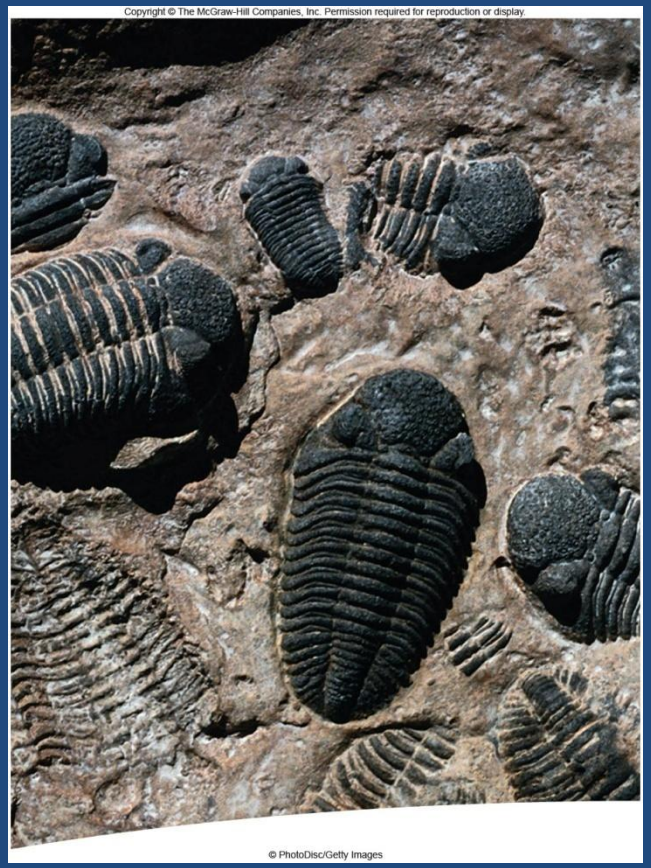
Evolution



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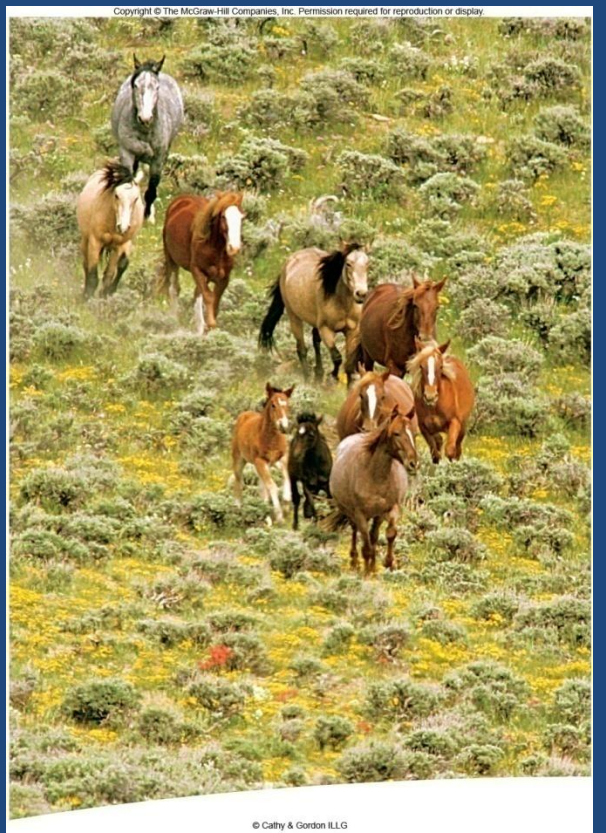

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- **Evolution:** The process by which organism change over time. Based on science, not opinion.

- **Darwin:** Evolution is descent with modification
- **Evolution:** changes through time
  1. Species accumulate difference
  2. Descendants differ from their ancestors
  3. New species arise from existing ones

- 1. **Micro-Evolution:** Change over a small period of time.
- **Kittlewell:** A scientist who proved that the species of Peppered Moths changed over a few years due to the change in tree color.
-

- 2. **Macro-Evolution:** Change over a large period of time.
- Domestic dogs evolved from wolves with the help from humans.

