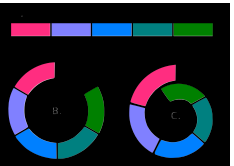
Ring species • Gulls • Salamanders • Warblers • Leopard Frogs



WHY

Speciation matters?

Ring species • Gulls • Salamanders • Warblers • Leopard Frogs

To understand how evolution has produced the diversity of life, we need to study two fundamental processes:

Ring species • Gulls • Salamanders • Warblers • Leopard Frogs

To understand how evolution has produced the diversity of life, we need to study two fundamental processes:

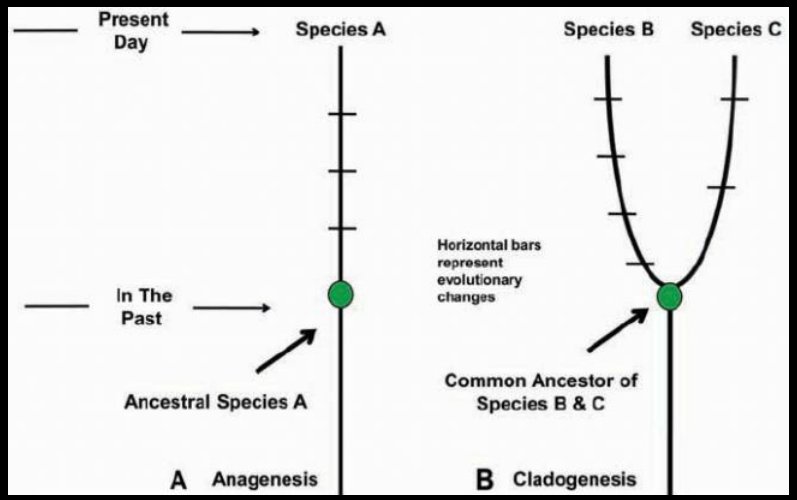
- How a single species changes through time?

Ring species • Gulls • Salamanders • Warblers • Leopard Frogs

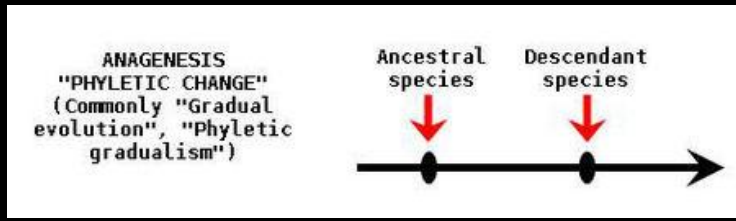
To understand how evolution has produced the diversity of life, we need to study two fundamental processes:

- How a single species changes through time.
- How a single species becomes two or more species? = speciation

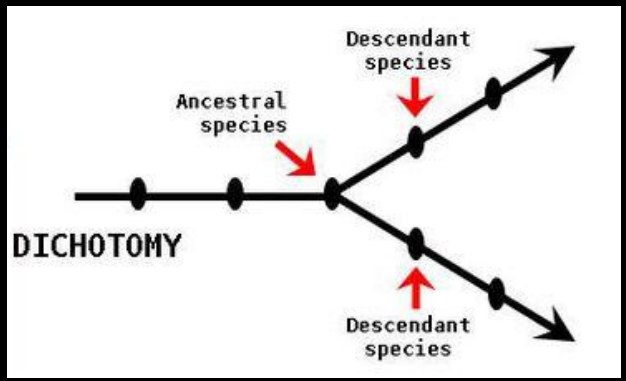
Ring species • Gulls • Salamanders • Warblers • Leopard Frogs



