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

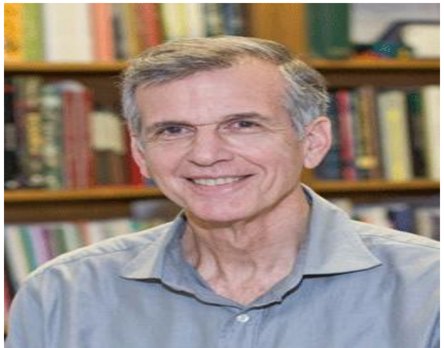
米湘成 裴男才 马克平

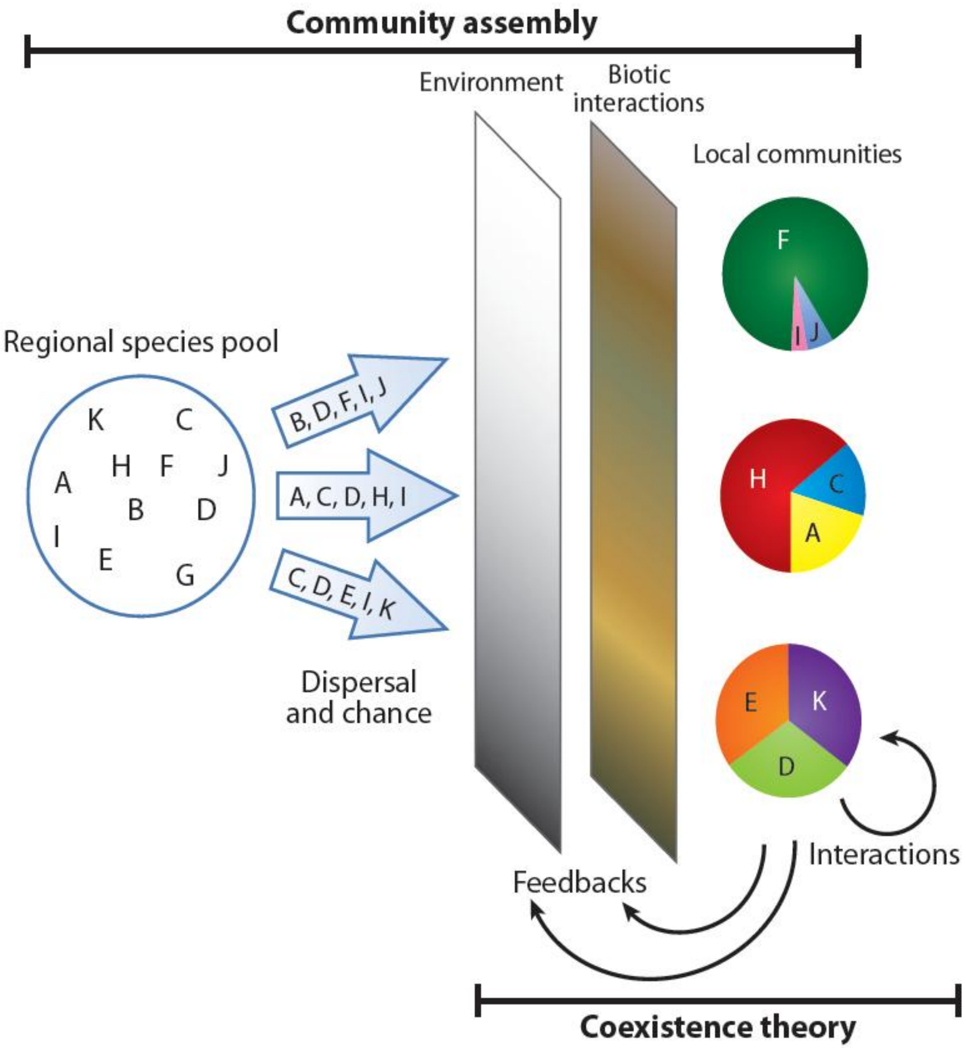
一、生物多样性格局与群落生态学范式

1. 生态位理论

2. 中性理论

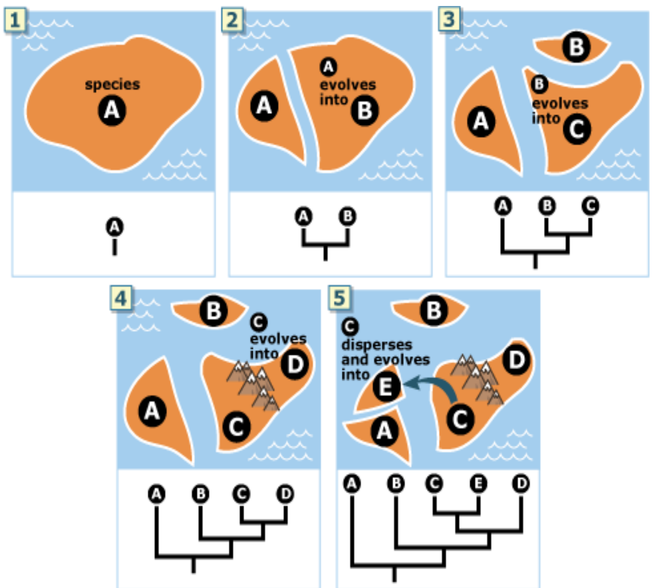
