66

Mean *pairwise* nodal distance =
 $(1 + 5 + 5 + 5 + 5 + 1) / 6$
 = 3.66

Mean *nearest* nodal distance =
 $(1 + 1 + 2 + 3) / 4 = 1.75$

Mean *nearest* nodal distance =
 $(1 + 1 + 1 + 1) / 4 = 1.0$

Webb, 2000. American Naturalist

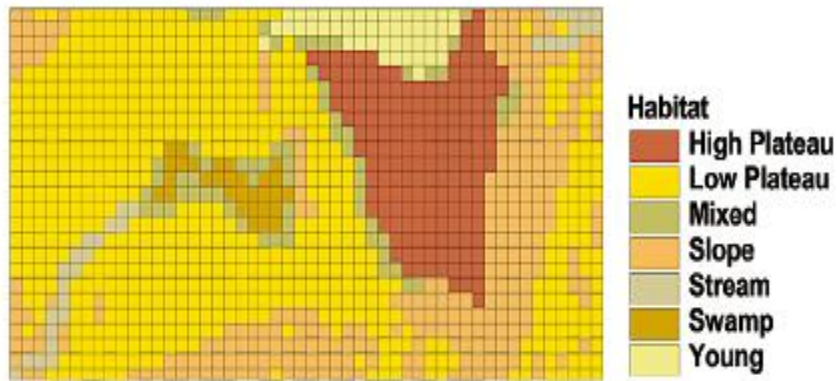
群落分子系统发育树的建立

Plant DNA barcodes and a community phylogeny of a tropical forest dynamics plot in Panama

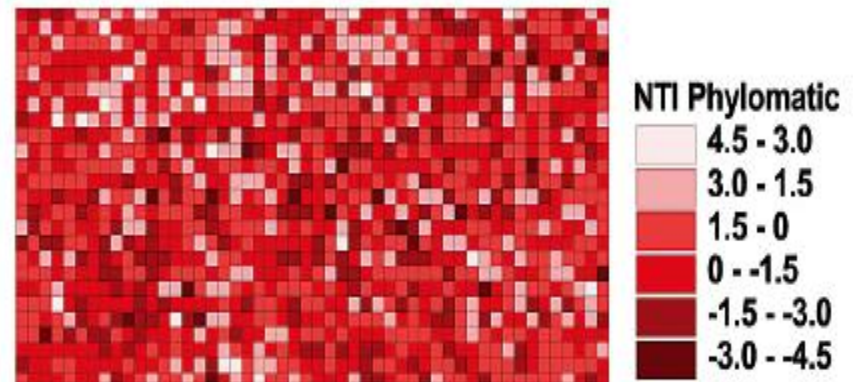
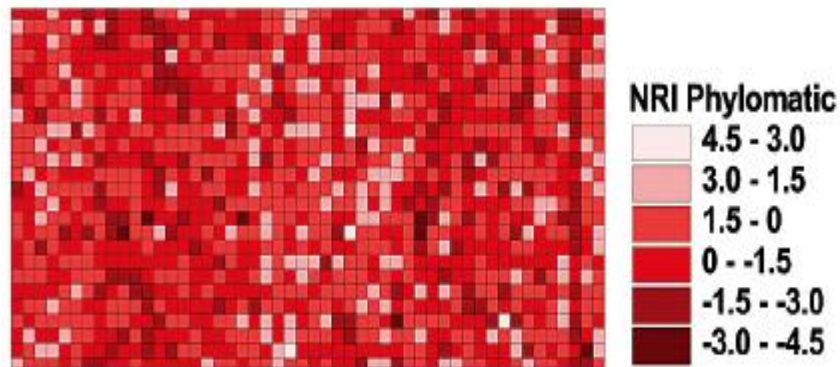
W. John Kress^{a,1}, David L. Erickson^a, F. Andrew Jones^{b,c}, Nathan G. Swenson^d, Rolando Perez^b, Oris Sanjurjo^b, and Eldredge Bermingham^b

