Genetics and Evolution IB 201 06- Lecture 13

Natural Selection and Adaptation

HISTORY

Essentialism vs Populationism

Darwin encouraged a change from typological or "essentialist" thinking about species to that of species as variable, changing populations of organisms. To the essentialist, a species is a *class*, which is completely *constant*—any variation within it was accidental noise and considered irrelevant. A species was defined by its essence, as a class. These typological or essentialist views were held by many scientists and philosophers and countered Darwin's population thinking well into the 20th century, long after Darwin published the On the *Origin of Species by Natural Selection* (1859).

Essentialist perspective: these differed in terms of the mechanism by which a species comes into being:

1. *Transmutationism* views evolution as occurring in jumps (saltation) via mutations
2. *Transformationism*: evolution occurs through the gradual transformation of the "type" into a new one by:
   - environmental influences or the use or disuse of parts and inheritance of acquired characters
   - an intrinsic drive toward a "goal", toward greater perfection

Population perspective: Darwin broke with the essentialist views by introducing the idea that a species is a set of local populations, each of which is variable, and within each population every individual is unique to some degree. Species-specific traits show variability. Thus, Darwin introduced population thinking. Population thinking infers evolutionary change to be a slow, gradual process within and between populations. *The change of populations of organisms* is what Darwin considered to be evolution.

But what is the mechanism by which a population changes from generation to generation?

I. Natural Selection

The populational view of evolution led Darwin (and, independently, Alfred Russel Wallace) to the theory _____

This is the _____ by which Darwin and Wallace viewed change (evolution) to occur.

In 1859 Darwin published his grand treatise, _____.

The book was concerned with the ***pattern*** of evolution

The book was concerned with the ***mechanism*** (***process***) that causes evolution

The full title of Darwin's book: *On the Origin of Species* ***by Means of Natural Selection, Or the Preservation of the Favoured Races in the Struggle for Life***.

Becoming intimately familiar with the methods of _____ _____

by reading literature outside of biology, including *economics theory*, Darwin recognized the following postulates:

1.
2.
3.
4.

Thus, Darwin **predicted that the individuals with the favored trait are better able to _____,**

and _____, and therefore are _____ _____..

This, in essence, is **Darwinian Natural Selection**

Examples from the text which provide evidence of Darwinian natural selection:

- **Snapdragons**

- **Galapagos Finches**

Natural selection (NS) is an ***elimination process***: individuals compete for food, shelter, mates; if they have particular traits that enable them to better survive and reproduce in a given environment, they will be the ones to pass on their heritable traits in greater numbers than those less able to survive and reproduce.

The process of NS includes aspects of ***chance*** variation in a population plus ***nonrandom*** survival and reproduction.

Chance variation arises via _____ and _____ during meiosis.

****Read the caveats concerning natural selection on pp. 87-92**

II. Adaptation

It may appear that all organisms are perfectly adapted to the environment in which they live—those that move through air have wings, those in water have fins and streamlined bodies and gills for breathing. All organisms seem to be perfectly adapted in structure and behavior to the inanimate and animate environment. The evolution of the eye of vertebrates, molluscs and insects is an example of seeming perfection; the migration of animals to the appropriate environments for over-wintering and for breeding (birds, insects, etc.); the cooperative societies of social insects; the correlation between tongue length of pollinating insects and the corolla length of flowers they visit—all examples of seeming perfect adaptations.

Question 1. How do organisms become so well adapted to a given environment

A. Historical explanation (17^{th} and 18^{th} centuries): such apparently perfect adaptations were presented as proof of a creator—the field of "natural theology". However, as more and more information about the natural world was discovered and considered, it became clear that there were many features of existence that were not "perfect" (apparent cruelty, waste, parasitism, etc.), which did not fit with a creator's design.

B. Darwinian explanation: A character is an adaptation when it has not been eliminated among the variable populations of its ancestors. The elimination of less well adapted organisms with a given trait results in the differential survival of those organisms with characters that are better fit to a given environment. Survival enables reproduction. Thus differential survival and reproduction are the key advantages that allow organisms to pass heritable adaptations along from generation to generation.

C. General definition

Any trait (structural, behavioral) that contributes to the survival and reproductive success of the individual or social group that has it.

A trait improving the survival and reproduction (i.e., the fitness) of its possessor is thought to be an *adaptive* trait.

Question 2. Are all organisms perfectly adapted to their environments?

It is thought that many traits arise through the process of natural selection. If occasionally they arise by *chance*, then they are *maintained* by natural selection.

Also, a given *environment can change* such that any given adaptation will become ill adapted after the change.

There is **no absolute adaptation;** an **adaptation is *relative*** to the environment in which it occurs.

Adaptations must be proven with observations and experiments

1. **Need to demonstrate that a trait has been selected for a particular function**

2. **The possession of the trait must result in increased survival and reproduction**

Examples in F&H on how adaptations are determined:

- Neck length in giraffes
- Thermoregulation in garter snakes
- Mimicry in tephritid flies
- MANY OTHERS—come up with some of these yourself

III. Phenotypic Plasticity

Variation in _____ due to _____.

Behavior and morphology can often exhibit phenotypic plasticity

This usually involves the interplay between genotype and environment (i.e., gene by environment interaction

References

F&H 69-86; 331-344; 350 - top 351; 597 - top 599.
Mayr, E. 2001. *What Evolution Is*. Basic Books (Perseus Books Group), NY.