Evolution

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Evolution
I. The Theory
II. Population Growth
III. Variation: heritability
   Non-heritable Variation
   Heritable Variation
IV. Patterns of Evolution
   Divergent Evolution
   Adaptive Radiation
   Convergent Evolution
   Coevolution

Evolution: genetically controlled changes in physiology, anatomy, and behavior that occur to a species over time.
Definitions
Chromosomes: structures that carry genes made up of DNA (genes and proteins)
Genes: the basic unit of heredity
Alleles: particular form of a gene, where multiple forms occur (allele for eye color, hair color, etc)

Definitions (cont.)
Mutation: genetic change in an organism, either from alteration of DNA or shift in the structure or number of chromosomes (change in genotype)
Genotype: genetic constitution
Phenotype: the way the gene is expressed

A little history

For the exclusive use of students in GEOG 316 at SFSU
Charles Darwin
British Naturalist
1809 -1882

I have called this principle, by which each slight variation, if useful, is preserved, by the term Natural Selection.
— Charles Darwin from “The Origin of Species”

Alfred Russel Wallace
(January 8 1823 — November 7 1913) was a British naturalist, geographer, anthropologist and biologist. Wallace's independent proposal of a theory of evolution by natural selection prompted Charles Darwin to reveal his own more developed and researched, but unpublished, theory sooner than he had intended.

And clearly, it was good fortune, and he was generally happy over the situation. Certainly the following passage, taken from a letter written to his mother on 6 October 1858—shortly after he heard that his paper had been read to the Linnean Society—would seem to indicate this:

“I have received letters from Mr. Darwin and Dr. Hooker, two of the most eminent naturalists in England, which has highly gratified me. I sent Mr. Darwin an essay on a subject on which he is now writing a great work. He showed it to Dr. Hooker and Sir C. Lyell, who thought so highly of it that they immediately read it before the Linnean Society. This assures me the acquaintance and assistance of these eminent men on my return home.” Marchant (1916; 1975 reprint ed.),
I. Natural Selection

More offspring are produced than will survive. Competition for survival will select for the fittest individuals. The fittest individuals will survive to mate and reproduce and their offspring will carry those inherited traits in their genes.

Natural selection:

*Observation 1:* More young are born than survive to reproduce

*Observation 2:* Variation exists among the members of a population

Deduction 1: Some of the variants are better suited to prevailing conditions and are more likely to survive to reproduce than other variants.
Observation 3: Some of this variation is heritable

Deduction 2: Because these attributes are to some degree heritable, favorable attributes will accumulate in the population over time.

II. Population

All populations have the potential for exponential growth but do not achieve this potential.
III. Barriers to Interbreeding

Isolating Mechanisms
1) courting rituals and mating behaviors
   (ex. Crickets in Hawaii)
2) mating sites may differ
3) timing of mating

Controversies
1) continuous vs. punctuated
   Continuous
   Punctuated (S.J. Gould)
2) Is isolation necessary?
   Allopatric speciation
   Sympatric speciation

Continuous vs. Punctuated (S.J. Gould)
Is Isolation necessary?

Allopatric vs. sympatric speciation

- **Allopatric**: new species arise in isolation, separated from area where ancestral species is found
- **Sympatric**: Speciation occurs within the area of ancestral species

III. Variation

**Non-heritable variation**: differences arise from environment

- ex. Sagebrush (*Artemisia tridentata*)
- Himalayan rabbit

**Heritable Variation**:

Differences are passed through genotype

**Geographic**
- Hornd Larks (*Eremophila alpestris*) facial colors
- Song Sparrow (*Melospiza melodia*) size and color

**Polymorphism**
- Common flicker (*Colaptes auratus*)
- Yellow rumped warbler (*Dendroica cornata*)
**Geographic (gradients)**

- Horned Larks (*Eremophila alpestris*) facial colors
- Song Sparrow (*Melospiza melodia*) size and color

**Horned larks**

Color variation: Moister to drier

**Song sparrows**

Geographic variation: Color and size
- Light to dark (tropics to PNW)
- Small in South, Large in North
Polymorphism
Yellow rumped warbler (Dendroica cornata)

Heritable Variation

Eastern population

Western population

IV. Patterns of Evolution
Divergent Evolution and Adaptive Radiation
(closely related species become different over time)
Divergent Evolution and Adaptive Radiation

Two conditions:
1) Species colonization of isolated habitat
2) Sudden evolutionary appearance of a novel morphological or physiological feature of an organism

1) Species colonization of isolated habitat

Darwin’s finches

Hawaiian honeycreepers
African cichlids

Hawk moths

Phlox Family

Polemoniaceae

Self pollinating

Long tongue flies

Bats

Beetles

Hummingbirds
**Convergent Evolution**

Evolutionary change causes unrelated species with very different evolutionary histories to acquire striking morphological, physiological and/or behavioral similarities.

*Examples:*
- Jerboas and Kangaroo rats
- Cacti and Euphorbs
- Longclaws and Meadowlarks
- Pocket Gophers and Tuco Tucos
Convergent Evolution

- Longclaws and Meadowlarks

- Pocket Gophers and Tuco Tucos

- Western quoll (Australia)

- Ocelot: Central America
CoEvolution

The interdependent evolution of two or more species

Examples:
- Ants and acacias
- Plants and pollinators
- Predator and prey

Ants and Acacias
Plants and pollinators

Some orchids lure their pollinators through sexual deception. Oncidium henekenii is pollinated by male bees trying to mate with the flower, which resembles a female bee.

Flowers like this Columbine have specialized nectaries which attract specific pollinators.

Predator/prey

Humans

Are humans messing with their own evolution, or are we still subjects of nature?
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