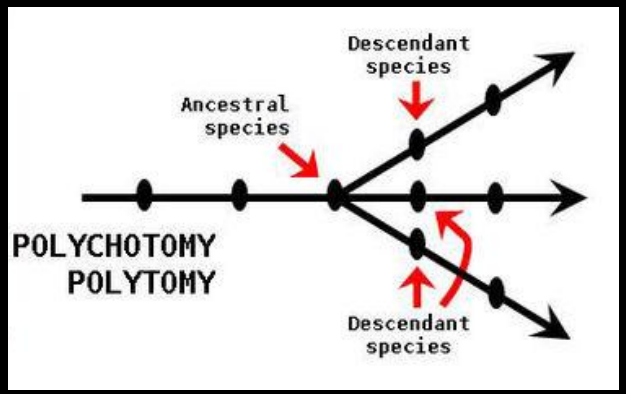
Ring species • Gulls • Salamanders • Warblers • Leopard Frogs

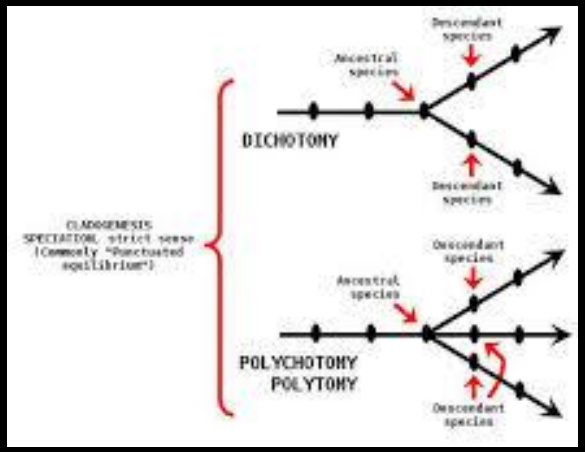


Ring species • Gulls • Salamanders • Warblers • Leopard Frogs



Ring species • Gulls • Salamanders • Warblers • Leopard Frogs





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ANAGENESIS VERSUS CLADOGENESIS

Anagenesis is an evolutionary change of a single lineage in which one taxon replaces by another without branching	Cladogenesis is an evolutionary change of a particular species in which new species are branched off from a common ancestral species

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ANAGENESIS VERSUS CLADOGENESIS

Branching of the lineage doesn't occur	Branching of the lineage occurs

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ANAGENESIS VERSUS CLADOGENESIS

An evolution within a lineage	An evolution which results in the splitting of a lineage

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ANAGENESIS VERSUS CLADOGENESIS

Called phyletic evolution or progressive evolution	Called the branching evolution

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ANAGENESIS VERSUS CLADOGENESIS

One gene pool is converted into another gene pool	A single gene pool is split into several gene pools

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ANAGENESIS VERSUS CLADOGENESIS

Does not promote biological diversity	Promotes biological diversity since it increases the number of species

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Speciation usually takes too long to observe in one lifetime.

but.....

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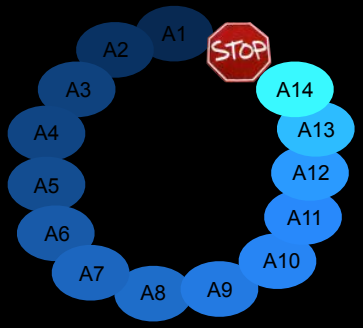

Imagine populations of the species A.

Over the geographic range there are a number of subpopulations.

These subpopulations (A1-A14) have limited regions of over-lap with one another, but in those regions, they interbreed successfully.

But, populations A14 and A1 no longer interbreed successfully – are these populations separate species?

