

Taxonomy I

History & Concepts
March 3, 2008

Taxonomy defined

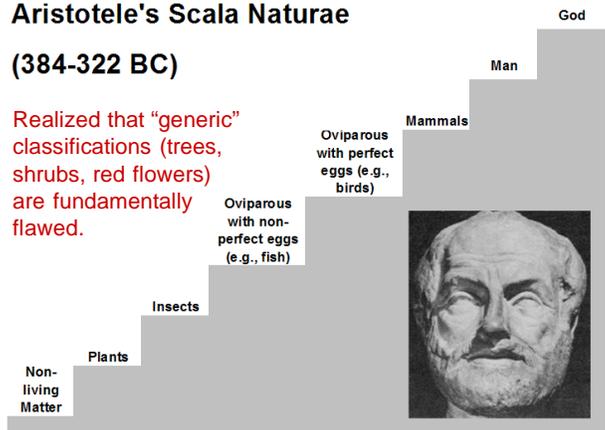
- Taxonomy deals with the **naming**, **classification** and **identification** of living organisms.

How many terrestrial plant species do we have ...

- Worldwide?
About 250,000 +/- a couple of 10,000
- In Canada?
About 5,000 +/- perhaps a few 100
- In Alberta?
About 1,500 with 500 rare 'peripherals'

Aristotle's Scala Naturae (384-322 BC)

Realized that "generic" classifications (trees, shrubs, red flowers) are fundamentally flawed.



Theophrastus (370 to about 285 BC)

- Ordered nearly 500 plant species in many ways (some whimsical):
 - By life form (trees, shrubs, herbs, etc.)
 - By smell (revolting to perfect)
 - Flower type
 - Seedling type
- Realized that "scala" also has limitations
- "Father of Taxonomy" referenced for hundreds of years



... but there were advances in naming Linnaeus (1707-1778 i.e. before Darwin)

- Theophrastus:
"annual, much-branched Physalis, with strongly-angled, glabrous branches and leaves with sawtoothed edges."
- Linnaeus:
Physalis angulata (Binomial System)
- Named 6000 plant species
And could actually recall the names



Artificial Identification Keys

A Key To Tree Leaves

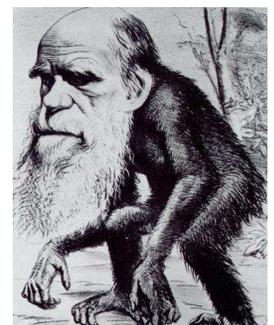
1. Leaves opposite	2	Maples have samara (helicopter) fruits
1. Leaves alternate	7	
2. Leaves simple	3	
2. Leaves compound	34	
3. Leaves lobed	4	
3. Leaves unlobed, veins parallel to margin	4	Flowering Dogwood
4. Margins of the lobes not		
4. Margins of the lobes definitely		
5. Edges of the leaf not toothed		
5. Edges of the leaf somewhat toothed		
6. Leaf broad, base of leaf is		
6. Edges of the leaf sparsely		
7. Leaves Simple	8	
7. Leaves Compound	36	
8. Leaves bristle-tipped	9	
8. Leaves not bristle-tipped	13	
9. Leaves Unlobed	10	
9. Leaves Lobed	11	
10. Sinuses deep, extending almost to midline of leaf	11	
10. Sinuses not as deep	18	
11. Leaves smooth (not furry)	12	
11. Leaves somewhat furry	12	
12. Leaves 5 to 8		
12. Leaves 3 to 5		
13. Leaves Lobed	14	
13. Leaves Unlobed	19	
14. Margins definitely toothed	15	
14. Margins not toothed	16	
15. Leaves star-shaped with 5 palmate lobes		Sweet gum
15. Leaves not palmately lobed		
16. Leaves have irregular lobes, bluish green		Red Mulberry
16. Leaves with 3-5 coarsely toothed main lobes, yellowish green		Sycamore
17. Leaves 2-5 inches long, lance shaped		Willow Oak
17. Leaves 4-6 inches long, also lance shaped		Shingle Oak
18. Has 7-11 lobes		Northern Red Oak
18. Has 5-7 lobes, petiole long and yellow		Black Oak
19. Leaf margins toothed or wavy	20	
19. Leaf margins not toothed	30	

