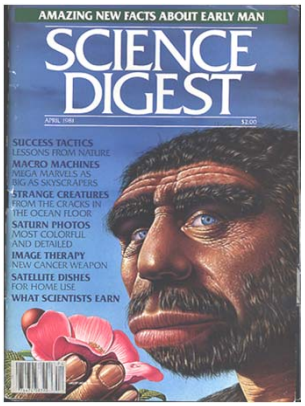
I. The Early Days

A. Folk Taxonomy



I. The Early Days

B. Theophrastus (ca. 371-286 BC)

1. *De Historia Plantarum*
2. *De Causis Plantarum*

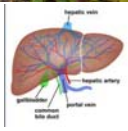
II. Herbalists

A. Herbals

II. Herbalists

B. The Doctrine of Signatures

e.g., *Hepatica*



Mandragora

II. Herbalists

C. Dioscorides
(40-90 AD)

De Materia Medica

De Materia Medica – Arabic translation from Spain (12-13th Century)
Photo courtesy of PHGCOM.

Dill (anti-gas, indigestion soother)

Cumin (parasites)

II. Herbalists

D. Others
(15th-17th Centuries AD)

II. Herbalists

D. Badianus Manuscript

Libellus de Medicinalibus Indorum Herbis (syn. ***Badianus Manuscript***)
(1552 AD, rediscovered in 1929)

de la Cruz
(?-1552-? AD)

Badianus Manuscript
(1552, rediscovered in 1929)

(*Calliandra anomala*; stalky cornsilk flower; Tlacoxiloxochitl)

For persistent cough.

-Drink juice of the root.
-Mix some of juice with honey and smear on throat.

-Fls of this plus water were said to improve eyesight and heal ulcers.

II. Herbalists

E. The Badianus Manuscript

Badianus Manuscript
(1552, rediscovered in 1929)

(Mixture including *Pinus* sp.)

For lightening strike.

-Drink made from lvs of a pine and other species.

II. Herbalists

E. The Badianus Manuscript

Badianus Manuscript
(1552, rediscovered in 1929)

(thistle, pepper)

For "Black Blood" (depression).

-Grind, cook in water. Add pearl, wolf's liver and wine. Drink. Dance.

II. Herbalists

E. The Badianus Manuscript

Badianus Manuscript
(1552, rediscovered in 1929)

(*Urtica chichicaztli*; water-nettle)

For nose bleeds (Atzitzicaztli)

-Grind juice w/ salt in urine, milk.
-Pour into nose to stop flow of blood.

III. Pre-Linnaean Taxonomists

A. Caesalpino (1519-1603)

De Plantis Libri

III. Pre-Linnaean Taxonomists

B. Tournefort (1656-1708)

Institutiones Rei Herbariae

III. Pre-Linnaean Taxonomists

C. Ray (1628-1705)

Historia Plantarum
&
Synopsis Methodica
Stirpium Britannicarum

IV. Linnaeus

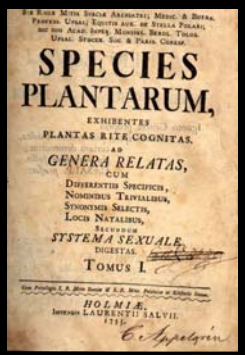
A. Carl von Linné
(1707-1778 AD)

Species Plantarum (1753)

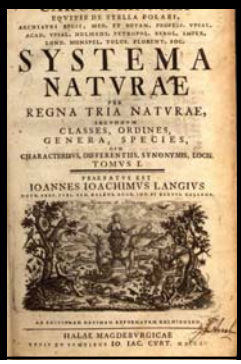
Download high resolution version (2126x1396, 3733 KB)
Swedish 100 kronor bill, released by The Swedish national bank as press photos [1]

IV. Linnaeus

Species Plantarum (1753)


SPECIES PLANTARUM,
EXHIBENTES
PLANTAS RITE COGNITAS,
AD
GENERA RELATAS,
CUM
Differentiis Specificis,
Nominibus Trivialibus,
Synonymis Selectis,
Locis Natalibus,
SECUNDUM
SYSTEMA SEXUALE
DIGESTAS.
TOMUS I.
HOLMIÆ,
IMPENSIS LAURENTII SALVII.
1753.

Systemae Naturae (1735-1758)


SYSTEMA NATVRÆ
PER
REGNA TRIA NATVRÆ,
SECUNDUM
CLASSES, ORDINES,
GENERA, SPECIES,
CUM
CHARACTERIBUS, DIFFERENTIIS, SYNONYMIS, LOCIS.
TOMVS I.
IOANNES IOACHIMVS LANGIVS
HALAE MAGDEBVRGICAE

IV. Linnaeus

Species Plantarum (1753)

-binomial
-synonymy
-hierarchical
-4400 species

Systemae Naturae (1758; 10th Ed.)