Early Ideas of Evolution

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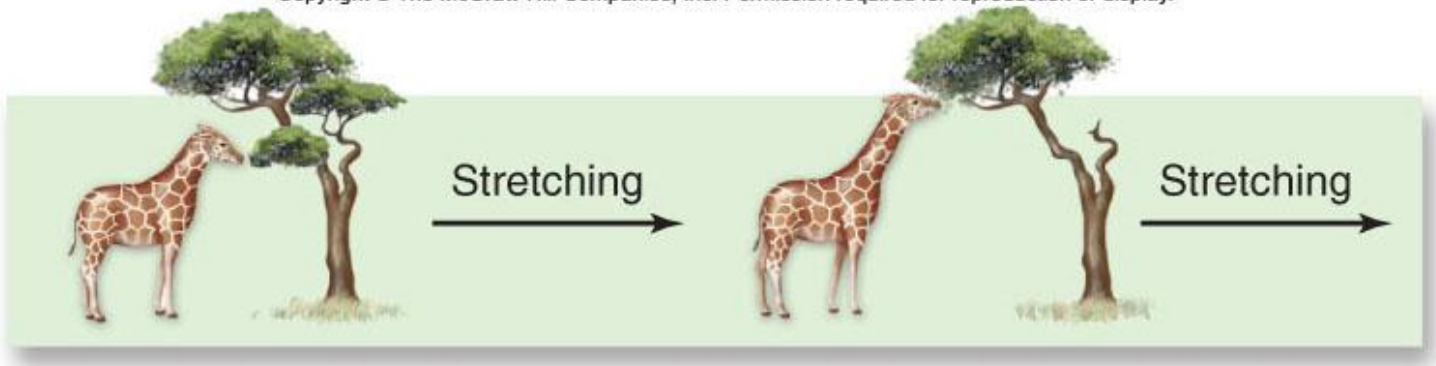
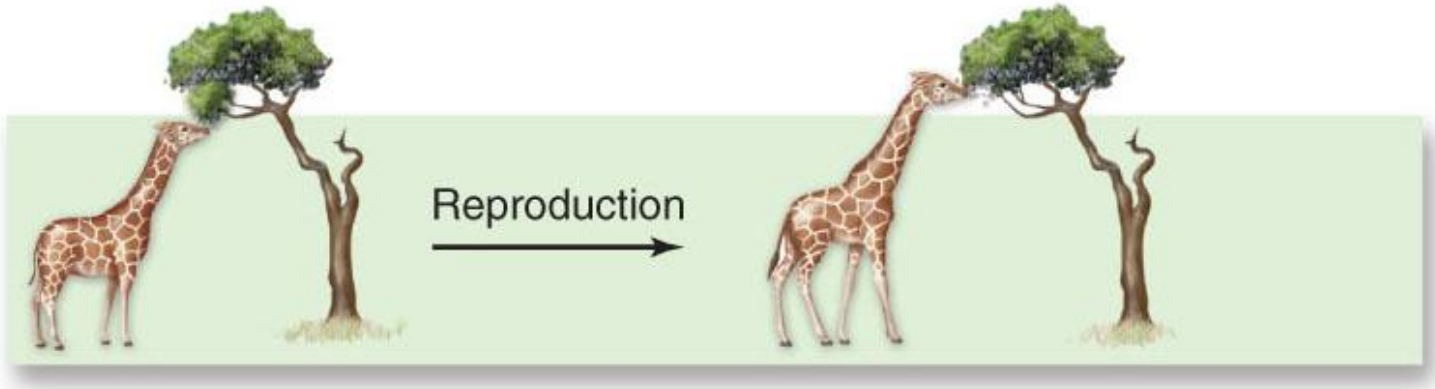
- **Lamarck's theory:** Before Darwin. first to realize living organisms change over time.
- By selective use or disuse of organs, organisms acquired or lost traits which were
- passed on to their offspring.



Proposed ancestor of giraffes has characteristics of modern-day okapi.

The giraffe ancestor lengthened its neck by stretching to reach tree leaves, then passed the change to offspring.



a. Lamarck's theory: acquired variation is passed on to descendants.

Lamarck's theory of how giraffes' long necks evolved

- **Malthusian Doctrine: 1859** (Thomas Malthus) He observed that the human birth rate was higher than the death rate. If it continued, humans would run out of room and food. (Malthusian Doctrine referred to during famine, war and mass disease)
- Competition for resources will cause variations.

Charles Darwin:

- **Charles Darwin: (1809 - 1882)** HMS Beagle. Traveled around the world to
- collect specimens at the age of 23 in 1831.
- Galapagos Islands: (Finches and Tortoises)
- Wrote: "The Origin of Species by Means of Natural Selection".

