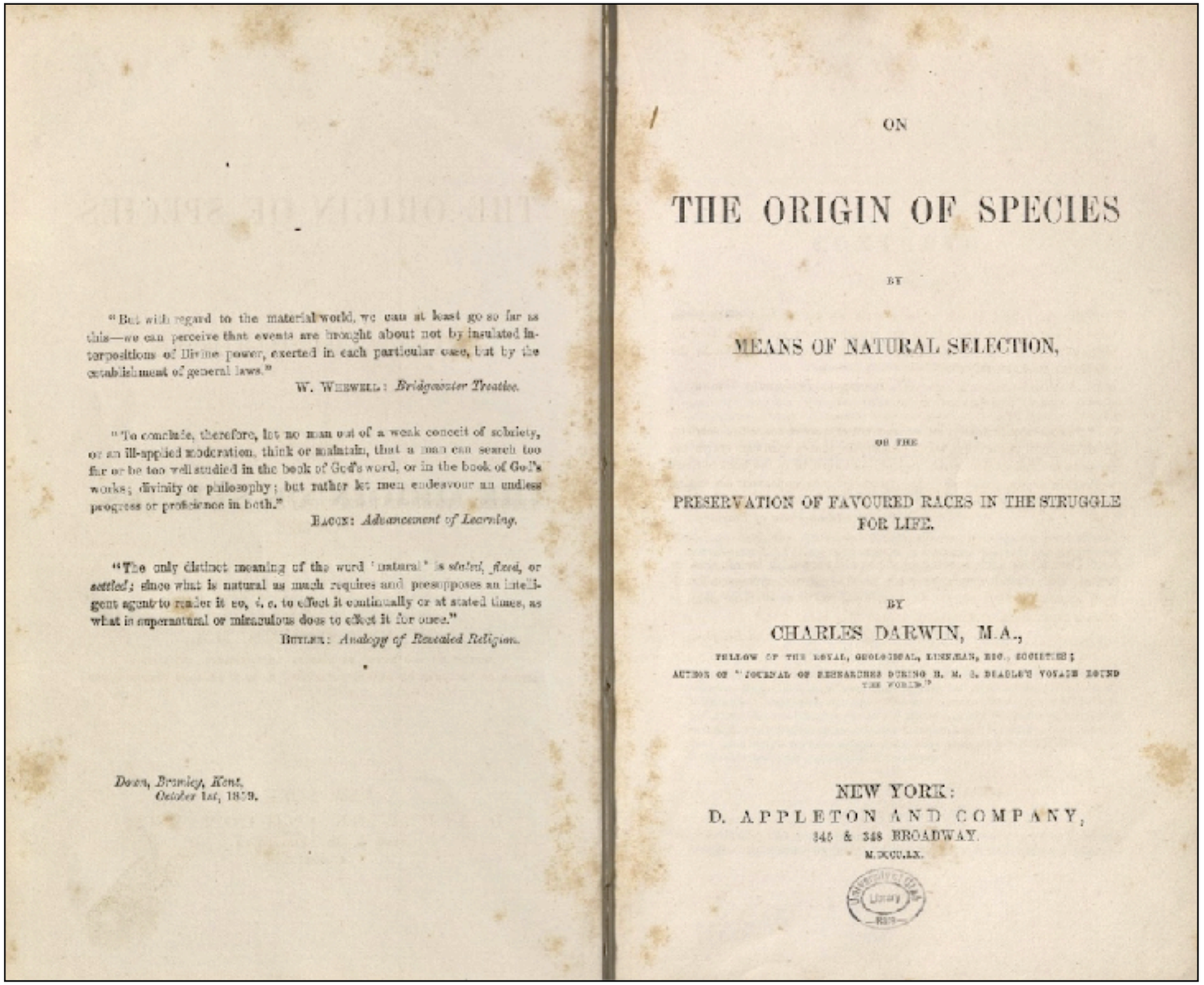
Evolution



"But with regard to the material world, we can at least go so far as this—we can perceive that events are brought about not by insulated interpositions of Divine power, exerted in each particular case, but by the establishment of general laws."

W. Whewell: *Bridgewater Treatise.*

"To conclude, therefore, let no man out of a weak conceit of sobriety, or an ill-applied moderation, think or maintain, that a man can search too far or be too well studied in the book of God's word, or in the book of God's works; divinity or philosophy; but rather let men endeavour an endless progress or proficience in both."

Bacon: *Advancement of Learning.*

"The only distinct meaning of the word 'natural' is *stated, fixed,* or *settled;* since what is natural as much requires and presupposes an intelligent agent to render it so, *i. e.* to effect it continually or at stated times, as what is supernatural or miraculous does to effect it for once."

Butler: *Analogy of Revealed Religion.*

Down, Bromley, Kent,
October 1st, 1859.

ON

THE ORIGIN OF SPECIES

BY

MEANS OF NATURAL SELECTION,

OR THE

PRESERVATION OF FAVOURED RACES IN THE STRUGGLE FOR LIFE.

BY

CHARLES DARWIN, M.A.,

FELLOW OF THE ROYAL, GEOLOGICAL, LINNEAN, ETC., SOCIETIES;

AUTHOR OF "JOURNAL OF RESEARCHES DURING H. M. S. BEAGLE'S VOYAGE ROUND THE WORLD."

NEW YORK:

D. APPLETON AND COMPANY,

345 & 348 BROADWAY.

M.DCCC.LX.

Lecture 4, BI271: Introduction to Ecology
Fall 2017

Modes of speciation

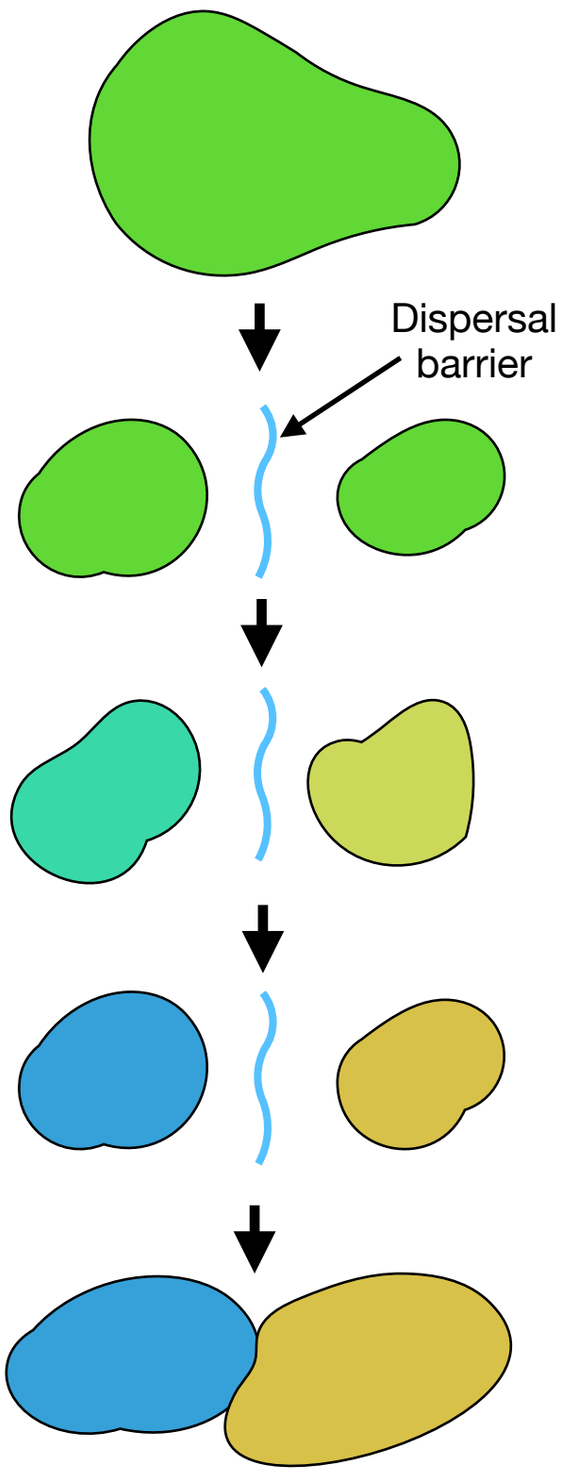
(from Futuyma, *Evolution*, Sinauer Press)