^aDepartment of Botany, MRC-166, National Museum of Natural History, Smithsonian Institution, P.O. Box 37012, Washington, DC 20013-7012; ^bSmithsonian Tropical Research Institute, P.O. Box 0843-03092, Balboa Ancón, Republic of Panamá; ^cImperial College London, Silwood Park Campus, Buckhurst Road, Ascot, Berkshire SL5 7PY, United Kingdom; and ^dCenter for Tropical Forest Science - Asia Program, Harvard University Herbaria, 22 Divinity Avenue, Cambridge, MA 02138

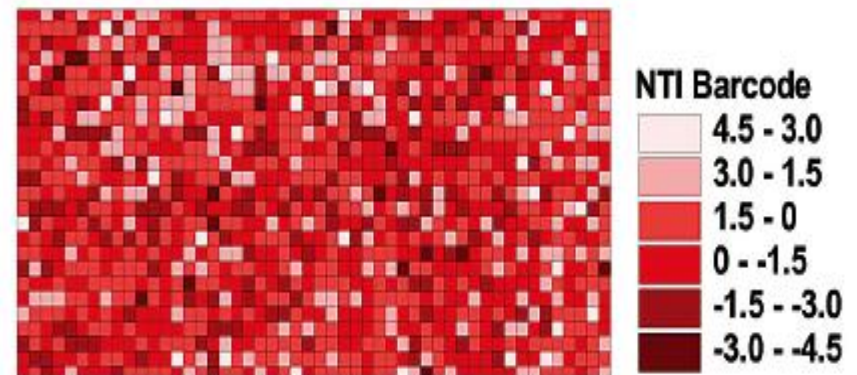
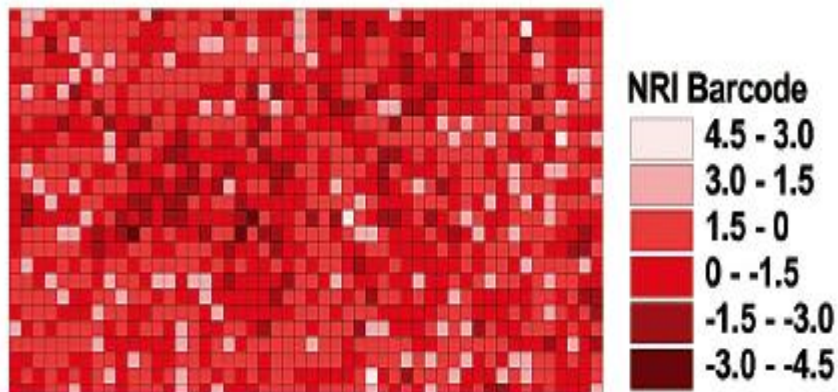
通过对rbcL、matK、trnH-psbA和ITS四对基因的测序，利用分子信息学手段，可以精确测定群落内种间的亲缘关系



低精度的系统发育树容易
产生假发散的结果！



Kembel & Hubbell, 2006. Ecology



NRI

NTI

Kress et al., 2009. PNAS

Phylogenetic Overdispersion in Floridian Oak Communities

J. Cavender-Bares,^{1,2,*} D. D. Ackerly,^{3,†} D. A. Baum,^{4,‡} and E. A. Bazzaz^{2,§}

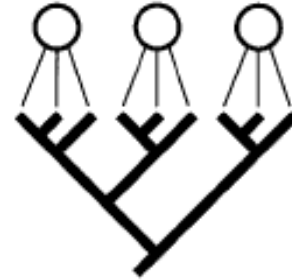
2. 群落系统发育结构逻辑框架

Measure
community
phylogenetic
metric (i.e. mpd)

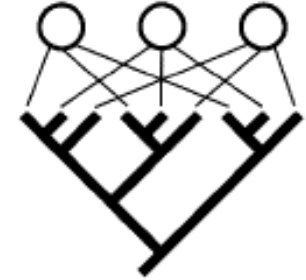
Measure
phylogenetic
signal in trait data