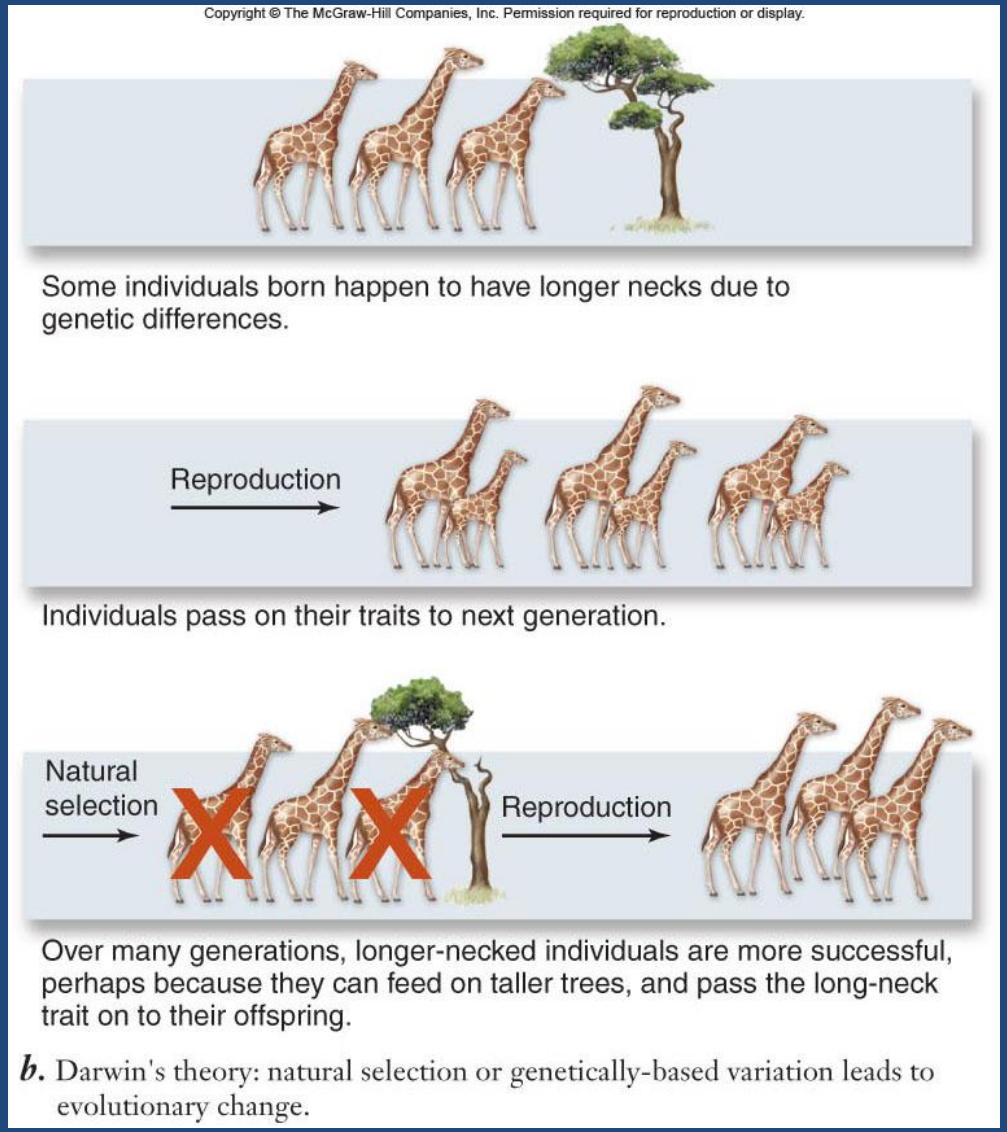
- Published 30 years after the voyage.
- It explained that evolution is a long slow process.
- All organisms have a common ancestor (Common descent)
- and are descendents from other species

Natural selection: mechanism of evolutionary change

Natural selection: proposed by Darwin as the mechanism of evolution

- individuals have specific inherited characteristics
- they produce more surviving offspring
- the population includes more individuals with these specific characteristics
- the population evolves and is better adapted to its present environment

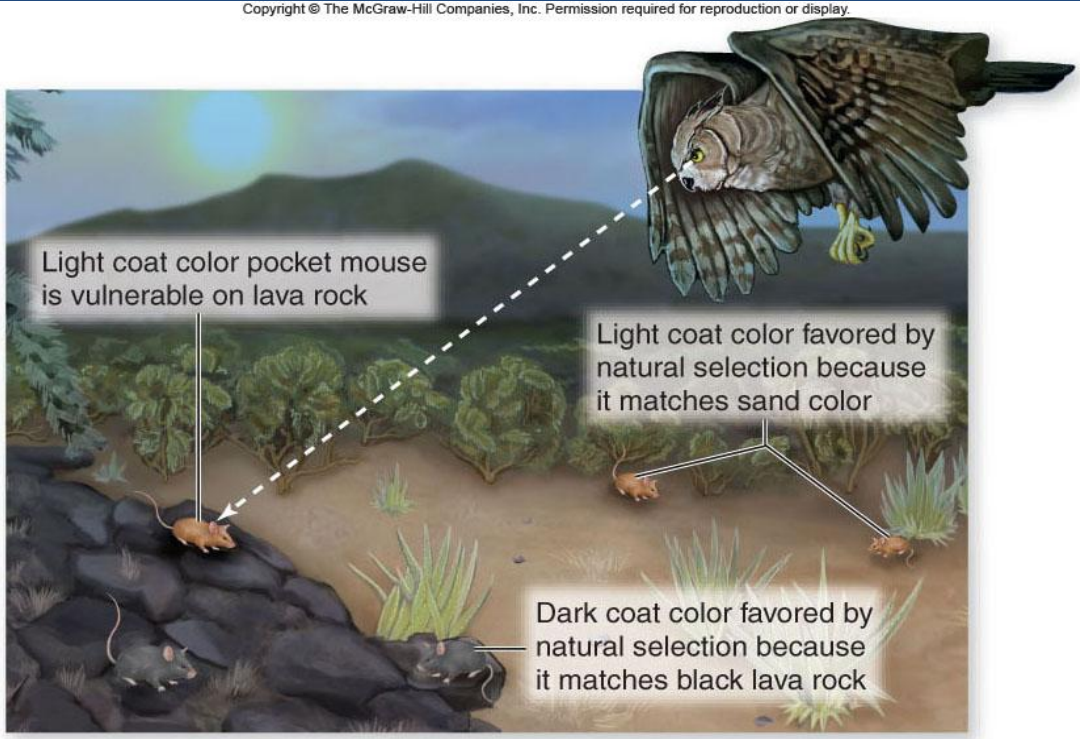
Darwin's theory for how long necks evolved in giraffes



Natural selection

- 3 conditions for natural selection to occur
  - Variation must exist among individuals in a population
  - Variation among individuals must result in differences in the number of offspring surviving
  - Variation must be genetically inherited

e. The only agent that produces *adaptive* evolutionary changes.



