Biology 317  
Spring Quarter

Week 1; Monday

Introductions - Instructor, graduate TAs, peer TAs

Announcements:  
Handouts  - Syllabus - go over this with class  
- Lab exercises for this week in lab.  
- Web Site: http://courses.washington.edu/bot113/spring/index.html

Expectations - lecture, lab, exams, quizzes, including 3 lecture ‘pop’ quizzes (@ 5 pts/)

Extra credit – There will be periodic extra credit exercises. Two are up on the website now and will begin today.

Books:  
Optional:  Hitchcock and Cronquist: Flora of PNW  
Harris and Harris: Illustrated Glossary

Field trips  
• Week 3 to Arboretum – required  
• Week 6 (Sat. May 7) – optional

Labs  
Start this week, in fact, TODAY!  
This week: learn Pacific Northwest conifers -- the PNW is unusual in having conifer dominated communities  
anecdote about AIBS field trip interest in conifers by botanists from all over

- Honors students must make an appointment to meet during first two weeks

Okay we’re going to dive right in, because life’s too short...

Reading assignment for next lecture:  Judd et al. - pp. 13-46

Class name:

Plant identification and classification = Plant Systematics = Plant Taxonomy
“Naturalists try to arrange the species, genera, and families in each class, on what is called the Natural System. But what is meant by this system?”

“...many naturalists think that something more is meant by the Natural System; they believe that it reveals the plan of the Creator; but ... it seems to me that nothing is thus added to our knowledge.

Such expressions as that famous one of Linnaeus, ... seem to imply that something more is included in our classification, than mere resemblance.

I believe that something more is included; and that propinquity of descent, the only known cause of the similarity of organic beings, is the bond, hidden as it is by various degrees of modification. All the foregoing rules ... in classification are explained, ... on the view that the natural system is founded on descent with modification; that the characters which naturalists consider as showing true affinity between any two or more species, are those which have been inherited from a common parent, and, in so far, 

all true classification is genealogical”

Today’s Lecture: Nomenclature and Classification [Judd et al. 1-11; 41-52]

Linnaeus system “Species Plantarum” (1753)
binomial nomenclature - Each species has a two word latin name consisting of its
genus and species names. These words are always underlined or italicized when
written.
“System” wherein newly discovered species can be sorted into groups by shared
traits.

Classification - the sorting of things into groups and the assigning of names to those
groups; biological classification is hierarchical – groups nested within groups

Artificial classification - with no regard for evolutionary relationships (e.g., any
classification of things other than living things would have to be artificial).
Linnaeus called his system the “Sexual System”, because he used the presence or
absence and number of sexual parts as the basis for classification. OVERHEAD

Natural, or Phylogenetic, classification - reflecting evolutionary relationships.
Darwin was the first to suggest that any classification of life should be “genealogical”
and would naturally be hierarchical; now we call this “phylogenetic” OVERHEAD

Much of the Linnaean system is still intact, because the characters he used are good
indicators of evolutionary relationships

hierarchical system - groups nested in larger groups

For example: Sitka Spruce
Kingdom
Phylum (Division)
Class
Order
Family
Genus
Species
Plantae
Coniferophyta
Coniferopsida
Coniferales
Pinaceae
Picea
Picea sitchensis

Another example: tomato
Kingdom
Phylum (Division)
Class
Subclass
Order
Family
Genus
Plantae
Magnoliophyta
Magnoliopsida
Asteridae
Solanales
Solanaceae
Solanum
Species  *Solanum lycopersicum* L.

Example of dynamic nature of classification with respect to new understandings of phylogeny:

Tree formerly known as *Chamaecyparis nootkatensis* was shown to not be related to other species of *Chamaecyparis* in study of Cupressaceae phylogeny (Gadek et al. 2000 American Journal of Botany), thus creating a problem for the taxonomy, because the genus *Chamaecyparis* is no longer monophyletic. **OVERHEAD** Discovery in 2002 (Farjon et al. 2002, Novon) of a new species of conifer in Vietnam shown to be the closest living relative of *Chamaecyparis nootkatensis*. **OVERHEAD**

Their conclusion was that these two species should be included in a new genus, *Xanthocyparis*:

*Xanthocyparis vietnamensis* and *Xanthocyparis nootkatensis*.

However, subsequent DNA sequencing studies (Terry & Adams, 2015, Phytologia) show conflicting results, with nuclear DNA sequences agreeing with Farjon et al., while the chloroplast DNA sequences place them as separate branches on the tree. **OVERHEAD**
Announcements - finish conifers and take campus walk today
Prop – Laurel cherry branch to demonstrate clades
SLIDES OF CONIFERS - point out distinguishing traits


Phylogeny = Pattern of evolutionary history among species
    Phylo- from phylum (Greek – tribe) and –genetic (from origin or genesis)

Taxonomy = Systematics – a discipline within Biology concerned with classification and evolutionary relationships.

taxon (plural – taxa) - taxonomic group at any hierarchical level (could be a species, genus, family, etc.) – taxonomy: description, naming, & classification of organisms.

phylogeny of a group of organisms is a real thing, we can only hope to estimate that pattern in a phylogeny reconstruction.