Measure
community
functional
diversity metric (i.e.
mpd with trait
dendrogram)

A
Communities
or Niches
Phylogeny

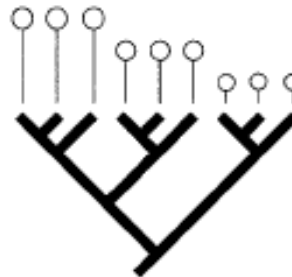


Phylogenetic clustering

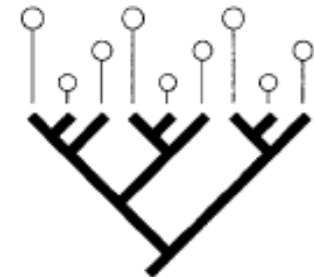


Phylogenetic overdispersion

B
Traits
(or Habitats)
Phylogeny

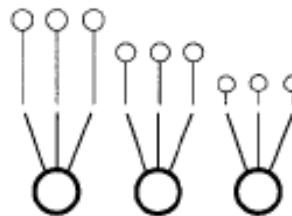


Trait conservatism

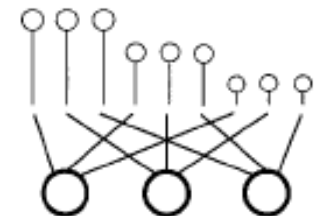


Trait convergence

C
Traits
Communities
or Niches



Phenotypic clustering



Phenotypic overdispersion

2. 群落系统发育结构逻辑框架

Trait similarity within communities

Clustering of traits

Overdispersion of traits

(driven by environmental filtering)

(driven by competitive interactions)

Trait evolution	Trait similarity within communities	
	Clustering of traits (driven by environmental filtering)	Overdispersion of traits (driven by competitive interactions)
Conserved	Phylogenetic clustering	Phylogenetic overdispersion
Convergent	Phylogenetic overdispersion	Phylogenetic clustering or random dispersion

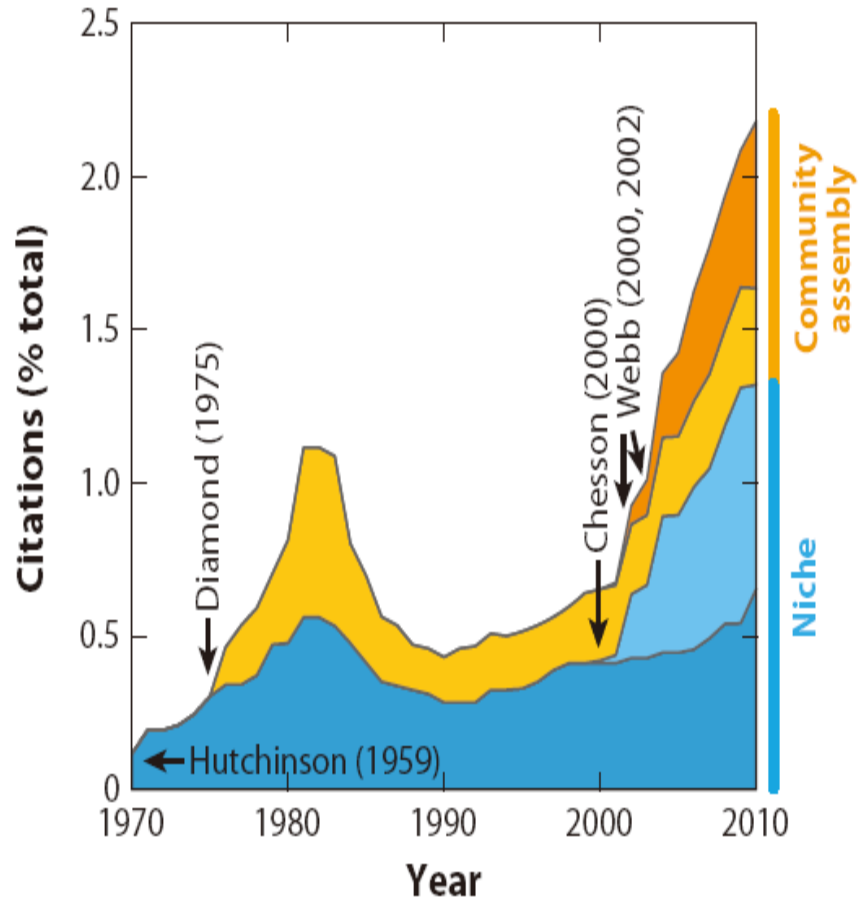
Cavender-Bare et al. 2004. American Naturalist