1. Classified by geographic origin of reproductive barriers

2. Classified by genetic and causal bases

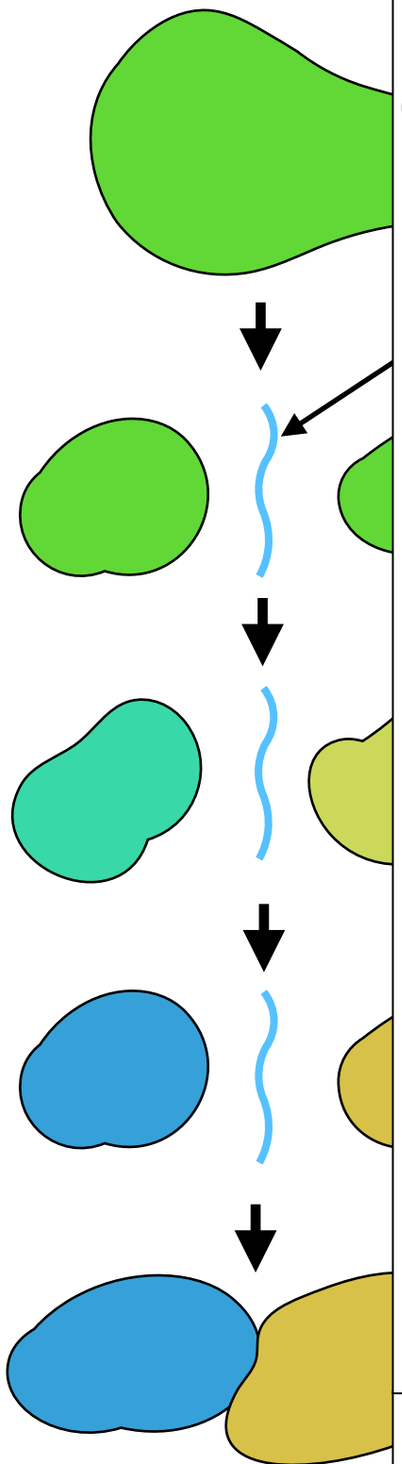
Geographic origin of reproductive barriers