Data from P.A. Powers, et al., "A Multidisciplinary Approach to the Selectionist/Neutralist Controversy." Oxford Surveys in Evolutionary Biology. Oxford University Press, 1993.

- **Adaptation**: Species pass on inherited traits that increase their ability to survive.
- He had internal conflicts with what he discovered. It went against what he believed.

Ideas That Helped Darwin's Theory:

- **1.) Geology**: By studying fossils he believed the earth was much older than people of his time had thought.
- He also studied and observed areas that were affected by volcanoes and earthquakes. These changed the surface of the earth.

- He also saw that certain places contained a certain species that changed as we looked thought the fossil record.

- **2.) Farmers / Breeders:** Farmers altered and improved their own live stalk though selective breeding Techniques. (Artificial Selection)
- He noticed this with Pigeons.
- **3.) Population Controls**: Over time conditions prevent the endless growth o a population.
- 1. Famine 2. Disease 3. War 4. Drought
- These apply to plants as well as animals.

Darwins Finches

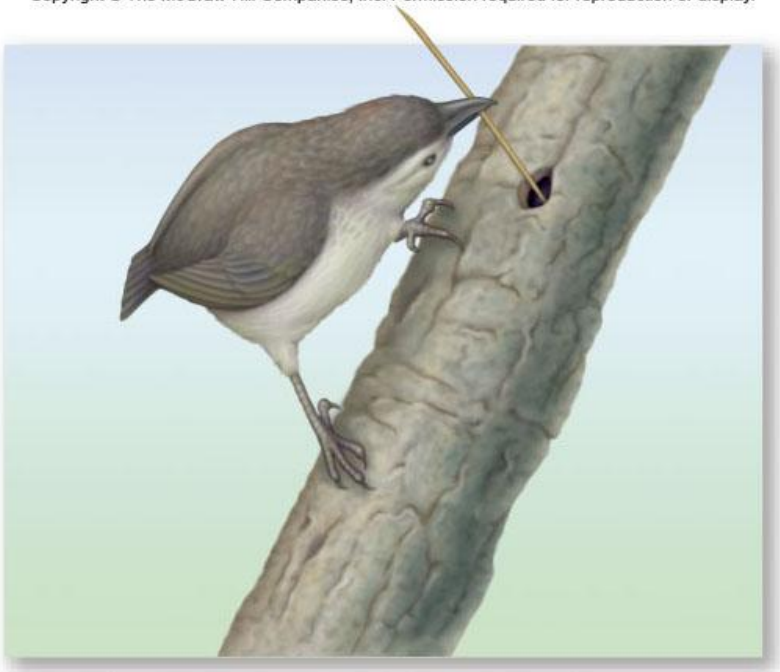
- Darwin spotted 14 different species of finches on the Galopagose Islands.
- All of these finches came from **1 single ancestral species**. Each lived in a different Niche. HOW DID THIS HAPPEN?

What we know and understand about Darwin's finches.

- 1. **Parent birds** came from the South American mainland to the island. How?
- 2. The island caused a **separation** of the population.
- 3. Once separated changes in the gene pool occur.
- This depends on the niche and this may lead to phenotypic differences.

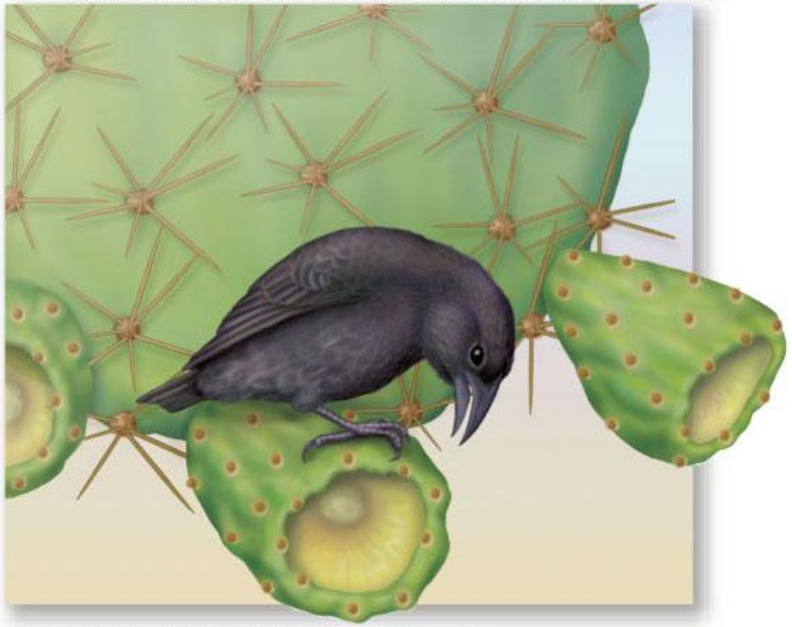
- 4. **Reproductive isolation** caused by gene pooling the genes change .

- 5. If the species migrated near each other 3 possible outcome could happen.
- **1**. **coexistance** if they occupy different niches.
- **2. Extinction** if they occupy the same niche and compete.
- **3. Further Evolution** if one species has many genetic variations this may be the result.



