# SYSTEMATICS & TAXONOMY
# EEOB 625 – 9 January 2004

What is the is the difference between systematics and taxonomy?

SYSTEMATICS - the study of diversity, which uses everything that is known about patterns and processes various taxa in a comparative framework to understand their evolution, construct phylogenies, & classify taxa.

TAXONOMY - the theory and practice of naming and classifying taxa. It is (a subset or branch of \ systematics) with three major areas of activity: nomenclature, classification, & ? identification?

**Nomenclature**: The goal is the assignment of unique, universal and stable names for taxa with the binomial system of nomenclature as set forth by Linnaeus in the Systema Naturae (10th Ed.) (1758)

Synomyms and the Law of Priority, applied to names given after 1758.

Authorship of genus species names. How and where is it recorded?

Concept of the Type and Type Location: A *type* specimen is one that was collected and used by the author in the original description of the species.

What then is a type location?

Synomyms in Hall (1981) and "your" species for the Taxonomy Take-home Questions

**Classification**: grouping and ranking of taxa into categories (Mayr 1981)
An inductive procedure done by specialists.

Two schools of systematics (classification) Evolutionary (traditional) vs. Phylogentic (cladistics) with:

Common goal: Reveal the course of evolution and accomplish taxonomy

Traditional evolutionary classification:
A process of hypothesis formation, to construct natural groups (taxa) that reflect phylogeny
Done by experts in a given taxon
Criteria for construction of phlogenies are not necessarily explicit and sometimes based on differences rather than characters that track ancestry and evolutionary descent

Classification by cladistic analysis (Hennig 1966 – Phylogenetic systematics)
Summarizes synapomorphic information on taxa in a branching diagram.

**Synapomorphy** – a shared derived character or character state.

The goal is to create **monophyletic taxa**: i.e. one that contains the most recent common ancestor of all members and all of its descendants.

**Paraphyletic** group is one that contains the most recent common ancestor and some but **not all** of its descendants.

PRINCIPLES OF CLADISTICS: Related taxa are recognized by synapomorphies Assumptions:
1). Taxa are related by descent from a common ancestor,
2). There is a bifurcating pattern of cladogenesis.
3) Change in characteristics occurs in lineages over time
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HOW TO CONSTRUCT A CLADOGRAM 1) Choose taxa of known evolutionary relationship (clades).
2) Select useful characters and determine character states/ taxon 3)Determine the polarity of character states (primitive or derived) relative to their state in an outgroup 4) Group taxa by synapomorphies, which are common to all taxa above a given node, with successively smaller clades, 5) Use each synapomorphy only once
Apply these steps in constructing a cladogram using the characters and taxa listed below

**Common name of representative and Formal name of the Taxon**

| **Character & State**: (+ / -) | Amphioxus (out group) | Bass | Dog | Frog | Horse | Lizard | Monkey | Shrew |
|---|---|---|---|---|---|---|---|---|
| Formal Name | | | | | | | | |
| Amnion | - | - | + | - | + | + | + | + |
| Dorsal hollow Nerve chord | + | + | + | + | + | + | + | + |
| Functional Digits | | | | | | | | |
| 1 or 3 | - | - | - | - | + | - | - | - |
| 4 or less | - | - | + | - | - | - | - | - |
| 5 | - | - | - | + | - | + | + | + |
| Mammary glands | - | - | + | - | + | - | + | + |
| Tetrapod | - | - | + | + | + | + | + | + |
| Vertebrae | - | + | + | + | + | + | + | + |

Background on Cladistic Analysis:

The first assumption is a general assumption made for all evolutionary biology. It essentially means that life arose on earth only once, and therefore all organisms are related in some way or other. Because of this, we can take any collection of organisms and determine a meaningful pattern of relationships, provided we have the right kind of information. Again, the assumption states that all the diversity of life on earth has been produced through the reproduction of existing organisms.

The second assumption is perhaps the most controversial; that is, that new kinds of organisms may arise when existing species or populations divide into exactly two groups. There are many biologists who hold that multiple new lineages* can arise from a single originating population at the same time, or near enough in time to be indistinguishable from such an event. While this model could conceivably occur, it is not currently known how often this has actually happened. The other objection raised against this assumption is the possibility of interbreeding between distinct groups. This, however, is a general problem of reconstructing evolutionary history, and although it cannot currently be handled well by cladistic
methods, no other system has yet been devised which accounts for it.

The final assumption, that characteristics of organisms change over time, is the most important assumption in cladistics. It is only when characteristics change that we are able to recognize different lineages or groups. The convention is to call the "original" state of the characteristic plesiomorphic and the "changed" state apomorphic. The terms "primitive" and "derived" have also been used for these states, but they are often avoided by cladists, since those terms have been much abused in the past.

Sixth Step ----------

6. Build your cladogram, which is NOT an evolutionary tree*, following these rules:
   -- All taxa go on the endpoints of the cladogram*, never at nodes.
-- All cladogram nodes must have a list of synapomorphies (unless the character is later modified).
   -- All synapomorphies appear on the cladogram only once unless the character state was derived separately by evolutionary parallelism.

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Finally, accomplish the task of creating a good cladogram, you must use your judgement. Ask yourself the following questions. Could a proposed synapomorphy be the result of independent evolutionary development? Are your characters chosen well? Should you consider other characters or other taxa?