

Natural History of Vertebrates

Lecture Notes

Chapter 1 - The Diversity, Classification, and Evolution of Vertebrates

These notes are provided to help direct your study from the [textbook](#). They are not designed to explain all aspects of the material in great detail; they are a supplement to the discussion in class and the [textbook](#). If you were to study **only** these notes, you would not learn enough to do well in the course.

We will not spend much time in Chapter 1. Several of these concepts you have probably covered in other courses (GB 140 or ZO 214).

[List of Terms](#)

Be sure to study carefully figures 1-1 and 1-4. We will cover the numbers of species of each group as we go through the semester, but an overview will help greatly from the beginning. Pay particular attention to the cladogram of extant vertebrates as this will be a question on the final exam.

Be sure to study carefully the concepts in the sections entitled "Classification of Vertebrates" (1.2) and "Earth history and vertebrate evolution" (1.6). These concepts will permeate much of what we talk about in the course.

The theory of evolution via natural selection is the overarching principle behind the information in this book. This theory has several points, which are:

- 1) excess progeny
- 2) variability
- 3) heritability
- 4) differential reproduction

Natural selection always acts to increase the population's mean level of fitness.

Natural selection only operates in the present; it cannot anticipate what a future environment might bring.

Natural selection is only one of several processes that can change a population, but it is the only process that increases a population's adaptation to its environment.

Natural selection operates at the level of the individual to create a change in a population. Differential reproductive success is at the level of the individual and individuals do not act for the good of the species, but only in their self-interest.

In a series of changes, for example from an eyeless organism to an organism with eyes, every intermediate stage must confer an advantage on those individuals relative to what condition previously existed.

Cladistics (pages 7 - 12).

One of the reasons that I chose this book is that the story of the vertebrates is told from the standpoint of their evolution. The way that phylogenies are proposed is through a process called cladistics. **Cladistics** attempts to produce an hypothesis about the evolutionary sequence of events that led to a group of organisms through the use of shared derived characters. These hypothesized phylogenies are put forth as **cladograms**. It is important to realize that a cladogram is an hypothesis about a group of organisms. Cladograms, like any hypothesis in science, are subject to change as more data are accumulated or data are reevaluated. Cladograms are NOT truth. It might be (and we certainly hope) that a cladogram portrays the correct phylogeny, but we will never know if it does. For example, many studies have addressed the evolutionary relationships among the great apes and humans. There have been many cladograms produced. The majority of the cladograms show humans as the sister taxon to the chimpanzees, however other studies (with their cladograms) show the gorilla to be the sister taxon to the chimpanzees. We will never know which taxon diverged first, but we have more data (the preponderance of evidence) supports the cladogram that shows humans as the sister taxon to the chimpanzees. Thus the cladogram is a hypothesis that, like any hypothesis or theory in science, is subject to change as more data are accumulated.

When you read the textbook you will see many cladograms. You must not only learn the relationships among the taxa but you must learn and understand the data that supports these cladograms. Ask yourself, "What other data could I collect to address the hypothesized relationships shown in the cladogram?" Be sure to learn the following terms.

- **Shared derived character (synapomorphy)** is a character that is derived from the ancestral conditions and is shared among several taxa that all descended from a common ancestor that first exhibited the derived character. These characters carry information regarding the phylogeny of the organisms under study.
- **Shared primitive character (symplesiomorphy)** is a character that is the same as the ancestral condition and is shared among several taxa. These characters carry no information regarding phylogeny of the organism under study.
- **Uniquely derived character (autapomorphy)** is a character that is derived from the ancestral condition but is present in only a single taxon and thus not shared. These characters carry no information regarding the phylogeny of the organisms under study.
- The groupings of organism in a cladogram are referred to as **clades**. The goal of cladistics (phylogenetic systematics) is the identification of **monophyletic** groups. They are groups which contain the common ancestor plus all of the descendants. For example, Mammalia is a monophyletic group as it contains all living and extinct mammals plus the ancestor of all mammals.
- Reptiles, as commonly defined, is not a monophyletic group. It is a **paraphyletic** group in that some descendant groups are not included in the reptiles, for example birds or mammals. The group called reptiles really has no validity in a cladistic analysis and as such would not be given a name.

- **Polyphyletic** groups are groups that do not contain the common ancestor for the group. For example, to try to name a group that was composed of Aves and Mammalia (perhaps on the basis of endothermy) would not include the common ancestor of these two groups and thus the named group would not be monophyletic.
- A **sister taxon** is the most closely related monophyletic clade to the clade in question. For example, in figure 1-3, the Sauropsida is the sister taxon to the Mammalia; the Crocodylia is the sister taxon to the Aves; the Amphibia is the sister taxon to the Amniota.

Be sure to study carefully figure 1-3. One of the major goals of this course is to understand the evolution of the extant vertebrates and this cladogram is the current hypothesis about that evolution. This cladogram will be a recurring theme throughout this course. You will need to not only know this cladogram but the evidence that supports the phylogenetic hypotheses that the cladogram represents.

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