Woodpecker finch (*Cactospiza pallida*)

Large ground finch (*Geospiza magnirostris*)



Cactus finch (*Geospiza scandens*)

Warbler finch (*Certhidea olivacea*)

- **Eugenics Movement**: (1930's) (Humans are genetically becoming weaker!!)
- (Hitler) (Mental institutions)
- All of what we have leaned about DNA and evolution show that this idea will never work.

- **Artificial Selection:** People select the desired traits in the parents so the offspring
- will possess those desired traits. (ex. farmers = corn, or cows etc) (dog breeder
- = good hunting dog, friendly, guard dog etc.)

- **Natural Selection:** The fittest organisms survive so the offspring will posses those fit traits. (Mother Natures way of artificial selection).
- Nature produces the most fit offspring.
- **Ex.** Dogs their are many breeds and wild dogs and street dogs have the same traits everywhere around the world. (Short hair, curly tails, about 30-40 pounds).

- "**Survival of the fittest":** Species of Organisms compete for food and space to live.Those that can are consided more fit and win the struggle to exist.
- **Genetic Fitness:** The fitness of an organism is based on the **genetic makeup.**

- **Gene Variation:** All organisms are genetically different. (Mutations and Gene shuffling)

Gene Variation in Nature

- **Measuring levels of genetic variation**
  - blood groups
  - enzymes
- **Enzyme polymorphism**
  - A locus with more variation than can be explained by mutation is termed polymorphic.
  - Natural populations tend to have more polymorphic loci than can be accounted for by mutation.
- **DNA sequence polymorphism**

Hardy-Weinberg Principle

- Godfrey H. Hardy: English mathematician
  Wilhelm Weinberg: German physician

  Concluded that:
  The original proportions of the genotypes in a population will remain constant from generation to generation as long as five assumptions are met

Hardy-Weinberg Principle

Five assumptions :

1. No mutation takes place
2. No genes are transferred to or from other sources
3. Random mating is occurring
4. The population size is very large
5. No selection occurs

Hardy-Weinberg Principle

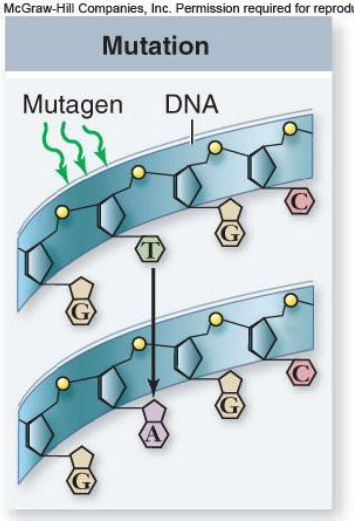
Calculate genotype frequencies with a binomial expansion

$$(p+q)^2 = p^2 + 2pq + q^2$$

- p = individuals homozygous dominant for first allele
- $2pq$ = individuals heterozygous for both alleles
- q = individuals homozygous recessive for second allele
- because there are only two alleles:
  p plus q must always equal
- *www.bozemanscience.com/solving-hardy-weinberg-problems*

	Generation One		
Phenotypes	 84%		16% 
Genotypes	*BB*	*Bb*	*bb*
Frequency of genotype in population	0.36	0.48	0.16
Frequency of gametes	0.36 + 0.24 = **0.60***B*	0.24 + 0.16 = **0.40***b*	

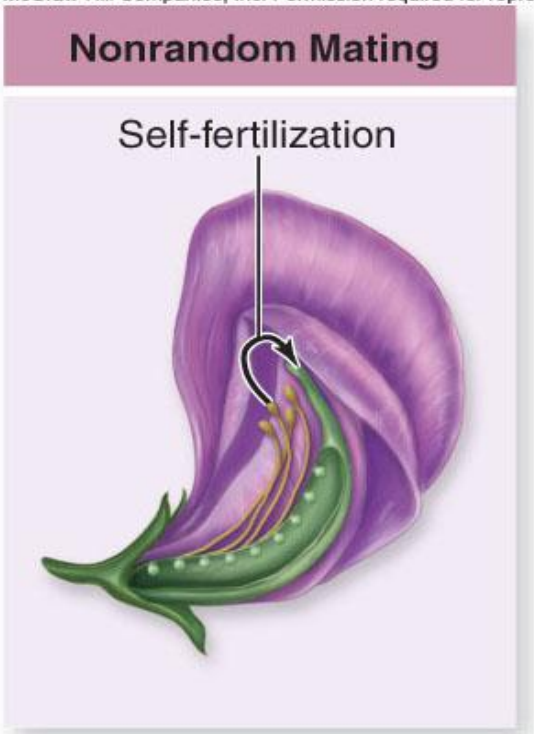
A population *not* in Hardy-Weinberg equilibrium indicates that one or more of the five evolutionary agents are operating in a population



a. The ultimate source of variation. Individual mutations occur so rarely that mutation alone usually does not change allele frequency much.

b. A very potent agent of change. Individuals or gametes move from one population to another.

Five agents of evolutionary change



c. Inbreeding is the most common form. It does not alter allele frequency but changes the proportion of heterozygotes.

d. Statistical accidents. The random fluctuation in allele frequencies increases as population size decreases.

Five agents of evolutionary change

e. The only agent that produces *adaptive* evolutionary changes.