2. 群落系统发育发育结构逻辑框架

		Trait similarity within communities		Randomness of traits (driven by neutral process)
		Clustering of traits (driven by environmental filtering)	Overdispersion of traits (driven by competitive interactions)	
Trait evolution	Conserved	Phylogenetic clustering	Phylogenetic overdispersion	Phylogenetic randomness
	Convergent	Phylogenetic overdispersion	Phylogenetic clustering or random dispersion	Phylogenetic randomness

Cavender-Bare et al. 2004. American Naturalist

Kraft et al. 2007. American Naturalist



Disturbed old fields (Canada)	u	Dinnage 2009
California plant communities ^a	o, u	Cadotte et al. 2010
Brazilian cerrado	u	Silva & Batalha 2009
Bornean rainforest	u	Webb 2000
Amazonian forests ^a (Peru)	o, u	Fine & Kembel 2011
Neotropical forests ^a (Panama)	o, u	Kembel & Hubbell 2006
Subtropical forests ^a (China)	o, u	Pei et al. 2011
Tropical forests (Panama, Puerto Rico, Costa Rica)	o, u	Swenson et al. 2007
Costa Rican secondary forests	o	Letcher 2010

3. 群落系统发育发育结构和功能结构



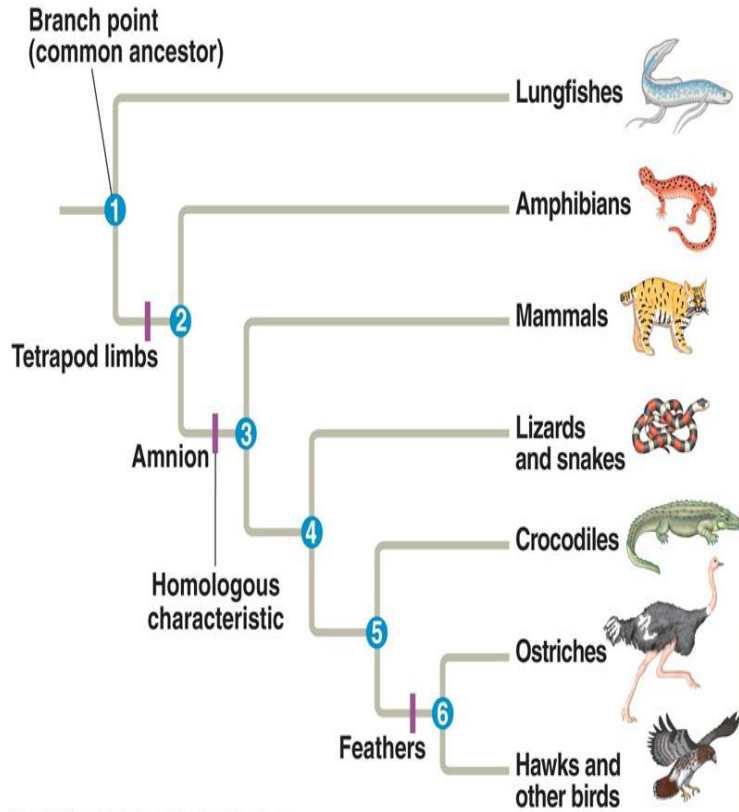
中国科学院植物研究所
INSTITUTE OF BOTANY, THE CHINESE ACADEMY OF SCIENCES