3. 种库理论

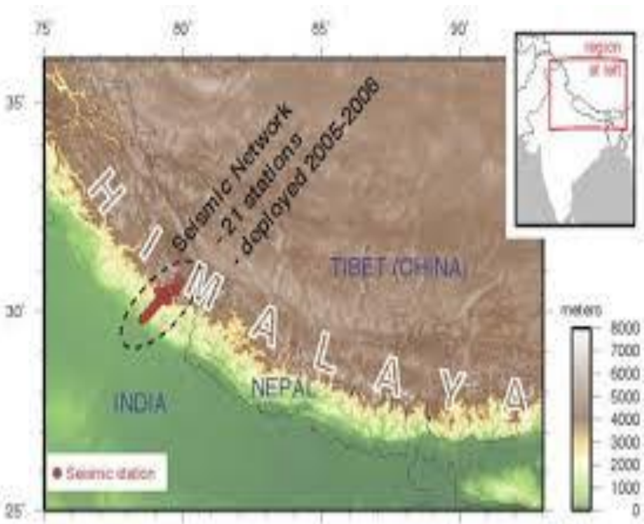


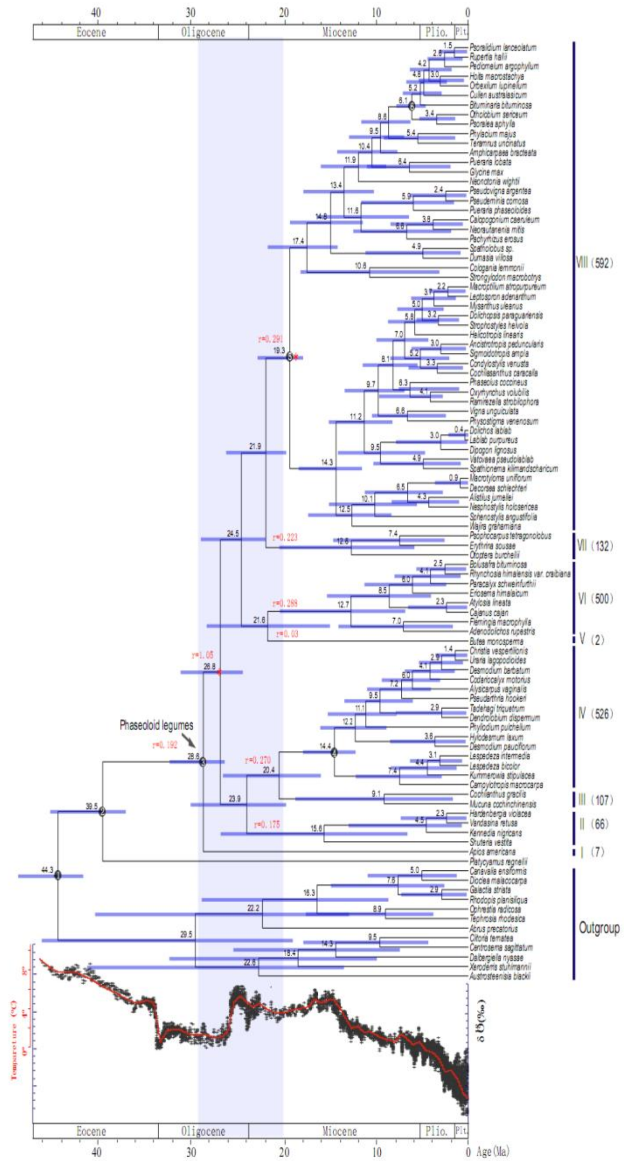


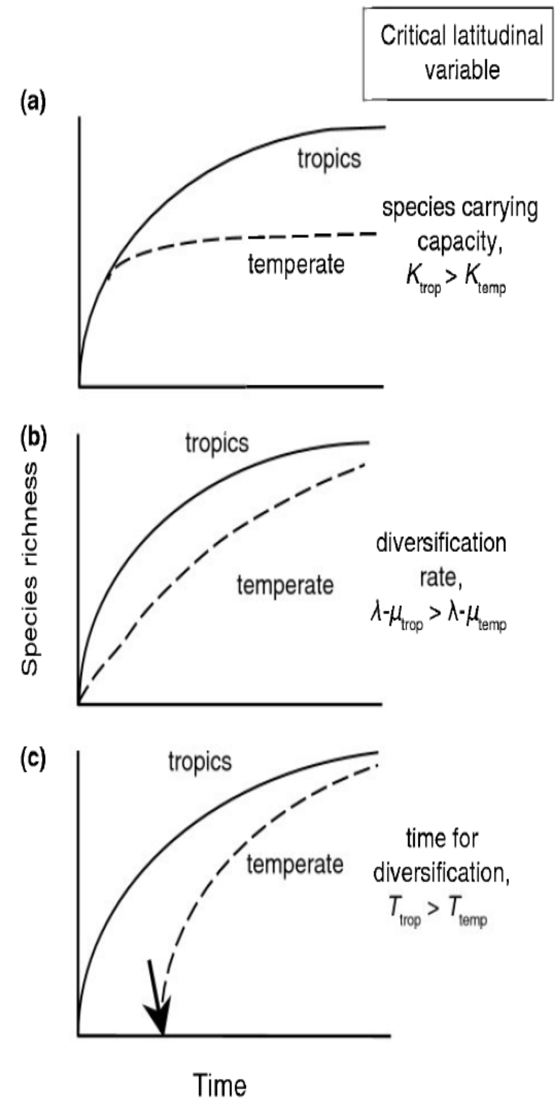
HilleRisLambers et al.2012.
Annu. Rev. Ecol. Evol. Syst