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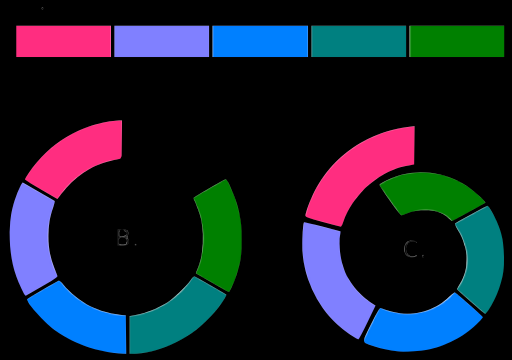
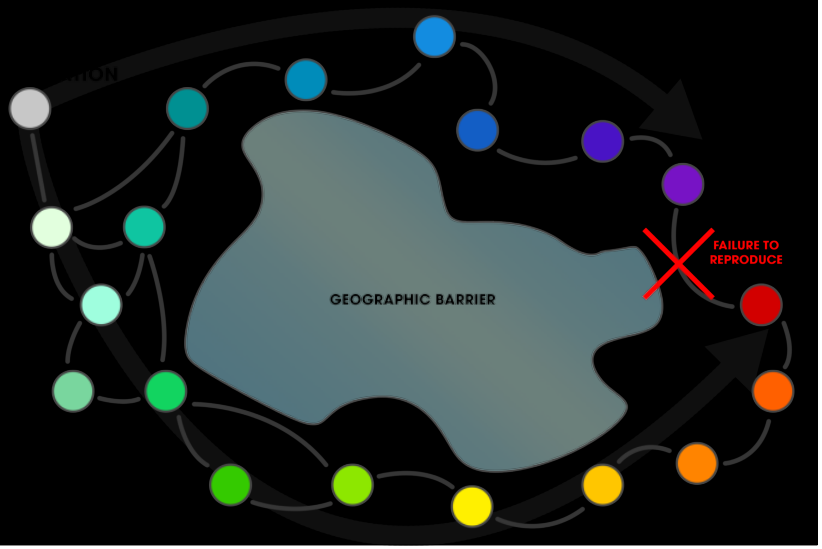
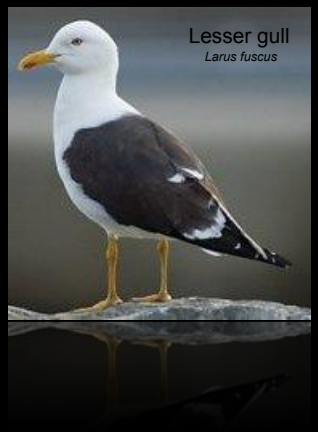


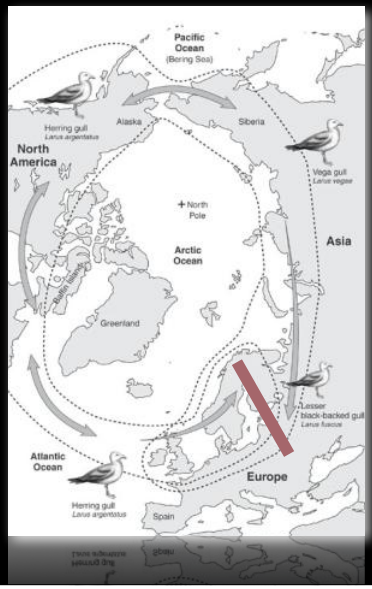
Ring species • Gulls • Salamanders • Warblers • Leopard Frogs



Ring species • Gulls • Salamanders • Warblers • Leopard Frogs



Ring species • **Gulls** • Salamanders • Warblers • Leopard Frogs



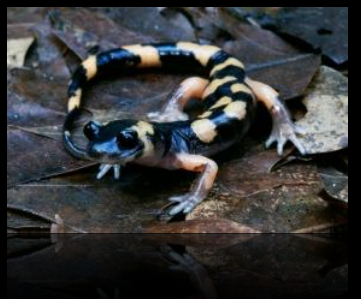
Two species of gull: the herring gull and the lesser black-backed gull.

Diverged from a common ancestry as they have colonized and encircled the northern hemisphere.

Where they occur together in northern Europe they fail to interbreed and are clearly recognized as two distinct species.

However, they are linked along their ranges by a series of freely interbreeding races or subspecies. (After Brookes, 1998.)

