L22-Speciation
Announcements

1st Drafts for papers due Oct 29th
-DO NOT INCLUDE YOUR NAME
--first and last initials and last four-digits of student ID
--include the recitation date and time as well.

TITLE OF PAPER by ZS1234
Announcements

Supplemental materials on speciation posted to Carmen (will be in exam 3)

PollEverywhere msg that “maximum responses reached”...don’t worry!
THINK-PAIR-SHARE (90 sec)

If 'things' look alike, what would qualify them as being of the same species?
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_________ speciation follows subdivision of a population due to physical barriers.

A. parapatric
B. peripatric
C. sympatric
D. allopatric
Low relative genetic diversity is a consequence of the founder effect in peripatric speciation.

A. True
B. False
THINK-PAIR-SHARE (90 sec)

Why are there so many unusual species on the Galapagos Islands or in Madagascar? What kind of speciation might explain this phenomenon?
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Modes of speciation: Parapatric speciation

A gradient or **cline** causes adjacent populations to experience different selective conditions

- *but the populations can still mate, generating hybrids*

Hybrids may lack traits that facilitate success in any part of the cline, causing them to be outcompeted by nonhybrids.
Modes of speciation: Parapatric speciation

A gradient or **cline** causes adjacent populations to experience different selective conditions—but the populations can still mate, generating hybrids.

Bounded hybrid superiority suggests that hybrids occupying the HZ harbor unique traits exclusive of the progenitors that make them well-suited to environmental conditions not found in either extreme of the cline.
Modes of speciation: Sympatric speciation

Speciation in the absence of physical or spatial barriers

Two genetically related cichlids arose in a small, young lake with no obvious barriers between these species to prevent gene flow.

Diet appeared to drive the divergence as each species was well-adapted to their habitats and preferred within-species mating, driving fixation of divergent alleles.
Modes of speciation: Sympatric speciation

Speciation in the absence of physical or spatial barriers

Apple (A) and hawthorne (H) trees exist sympatrically and apple maggot (AM) fly ‘races’ (A-AM and H-AM) emerged~140 years.

Sympatric speciation of apple maggot flies appears to be influenced by the different fruiting times (3-4 wk/AM life span) of the host plants.

Reduced gene flow between sympatric AM on different host trees.
Modes of speciation: Sympatric speciation
Speciation in the absence of physical or spatial barriers

Niche partitioning—selection drives speciation facilitating differential patterns of resource usage
Niche conservatism is the degree to which species retain their ancestral ecological traits, suggesting a genetic component to their behavior.
Character displacement ________ competition between related species and ________ species diversity.

A. increases, increases
B. decreases, increases
C. decreases, decreases
D. increases, decreases
Facilitating sympatric speciation: Character displacement

Traits emerge that reduce competition where co-occurring species exist

Ecological character displacement: trait evolution stemming from selection to lessen resource competition between species and therefore acts on traits associated with resource use (e.g., morphological structures such as beaks and jaws) (Pfennig, 2012)
Facilitating sympatric speciation: Character displacement

Traits emerge that *reduce competition* where co-occurring species exist

**Reproductive character displacement**: divergent mating signals and morphological barriers to successful mating events (Pfennig, 2012)
THINK-PAIR-SHARE (90 sec)

Why would reproductive character displacement emerge?
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Facilitating sympatric speciation: Character displacement

Traits emerge that *reduce competition* where co-occurring species exist

**Reproductive character displacement:** divergent mating signals and morphological barriers to successful mating events (Pfennig, 2012)

- minimize costly reproductive interactions
- hybrids with reduced fitness
Reproductive isolation mechanisms

Prezygotic isolating mechanisms prevent mating or successful fertilization between different, closely-related species

- **behavioral** (mating calls)
- **temporal** (divergent mating times)
- **habitat** (spatially isolated)
- **physiological** (incompatible mating physiology) see BOX 14.2 in the *Evolution* textbook
Reproductive isolation mechanisms

Postzygotic isolating mechanisms affect zygote/embryo survival
-zygote doesn’t survive
-sterile hybrids
-backcrosses or F2 hybrids are sterile
Hybrid sterility

• Hybrids viable but not fertile
  – Asymmetry between crosses
    • Heterogametic sex most often sterile

• Aneuploid gametes
  – Chromosomes have different genes or morphologies, and so can’t segregate properly
Reproductive isolation mechanisms

Haldane’s dominance rule

If hybrids have reduced fitness, then hybrids will be under strong negative selection in *heterogametic* sexes.

XX       XY       XX       XY
XX – X-linked recessive/deleterious traits are masked by complementary chromosome
XY – X-linked recessive/deleterious traits are not masked
Reproductive isolation mechanisms

Haldane’s dominance rule

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XX  XY  XX  XY
XX – X-linked recessive/deleterious traits are masked by complementary chromosome
XY – X-linked recessive/deleterious traits are not masked

“When in the F1 offspring of two different animal races one sex is absent, rare, or sterile, that sex is the heterozygous [heterogametic] sex.”
Haldane JBS (1922) Sex ratio and unisexual sterility in hybrid animals.” J. Genet. 12, 101-109.
Reproductive isolation mechanisms

Dobzhansky-Muller Incompatibility

Epistasis: how gene products impact one another

Post-mating isolation due to hybrid incompatibility

![Diagram showing the process of post-mating isolation due to hybrid incompatibility](image-url)
Diagnosing species

Testing ability to interbreed can be challenging

Genetic, morphological and other phenotypes can act as markers or indicators of different sp.
Diagnosing species

Random mating = normal distribution of markers

Nonrandom mating = nonnormal distribution, which suggest what?
Differences between species

Positive relationship between genetic distance and degree of reproductive barriers
Reinforcement of reproductive isolation

Allopatric populations have a lower ‘threat’ of hybridization when compared to sympatric pops.

Prezygotic barriers to reproduction can be enhanced thus reinforcing the isolation

*Pseudacris* (chorus frogs)
Relatedness between species is evidenced by the amount of shared genetic information.

**Coalescence theory** argues that all genes in a population originate from a common ancestor.

Recent speciation = rapid coalescence

Ancient speciation = not so rapid
Selection resulting in speciation

Ecological selection is adaptive divergence and subsequent reproductive isolation

“Magic traits”
Sexual selection and speciation
Promiscuity may drive speciation to prevent hybridization (assuming reduced fitness)
Higher species diversity in birds with promiscuous mating systems than those that pair-bond
Speciation with gene flow

Genes with neutral effects can be exchanged between recently speciated populations (introgression)

Successful matings yielding nonsterile hybrids decrease linkage disequilibrium via recombination
Rate of speciation

- mutation and genetic drift of neutral alleles... really slow
- ecological/sexual selection... faster
- reinforcement of isolation... ZOOM!

Traits involved in sexual selection and animal-based pollen dispersal drive rapid speciation