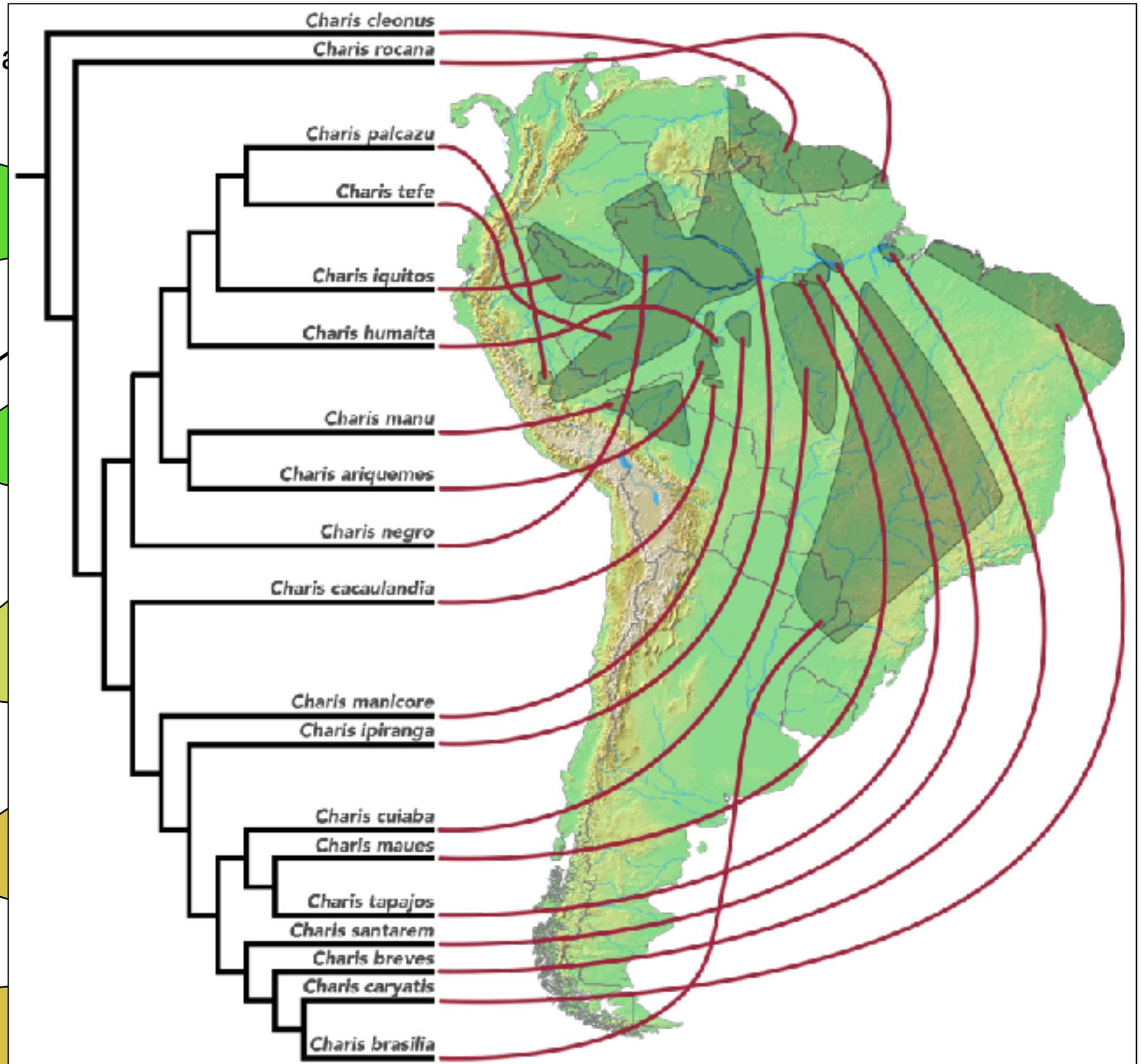
Allopatric speciation



Geographic origin of reproductive barriers

Allopatric specia

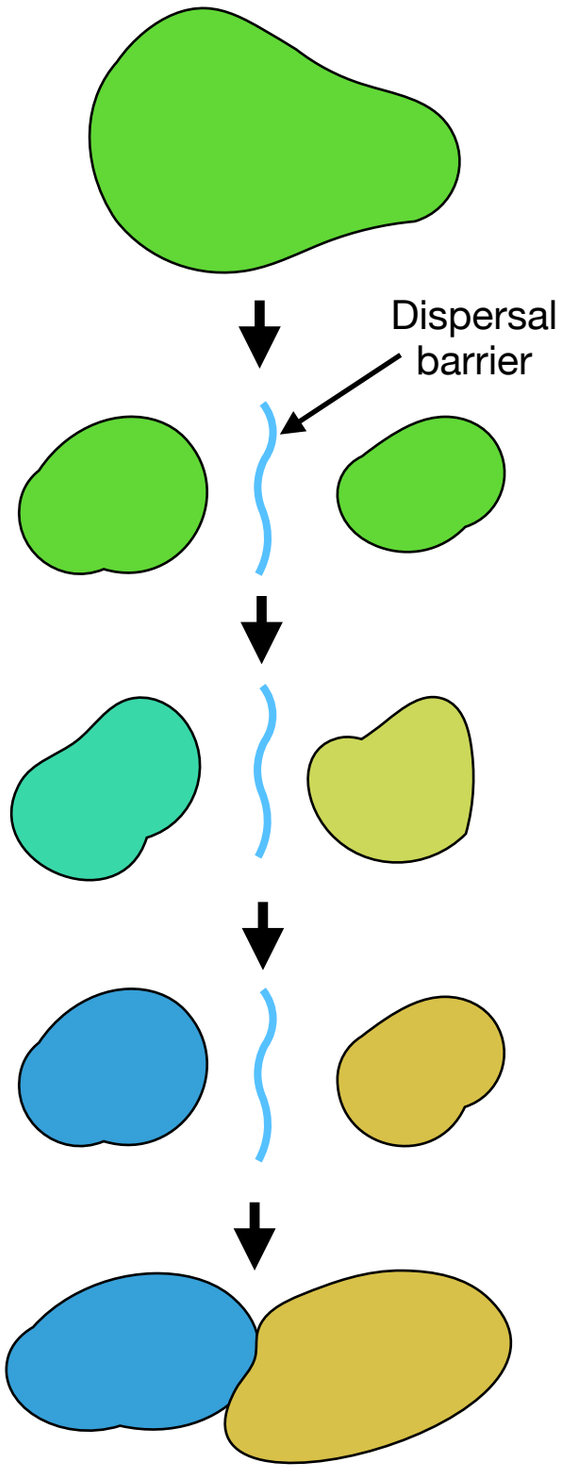




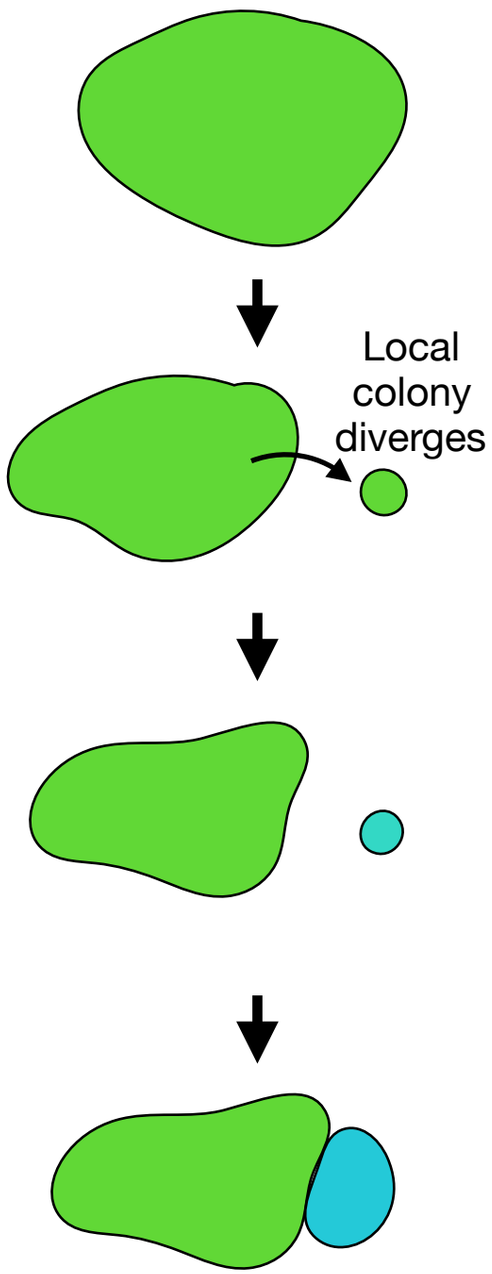
Hall, J. P. W. and Harvey, D. J. (2002), THE PHYLOGEOGRAPHY OF AMAZONIA REVISITED: NEW EVIDENCE FROM RIODINID BUTTERFLIES. Evolution, 56: 1489–1497. doi:10.1111/j.0014-3820.2002.tb01460.x