进化生物学与生物多样性

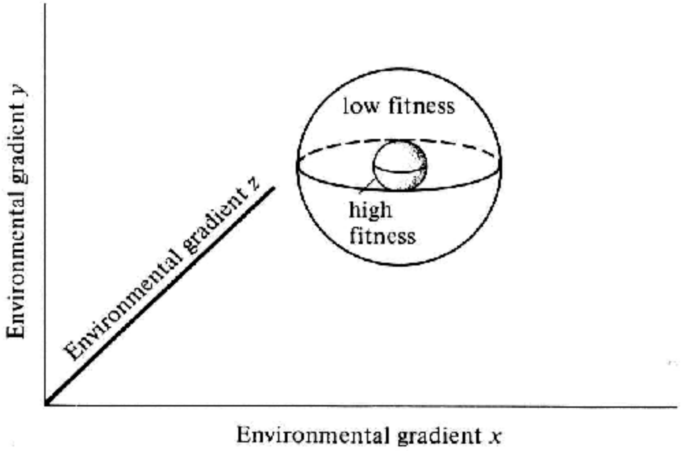








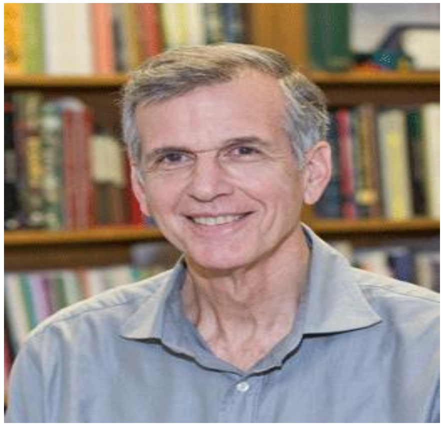
Evelyn Hutchinson



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

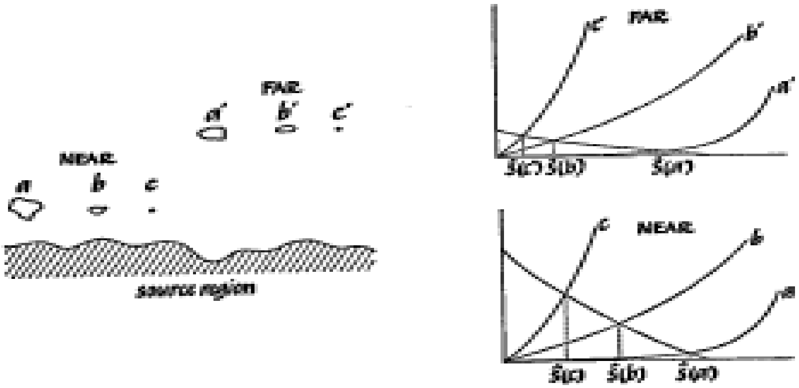
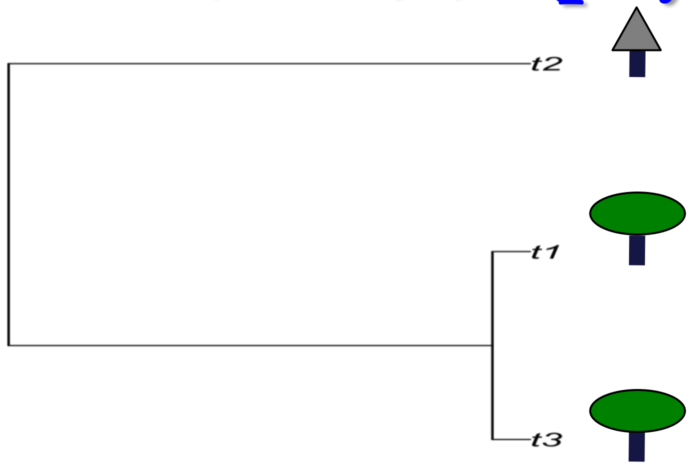


FIGURE 12. Diagram contrasting near and far archipelagos within which island area varies. The number of species increases with area more rapidly on the far archipelago. In this case the scale of the abscissa is in absolute number of species; the relationship becomes more nearly universal when the scale 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. Crisp[1], Mary T. K. Arroyo[2], Lyn G. Cook[3], Maria A. Gandolfo[4], Gregory J. Jordan[5], Matt S. McGlone[6], Peter H. Weston[7], Mark Westoby[8], Peter Wilf[9] & H. Peter Linder[10]

LETTERS

Ecological interactions are evolutionarily conserved across the entire tree of life

José M. Gómez[1], Miguel Verdú[2] & Francisco Perfectti[3]

1. 增加系统发育关系精度

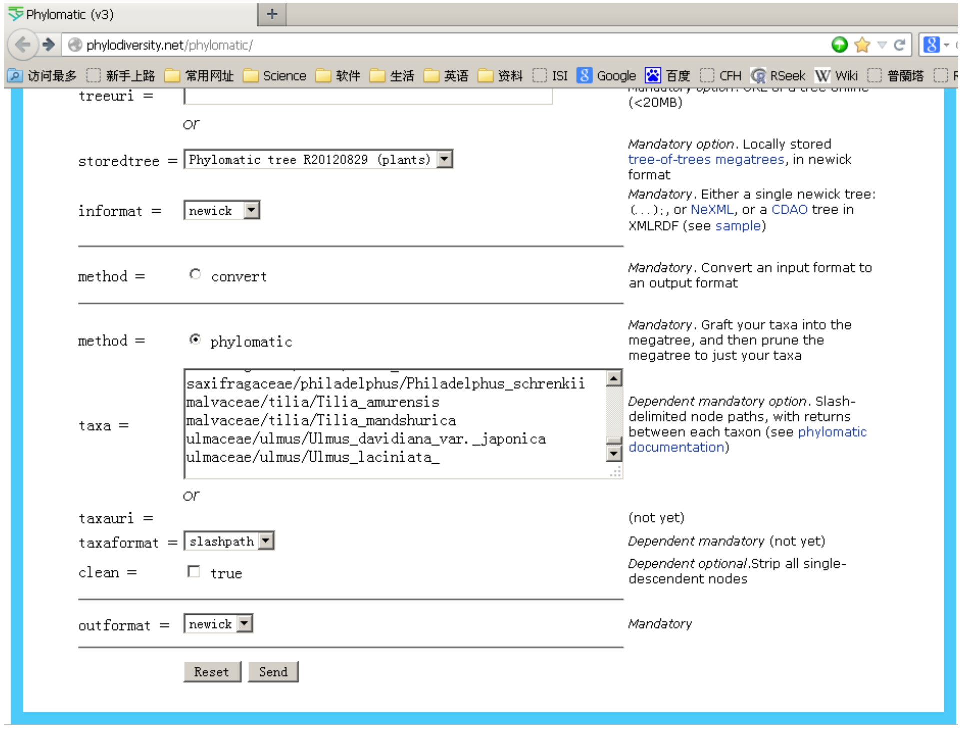
Molecular Ecology Notes (2005) 5, 181–183 doi: 10.1111/j.1471-8286.2004.00829.x

PROGRAM NOTE

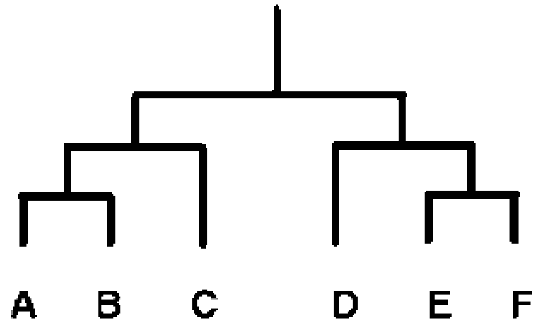
Phylomatic: tree assembly for applied phylogenetics

