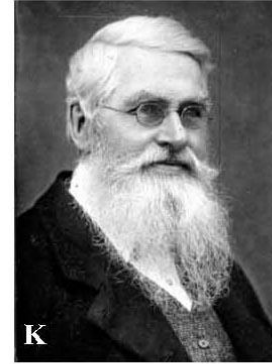


Evolutionary Theory Evolves

	<i>Darwin</i> 1859	<i>Modern Synthesis</i> 1942	<i>Integral Model</i> 2012
<i>V</i>ariation	Unknown	<ul style="list-style-type: none"> • Changes in “genes” • Random mutations due to copy errors and damage 	<ul style="list-style-type: none"> • Changes in DNA • Mobile DNA • Changes in regulation • Dynamic Genome • Endosymbiosis • Hybridization • Random mutations
<i>I</i>nheritance	Vertical	Vertical	<ul style="list-style-type: none"> • Vertical • Horizontal
<i>S</i>election	Natural, Artificial, Sexual	Natural, Artificial, Sexual, Drift	Natural, Artificial, Sexual, Drift, Kin. Group
<i>T</i>ime	~ 500 million years	~ 2 billion years	~ 3.7 billion years

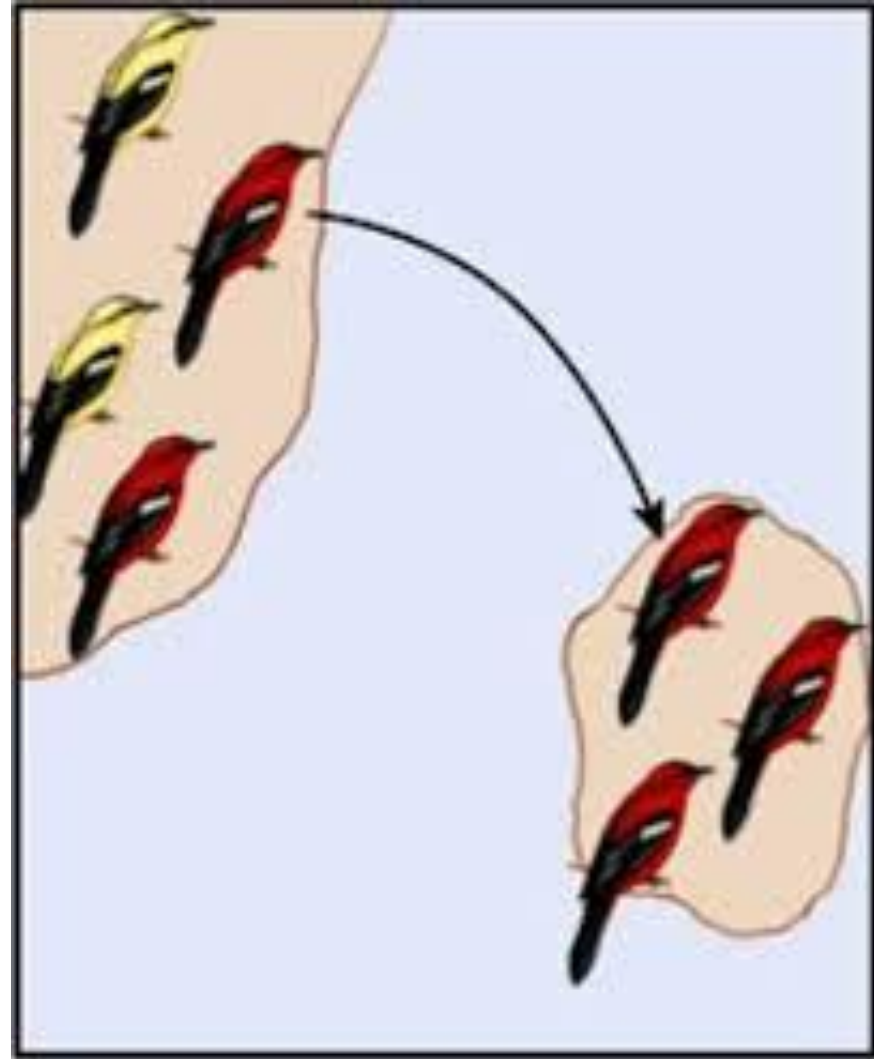
What we have so far

- ▶ Lamarck's ideas helped Darwin's theories
- ▶ Mendel further explained Darwin's theories
- ▶ Theories continue to evolve as scientists formulate theories about evolutionary change