Geographic origin of reproductive barriers

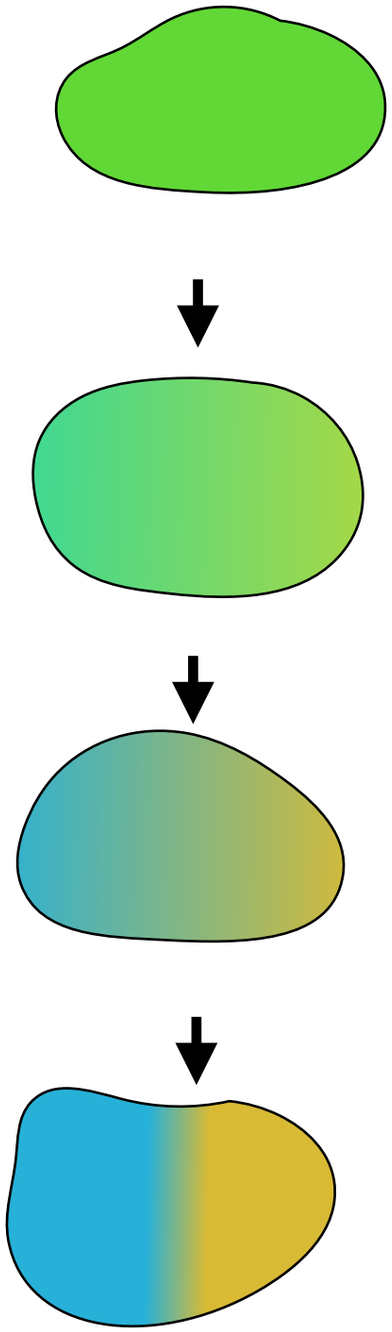
Allopatric speciation



Peripatric speciation

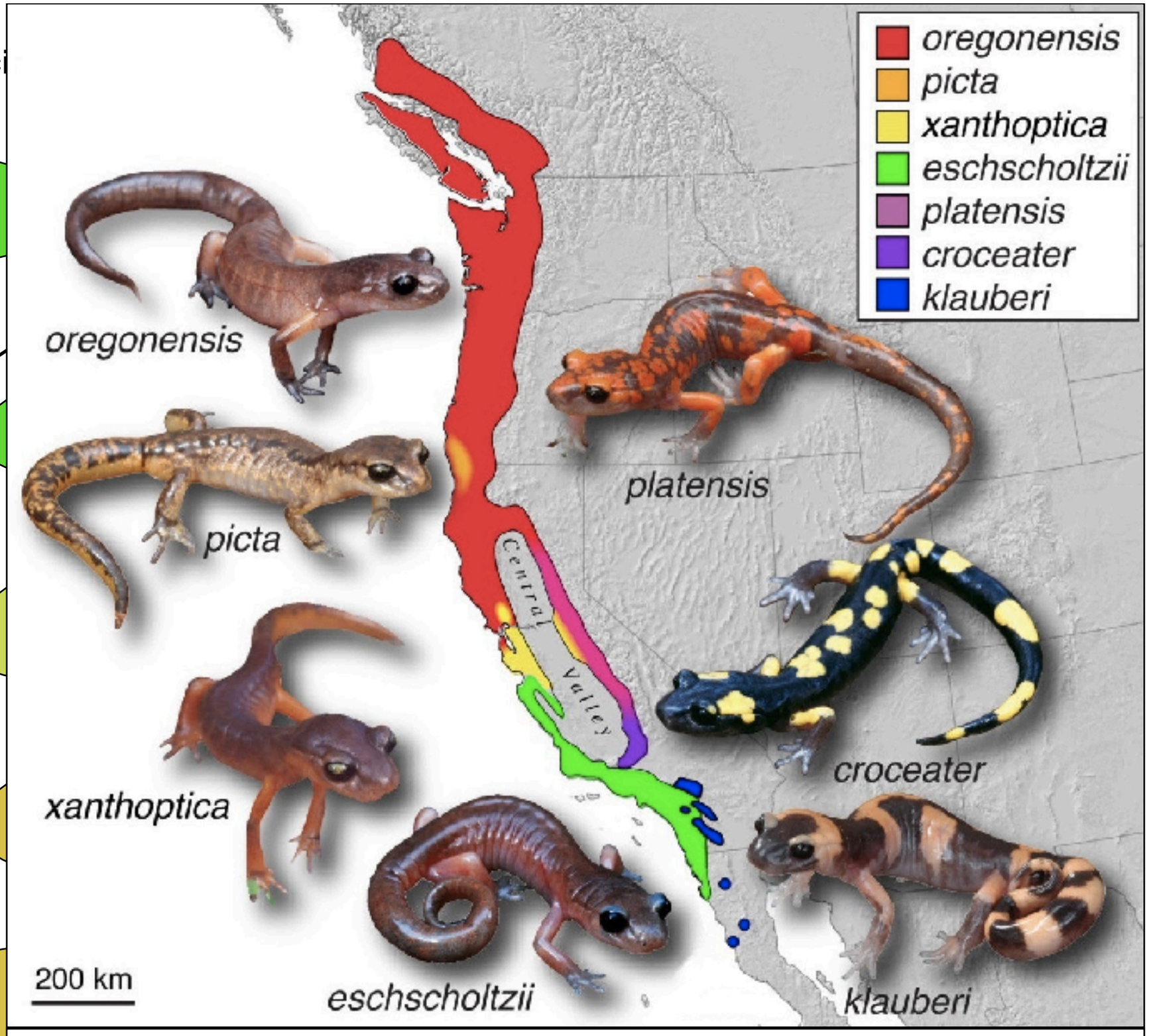


Parapatric speciation



Geographic origin of reproductive barriers

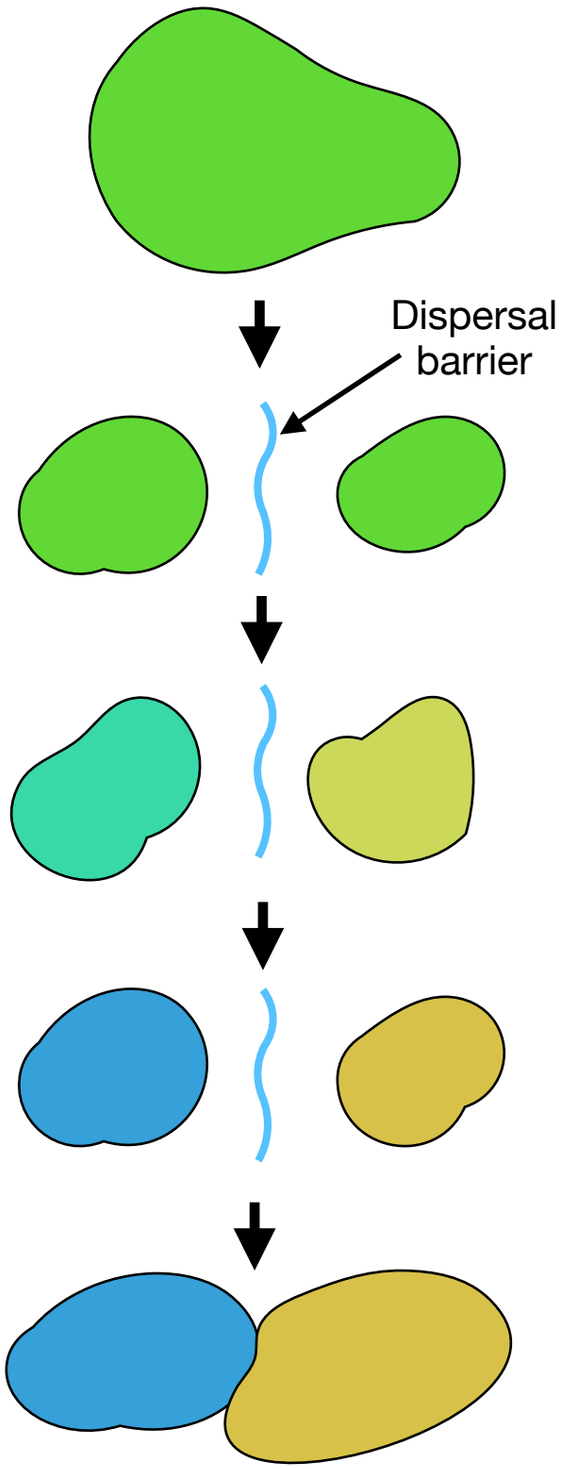
Allopatric speci



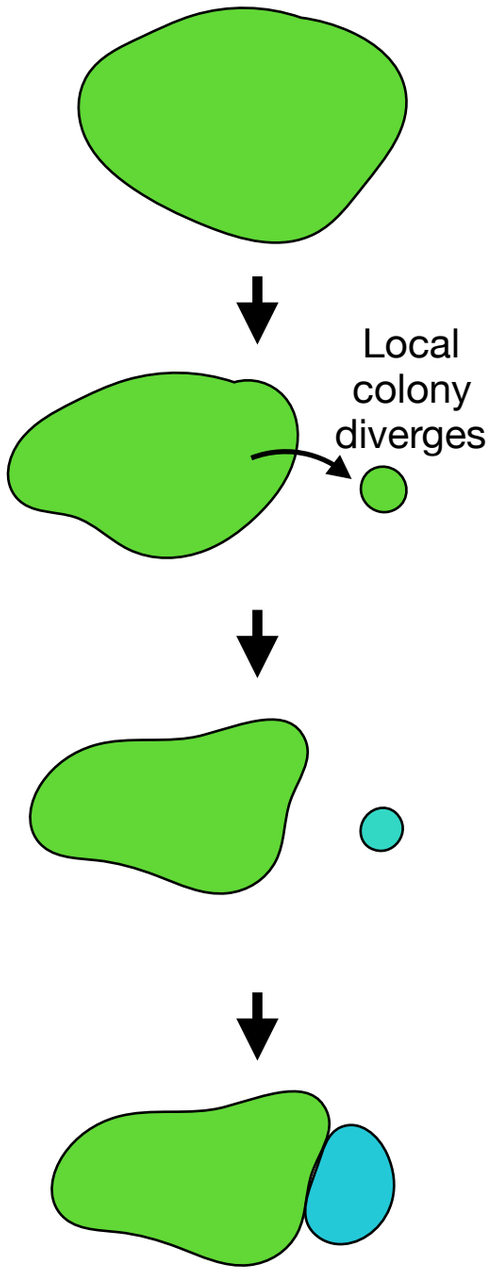
Devitt, Thomas J., Stuart JE Baird, and Craig Moritz. "Asymmetric reproductive isolation between terminal forms of the salamander ring species Ensatina eschscholtzii revealed by fine-scale genetic analysis of a hybrid zone." BMC Evolutionary Biology 11.1 (2011): 245.