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/phylomatic/



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

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

MNTD

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

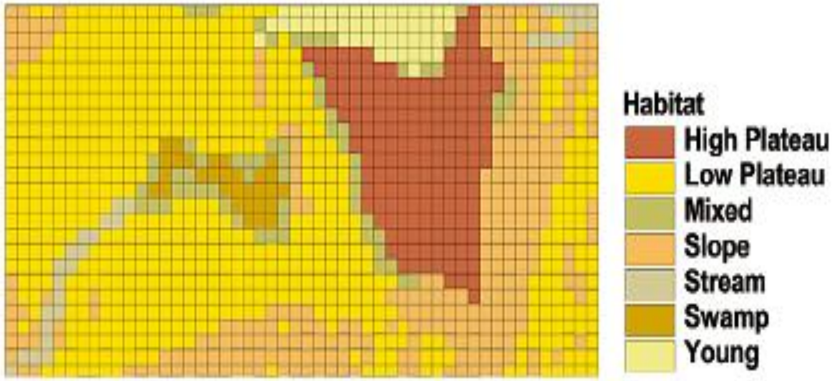
群落分子系统发育树的建立

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

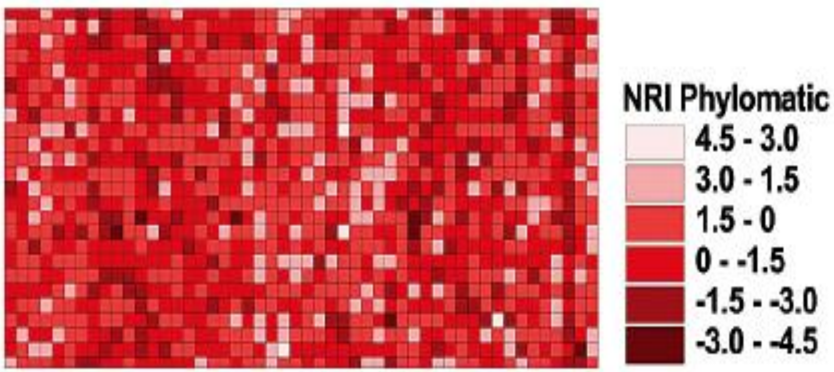
W. John Kress[a,1], David L. Erickson[a], F. Andrew Jones[b,c], Nathan G. Swenson[d], Rolando Perez[b], Oris Sanjur[b], and Eldredge Bermingham[b]

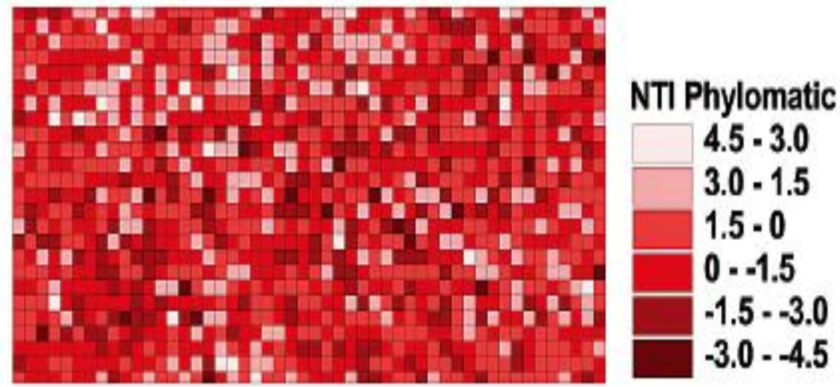
[a]Department of Botany, MRC-166, National Museum of Natural History, Smithsonian Institution, P.O. Box 37012, Washington, DC 20013-7012; [b]Smithsonian Tropical Research Institute, P.O. Box 0843-03092, Balboa Ancón, Republic of Panamá; [c]Imperial College London, Silwood Park Campus, Buckhurst Road, Ascot, Berkshire SL5 7PY, United Kingdom; and [d]Center 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