Five agents of evolutionary change

Genetic Drift

- **Genetic drift:** Random fluctuation in allele frequencies over time by chance
  - important in small populations
    - **founder effect** - few individuals found new population (small allelic pool)
    - **bottleneck effect** - drastic reduction in population, and gene pool size

    http://www.bozemanscience.com/003-genetic-drift

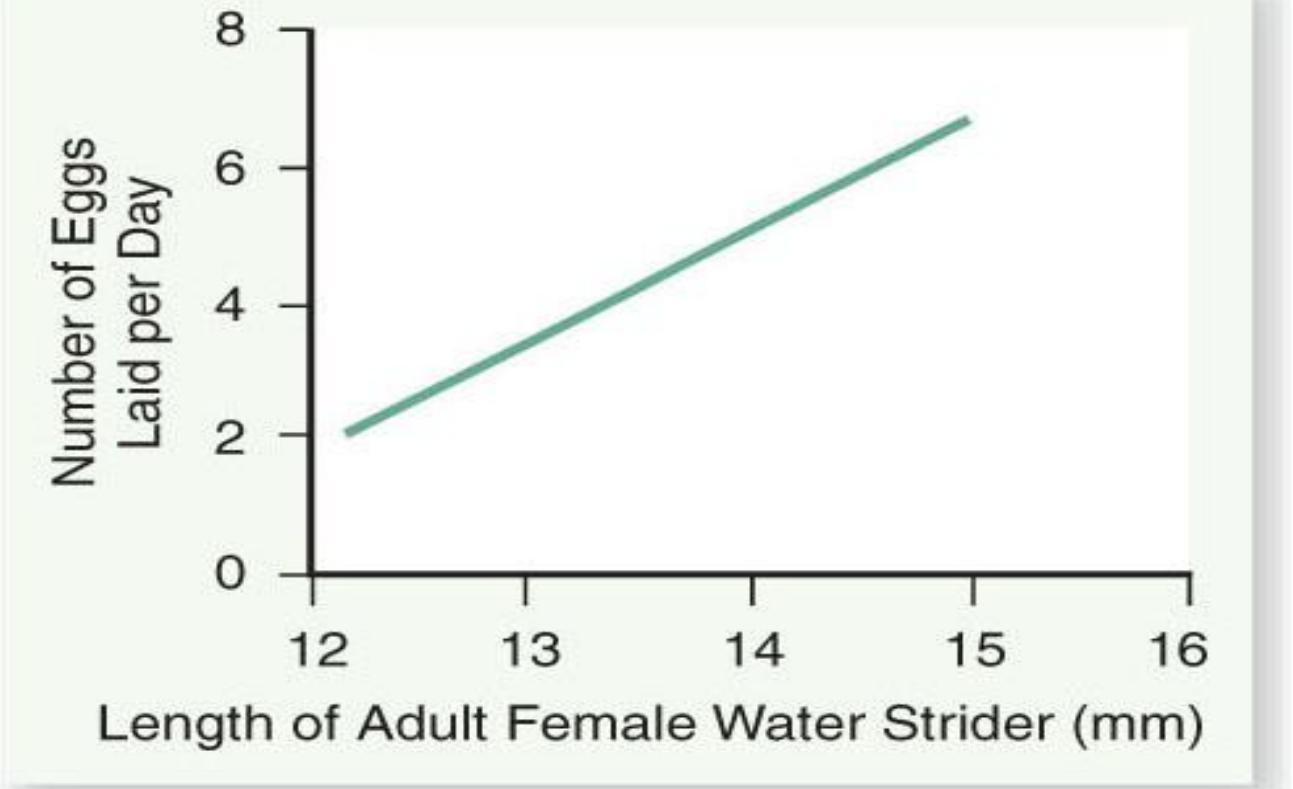
Fitness:

- Physical traits and behavior that enable an organism to survive and
- reproduce. Gene mutations make some organism more fit, others less fit. The more
- fit will survive and reproduce. **Based on Genetics**. This is the bases of Evolution.
- **Fitness is a combination of:**
  - Survival: how long does an organism live
  - Mating success: how often it mates
  - Number of offspring per mating that survive

Fitness

- **Fitness Topography:** Two curves that fit over each other. One is the environmental
- fitness level. The other is the organisms genetic fitness level.
-

Body size and egg-laying in water striders



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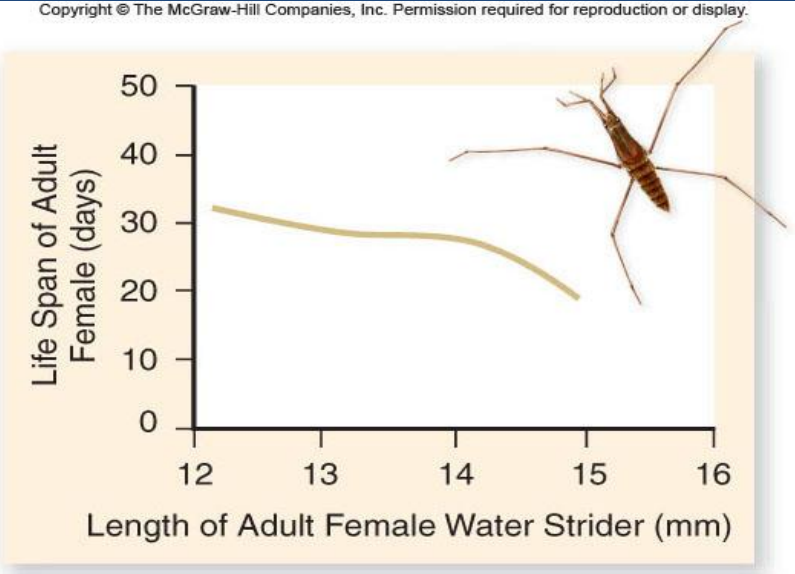

