

Macroevolution and microevolution

Microevolution is the process of change in individual species. Macroevolution is evolutionary change above the species level, including the formation of species, the diversification of species, and the appearance of major evolutionary developments.

One of the important questions in evolutionary biology is how well macroevolutionary patterns can be predicted from our understanding of microevolution.

The punctuated equilibrium theory

- *Pattern:* The punctuated equilibrium theory is a generalization about the pattern of evolution as seen in the fossil record. The pattern is the stasis of established wide-spread lineages and morphological change when new species appear. The two are compared in Fig. 24.13.

What is not seen very often in the fossil record is gradual and continuous change in widespread species. Darwin's explanation for not seeing this pattern was the imperfection of the fossil record. Even when the fossil record of some groups is more complete, the punctuated equilibrium pattern instead of a gradual pattern is often found. The fossil record of humans and their immediate ancestors, which will be reviewed later, is an example of the punctuated equilibrium pattern.

- *Consistent with neo-Darwinism:* Rapid changes can be explained by the effects of natural selection. What appears to be very rapid in the fossil record may have taken 50,000 years or longer, which is plenty of time for natural selection and genetic drift to cause substantial morphological change.

Stasis can result from selection and from habitat choice. Species tend to remain in those environments to which they are well adapted. During the Pleistocene, glaciers covered much of the northern Europe, Asia and North America. Many species, including oak and spruce trees, that previously lived in the north shifted their ranges to the south and then returned to the north as the climate changed.

Major changes in form can be caused by relatively minor changes occurring during growth and development.

- *Heterochrony*: Heterochrony can result in the appearance of several coordinated changes because of a single change in the timing of some event during development. By looking only at the adult phenotype, it is not always easy to decide what changes actually cause the difference in adult morphology. The PowerPoint slides give examples of the four kinds of heterochronic processes that lead to either peramorphosis or paedomorphosis. You should know these processes!

Paedomorphosis is one type of heterochrony. Some salamanders retain gills as adults. Gills are a juvenile character in most species of salamander.

Another example of how a subtle change during growth can cause a major change in morphology is the evolution of lobate flowers in plants, through differences in the rate of mitoses in different parts of the flowers. This was also discussed in some detail in lecture, and something you should know.

- *Homeotic genes*: Homeotic or Hox genes control where specific structures are formed. They were first discovered in *Drosophila* but are now known in many plants and animals. The bithorax mutation in *D. melanogaster* is a mutation to a Hox gene that results in two pairs of wings. Hox genes form a large multigene family.

Hox genes in vertebrates: There were two duplications of the Hox gene cluster which may have resulted from two genomic duplications. The first duplication occurred about 520 mya and may have been a critical step in the evolution of vertebrates, and the second, about 425 mya may have permitted an increase in morphological complexity of vertebrates.

Example test questions

Q1. Which pair of words best fills the blanks in the following sentence? The punctuated equilibrium theory is a generalization about the _____ of evolution seen in _____.

- A. mechanism, Paleozoic
- B. theory, *The Origin of Species*.
- C. pattern, fossil record.
- D. fact, fossil record.
- E. repeatability, plants and animals.

Q2. Which statement best provides the best definition of heterochrony?

- A. A change in the timing or rate of an organism's development.
- B. A change in the time of mating.
- C. A change in life span.
- D. A loss of radial symmetry of flowers.

E. The differentiation of repeated structures.

Q3. The bithorax mutation in *Drosophila melanogaster* is an example of which one of the following?.

- A. Paedomorphosis.
- B. Exaptation.
- C. Species selection.
- D. An advantageous mutation.
- E. A mutation of a Hox gene.

Answers: C, A, E