SPECIATION

- Provides the link between evolutionary change within lineages (anagenesis/microevolution) and the macroevolutionary patterns that result from cladogenesis.
- Is a <u>process</u> (degree of reproductive isolation varies along a continuum).
- Requires the disruption of gene flow and the evolution of reproductive isolating mechanisms (RIMs).

THE CLASSIC VIEW OF SPECIATION

- Barrier to gene flow develops
- Slow accumulation of genetic differences through mutation, drift, and natural selection
- Genetic divergence leads to reproductive isolating mechanisms (RIMs) as a byproduct
- Perhaps secondary contact, with some level of hybridization possible





CONSEQUENCE OF SECONDARY CONTACT

The strength of RIMs that have developed in *allopatry* determines the shape of the hybrid zone; possibilities include:

- No hybridization (no hybrid zone)
- Hybridization but no introgression (narrow hybrid zone)
- Limited introgression (wider hybrid zone)
- Reunification of the gene pool













BARRIERS TO GENE FLOW

Prezygotic Barriers.

- Potential mates (although sympatric) do not meet.
 - Temporal isolation.
 - Habitat isolation.
- Potential mates meet but do not mate.
- Copulation occurs, but gametes are not transferred.
- Gametes are transferred, but eggs are not fertilized.









I think it will be admitted by naturalists... that secondary sexual characters are highly variable. It will also be admitted that species of the same group differ from each other more widely in their secondary sexual characters than in other parts of their organization...

Darwin, The Origin of Species











BARRIERS TO GENE FLOW

- Postzygotic Barriers.
 - Zygote dies.
 - F₁ hybrid has reduced viability.
 - F₁ hybrid viable, but has reduced fertility.
 - Reduced viability or fertility in F₂ or backcross.

POST-ZYGOTIC REPRODUCTIVE ISOLATION

- Post-zygotic reproductive barriers are due to developmental incompatibility, or reduced hybrid fitness.
- These incompatibilities are often the result of chromosomal differences, or *epistatic interactions* among genes.
- Post-zygotic isolation is often partial with one reciprocal cross producing viable offspring and the other producing sterile offspring.













HALDANE'S RULE	FOR PARTIAL POS	ST-ZYGOTIC	STERILITY
 If hybrid sterilit is almost alwa 	ty or inviability is four ys the heterogametic	nd in only one c sex	sex, it
	Examples:	Hybrid <u>Females</u>	Hybrid <u>Males</u>
	Drosophila	XX	XY, sterile
J. B. S. Haldane	Aedes mosquito	$X_F X_F$	$X_F X_M$, sterile
	Mammals	XX	XY, sterile
	Birds	ZW, sterile	ZZ
	Butterflies	ZW, sterile	zz



FITNESS LOSS IN THE HETEROGAMETIC SEX

Group	Trait	Hybridizations with asymmetry	Number obeying Haldane's rule
Mammals	Fertility	20	19
Birds	Fertility	43	40
	Viability	18	18
Drosophila	Fertility and viability	145	141
Source: Coyne and	d Orr 1989.		









MODELS OF SPECIATION

Allopatric Speciation:

- Speciation with geographic isolation.
- Evolution of reproductive isolating mechanisms between populations that are geographically separated.
- Geographic separation is defined by spatial restriction of gene flow, not just physical distance.

ALLOPATRIC DISTRIBUTIONS

- Species do not start with *allopatric* distributions.
- Vicariance: Formerly widespread population becomes fragmented.
 - New geographic feature form barriers to gene flow, e.g., mountains, rivers, emergence of the Isthmus of Panama
 - Extinction of intermediate populations due to habitat fragmentation.





The marine inhabitants of the eastern and western shores of South America are very distinct, with extremely few shells, crustacea, or echinodermata in common; but Dr. Gunther has recently shown that about thirty per cent of the fishes are the same on the opposite sides of the isthmus of Panama; and this fact has led naturalists to believe that the isthmus was formerly open.

Darwin, The Origin of Species



ALLOPATRIC SPECIATION IN SNAPPING SHRIMP















MODELS OF SPECIATION

Peripatric Speciation:

- Speciation in a peripheral isolate.
- Due to rare dispersal or colonization events.
- Also referred to as *Founder Effect* speciation.



Olde