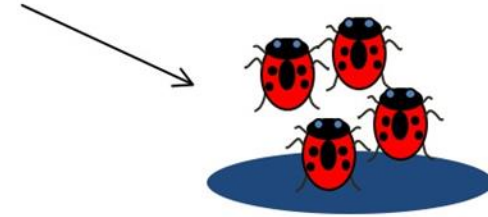
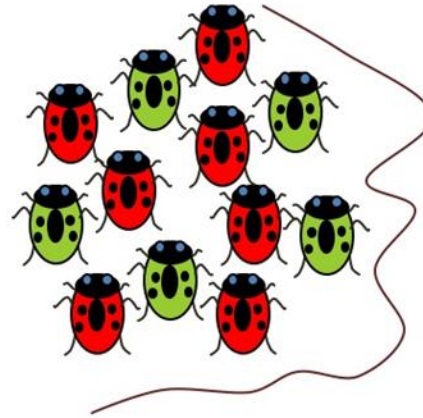
Genetic Drift

- ▶ Natural Selection is not always necessary for genetic change to occur
- ▶ Genetic Drift: Random change in the frequency of alleles that occur in **SMALL** populations
 - ▶ In small populations, individuals that carry a particular allele may leave more descendants than others just by chance
 - ▶ Over time a series of **CHANCE** occurrences can cause an allele to become more common in a population.



How does Genetic Drift work?

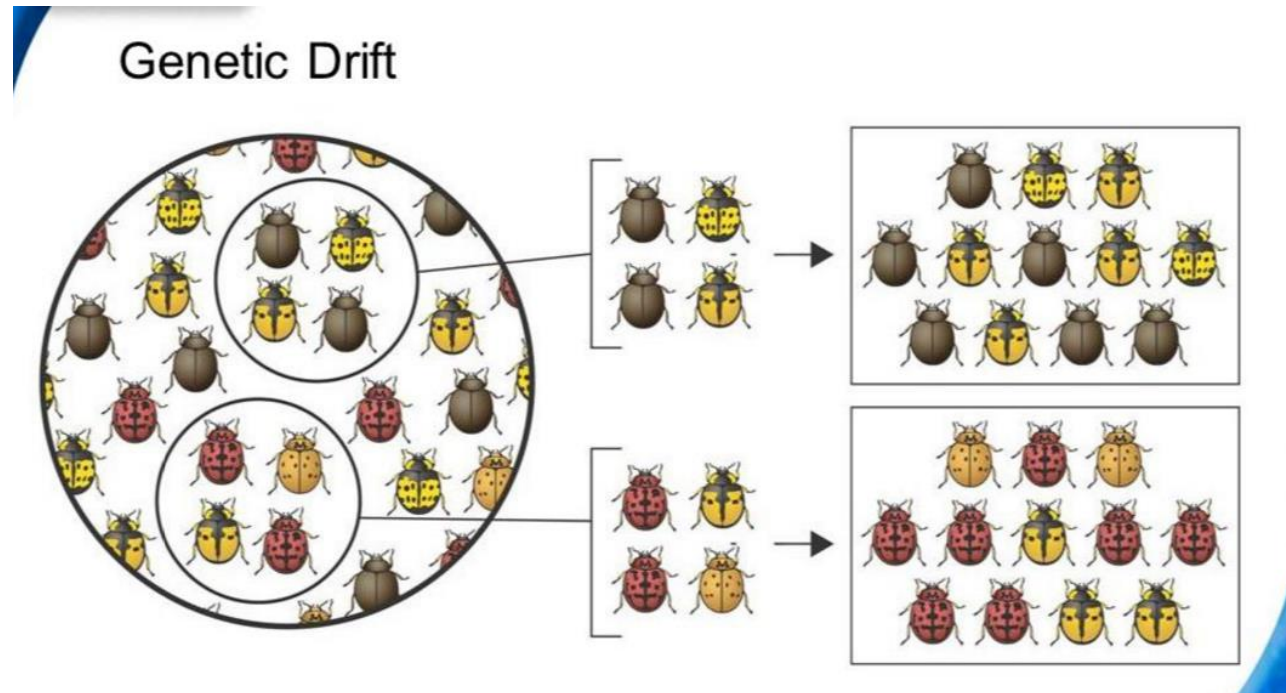
- ▶ It may occur when a small group of individuals colonize a new habitat
 - ▶ They may carry alleles in different relative frequencies than the larger population
 - ▶ This population will be genetically different from the original population due to chance.