Contingency and Determinism in Replicated Adaptive Radiations of Island Lizards

Jonathan B. Losos,* Todd R. Jackman, Allan Larson,
Kevin de Queiroz, Lourdes Rodríguez-Schettino



4. 群落系统发育结构与零模型

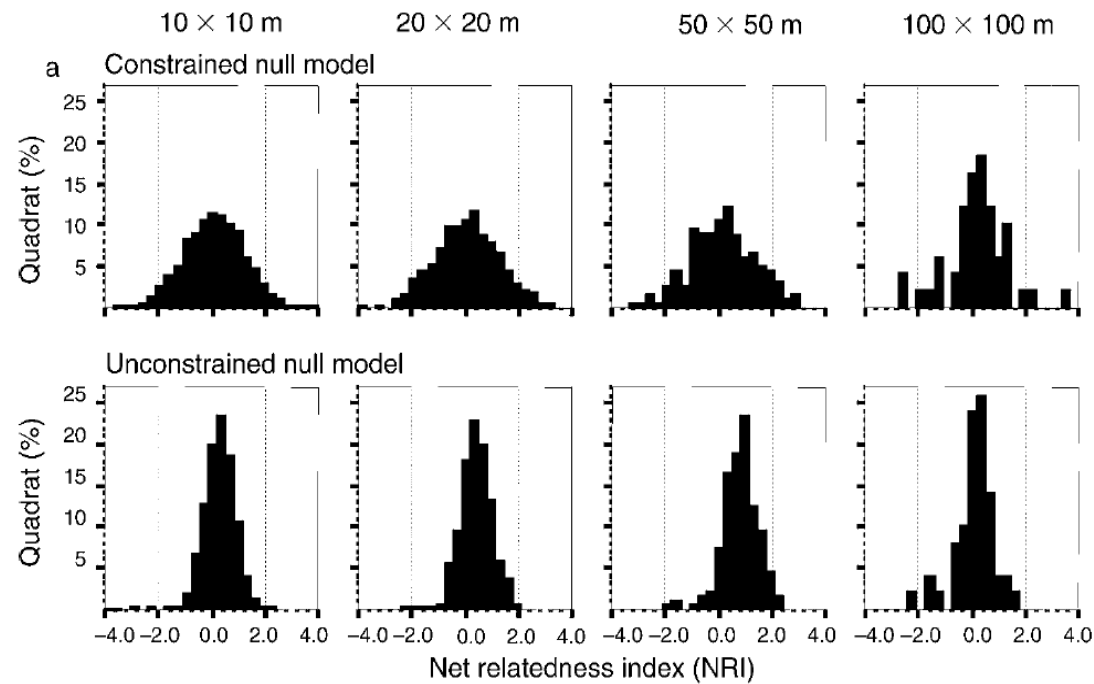
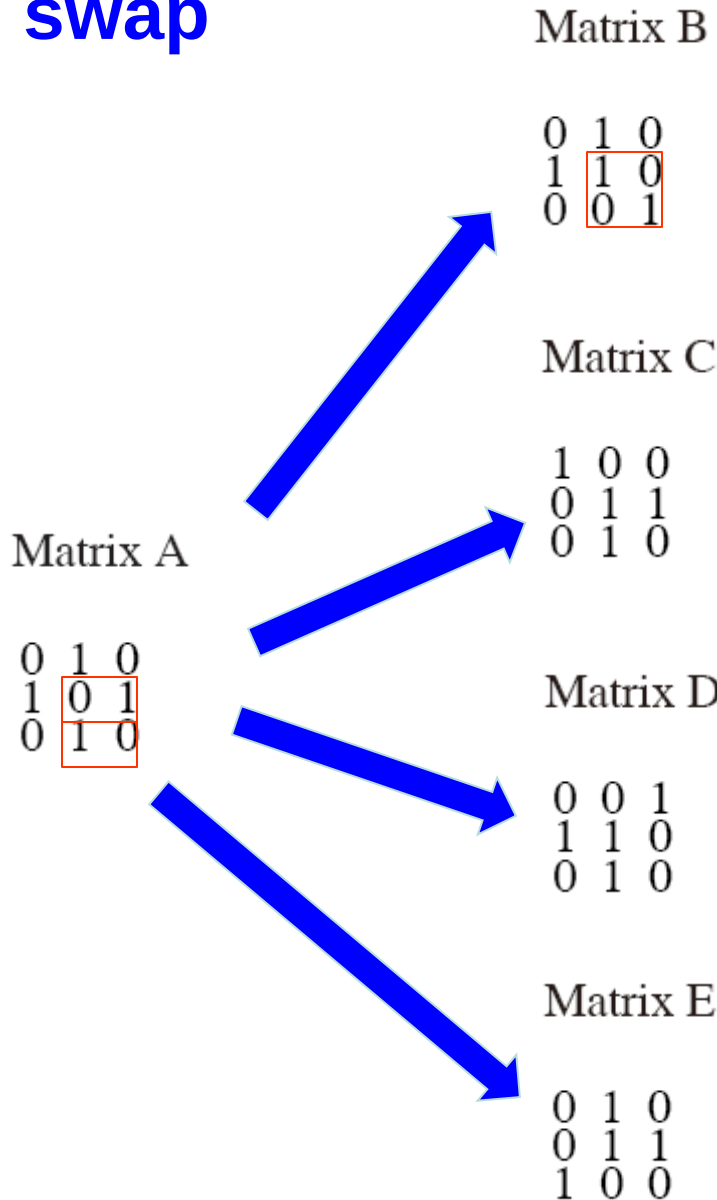


