



Mechanisms of Evolution

Honors Biology 2012

1

Adaptations

- ✦ Behavioral
- ✦ Structural
- ✦ Biochemical
- ✦ Physiological



2

Old Ideas about Evolution

- ✦ Aristotle (viewed species perfect and unchanging)
- ✦ Lamarck suggested that life evolves by use and disuse and inheritance of acquired characteristics

3

Fig. 13.1

Darwin



- ✦ Traveled on the H.M.S. Beagle around the world
- ✦ Published *On the Origin of Species by Means of Natural Selection* in 1859
- ✦ Natural Selection - mechanism of evolutionary change producing adaptation of organisms to their environment; the differential survival and reproduction of individuals within a population
- ✦ Influenced by geology and realized the Earth was very old and that present day species have arisen from ancestral species
 - ✦ Study of fossils suggests species change over time



4

Darwin's Observations

- ✦ Based around the idea of descent with modification
- ✦ Observations:
 - ✦ Organisms produce more offspring than the environment can support
 - ✦ Organisms vary in many traits
- ✦ Reasoned that traits increase their chance of survival and reproduction in their environment tend to leave more offspring than others
 - ✦ Favorable traits accumulate in populations over generations
- ✦ Artificial selection also shows evidence for natural selection

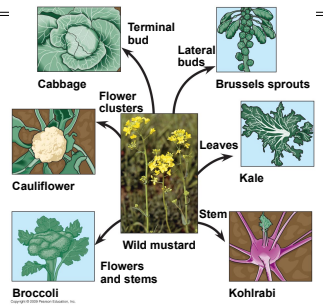


Fig. 13.2

5

Important Points

- ✦ Individuals do not evolve: populations evolve
- ✦ Natural selection can amplify or diminish only heritable traits; acquired characteristics cannot be passed on to offspring
- ✦ Evolution is not goal directed and does not lead to perfection; favorable traits vary as environments change
- ✦ Comparisons of DNA and amino acid sequences between different organisms can reveal evolutionary relationships

6

Natural Selection in Action

- Development of pesticide resistance in insects
- Initial use of pesticides favors those few insects that have genes for pesticide resistance
- With continued use of pesticides, resistant insects flourish and vulnerable insects die.
- Proportion of resistant insects increases over time.

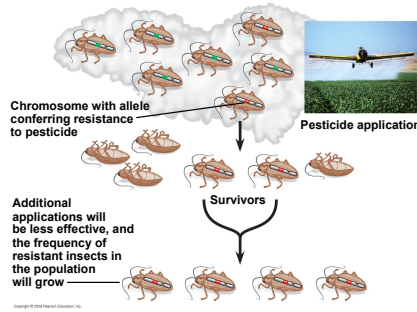


Fig. 13.3

7

Biogeography

- Geographic distribution of species
- Suggested to Darwin that organisms evolve from common ancestors
 - Darwin noted that animals on islands resemble species on nearby mainland more closely than they resemble animals on similar islands close to other continents
- Comparative anatomy - comparison of body structures in different species
- Homology - the similarity in characteristics that result from common ancestry (ex. vertebrate forelimbs)

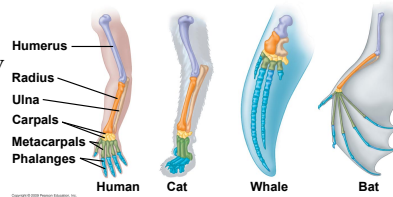


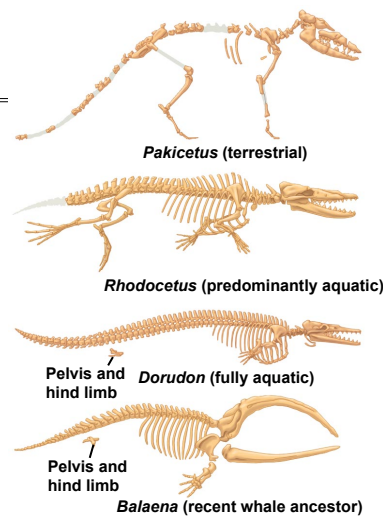
Fig. 13.5

8

Vestigial Organs

Fig. 13.4

- A structure in an organism that no longer retains its original function
- Ex. appendix in humans
- Ex. pelvic and hind-leg bones in whales



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9

Evolutionary Trees

✦ Darwin was the first to represent the history of life as a tree.

