Phylogenetic Classification & the Phylocode

'For if a citizen in a free commonwealth may speak his mind, it will be at least allowed for me to state my principals among botanists! I have not reached such extreme of hardihood as to believe that all my reasoning is so firmly based, but that someone else may propound reasoning much more mature: still mine will be truer ***until some other principles are shown to be truer*** [my emphasis]. To you, my dearly beloved botanist, I submit my rules, the rules which I have laid down for myself, and in accordance with which I intend to walk. If they seem to you worthy, let them be used by you also; if not, please propound something better!'

Clasif. Linnaei M. D.

Methodus plantarum Sexualis in Sistemate Naturae descripta (G. D. Ehret, ed). Leiden, 1736. p. 31.

"The suggestion that it may be as well to give up the attempt to define species, and to content oneself with recording the varieties of pelage and stature which accompany a definable type of skeletal and dental structure in the geographical district in which the latter is indigenous, may be regarded as revolutionary; but I am inclined to think that sooner or later we shall adopt it."

T.H. Huxley 1880

On the cranial and dental characters of the Canidae. Proc. Zool. Soc. 1880: 238.

Biological systematics encompasses three distinct activities: taxonomy, classification (which may or may not be a reasonable reflection of phylogeny) and nomenclature (Fig. 1). Although systematists rigorously and distinctly practice these three components, they are often amalgamated under the term "taxonomy." While the breadth of "taxonomy" is clearly understood among most practitioners, it can obscure the methodology and practices of modern systematics to others. On the other hand, not all systematists work across the full breadth of systematics. For example, they can be engaged in the study of molecular phylogenies without applying the results of their studies to the nomenclature of the group. Similarly, the resolution of nomenclatural issues can be carried out without a phylogenetic study of the species or the generation of a new classification, but usually not without extensive library resources.

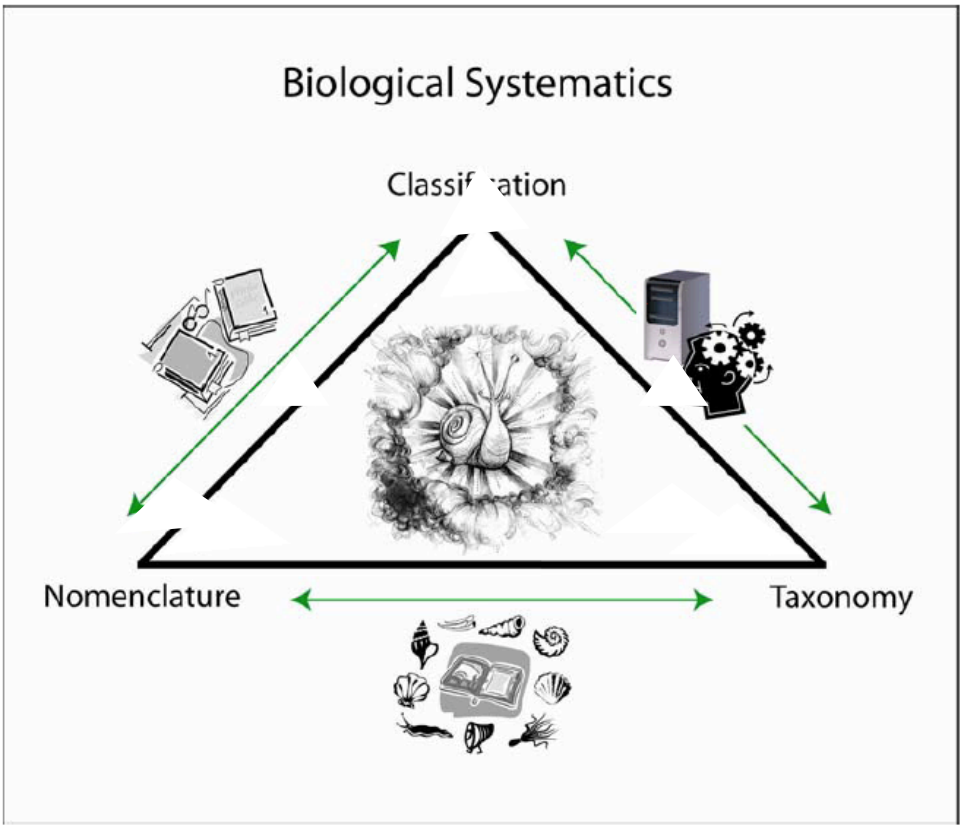


Figure 1. Biological Systematics - a summary showing the relationship between taxonomy, classification, and nomenclature.