Ring species • Gulls • **Salamanders** • Warblers • Leopard Frogs



http://evolution.berkeley.edu/evolibrary/article/0_0_0/devitt_01

Ring species • Gulls • **Salamanders** • Warblers • Leopard Frogs

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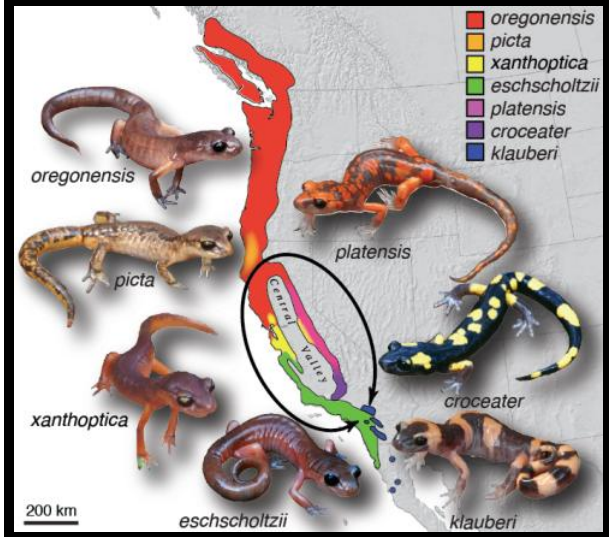
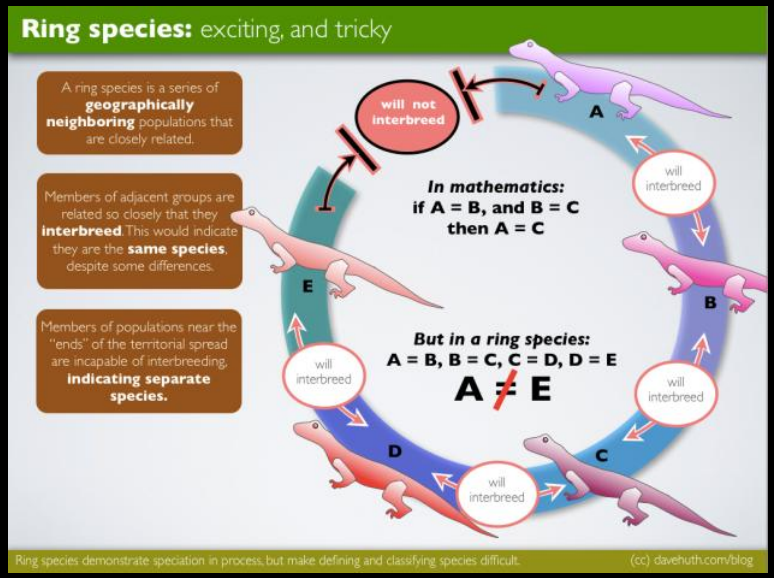
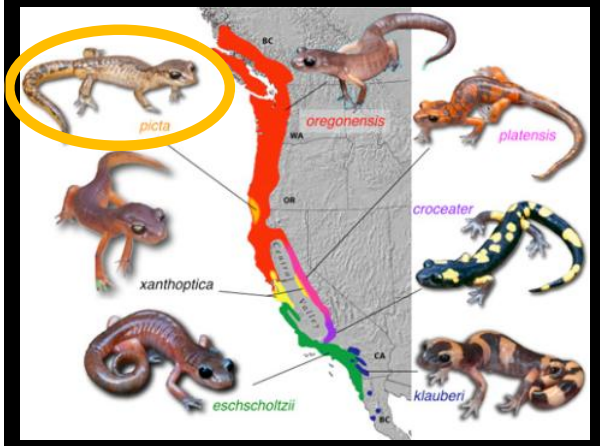


Neighboring subspecies are more similar to one another than to those across the ring.