Random drawing



Random Shuffling

Independence swap

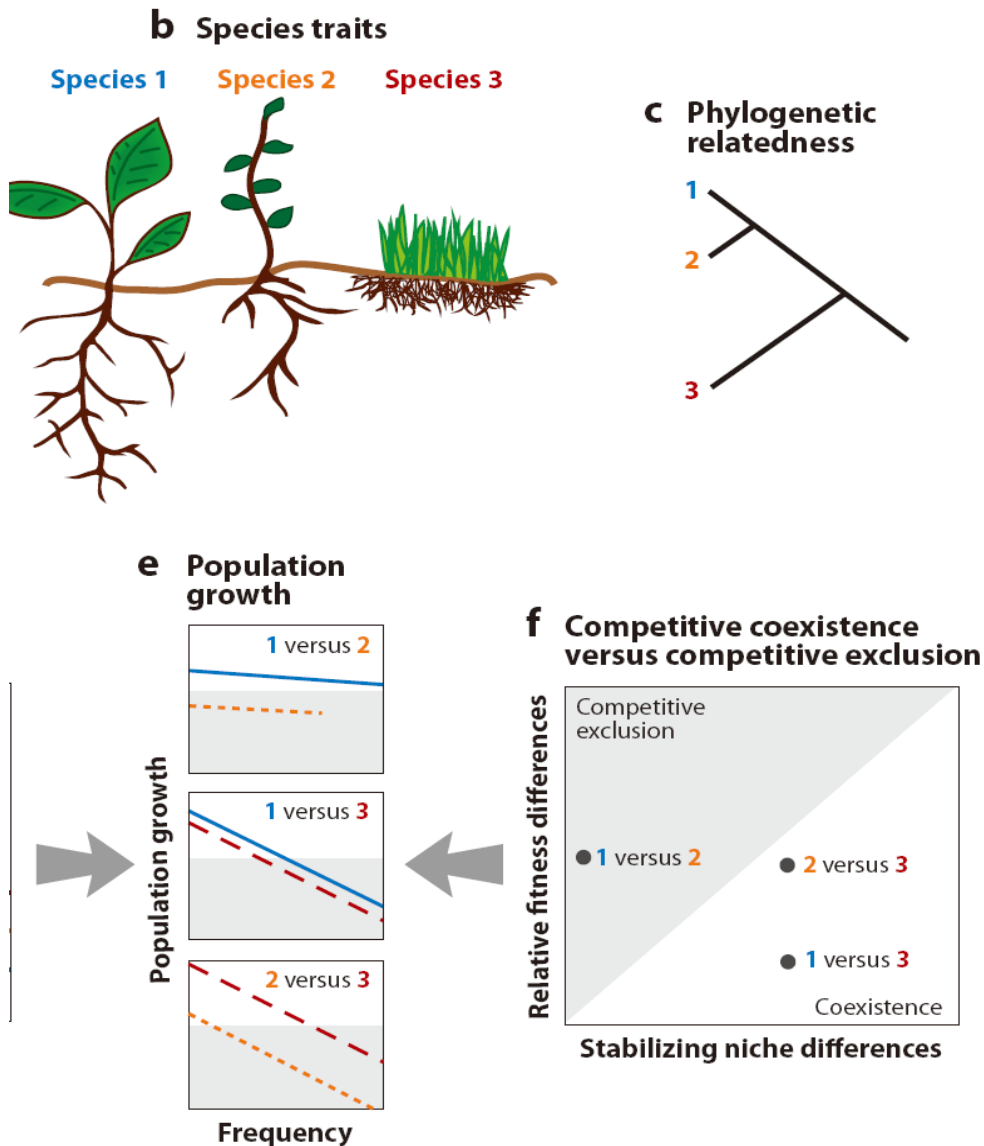


Kembel & Hubbell 2006. Ecology

Metric	Null model								
	1s	1p	1a	2s	2p	2x	3x	3i	3t
<i>MNTD</i> (one site)	60	118	8	58	121	7	6	90	89
<i>MPD</i> (one site)	204	364	12	203	364	7	6	39	41
<i>mMNTD</i>	266	340	23	445	509	109	111	336	285
<i>mMPD</i>	394	419	47	515	594	132	133	261	217
D_W^p	395	400	23	480	581	419	409	518	478
Π_{ST}	148	207	11	217	233	132	133	261	217
B_{ST}	33	73	11	70	91	169	163	54	18
R_{PD-CA}	385	393	69	422	516	239	269	270	207
R_{PD-CO}	384	392	30	411	502	280	281	305	231
R_{PD-RA}	174	161	6	247	403	42	57	44	31
R_{PD-RO}	145	166	14	191	342	47	50	242	237
R_{PD-DO}	14	15	5	15	207	9	10	54	54