Classification - Like the term taxonomy, classification is commonly used outside the biological systematic community as almost any animate or inanimate object, place, concept or event can be classified according to some criteria or scheme. It is the act of assigning individuals to a class or classes based on some common relations or affinities. Biological classifications, produced by phenetic and cladistic computations, are trees of hieratical relationships. In evolutionary systematics classifications may be represented by assignment of 'taxonomic' rank (species, genera, families, superfamilies, orders etc.) or by evolutionary scenarios. Classifications may or may not reflect putative evolutionary relationships (phylogenies) and when characters are heavily weighted or the groupings are based on algorithms that feature overall similarity, there is a far greater probably that the classifications will not reflect evolutionary history.

Classification interacts with both taxonomy and nomenclature (Fig. 1). With classifications that provide trees, the tips and nodes can be formally named following nomenclatural practices. Classifications provide predictions that can be tested by examining additional taxa or characters. Previously unstudied taxa can be predicted to have certain character states while the discovery of homoplasy may necessitate reexamination of the study taxa to document putative convergences.

Classification also provides an important interface to other biological enterprises. The benefits of using classifications that reflect the evolutionary history (phylogeny) of a taxon in research, conservation and economic ventures is being increasingly recognized throughout the biological sciences. Unfortunately, the replacement of existing classifications by new classifications that reflect phylogeny often require name changes at various taxon levels that can cause short term angst, but the classification is not the problem. Name changes are nomenclatural (see below). The tips of the trees in classifications may be an individual, a composite taxon (population, species, genus, etc.), or a grade. They do not necessarily have or need formal names and a tree of microcentrifuge tube numbers may be all that is necessary to test competing hypotheses.

Question Authority - Is there now a case for a range of different and explicit classifications that address different audiences? Undoubtedly, such classifications have existed for a long time but have had no scientific legitimacy. Do they now need some kind of formal framework? What would be the classifications associated with the following?

- the technological taxonomists (e.g., the molecular geneticist - electron microscopist)
- the professional field biologist (e.g., university teachers who take students into the field)
- the amateur field naturalist (e.g., members of local field clubs;)
- children (e.g., children on a field trip)
- collectors (e.g., shell collectors)

If there are different classifications, is there any area of overlap between them? Is there any area in which the museum expert is talking the same language as the school child, is talking the same language as the field naturalist etc.? If there is a common ground, does it need examining and defining?

Some colleagues have argued that "… a classification, which has the most pedagogic value for my students, is not the one that is being developed in the cutting-edge taxonomic literature. Obviously, if the focus of the course IS this cutting-edge taxonomy, I should deal with it. However, if that taxonomy IS NOT the focus of the course, which taxonomy do I use? I need something that is not only fit-for-its-purpose but is also academically legitimate."

All three schools of taxonomy have sought to produce **natural classifications**.

1. Phenetists view natural groups as those taxa linked by the greatest similarity to one another
2. To evolutionary taxonomists natural groups are delimited by morphological gaps between taxa and the distribution of characters for which an evolutionary scenario can be argued.
3. Cladists consider natural groups to be monophyletic, and natural classifications to reflect organismal history.