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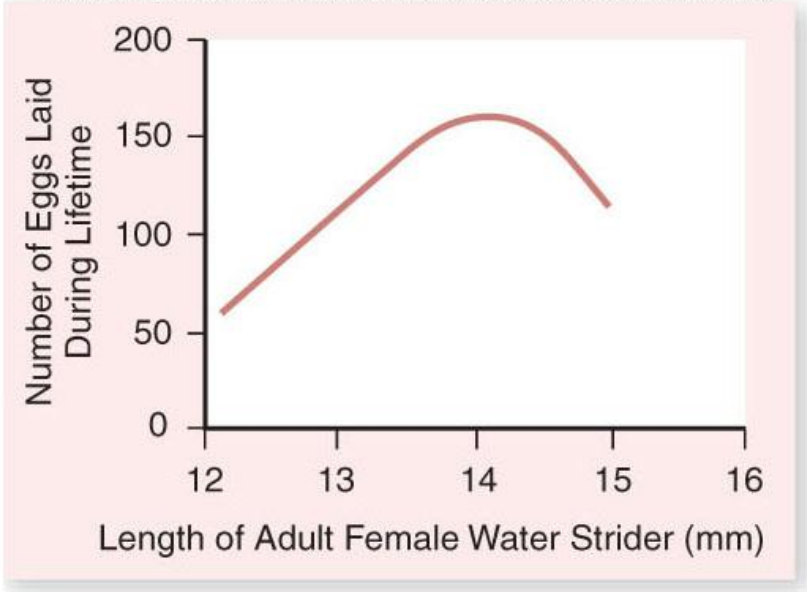

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Maintenance of Variation

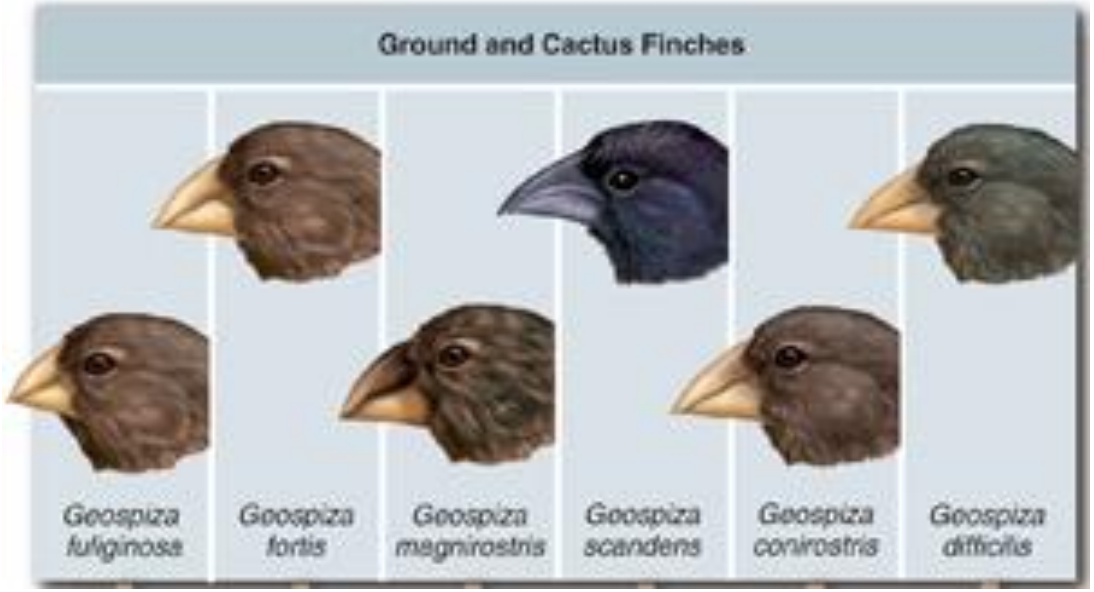
- **Frequency-dependent selection**: depends on how frequently or infrequently a phenotype occurs in a population
  - Negative frequency-dependent selection: rare phenotypes are favored by selection
  - Positive frequency-dependent selection: common phenotypes are favored; variation is eliminated from the population
- Strength of selection changes through time

Maintenance of Variation

- **Oscillating selection:** selection favors one phenotype at one time, and a different phenotype at another time
- Galápagos Islands ground finches
  - Wet conditions favor big bills (abundant seeds)
  - Dry conditions favor small bills

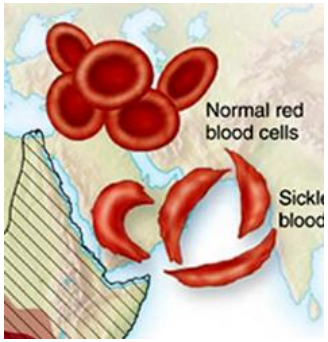
Maintenance of Variation

- Fitness of a phenotype does not depend on its frequency
- Environmental changes lead to oscillation in selection