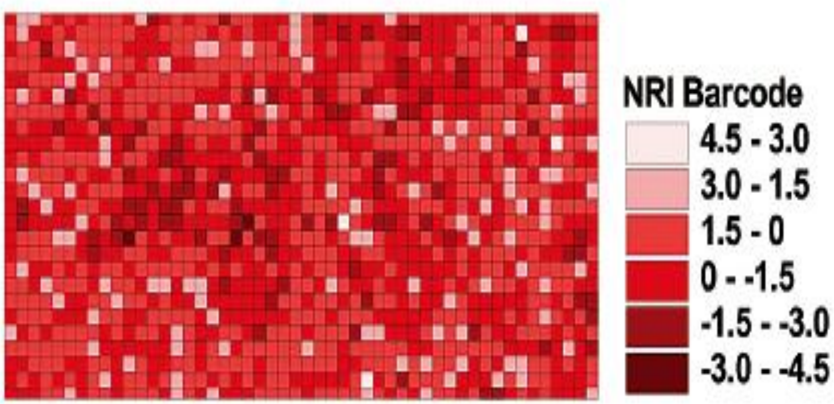


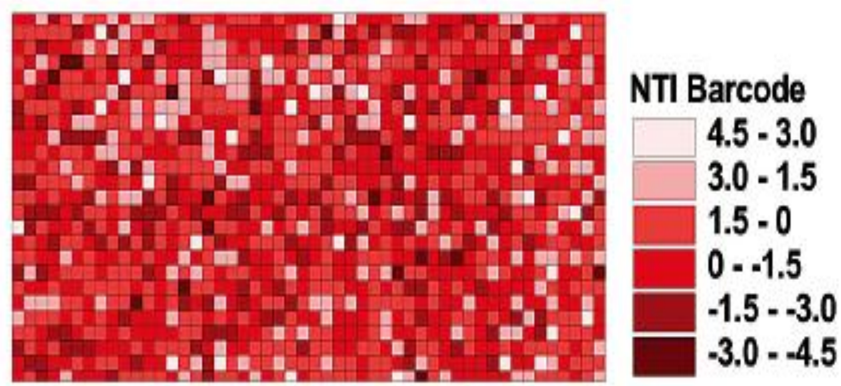
低精度的系统发育树容易产生假发散的结果！





Kembel & Hubbell, 2006. Ecology





NRI

NTI

Kress et al., 2009. PNAS

2. 群落系统发育结构逻辑框架

VOL. 163, NO. 6 THE AMERICAN NATURALIST JUNE 2004

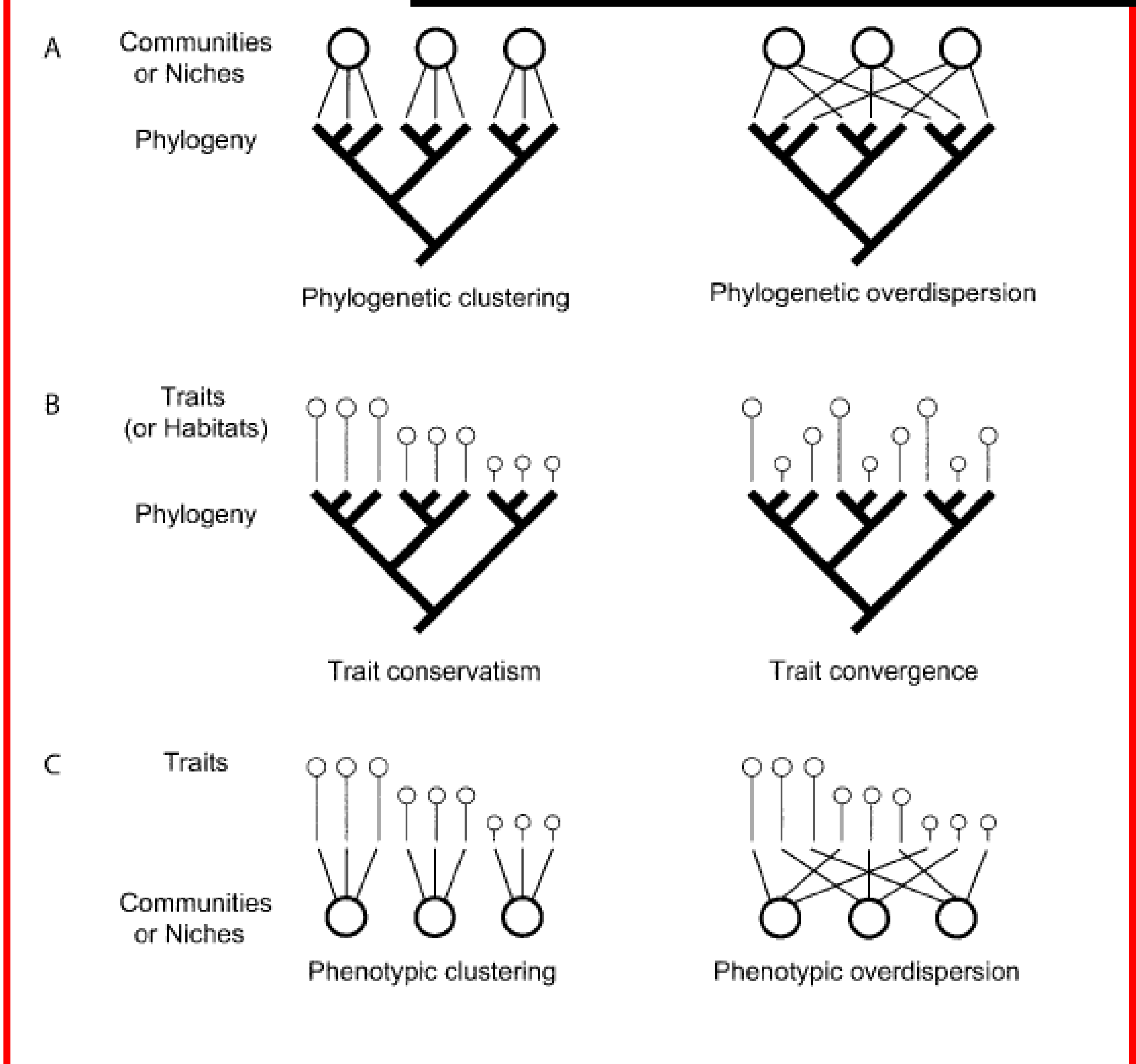
Phylogenetic Overdispersion in Floridian Oak Communities

J. Cavender-Bares,[1,2,*] D. D. Ackerly,[3,†] D. A. Baum,[4,‡] and F. A. Bazzaz[2,§]

Measure community phylogenetic metric (i.e. mpd)

Measure phylogenetic signal in trait data

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



2. 群落系统发育结构逻辑框架

Trait similarity within communities

Trait evolution		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

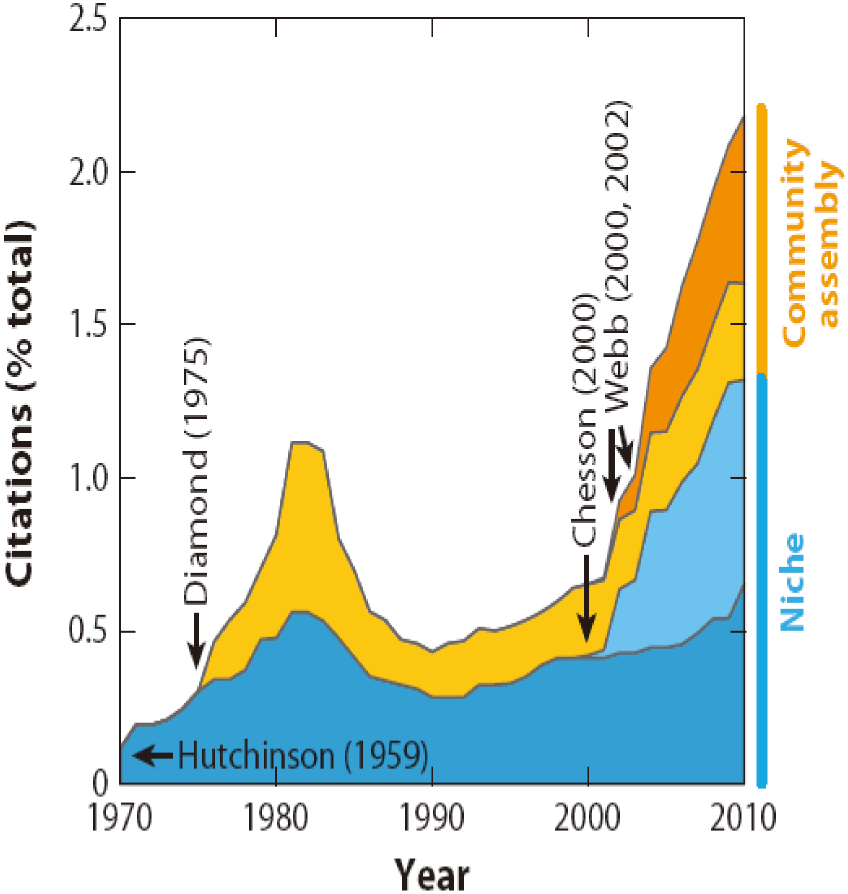
2. 群落系统发育结构逻辑框架

Trait similarity within communities

Trait evolution	Clustering of traits (driven by environmental filtering)	Overdispersion of traits (driven by competitive interactions)	**Randomness of traits (driven by neutral process)**
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