Newly founded populations don't always represent the genetic diversity in their sources.

Founder effect

- ▶ Allele frequencies change as a result of migration of a small subgroup of a population
 - ▶ Example: evolution of several hundred species of fruit flies on the Hawaiian Islands
 - ▶ All have descended from the original mainland population



What results from Genetic Drift?

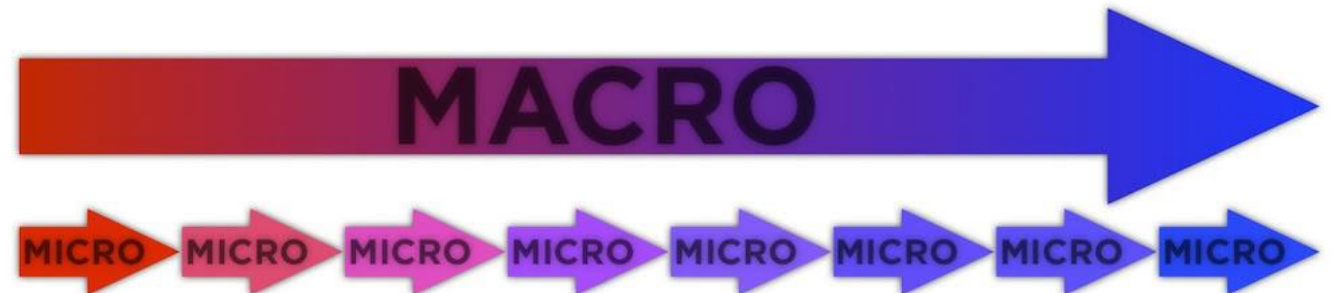
- ▶ Allele frequencies change (evolution)
- ▶ In special circumstances, a new or previously rare allele may become common in a population after a few generations
- ▶ This usually work in small populations ONLY
 - ▶ Why?
 - ▶ Chance events are less likely to affect all members of a very large population



Patterns of Evolution

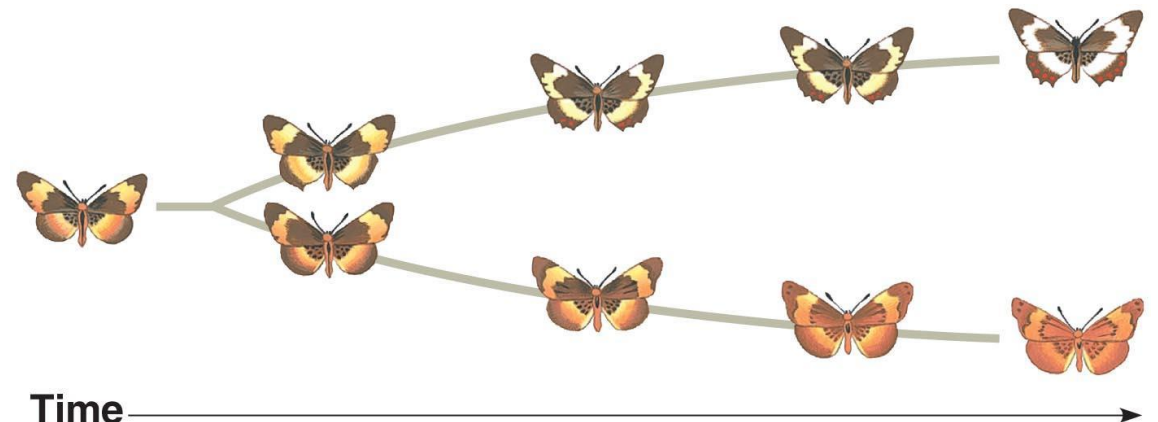
► Macroevolution

- Large scale evolutionary patterns and process that occurs over long periods of time
 - Extinction
 - Gradualism
 - Adaptive Radiation (Divergent Evolution)
 - Convergent Evolution
 - Punctuated equilibrium



