Biometrics and Numerical Taxonomy

**Description** is the assignment of features or attributes to a taxon. The features are called **characters**. Two or more forms of a character are **character states**. One example of a character is petal color, for which two character states are yellow and blue. Another character is leaf shape, for which possible character states are elliptic, lanceolate, and ovate.

**Descent** is the transfer of genetic material (enclosed within a cell, the unit of life) from parent(s) to offspring over time.

Descent may occur by simple clonal reproduction, such as a single bacterial cell parent dividing by fission to form two offspring cells or a land plant giving rise to a vegetative propagule. It may also occur by complex sexual reproduction, in which each of two parents produces specialized gametes (e.g., sperm and egg cells), each of which has half the complement of genetic material, the result of meiosis. Two of the gametes fuse together to form a new cell, the zygote, which may develop into a new individual or may itself divide by meiosis to form gametes.

Descent through time results in the formation of a **lineage**, or **clade**, a set of organisms interconnected through time and space by the transfer of genetic material from parents to offspring.

Evolution is viewed as descent with modification. The **modification** component of evolution refers to a change in the genetic material that is transferred from parent(s) to offspring, such that the genetic material of the offspring is different from that of the parent(s). This modification may occur either by mutation, which is a direct alteration of DNA, or by genetic recombination, whereby existing genes are reshuffled in different combinations (during meiosis, by crossing over and independent assortment).

It should also be asked, *what* evolves?

Although genetic modification may occur in offspring relative to their parents, individual organisms do not generally evolve. This is because a new individual begins when it receives its complement of DNA from the parent(s); that individuals DNA does not change during its/his/her lifetime (with the exception of relatively rare, non-reproductive somatic mutations that cannot be transmitted to the next generation). The general units of evolution are populations and species. So we can that populations evolve. With changes in the genetic makeup of offspring (relative to parents), the genetic makeup of
populations and species changes over time.

Hence due to evolution the character states present in a population change.

There are two major means of arriving at a classification of life: phenetic and phylogenetic.

**Phenetic** classification is that based on overall similarities i.e. natural classifications are phenetic. For efficiency of organization (e.g., storing and retrieving objects, like nuts and bolts in a hardware store) we group similar objects together and dissimilar objects apart. Example Bentham and Hooker Classification

**Phylogenetic** classification is that which is based on evolutionary history, or pattern of descent, which may or may not correspond to overall similarity.

**Phylogeny** refers to the evolutionary history of a group of organisms. Phylogeny is commonly represented in the form of a **cladogram**.

A **cladogram** or phylogenetic tree is a branching diagram that conceptually represents the evolutionary pattern of descent. The lines of a cladogram represent **lineages** or **clades**, which denote descent, the sequence of ancestral-descendant populations through time. Thus, cladograms have an implied (relative) time scale. Any branching of the cladogram represents lineage **divergence** or the diversification of lineages from one **common ancestor**.

Evolution may occur in lineages over time. Evolution may be recognized as a change from a preexisting, or **ancestral**, character state to a new or **derived** character state. The derived character state is also called an **apomorphy**.

**Phylogenetic systematics**, or **cladistics**, is a methodology for inferring the pattern of evolutionary history of a group of organisms, utilizing these apomorphies.

Cladograms serve as the basis for phylogenetic classification. A key component in this classification system is the recognition of what are termed monophyletic groups of taxa.

A **monophyletic group** is one which consisting of a common ancestor plus all (and only all) descendants of that common ancestor.

For example, the monophyletic groups of the cladogram are circled. Note that some
monophyletic groups are included within others, the group containing taxa $E$ and $F$ is included within the group containing taxa $D$, $E$, and $F$, which is included within the group containing taxa $B$, $C$, $D$, $E$, and $F$, etc.). The sequential listing of monophyletic groups can serve as a phylogenetic classification scheme.

In contrast to a monophyletic group, a **paraphyletic group** is one consisting of a common ancestor but *not all* descendants of that common ancestor;

A **polyphyletic group** is one in which there are two or more separate groups, each with a separate common ancestor.

Paraphyletic and polyphyletic groups distort the accurate portrayal of evolutionary history and should **not** be considered for classification.

References