Hardy 2008. Journal of Ecology

6. 群落系统发育结构逻辑框架 与现代物种共存理论



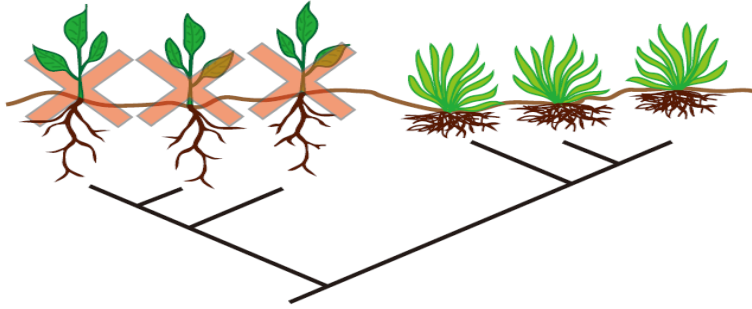
稳定生态位差异：引起种内竞争大于种间竞争的因素；

相对适合度差异：在没有稳定生态位差异的情况下种间竞争能力的差异；

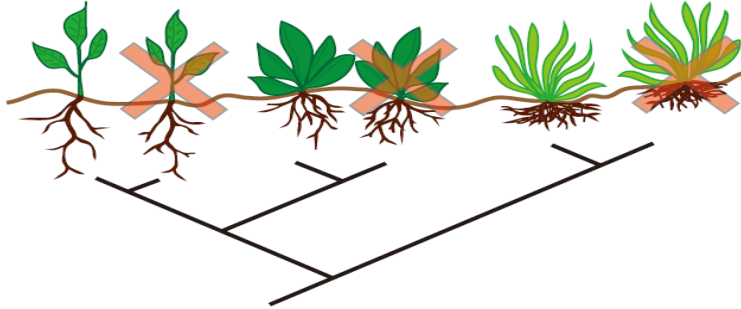
HillResLumber. 2012. Ann Rev
Eco Evo Sys

3. 群落系统发育结构逻辑框架 与现代物种共存理论

a Traits and phylogenetic relatedness clustered



b Traits and phylogenetic relatedness overdispersed



Niche differences

Unimportant or
unrelated to
phylogeny

Important and
positively correlated with
phylogenetic distance

Competitive ability differences
Unimportant or
positively correlated with
phylogenetic distance

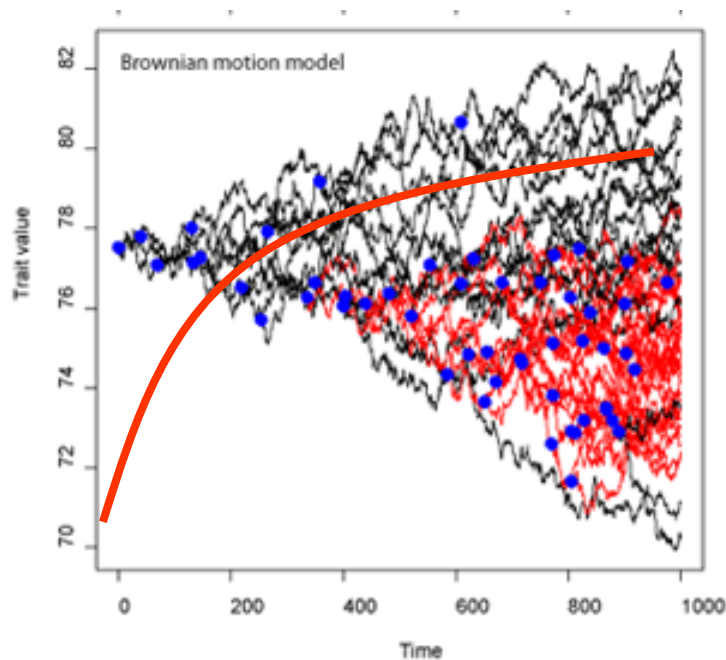
Unimportant or positively correlated with phylogenetic distance	Unimportant or unrelated to phylogeny	Competitive exclusion is random with respect to phylogeny	Competitive exclusion favors overdispersion
Unimportant or positively correlated with phylogenetic distance	Important and positively correlated with phylogenetic distance	Competitive exclusion favors clustering	Competitive exclusion can favor clustering or overdispersion

Mayfield and Levine et al. 2010. Ecology Letters

三. 群落系统发育学的优点和缺点

缺点:

1. 群落系统发育结构
还受裸子植物的影响;
2. 不同进化阶段分支代表性
不一样;



小心掉入错误的泥坑!

优点:

1. 可能比功能性状信息量大;
(Cadotte et al. 2008. PNAS)
2. 手段简便;

What's the next step?

1. The flood of genetic data will be little use to evolutionary biologists unless the ecologist context of the organism's place in its environment is well understood. Ecologists still have tremendous amounts of the ecological work head to develop a comprehensive understanding of **the ecological dynamics of evolutionary processes at both the micro and macro scales.**

What's the next step?

2. There is still a lack of fundamental understanding of how ecological interactions with the abiotic environment as well as within and among species generate the evolutionary dynamics of natural selection in turn shape broader ecological patterns of species distributions and abundances.

McPeck 2010. Ecology in evolutionary biology