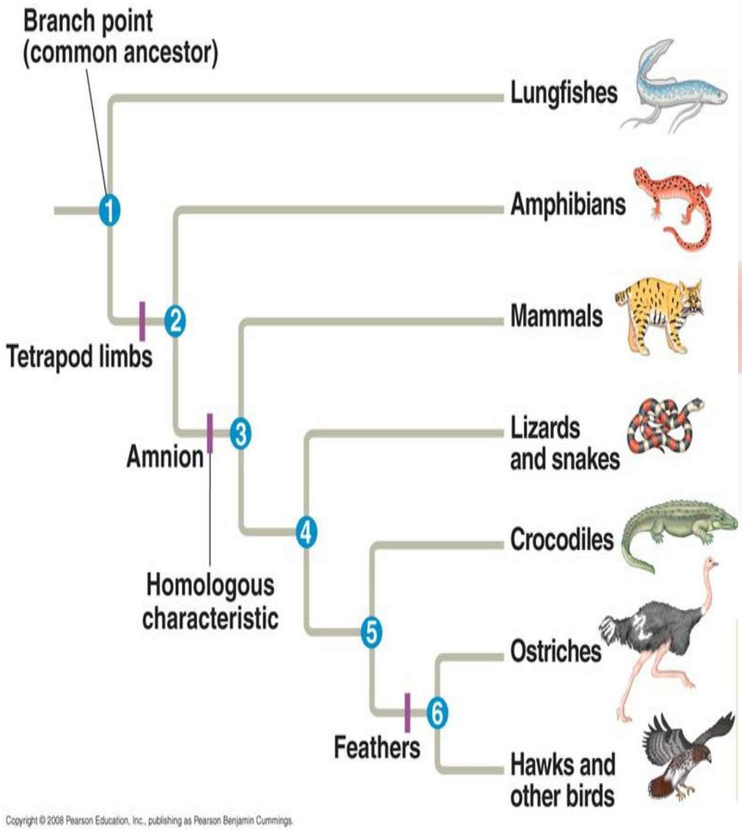
Disturbed old fields (Canada)	u	Dinnage 2009
California plant communities[a]	o, u	Cadotte et al. 2010
Brazilian cerrado	u	Silva & Batalha 2009
Bornean rainforest	u	Webb 2000
Amazonian forests[a] (Peru)	o, u	Fine & Kembel 2011
Neotropical forests[a] (Panama)	o, u	Kembel & Hubbell 2006
Subtropical forests[a] (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. 群落系统发育结构和功能结构

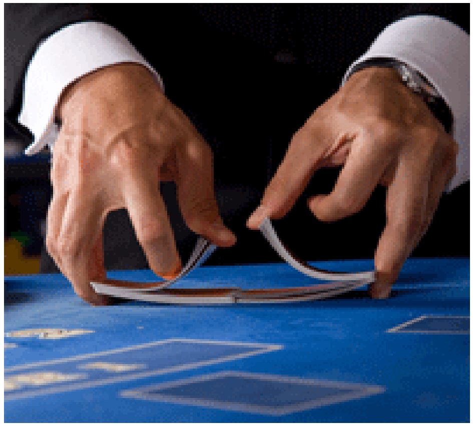
Contingency and Determinism in Replicated Adaptive Radiations of Island Lizards