Geographic origin of reproductive barriers

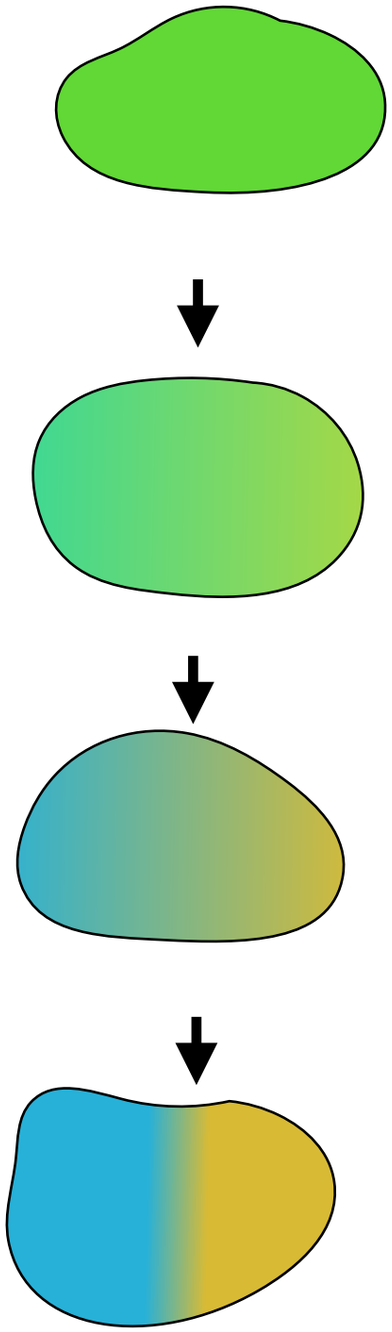
Allopatric speciation



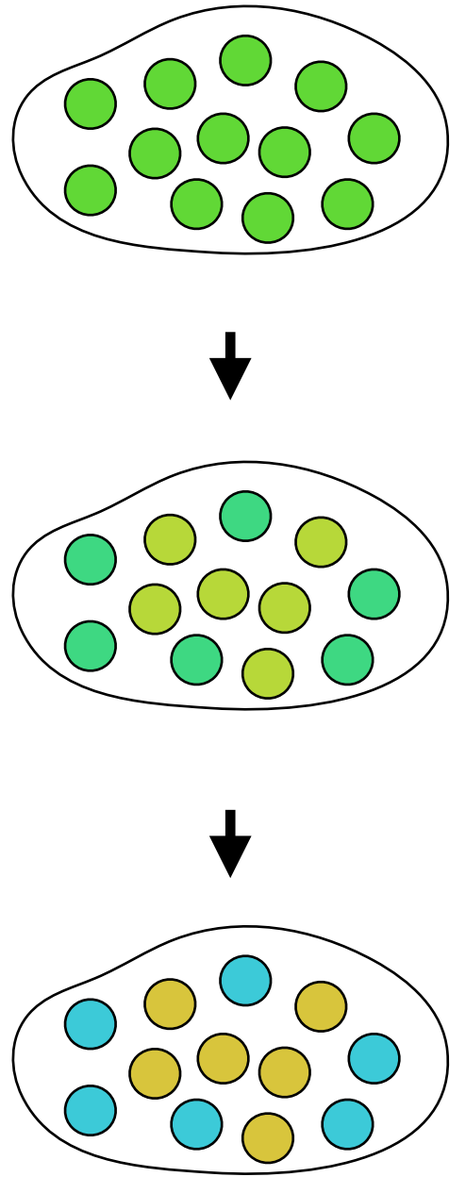
Peripatric speciation



Parapatric speciation



Sympatric speciation



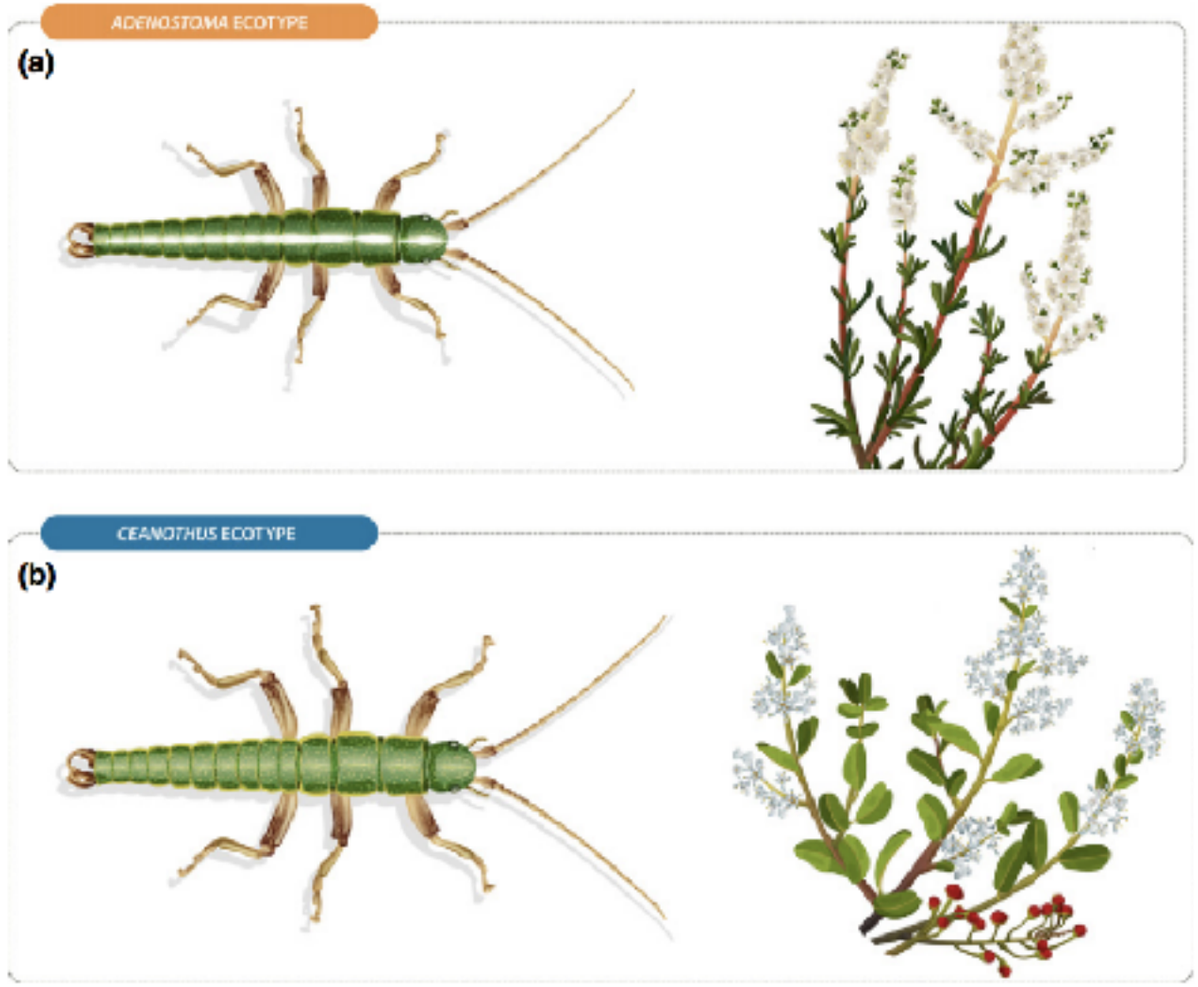
Ge

Allopatric

tric speciation

Sympatric speciation

Link to Nosil's website with papers on the genomics of speciation



nature ecology & evolution

ARTICLES

PUBLISHED: 17 FEBRUARY 2017 | VOLUME: 1 | ARTICLE NUMBER: 0082

Transitions between phases of genomic differentiation during stick-insect speciation

Rüdiger Riesch[1†*], Moritz Muschick[2†], Dorothea Lindtke[3†], Romain Villoutreix[3†], Aaron A. Comeault[4], Timothy E. Farkas[5], Kay Lucek[3], Elizabeth Hellen[3], Victor Soria-Carrasco[3], Stuart R. Dennis[6], Clarissa F. de Carvalho[5], Rebecca J. Safran[7], Cristina P. Sandoval[8], Jeff Feder[9], Regine Gries[10], Bernard J. Crespi[10], Gerhard Gries[10], Zach Gompert[11*] and Patrik Nosil[3*]

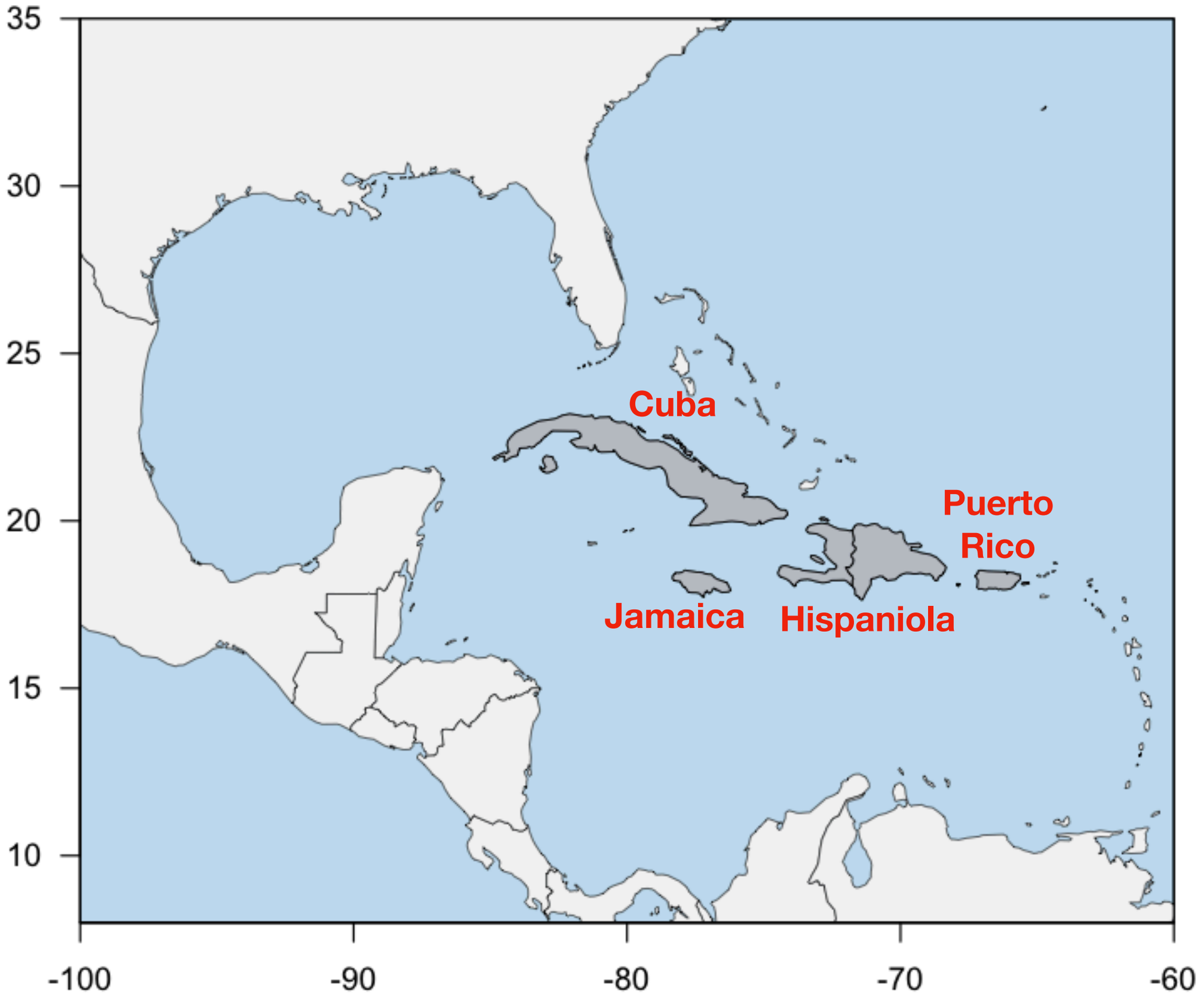
Speciation can involve a transition from a few genetic loci that are resistant to gene flow to genome-wide differentiation. However, only limited data exist concerning this transition and the factors promoting it. Here, we study phases of speciation using data from >100 populations of 11 species of *Timema* stick insects. Consistent with early phases of genic speciation, adaptive colour-pattern loci reside in localized genetic regions of accentuated differentiation between populations experiencing gene flow. Transitions to genome-wide differentiation are also observed with gene flow, in association with differentiation in polygenic chemical traits affecting mate choice. Thus, intermediate phases of speciation are associated with genome-wide differentiation and mate choice, but not growth of a few genomic islands. We also find a gap in genomic differentiation between sympatric taxa that still exchange genes and those that do not, highlighting the association between differentiation and complete reproductive isolation. Our results suggest that substantial progress towards speciation may involve the alignment of multi-faceted aspects of differentiation.