Often dichotomous, but they don't have to be (e.g. 1,2, or 3 pistils)

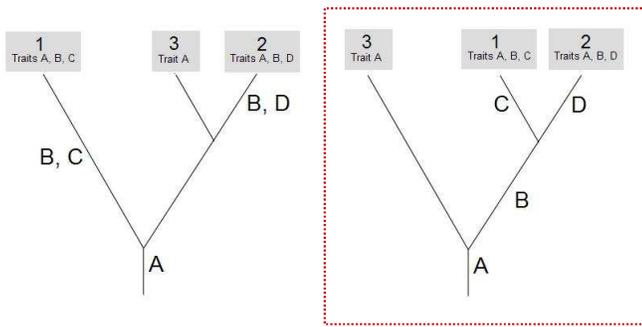
Binomial system is something that we do quite naturally

Darwin (1809 –1882)

- Artificial classification system
 - for convenience
 - different classification for different purposes
 - usually for a country/region
- Natural classification system is based on evolution



Tree of life concept



Cladistics defined

- **Cladistics** studies the evolutionary relationship of organisms.
- Heavy focus on objective quantitative analysis rather than subjective similarities
- Unlike taxonomy, **cladistics** does not worry about “specific” or “generic” classifications.

Taxonomists vs. Cladists

Taxonomy

- Limited number of subjective classifications that make sense
- Arbitrary fixed hierarchical levels that are “permanent”
- Many paraphyletic groups are in use
- Naming species and classes is essential
- Identification relatively easy

Cladistics

- Each node is a hypothetical taxonomic unit (HTU)
- Taxa flexible and quickly changeable if required
- Only monophyletic groups are acceptable
- Only gives temporary names to groups, no names for species
- Identification requires quantitative/genetic analysis

Darwinian “updates” to the taxonomist’s classification

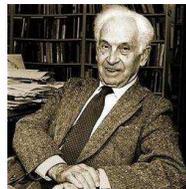
- Kingdoms
- Phyla (-phyta)
- Subphyla (-phytina)
- Class (-opsida)
- Order (-ales)
- Superfamily (-acea)
- Families (-aceae)
- Subfamily (-oideae)
- Tribe (-eae)
- Subtribe (-inae)
- Genera
- Species



Heinrich Gustav Adolf Engler (1844 – 1930)

Darwinian “update” to the species definition

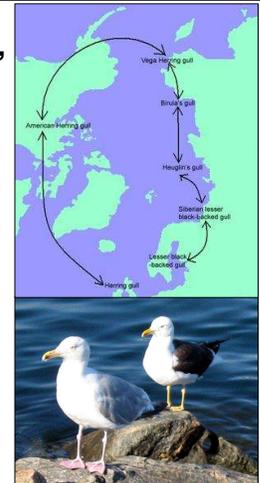
- A **species** is as a group of organisms capable of interbreeding and producing fertile offspring.
- What could be the problem with that?



Ernst Mayr (1904–2005)

The “Species Problem”

- What is the better definition? **actually or potentially interbreeding?**
- What to do with subspecies that become species?
- Think of it as a useful “category” and “single evolving unit”
- And then there’s the complete misfit ...



Study Questions

- Define the scientific fields: *Evolution, Ecology, Genetics*
- Define: *Taxonomy*
- Describe three historical or current systems of plant taxonomy
- What are Linnaeus' two major contributions to taxonomy?
- What are the implications of Darwin's work for taxonomists?
- What are the objectives of modern taxonomic systems?
- What are the names and hierarchical order of the various groupings in plant taxonomy?
- What are the objectives of identification keys?
- Why are taxonomies and identification keys different?
- What is the contribution of genetics to taxonomy?
- Why are DNA-based taxonomies not readily accepted by taxonomists?

Study Questions

- What are the disadvantages of using common names instead of scientific names?
- Explain what the *binomial naming system* is. Who invented it?
- What is a *dichotomous key*?
- What is an *artificial key*?
- Are artificial keys always dichotomous?
- Is a strictly evolutionary taxonomy always dichotomous?
- Define the term *clade*
- Explain what *monophyletic*, *paraphyletic*, and *polyphyletic* groups are
- What is the difference between taxonomy and cladistics?
- What are the advantages taxonomic over cladistic systems and vice versa?