Vascular Plant Systematics - Fall 2001
Lecture #9 - Sources of Taxonomic Evidence

**** Taxonomic evidence for the establishment of classifications and phylogenies is gathered from a variety of sources:**

I. Morphology (external plant characteristics) -

- **Morphology provides most of the characters used in constructing taxonomic systems**
- **Floral Morphology is probably the most critical vs. vegetative morphology in most groups**
- **Natural selection, associated with successful reproduction, maintains a basic similarity of the features of flowers, fruits and seeds within varies plant taxa .... that is reproductive features within a plant family, genus or species are much less plastic than are the vegetative features.**

Modifications of floral morphology - are related to the mode of flower pollination.

** - Wind pollinated plant taxa frequently have unisexual, reduced flowers that are individually inconspicuous. ** - Insect-pollinated plants usually have large colorful conspicuous flowers and are valuable to pollinators.

** - When a student of plant systematics becomes familiar with plant families in general, certain generalizations can be made .... for example, virtually all members of the mint and snapdragon families have square stems and unique stamen characteristics; composites have head arrangements of flowers; queen anne s family possesses an inferior ovary as does the evening primrose family; legumes have highly zygomorphic flowers etc...

** Growth habit may be important (herbaceous vs. woody) ... virtually all monocots (grasses, sedges, irises, lilies, etc..) are herbaceous; all members of the family Cruciferae are herbaceous (mustard family); some composites are herbaceous while others become woody (same with Leguminosae and Rosaceae).

** Vegetative features might be more important in some plant groups and low-ranking taxa. For example, flowers and fruits are of little value in many trees including the elms; in many trees, leaf characteristics are critical to identifying the plant to species. In others, leaf shape, as well as the fruit characteristics, are used to ID them (e.g., maples, oaks).

II. Comparative Plant Anatomy - (internal characteristics)

Anatomical features tend to be most useful in classification of the higher taxonomic categories and less useful when examining plants at the genus and species level.

Since the 1930s, the value of evolutionary trends of specialization of the secondary xylem has been established ..... which is a continual progression from plants with only tracheids to those with specialized vessel elements. Angiosperms with vesselless wood are considered primitive.

** - Anatomical features of leaves frequently provide characters. For example, C3 plants vs. C4 plants as pathways for photosynthesis ... but again these characters are really only useful at higher taxonomic levels (family & up). Also, most monocots including corn, sorghrum, sugar cane etc..use the more efficient C4 pathway and possess larger vascular bundles with prominent bundle sheaths that are absent in C3 plants.

** - Variation in patterns of epidermal hairs or trichomes provide characters for species-genus-family level classification. Example: trichomes are diagnostic characters for certain species of Vernonia (Iron Weeds).

** - Stomata types produced by characteristic arrangements of guard cells and subsidiary cells .... can be of taxonomic use at the family or higher level.

** Anatomical features (plant cell & tissue types) (vs. morphological features) are somewhat more conservative characters that are not easily modified by growing conditions.

** Anatomical features of vegetative structures (roots, stems, leaves) are used to distinguish gymnosperms from angiosperms and monocots from dicots (so these features are most useful at higher ranks).

III. Plant Embryology - micro & megasporogenesis, fertilization and development of the endosperm, embryo and seed coats

** - There is a strong embryological unity throughout the angiosperms = **double fertilization.**

The major embryological character that separates the monocots from the dicots is the number of embryonic cotyledon leaves.

** - Embryological features associated with all angiosperms: 4 microsporangia; two-celled pollen grains; eight-nucleate embryo sac; nuclear endosperm.

** - Embryological features are normally constant at the family level and below.

IV. Cytology - the study of the cell - in plants, only information about chromosome number, shape or pairing at meiosis is used for classification purposes. Cytogenetics includes studies dealing with observations of chromosomes pairing up etc...

** Most angiosperms have a haploid chromosome number from 7 to 12. However, about 35% of the flowering plants are **polyploids**, having more than 2 sets of chromosomes .... because of the multiplication of chromosome sets.

** - Some members of the genus *Aster* possess species with 9, 18, or 27 chromosomes.

V. Palynology - the study of plant pollen and spores. Pollen grains do not differ within most plant genera; however, pollen has been very useful in determining patterns of species relationships in the Iron weeds (*Vernonia*).

** There are two pollen types: **monosulcate** and **tricolpate**

** - **Monosulcate pollen** are boat shaped with one long furrow and one germinal aperture (associated with primitive docots and the majority of monocots, the cycads and ferns).
Triculpate pollen are found and typically have 3 apertures and is characteristic of the more advanced dicots.

VI. Paleobotany - the use of microfossils such as pollen or macrofossils of leaves, stems and other plant parts as sources of data. The main goal is to trace the evolutionary developments through stratigraphic sequences and determine past ecological conditions etc...

On the upswing - recent findings show that by the Eocene (60 million years ago), plants were well adapted for wind pollination; insect pollinated plants were also present during the mid-Eocene. Many flowers and insects co-evolved.

VII. Chemosystematics - the application of chemical data to systematic problems ..... many plant families and genera have unique chemical constituents (e.g., milkweed, pokeweed) that may assist in classifying them .... and explaining their phylogeny.

VIII. Ecological Evidence - provides information about variation within plant taxa associated with plant adaptations and the distribution of plants .... and association of plants with particular habitats. Ecological studies have demonstrated that the character states of many morphological features are correlated with environmental factors such as light, moisture availability, mineral content etc...

** Plant ecologists frequently examine edaphic (soil) specializations, pollinating mechanisms (co-evolution), effect of habitat on hybridization, plant-herbivore interactions (co-evolution), seed-dispersal mechanisms, reproductive isolating mechanisms ..... etc...

** - Information from plant ecology has implications for classification below the level of genus. Yet ecological research has provided generalizations that may be applicable to the evolution of angiosperms as a whole. For example, angiosperms appear to have evolved in a climate associated with seasonal drought ... and a short growing season ... which likely resulted in a reduction in the angiosperm reproductive cycle.

**** - Physiological Evidence -** C3 vs. C4 vs. CAM plants (in terms of their strategies for photosynthesizing. C4 and CAM photosynthesis occurs in about 10 unrelated families of monocots and dicots .... and is associated with plants that are adapted to arid environments.