Maintenance of Variation

- Heterozygotes may exhibit greater fitness than homozygotes
- **Heterozygote advantage:** keep deleterious alleles in a population
- **Example:** Sickle cell anemia
- Homozygous recessive phenotype: exhibit severe anemia



- **Adaptation**: Having a mutation which enables an organism to survive and
- reproduce better. (without adaptation, species would become **extinct)**
- **(**Remember, over 99% of all species on earth have already become extinct)

- **Evolutionary Tree:** A linear chart showing how species might be related.
- http://www.bozemanscience.com/cladograms
-
- **Adaptive Radiation**: One species evolved into many different species.
-
- **Coevolution:** Two unrelated organism evolve together and become dependent on each
- other. (ex. Certain bees and flowers
- http://www.bozemanscience.com/coevolution

- **Convergent Evolution:** Unrelated organisms evolve similar body parts which best suits
- the environment. (dolphins, fish, penguins)

- http://www.pbs.org/wgbh/nova/evolution/evolution-action-salamanders.html

Genetics And Evolution:

- Genes can cause random variations for natural selection, in the form of **Mutations** or changes caused by **crossing over**.
- Remember that natural selection only works on the **Phenotipic Variations**.

- **Development of a New Species: (Speciation)**
- All species eat different foods and live in different areas or the organisms will not survive. This role that an organism plays is called a **Niche**.
- If Two organisms occupy the same niche than they must compete. and no two speicies can occupy the same niche or very long.

- **A new species will form only if populations are isolated or separated.**
- If this does not occur than the gene pools will blend together and the species will look the same.

Isolation can happen by……

- 1. **Geographic barriers**. Rivers Mountains, lakes, Oceans etc.... Ecological Isolation
- 2. **Courtship Behaviors or Fertile Periods**: Each species has their specific behaviors for finding a mate. The individual with the best method will pass on there traits more often.
- Temporal Isolation: Different Species mate at different times due to Temperature Changes.

Behavioral Isolation

- 3. **Obtaining Food**. The individuals that obtain food the easiest will look much healthier and therefore have a better chance of mating.

- Mechanical Isolation: Shape of body or body parts.
- http://www.bozemanscience.com/003-genetic-drift

- **Once Reproductive isolation happens natural selection usually increases the difference between separate populations

Fossils

- **Fossil Records:** Preserved remains of old organisms.
- * Petrification. minerals in soil replace calcium.
- * Imprints.
- * molds

- 99% of all species that have ever been on earth are now **EXTINCT.** (gone forever!!!)
- **Paleontologists**: People who study fossils. (Mary and Lewis Leaky)
- **Relative Dating:**
- Comparing fossil with surrounding layers of rocks.
- Layers in trees.

- **<u>Absolute Dating:</u>**
- Radio-Active Dating: (ex. Carbon 14 and Potassium 40)
- **<u>Geologist.</u>** People who study rocks and land forms. (Pangea, Continental Drift,
- Mid-Atlantic Ridge).

Geologic Time Scale:

- (time line of the earth) Eras and periods.

- **Precambrian Time:** 90 % of Earths history. Few fossils.

Paleozoic Era: (544 - 245 millions years ago)

- **Cambrian Period:** Many marine life forms (hard shells). Drifted around the world in the oceans.
- **Ordovician Period:**
- **Silurian Period:**
- **Devonian Period:** "Age of the fish"
- **Carboniferous Period:** Reptile, fish and insects .
- **Permian Period:** Reptile, fish and insects abundant.

- **MASS EXTINCTION AT END OF PALEOZOIC ERA:**
- 95 % of all life died. 5% survived
- **<u>Mesozoic Era:</u>** (Age of the Reptile)
- **Triassic Period:**
- **Jurassic Period:** (DINOSAURS RULED)
- **Cretaceous period:** small mammals

- **MASS EXTINCTION AT END OF MESOZOIC ERA:**
- Over 50% of all live died, Including most dinosaurs.

- **<u>Cenozoic Era:</u>** (65 mya - present) (Age of Mammals)
- **Tertiary Period**
- **Quanternary Period**

- **Fossils not the only evidence:**
- **1. <u>Embryonic Stage</u>:** (handout)
- * gill slits, notocord. etc
- * Similarity in all cells(Organelles, mitosis, meiosis)
- * DNA (ATCG).

- **2. <u>Similar Body Structure:</u>**
- * Homologous Structures
- Bird wings, dog legs (same bones)
- * Vestigial organs.
- (don’t serve a function anymore. Tail bone, appendix, ear muscle, legs on snakes, etc)

Endosymbiosis

Endosymbiosis

-proposal that eukaryotic organelles evolved through a symbiotic relationship

-one cell engulfed a second cell and a symbiotic relationship developed

-mitochondria and chloroplasts are thought to have evolved this way

Endosymbiosis

Much evidence supports this endosymbiosis theory.

Mitochondria and chloroplasts:

-have 2 membranes

-possess DNA and ribosomes

-are about the size of a prokaryotic cell

-divide by a process similar to bacteria