Neighboring subspecies seem to blend into one another.

http://www.parksconservancy.org/about/newsletters/park-e-ventures/2013/06-ggro.html



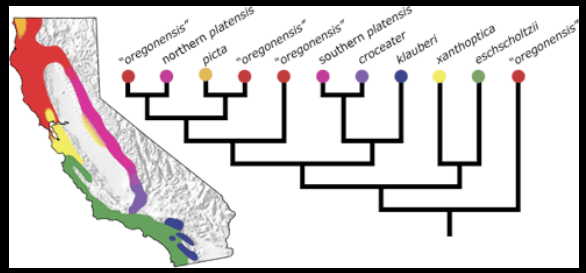


The northern coastal form, called *E. picta*, had a pattern of colors that seemed to encompass the other subspecies.

It was easy to imagine how the more specialized southern forms could have evolved from *E. picta*.

Hypothesis: the two southward-moving *Ensatina* lineages have both emerged from *E. picta* immediate ancestors.

http://evolution.berkeley.edu/evolibrary/article/0_0_0/devitt_01



Ensatina phylogeny based on mitochondrial DNA.

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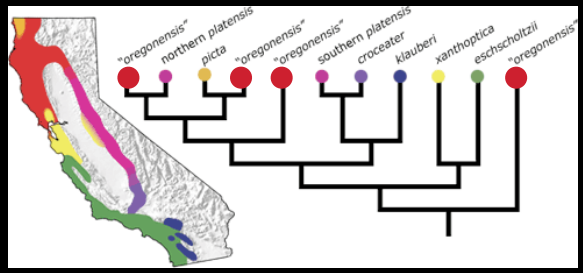

Ensatina phylogeny based on mitochondrial DNA.
E.e. oregonensis ● is composed of four separate evolutionary lineages, which happen to be morphologically similar to one another.

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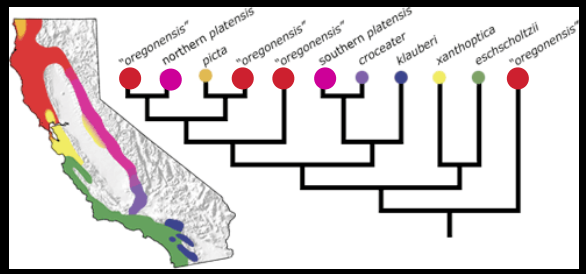
Ring species • Gulls • Salamanders • Warblers • Leopard Frogs



Ensatina phylogeny based on mitochondrial DNA.
E.e. oregonensis ● is composed of four separate evolutionary lineages, which happen to be morphologically similar to one another.
Similarly, *E.e. platensis* ● is made up of two distinct lineages.

Ensatina DNA reveals distinct evolutionary histories that morphology alone did not.

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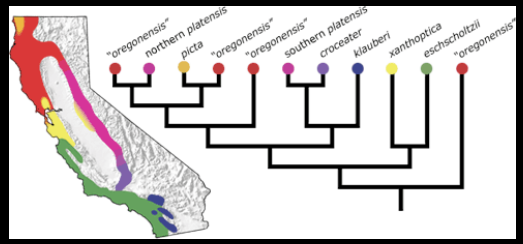
Ring species • Gulls • Salamanders • Warblers • Leopard Frogs



The midpoints of the ring salamander lineages branched off near the base of the tree — suggesting that they are closely related to the ancestor of the ring.

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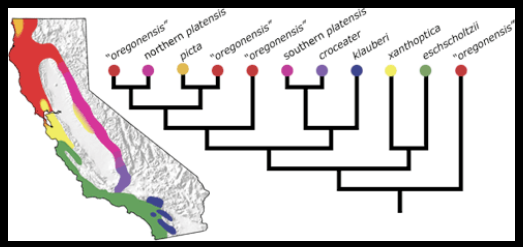
Ring species • Gulls • Salamanders • Warblers • Leopard Frogs



The forms near the eastern and western endpoints of the ring formed distinct groups — as expect if they each evolved separately from *Ensatina*'s ancestor.