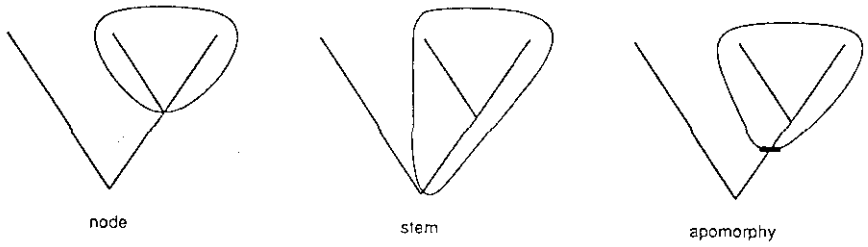
The current Linnean **ranked classification** scheme is reasonably compatible with the results of both phenetic and evolutionary taxonomic studies. However, it is inadequate in expressing the results of cladistic analyses. Here **unrank classifications** probably best reflect the nested sets of relationships that evolution has produced taxonomy.

A phylogenetic system of taxonomy has as its central tenet **evolutionary descent**. The Linnaean system has as its central tenets **priority, consensus, and stability**.

Should nomenclatural stability take precedence over information content of a classification?

Phylogenetic Classification

1. Taxon names are names of clades
   A. Definitions of taxon names
      1. node
      2. stem
      3. apomorphy



Three possible ways of defining axon names phylogenetically. *Left:* The name is defined as referring to the most recent Common ancestor of two designated taxa and its descendants (node-based definition). *Middle:* The name is defined as referring to all organisms sharing a more recent common ancestor with one designated taxon than with a second such taxon (stem-based definition). *Right:* The name is defined as referring to the first ancestor to evolve a designated character (bar) and its descendants (apomorphy-based definition).

This is just a subset see (Cantino et al. 1999; *Systematic Biology* **48**: 790-807) for 13 possible ways to name species phylogenetically.

2. Synonymy
   A. currently tied to Linnean categories
   B. taxon names are synonymous if and only if they refer to the same clade

3. Priority
   A. currently tied to Linnean categories
   B. priority in the phylogenetic system is not based on the first use of a name associated with a particular Linnean category, but on the first use of the name in association with a particular clade.

4. Unranked classification
    A. Avoids redundancy of names
    B. Conventions

(*http://www.ohiou.edu/phylocode/index.html*)
(Ver. 4b September 2007)

The PhyloCode is based on ideas presented in the literature since the late 1980s (primarily by Kevin de Queiroz & Jacques Gauthier) and, more formally, on the outcome of a workshop held at Harvard University in August 1998.

The PhyloCode has been designed so that it can be used concurrently with the existing nomenclatural codes, although the scientific community might ultimately decide that the PhyloCode should become the sole code governing the names of taxa. At present the intent is to provide an alternative system, not a replacement.

The fundamental characteristic that distinguishes the PhyloCode from the conventional hierarchic nomenclatural systems is its **ranklessness.** The PhyloCode covers the naming of clades ***and species***, but in this system these terms refer not to ranks, but to different kinds of biologic entities. Both clades and species considered to be products of evolution that are discovered, rather than created, by systematists, and both have an objective existence regardless of whether they are named.

Principles of the PhyloCode (http://www.ohiou.edu/phylocode/principles.html)

1. Reference—The primary purpose of taxon names is to provide a means of referring to taxa, as opposed to indicating their characters, relationships, or membership.

2. Clarity—Taxon names should be unambiguous in their designation of particular taxa. Nomenclatural clarity is achieved through explicit definitions, which describe the concept of the taxon designated by the defined name.

3. Uniqueness—To promote clarity, each taxon should have only one accepted name, and each accepted name should refer to only one taxon.

4. Stability—The names of taxa should not change over time. As a corollary, it must be possible to name newly discovered taxa without changing the names of previously discovered taxa.

5. Phylogenetic context—This code is concerned with the naming of taxa and the application of taxon names in the context of phylogenetic concepts of taxa.

6. Taxonomic freedom. This code permits freedom of taxonomic opinion with regard to hypotheses about relationships; it only concerns how names are to be applied within the context of a given phylogenetic hypothesis.

7. There is no "case law" under this code. Nomenclatural problems are resolved by the Committee on Phylogenetic Nomenclature (CPN) by direct application of the code; previous decisions will be considered, but the CPN is not obligated by precedents set in those decisions.

Membership in The **I**nternational **S**ociety for **P**hylogenetic **N**omenclature is open to all.
(*www.phylonames.org*)