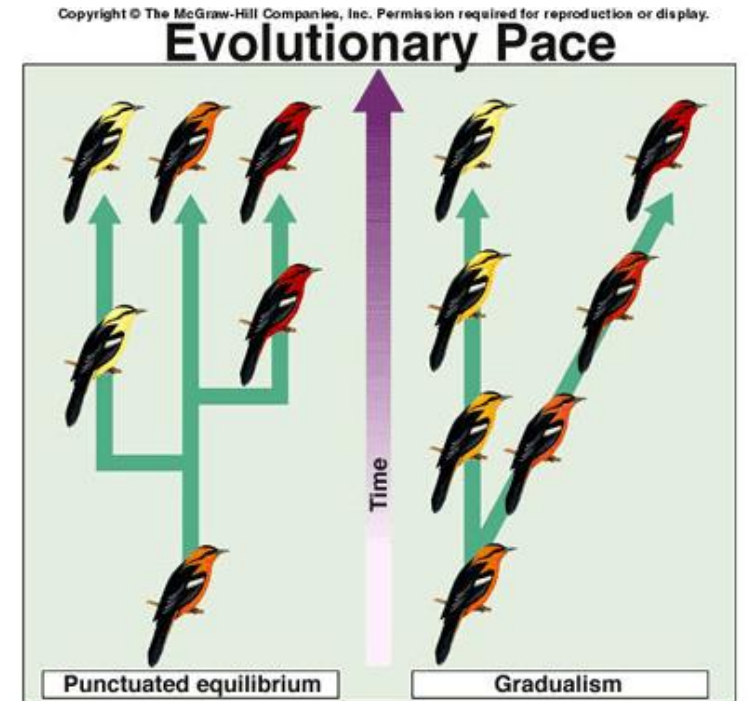
Gradual and Rapid Evolutionary Change

- ▶ Remember Charles Lyell
 - ▶ Earth changed slowly and gradually over time
 - ▶ Darwin also believed that biological change was also very slow and steady
- ▶ Gradualism: The theory that evolutionary change occurs slowly and gradually
- ▶ Fossil Record shows that some groups of organisms have changed gradually over time



Equilibrium

- ▶ Evidence that some species did NOT change gradually
- ▶ They did not change very much from the time they appeared in the fossil record to the time they disappeared
- ▶ They are in a state of equilibrium