Modes of speciation

(from Futuyma, *Evolution*, Sinauer Press)

1. Classified by geographic origin of reproductive barriers
    1.1. Allopatric speciation
        1.1.1. Vicariance
        1.1.2. Peripatric speciation
    1.2. Parapatric speciation
    1.3. Sympatric speciation
2. Classified by genetic and causal bases
    2.1. Genetic divergence (allele substitution)
        2.1.1. Genetic drift
        2.1.2. Peak shift (peripatric speciation)
        2.1.3. Natural selection
            2.1.3.1. Ecological selection
                2.1.3.1.1. Reproductive isolation
                2.1.3.1.2. Reproductive barriers
                2.1.3.1.3. Pleiotropic genes
            2.1.3.2. Sexual selection
    2.2. Cytoplasimic incompatibility
    2.3. Cytological divergence
        2.3.1. Polyploidy
        2.3.2. Chromosome rearrangment
    2.4. Recombinatorial speciation

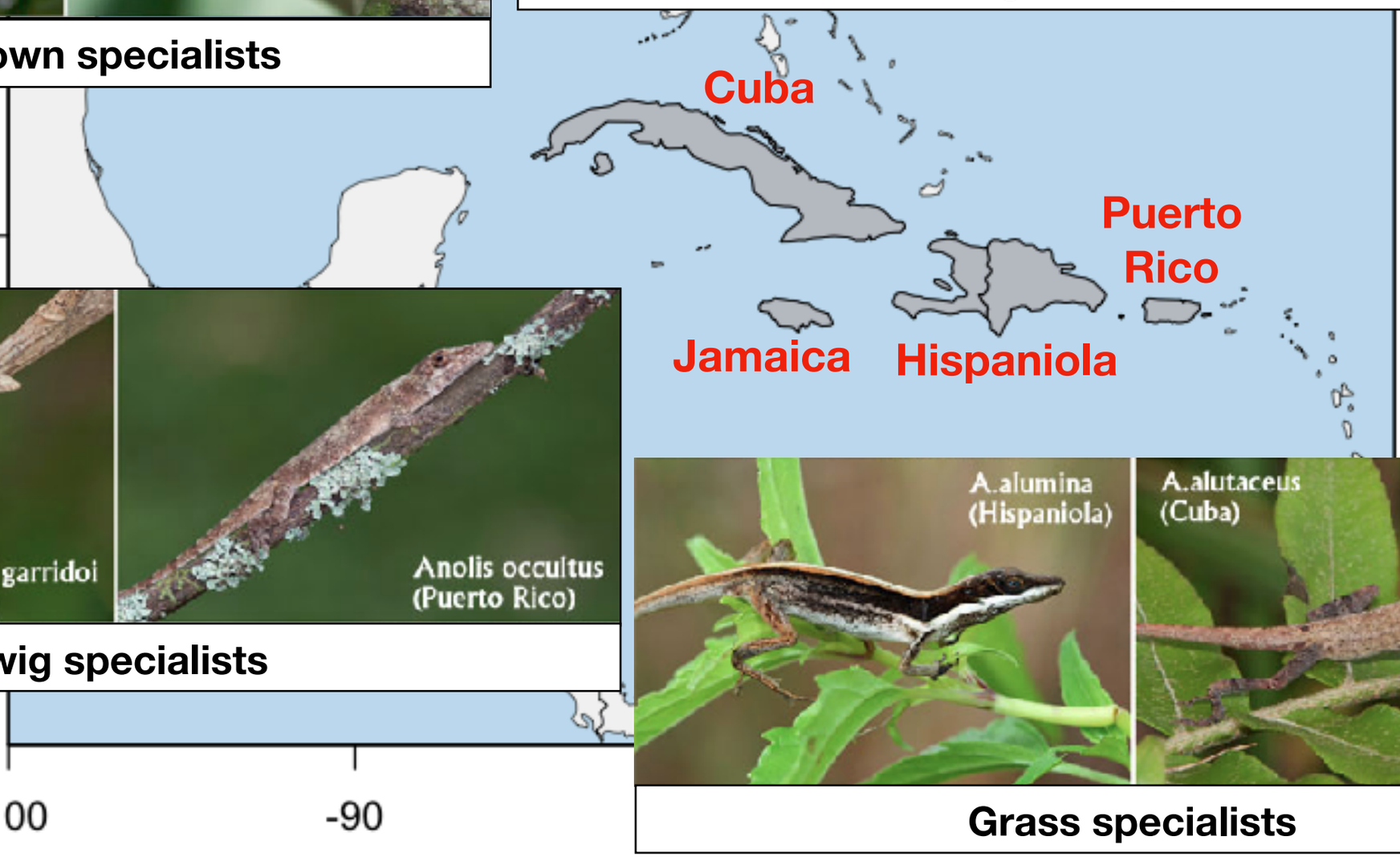
Adaptive radiation of *Anolis* spp.