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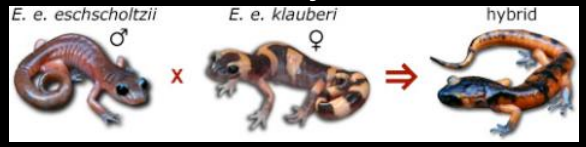
Why doesn't *Ensatina*'s ring join up fully?

Ring species • Gulls • Salamanders • Warblers • Leopard Frogs

Why doesn't *Ensatina*'s ring join up fully?

Love in the hybrid zone



Why do the two forms interbreed in some places and not others?
Since they do sometimes interbreed — what's keeping the two forms distinct?
Why don't these two subspecies blend into one another, as the forms around the rest of the ring do?

http://evolution.berkeley.edu/evolibrary/article/0_0_0/devitt_01

Ring species • Gulls • Salamanders • Warblers • Leopard Frogs

1. **Perhaps they rarely recognize each other as potential mates.** Many animals use particular clues to help them determine who would make an appropriate mate. Those clues may come in the form of a smell (e.g., a pheromone), a physical trait (e.g., a color pattern), or a behavior (e.g., a particular mating call or dance). Maybe *eschscholtzii* and *klauberi* have evolved such that they are attracted to different cues and so now avoid each other in the salamander singles scene.

2. **Perhaps they are reproductively incompatible.** The two subspecies might have no qualms about mating with one another but rarely produce healthy offspring because of basic biological differences that have evolved as the two lineages moved south.

3. **Perhaps they rarely mate because they rarely meet.** For example, the two might prefer different habitats or have such different lifestyles that they rarely even run into one another — let alone get together and mate.

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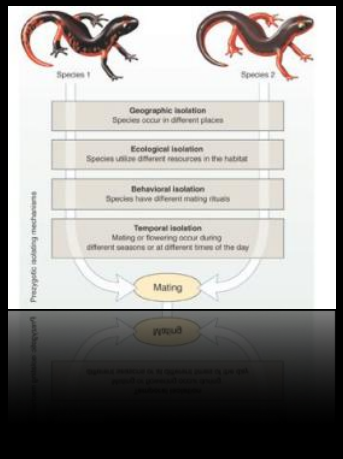

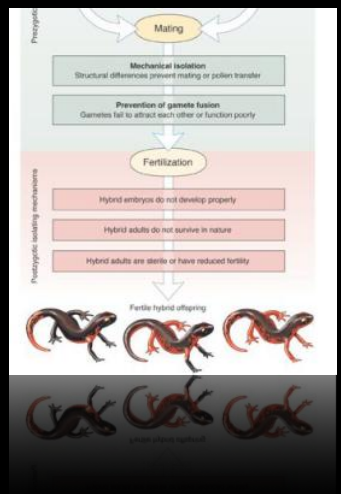

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West Siberian greenish warbler (felosa)
(*Phylloscopus trochiloides viridanus*)

East Siberian greenish warbler (felosa)
(*Phylloscopus trochiloides plumbeitarsus*)