✦ Homologous structures and genes can be used to determine the branching sequence of an evolutionary tree

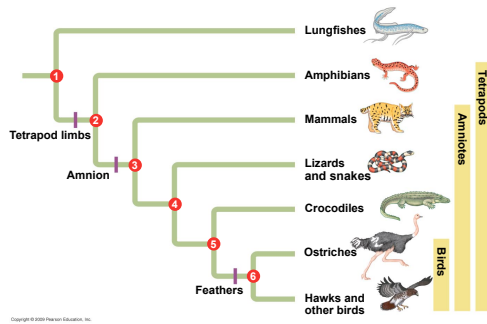


Fig. 13.6

10

Evolution of Populations

- ✦ Population - a group of individuals of the same species living in the same place at the same time
- ✦ Evolution - change in heritable traits in a population over generations
- ✦ Gene pool - total collection of genes in a population at any one time
- ✦ Microevolution - change in the relative frequencies of alleles in a gene pool over time
- ✦ Population genetics - studies how populations change genetically over time

11

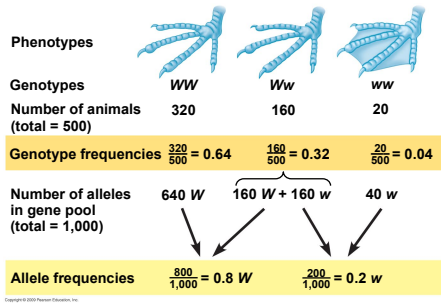
Mutation

- ✦ Changes in nucleotide sequence of DNA is the ultimate source of new alleles
 - ✦ Occasionally, mutant alleles improve the adaptation of an individual to its environment and increase its survival and reproductive success
- ✦ Sources of variation:
 - ✦ Chromosomal duplication
 - ✦ Sexual reproduction

12

Hardy-Weinberg

* Hardy-Weinberg principle - allele and genotype frequencies within a sexually reproducing diploid population will remain in equilibrium unless outside forces act to change those frequencies



* Hardy-Weinberg equation - used to test whether a population is evolving

$$p^2 + 2pq + q^2 = 1$$

* Ex. Blue-footed booby population where: W = nonwebbed feet, w = webbed feet

Fig. 13.9

13

Hardy-Weinberg Equilibrium

* If a population is in Hardy-Weinberg equilibrium, allele and genotype frequencies will not change unless something acts to change the gene pool.

* Must satisfy five conditions:

- * Very large population
- * No gene flow (immigration or emigration)
- * No mutations
- * Random mating
- * No natural selection

14

Three Main Causes of Evolution

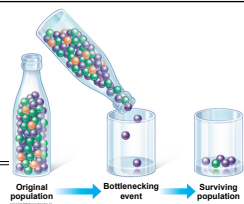


Fig. 13.11

* Natural selection - individuals differ in their survival and reproductive success

* Genetic drift - change in the gene pool of a population due to chance (In a small population, chance events may lead to loss of genetic diversity.)

- * Bottleneck effect - loss of genetic diversity when a population is greatly reduced (ex. The elephant seal was hunted to near extinction, and now, even though numbers have increased, genetic diversity is very low.)
- * Founder effect - loss of genetic diversity when a few individuals colonize a new habitat

* Gene flow - movement of individuals (or gametes or spores) between populations

15

Types of Selection

- ✦ Stabilizing selection - favors intermediate phenotypes (acting against extreme phenotypes)
- ✦ Directional selection - acts against individuals at one of the phenotypic extremes (common in periods of environmental change)
- ✦ Disruptive selection - favors individuals at both extremes

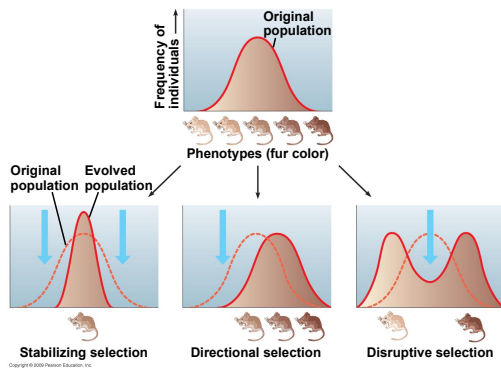


Fig. 13.13

16

Sexual Selection

- ✦ Sexual dimorphism - distinctly different appearance between males and females
- ✦ Intrasexual competition - competition for mates (usually by males)
- ✦ Intersexual competition - individuals of one sex (usually females) are choosy in picking mates



Fig. 13.14

17

Evolution Connections

- ✦ Antibiotic resistance
- ✦ Pesticide resistance
- ✦ Heterozygote advantage (ex. sickle-cell anemia)

18