Adaptive radiation of *Anolis* spp.

Tree-crown specialists

Trunk and ground specialists

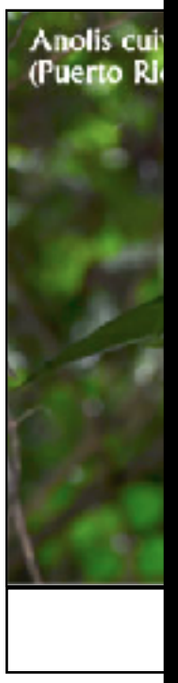


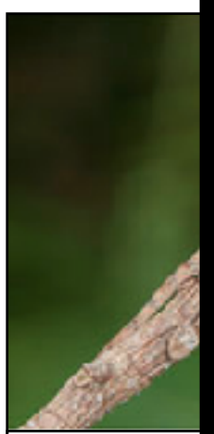
Twig specialists

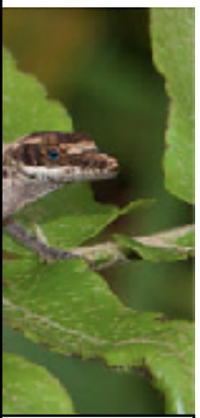
Grass specialists

Photos from National Geographic: link

Adaptive radiation of *Anolis* spp.







TWIG – *Puerto Rico*
CANOPY – *Puerto Rico*
GRASS – *Puerto Rico*

TWIG – *Cuba*
CANOPY – *Cuba*
GRASS – *Cuba*

TWIG – *Hispaniola*
CANOPY – *Hispaniola*
GRASS – *Hispaniola*

TWIG – *Jamaica*
CANOPY – *Jamaica*
GRASS – *Jamaica*

TWIG – *Puerto Rico*
TWIG – *Cuba*
TWIG – *Jamaica*
TWIG – *Hispaniola*

CANOPY – *Puerto Rico*
CANOPY – *Jamaica*
CANOPY – *Cuba*
CANOPY – *Hispaniola*

GRASS – *Hispaniola*
GRASS – *Puerto Rico*
GRASS – *Cuba*
GRASS – *Jamaica*

EVOLUTIONARY TREES depict two of many possible hypotheses about the anole lizards' genetic relatedness. At one extreme, each kind of specialist evolved again and again, on different islands (*left*). At the other extreme, each specialist evolved only once and then ended up on various islands (*right*). DNA analysis suggests that a situation similar to the first scenario is more likely.

graphic: link

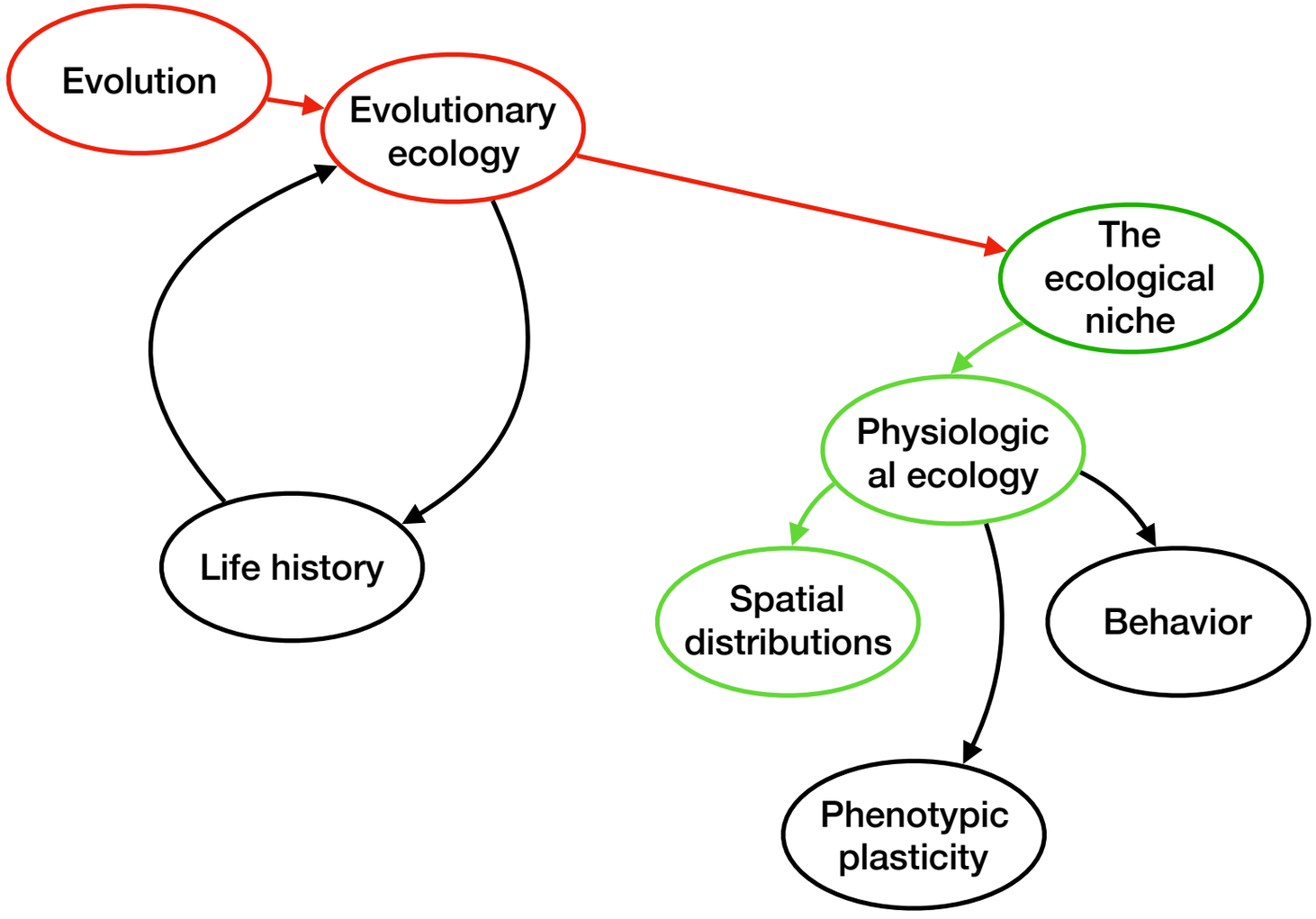
The major transitions in evolution

Transition from	Transition to
Replicating molecules	“Populations” of molecules in compartments (cells)
Independent replicators	Chromosomes
RNA as both genes and enzymes	DNA as genes; proteins as enzymes
Prokaryotes	Eukaryotes
Asexual clones	Sexual populations
Single-celled organisms	Multicellular organisms
Solitary individuals	Colonies with non-reproductive castes

Next week

Topics

1. The ecological niche
2. Physiological ecology
3. Spatial distributions



Reading

1. CBH: ch. 4,5

Assignment

1. Paper critique due 1 (Friday, 9/22)