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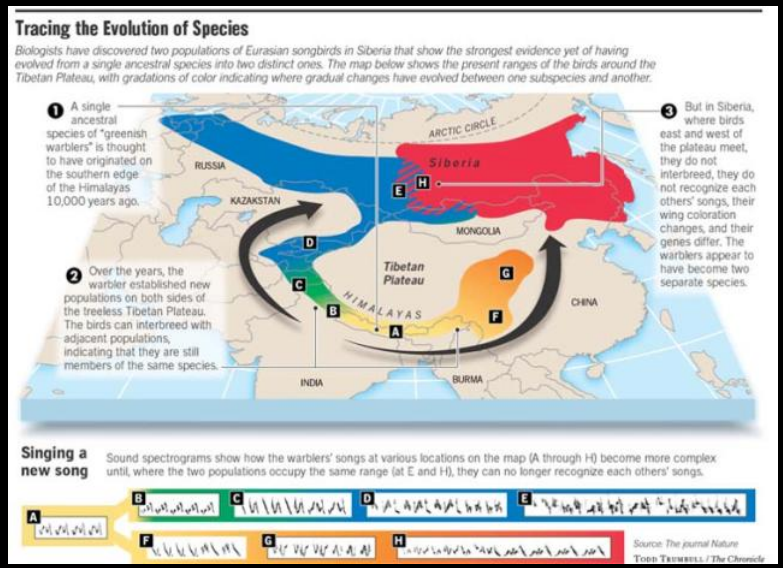
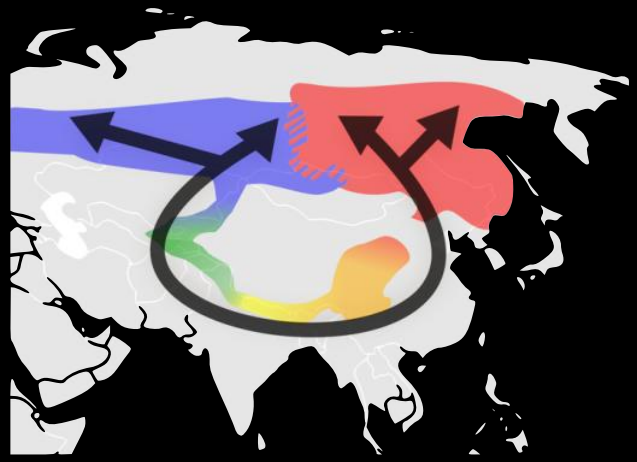


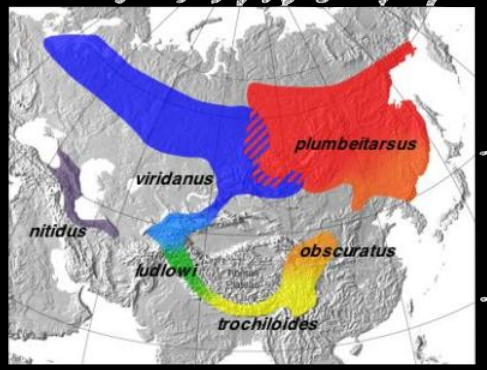
Ring species • Gulls • Salamanders • Warblers • Leopard Frogs



Map of Asia showing the six subspecies of the greenish warbler described by Ticehurst in 1938. The crosshatched blue and red area in central Siberia shows the contact zone between *Phylloscopus trochiloides viridanus* and *Phylloscopus trochiloides plumbeitarsus*, which do not interbreed. Colors grade together where Ticehurst described gradual morphological change. The gap in northern China is most likely the result of habitat destruction.

http://www.zoology.ubc.ca/~irwin/GreenishWarblers.html

Ring species • Gulls • Salamanders • Warblers • Leopard Frogs



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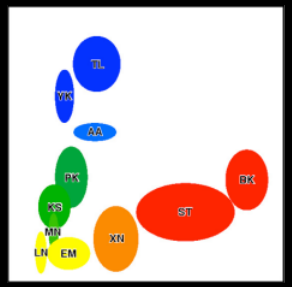
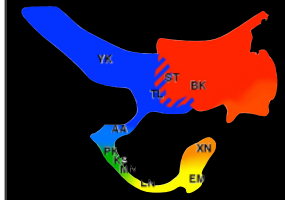
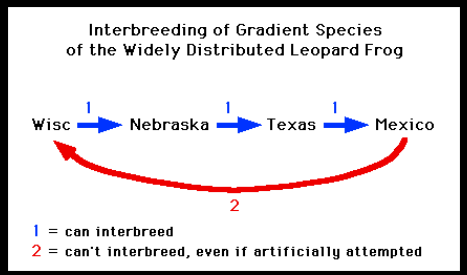
PC2 Increases with complexity (Frequency range and length per unit)