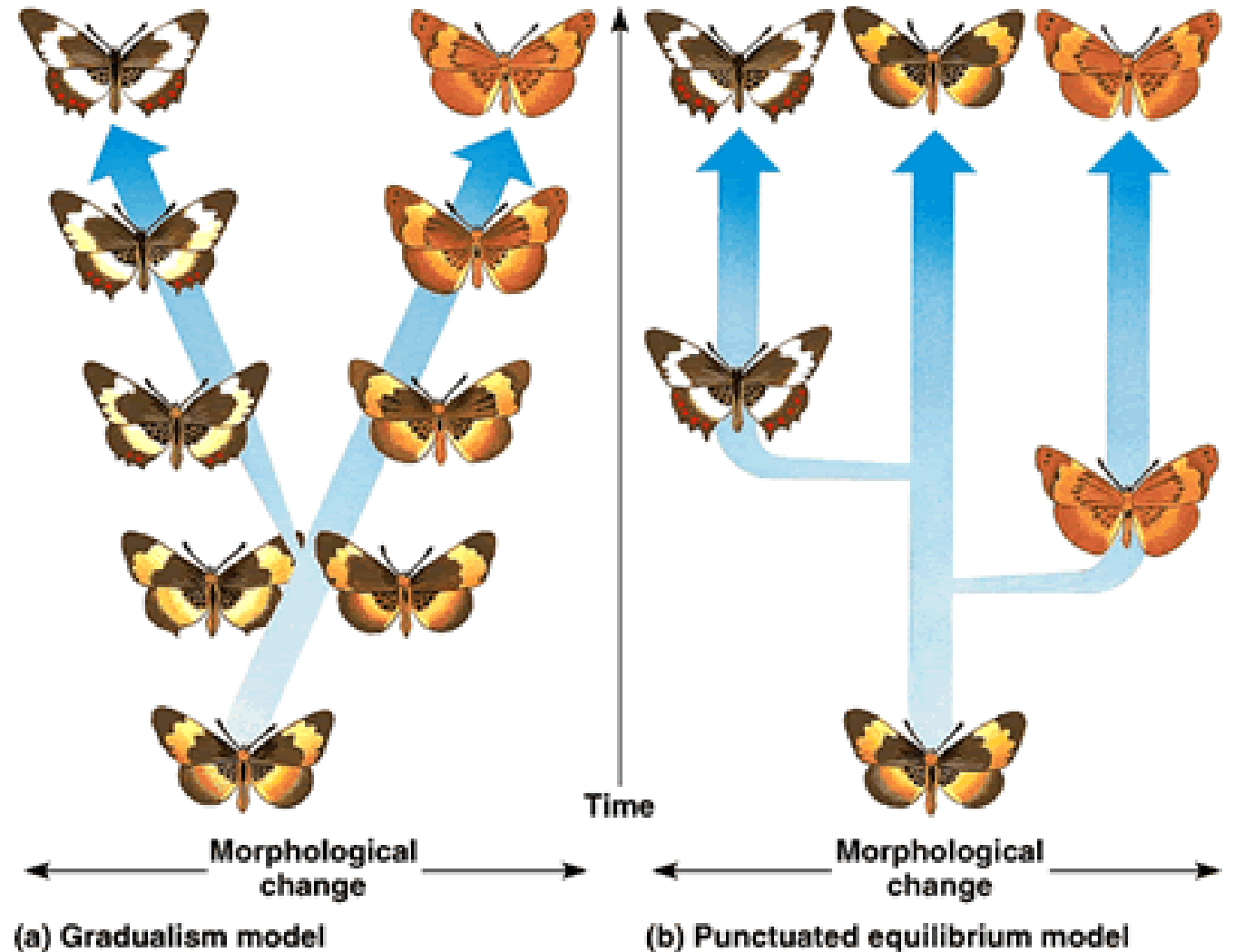


- ▶ **Equilibrium:** no large changes are happening to a species
 - ▶ This is not always the case
- ▶ Every now and again something happens to upset the equilibrium and cause rapid changes in organisms in a short time period
- ▶ Terms relative to the geologic time scale
 - ▶ “short” or “rapid” periods of time can still be hundreds, thousands or millions of years
- ▶ This is documented in the fossil record.



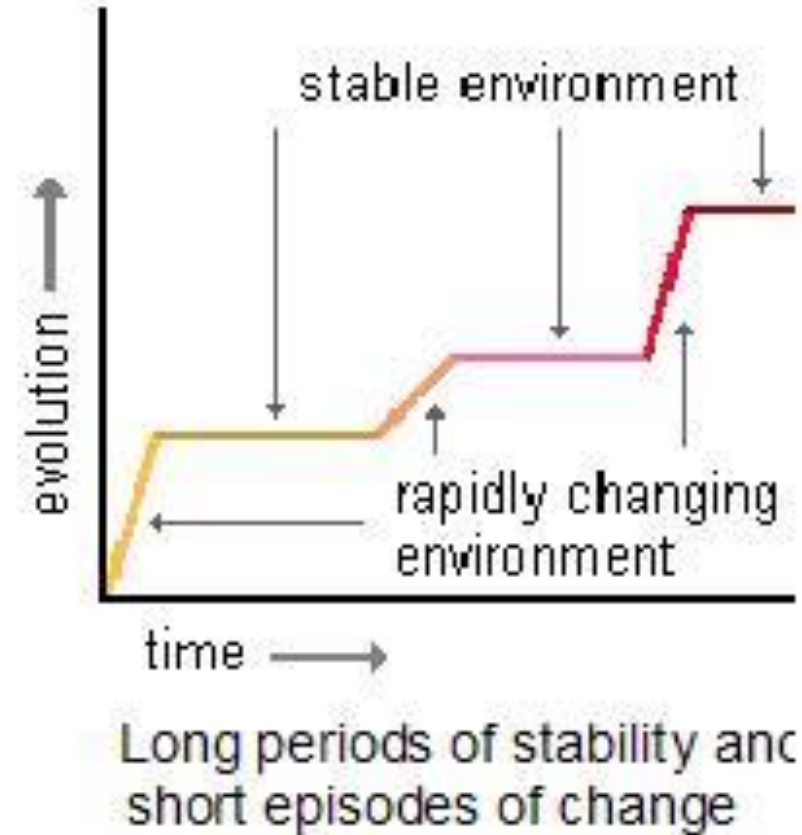
Punctuated Equilibrium

- ▶ Describes the pattern of long stable periods (equilibrium), interrupted by brief periods of rapid change
- ▶ Evolution does proceed at different rates for different organisms
- ▶ A new species changes most as it buds from a parent species and then changes little for the rest of its existence