Phylogenetic classification = hierarchical ordering of taxa according to phylogenetic relationships consisting of a nested set of ever more inclusive groups.  A more explicit term than “natural” classification.

Phylogeny reconstruction (cladistics) – the process by which we determine relationships

Goal: identify a nested, hierarchical, set of monophyletic groups
Monophyletic group - a group of species that includes an ancestral species and all of its descendants (identified by synapomorphies = homologies)
Paraphyletic group - ancestor and some, but not all, descendants
Polyphyletic group - a group of species in which the common ancestor does not belong to the group

How do we go about identifying groups and relationships?

We look for similarities, but similarities can reflect 3 different relationships:

1) Shared derived similarity (synapomorphy)
   Example: Feathers on birds - these evolved at the time birds first arose
2) Shared ancestral similarity (symplesiomorphy)
   Example: keratin scales on reptiles - these are transformed into feathers in birds
In these examples, feathers are evidence of monophyly in birds, but scales are NOT evidence of monophyly in reptiles.

3) **Convergent similarity** - similarity due to evolution in parallel in two different organisms – convergent evolution
   Example: wings on birds and bats - another term for this is **Parallel evolution**

These kinds of similarity correspond to the three kinds of groups:
- shared derived --> **monophyly**
- shared ancestral --> **paraphyly**
- **convergent** --> **polyphyly**
Week 1; Friday

Review: mono-, para-, and polyphyly; synapomorphy, symplesiomorphy, convergence

OVERHEADS

How do we know whether a similarity we observe is a synapomorphy (derived state) or a symplesiomorphy (retained ancestral similarity)?

This is called **Polarity** (= evolutionary direction) and there are several criteria that have been used to determine whether a trait is derived or ancestral.

**Polarity assessment** (= evolutionary direction):
1) **fossil record** - oldest is primitive (works sometimes, ... but when?)
2) **simple to complex** - evolutionary trends tend to be parallel between groups
3) **correlation** - primitive states tend to occur together in organisms
4) **common is primitive** - ingroup analysis
5) **Ontogeny** - developmentally early stages are primitive

The method that is applicable most uniformly and has the fewest problems is:
6) **Outgroup comparison** - inference from distribution of character states in sister group. This is most commonly used approach today

Operational definition: For a character with 2 or more states the state occurring in the outgroup is primitive. For a multi-state character, this is only effective for establishing the most primitive state.

**Outgroup comparison**: (show an example with a tree) **OVERHEAD**

Ingroup - study group (putatively monophyletic)
Sister group - closest outgroup - special case of outgroup

Once we know the polarity we can construct a tree from the characters. This is called **CLADISTIC ANALYSIS**
- grouping species by shared derived states of characters

In systematics we call **similar** structures **CHARACTERS** and variations in those structures **CHARACTER STATES**
Character - a variable trait in the group under study
States - alternate forms of a character

For example: CHARACTER = skin covering
CHARACTER STATES = 1) keratin scales, 2) feathers, 3) hair

**Sources of data**: any comparative data (e.g. morphology, cytology, behavior, DNA sequences, etc.)
The term we use for a character that arose with the evolution of the group and is shared due to common ancestry is: **HOMOLOGY**

A **character** is a hypothesis of homology.

"**Homology** - similarity in two or more organisms that can be traced back to the same feature in the common ancestor of those organisms." (Mayr 1969)

Example: wings on birds, also wings on bats, but NOT wings on birds AND bats

When we talk about ‘homology’ as evidence for relationship, we must refer both to a **trait** and a **group** of organisms. This provides a ‘level of universality’ for that homology

For example: feathers are a homology for birds and keratin structures as skin covering is a homology for all Amniotes (birds, mammals, and ‘reptiles’).

To know for sure that a **character** is a **homology**, we need to know the relationships among the species that share the character.

Sometimes there is conflicting evidence when convergence (or reversal or loss) occurs in the evolution of a character. Then we need a means to resolve the conflict.

We do this by invoking the Principle of **PARSIMONY**

parsimony - (Occam's Razor) - the principle that the explanation requiring the least change is preferred.

Simple example of 3 characters, two of which agree. We choose the tree that best fits the data.

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Draw the three possible rooted trees supported by these characters and show the distribution of changes inferred.

4 steps

5 steps

6 steps