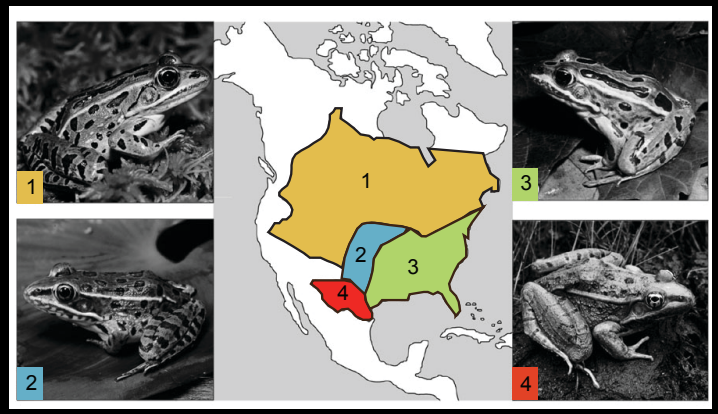




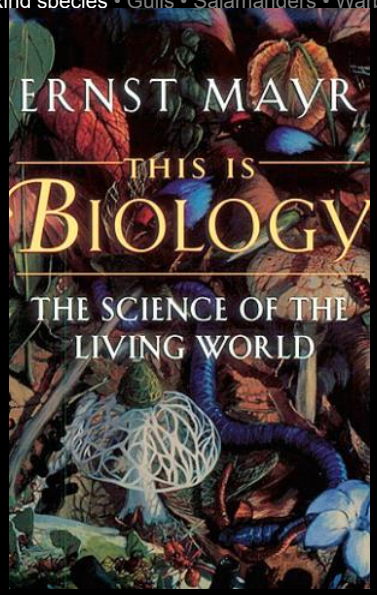
PC2
Increases with complexity
(length, units unit types)

The *Rana* species complex (the leopard frog, *Rana pipiens*, is one member of this complex) is widely distributed from Wisconsin to Mexico. Yet there is a problem when we attempt to classify these organisms and delineate subspecies and species geographical boundaries.





Ring species • Gulls • Salamanders • Warblers • Leopard Frogs



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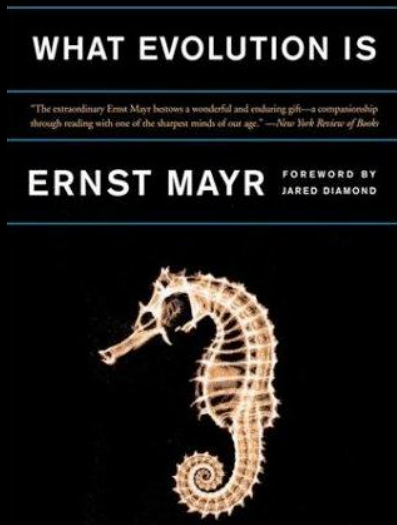
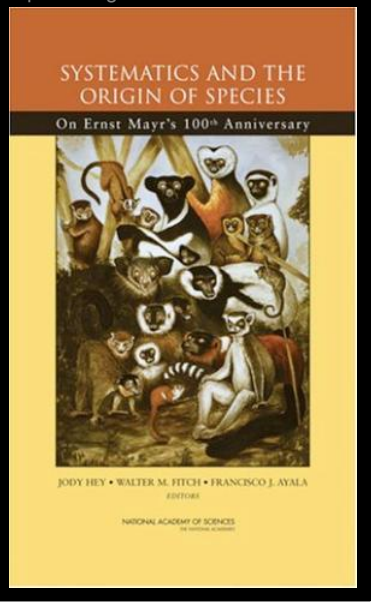


Ring species • Gulls • Salamanders • Warblers • Leopard Frogs



Ring species • Gulls • Salamanders • Warblers • Leopard Frogs

Ernst Mayr called ring species "the perfect demonstration of speciation" because they show a range of intermediate forms between two species.

They allow us to use variation in space to infer how changes occurred over time. This approach is especially powerful when we can reconstruct the biogeographical history of a ring species, as has been done in two cases.