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

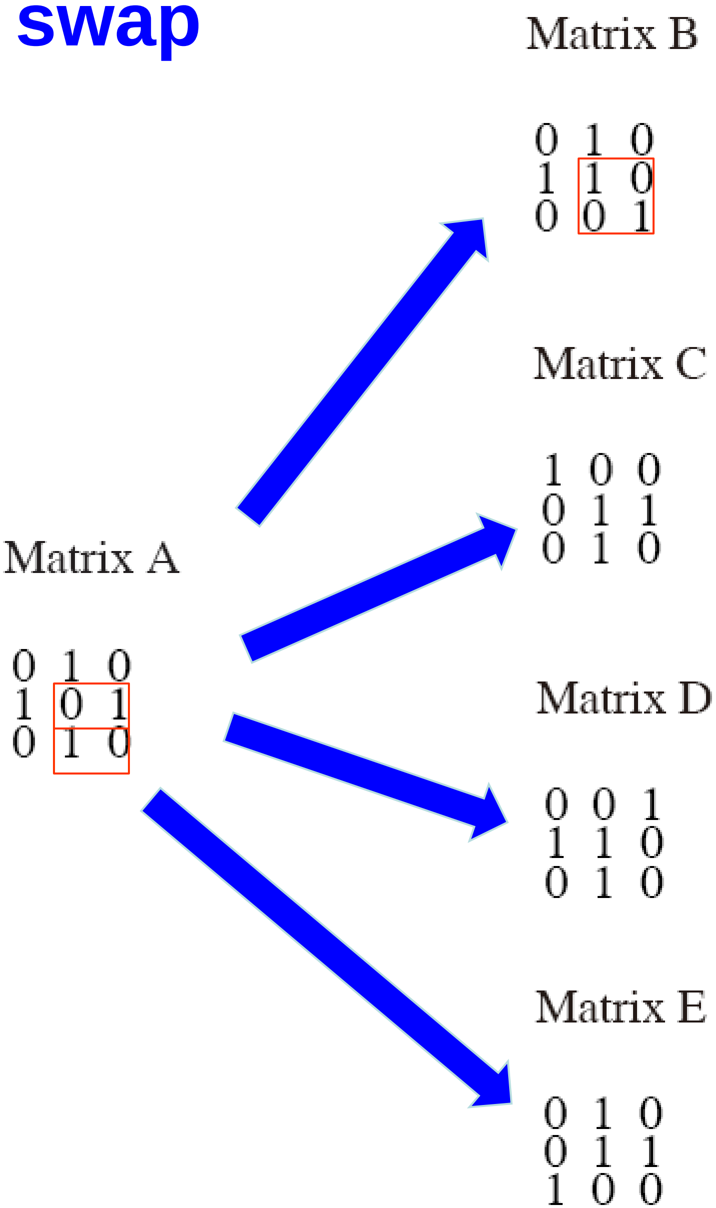


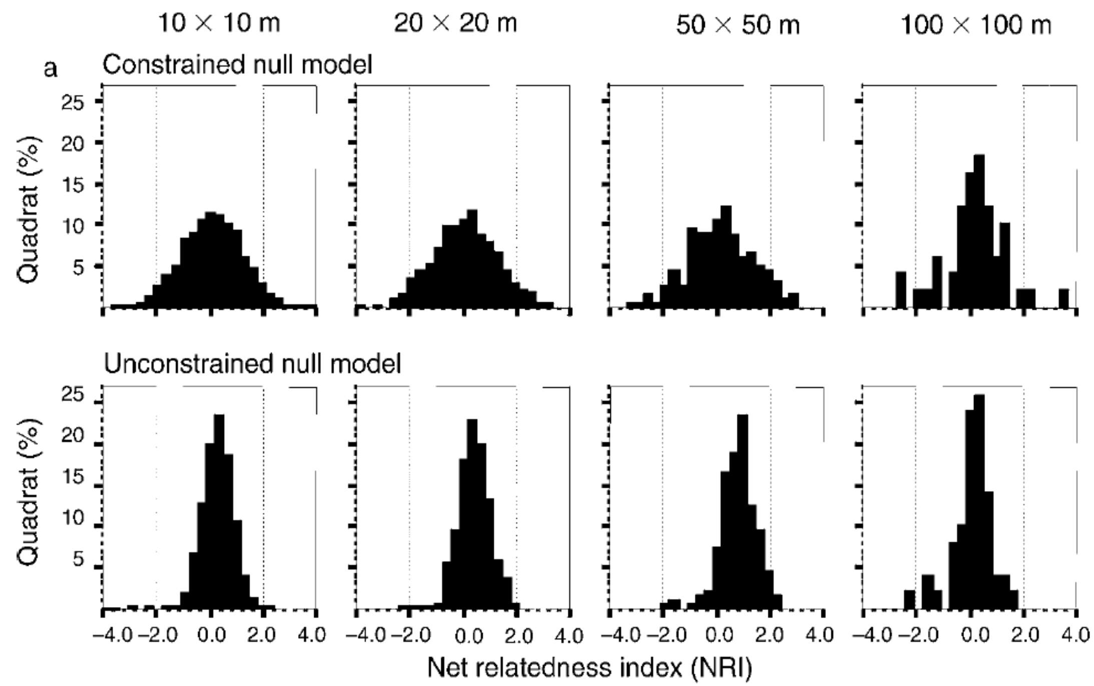
Random drawing



Random Shuffling

Independence swap



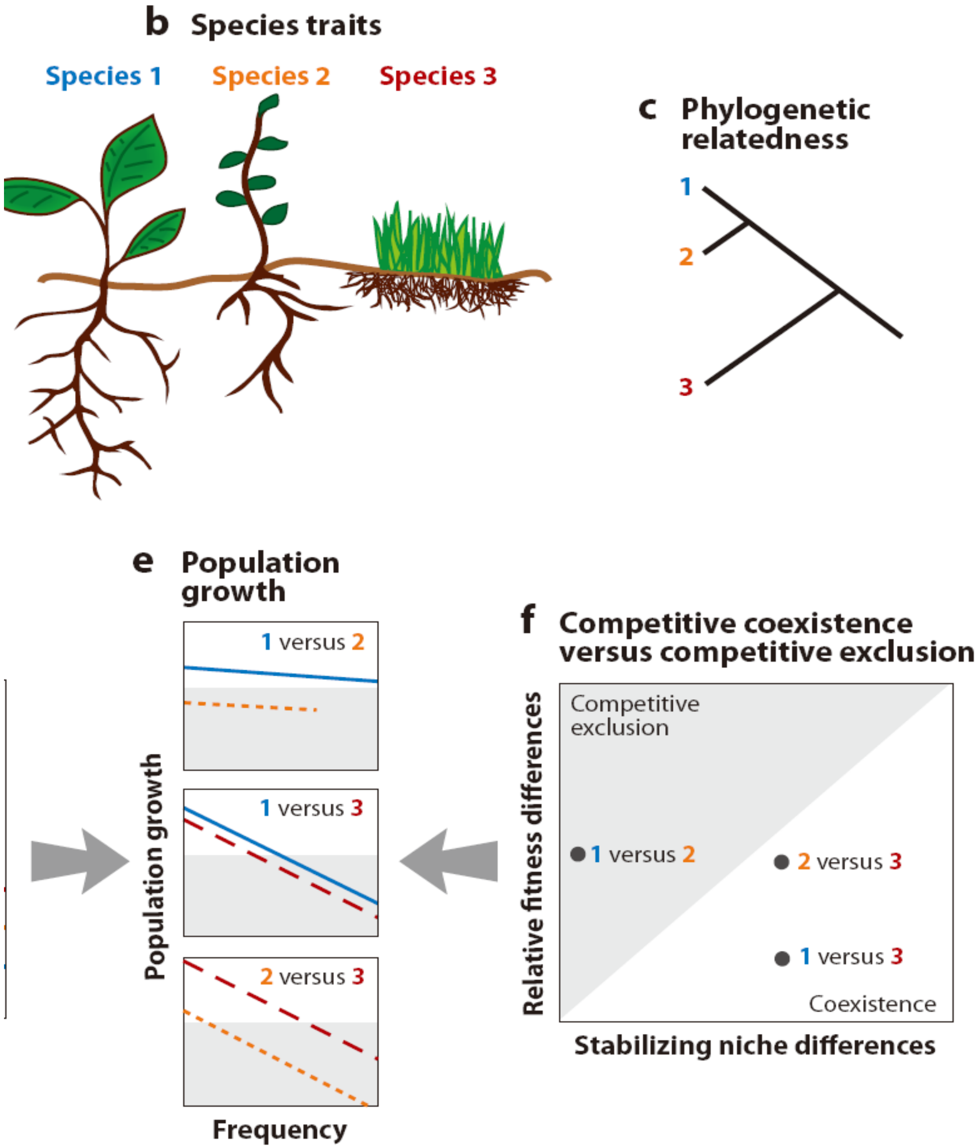


Kembel & Hubbell 2006. Ecology

	Null model								
Metric	1s	1p	1a	2s	2p	2x	3x	3i	3t
MNTD (one site)	*60*	*118*	**8**	*58*	*121*	**7**	**6**	*90*	*89*
MPD (one site)	*204*	*364*	**12**	*203*	*364*	**7**	**6**	*39*	*41*
mMNTD	*266*	*340*	*23*	*445*	*509*	*109*	*111*	*336*	*285*
mMPD	*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
$R_{PD\text{-}CA}$	*385*	*393*	*69*	*422*	*516*	*239*	*269*	*270*	*207*
$R_{PD\text{-}CO}$	*384*	*392*	*30*	*411*	*502*	*280*	*281*	*305*	*231*
$R_{PD\text{-}RA}$	*174*	*161*	**6**	*247*	*403*	*42*	*57*	*44*	*31*
$R_{PD\text{-}RO}$	*145*	*166*	**14**	*191*	*342*	*47*	*50*	*242*	*237*
$R_{PD\text{-}DO}$	**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