Rapid Evolution

- ▶ After long periods of equilibrium rapid changes can occur in several ways
 - ▶ 1. When a small population becomes isolated from the main population (genetic drift)
 - ▶ 2. When a small group migrates to a new environment and rapidly evolves to fill empty niches (Darwin's Finches)
 - ▶ 3. Mass extinction: rapid change on earth causes species to vanish
 - ▶ Global climate change
 - ▶ Meteors



Extinctions

- ▶ More than 99% of all species that have ever lived are now extinct!
- ▶ Reasons
 - ▶ Competition for resources, habitat
 - ▶ Changing environment
 - ▶ Natural selection
 - ▶ Mass extinctions that wipe out entire ecosystems



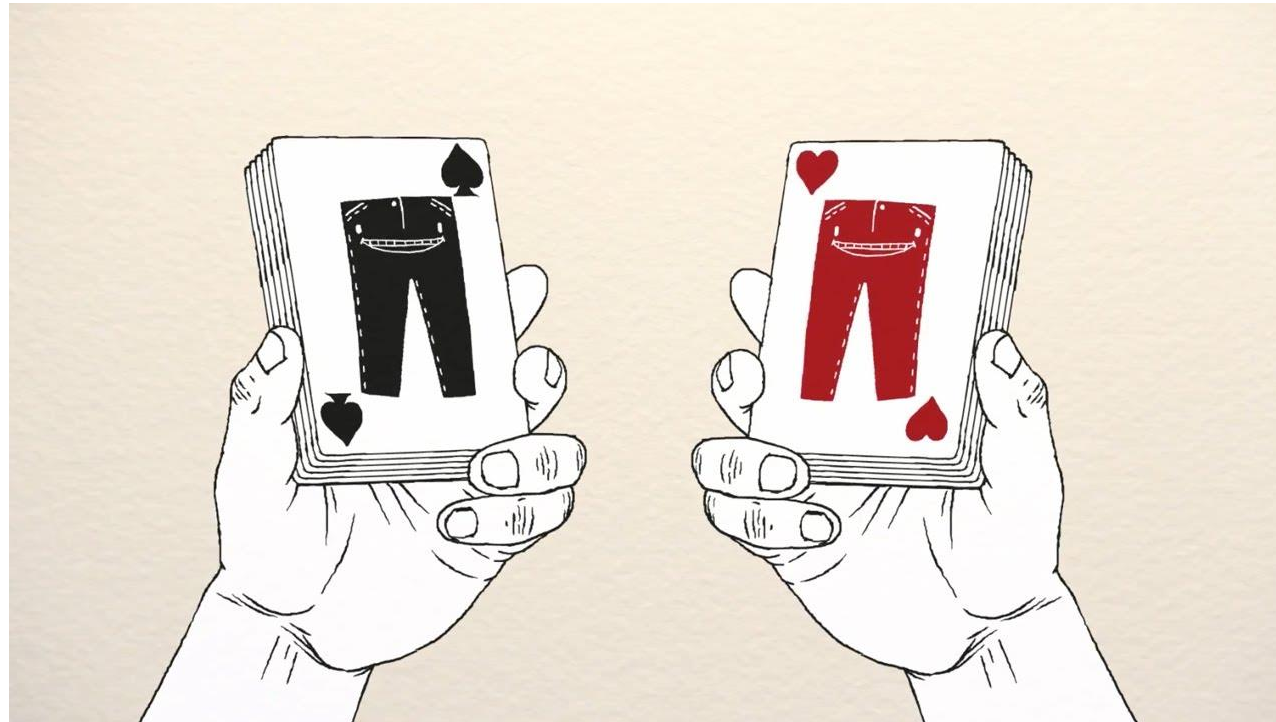
Mass Extinctions

- ▶ When these events occur many niches are left empty
- ▶ The species that remain that are able to survive and reproduce can potentially evolve to fill those empty niches
 - ▶ Forming many new species in the process
 - ▶ Burst of evolution
 - ▶ Adaptive Radiation
- ▶ The extinction of the dinosaurs cleared the way for the evolution of modern mammals and birds.



5 agents of evolutionary change

5 fingers of evolution



Causes allele frequencies to change (EVOLUTION)

- ▶ Non Random Mating: members of the population do not have equal opportunity to produce offspring
 - ▶ Organisms select specific traits
- ▶ Small Population: Chance takes over (genetic drift)
- ▶ Movement: New individuals bring new alleles
 - ▶ Gene flow
- ▶ Mutations: Mutations could mean new alleles
- ▶ Natural Selection: creates organisms better adapted to local environment