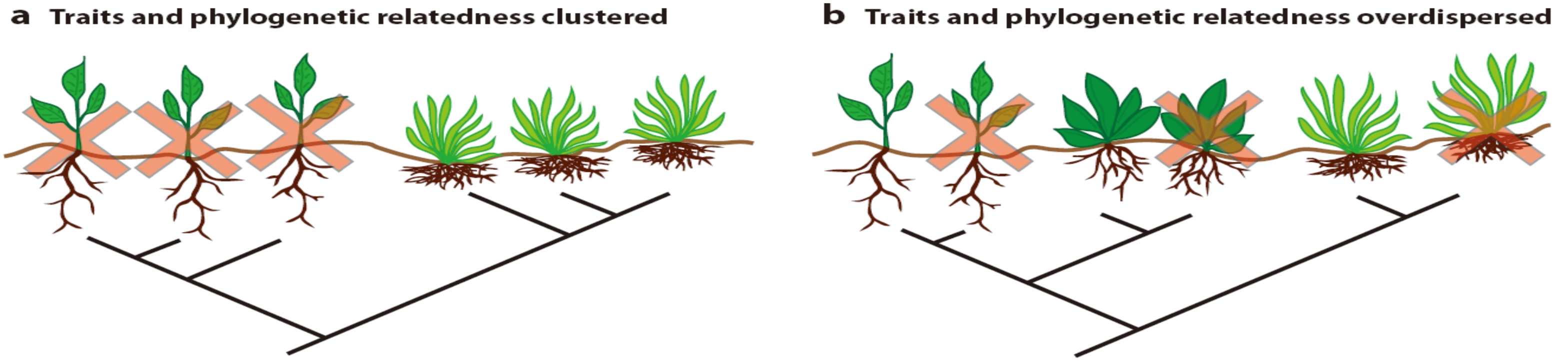


稳定生态位差异：引起种内竞争大于种间竞争的因素；

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



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

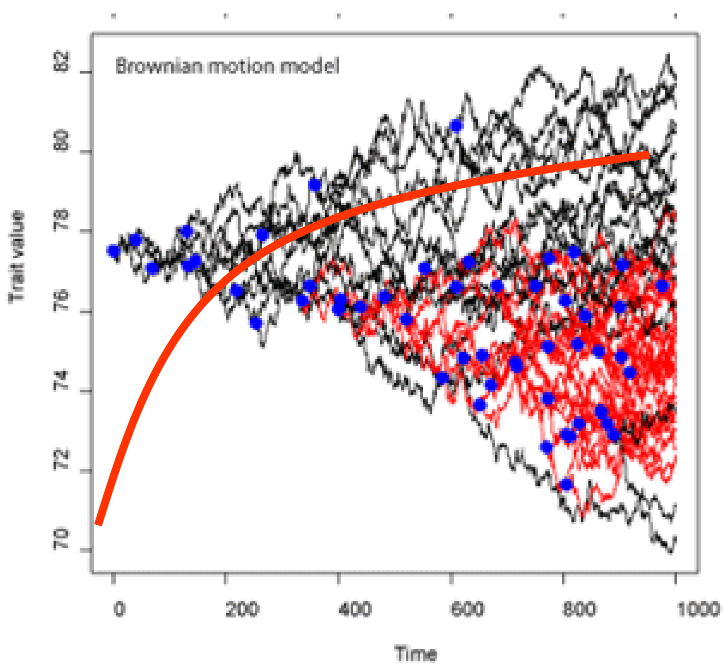
Mayfield and Levine et al. 2010. Ecology Letters

三. 群落系统发育学的优点和缺点

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

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?

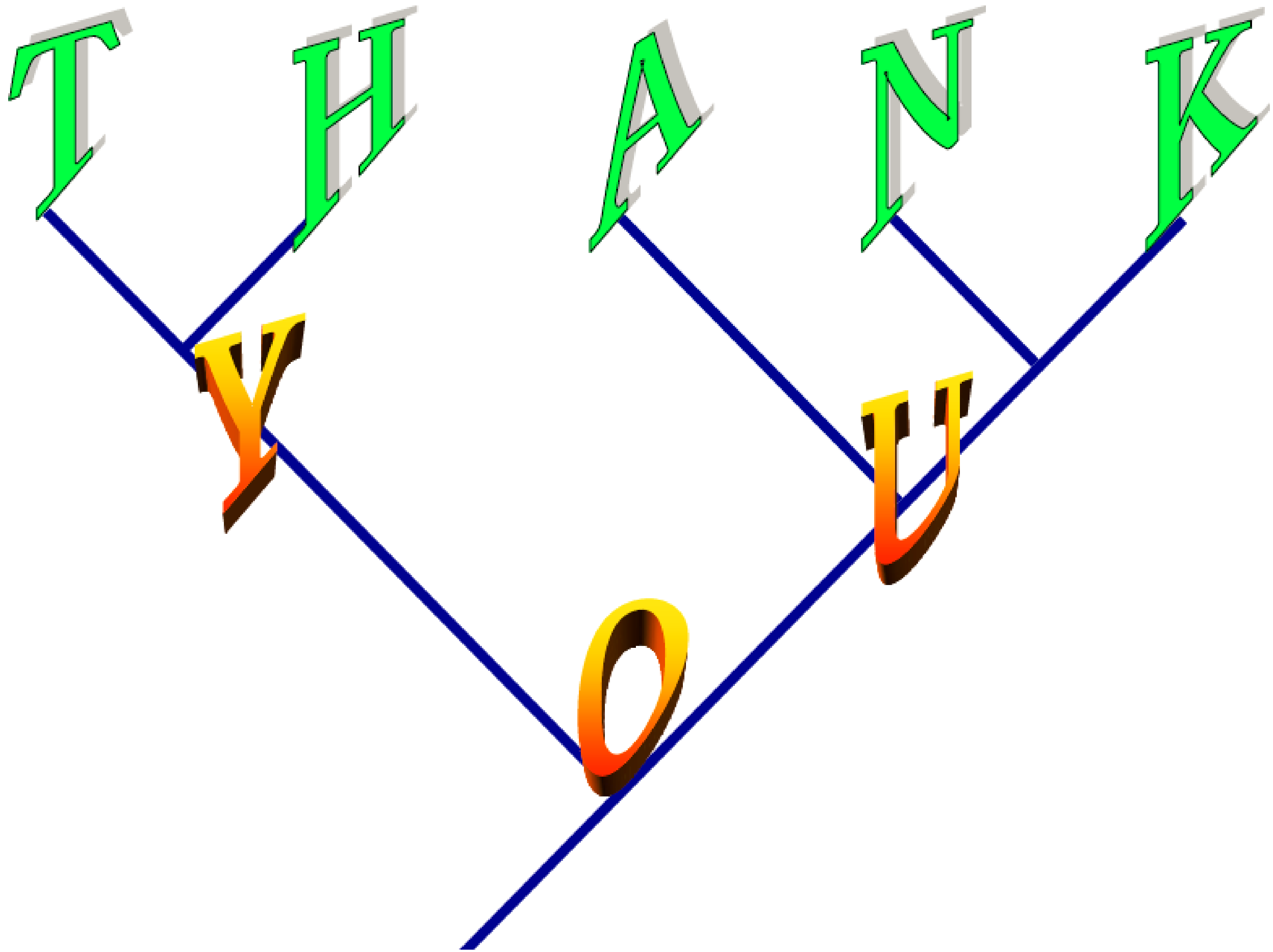
1. The flood of genetic data will be little use to evolutionary biologists unless the ecologist context of the organism's place in its environment is well understood. Ecologists still have tremendous amounts of the ecological work head to develop a comprehensive understanding of the ecological dynamics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

McPeek, 2010. Ecology in evolutionary biology

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.

McPeek 2010. Ecology in evolutionary biology


THANK
YOU