-binomial for animals
-synonymy
-hierarchical
-7700 animals

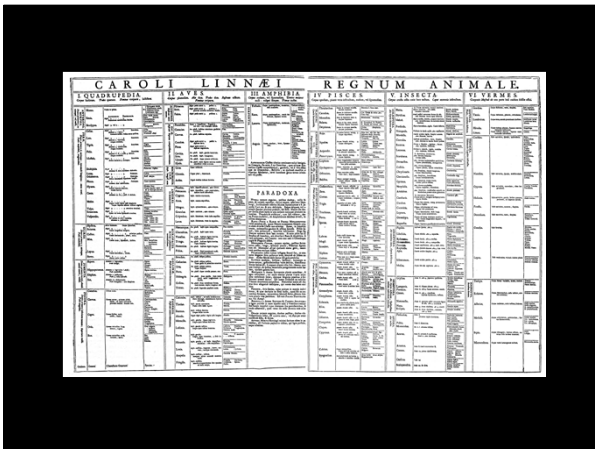
IV. Linnaeus

Species Plantarum (1753)

-binomial
-synonymy
-hierarchical
-4400 species

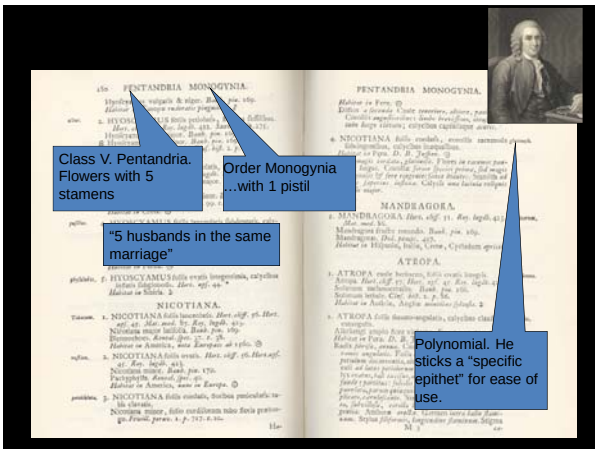
Systemae Naturae (1758; 10th Ed.)

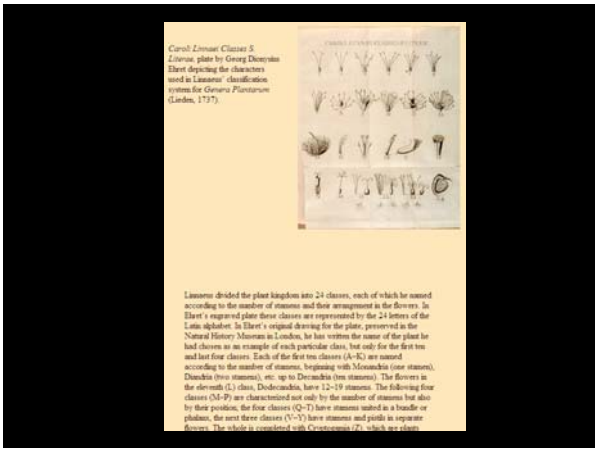
-binomial for animals
-synonymy
-hierarchical
-7700 animals


CAROLI LINNÆI REGNUM ANIMALE.

I QUADRUPEDIA | II AVES | III AMPHIBIA | IV PISCES | V INSECTA | VI VERMES

PARADOXA


Class V. Pentandria. Flowers with 5 stamens
Order Monogynia ...with 1 pistil
"5 husbands in the same marriage"
Polynomial. He sticks a "specific epithet" for ease of use.


Carol Linnæi Classes 5
Linnæus divided the plant kingdom into 24 classes, each of which he named according to the number of stamens and their arrangement in the flowers. In Ehret's engraved plate these classes are represented by the 24 letters of the Latin alphabet. In Ehret's original drawing for the plate, preserved in the Natural History Museum in London, he has written the name of the plant he had chosen as an example of each particular class, but only for the first ten and last four classes. Each of the first ten classes (A–K) are named according to the number of stamens, beginning with Monandria (one stamen), Diandria (two stamens), etc. up to Decandria (ten stamens). The flowers in the eleventh (L) class, Dodecandria, have 12–19 stamens. The following four classes (M–P) are characterized not only by the number of stamens but also by their position; the four classes (Q–T) have stamens united in a bundle or phalanx, the next three classes (V–Y) have stamens and pistils in separate flowers. The whole is completed with Cryptogamia (Z), which are plants

The Species Plantarum Project (SPP)
The Species Plantarum Project is a longer term project aiming to record essential taxonomic information on vascular plants on a world basis. It may be likened to a World Flora. It is expected that it will include accepted names and synonyms with places of publication and types, short descriptions of all taxa from family to infraspecific rank, keys, distributions, references to literature comments, etc. It will be linked to the Global Plant Checklist.
The parameters, details and modus operandi are being discussed by an international steering committee, and further announcements will be made in due course.
Contact the convener, Dick Brummitt, for further information.
International Organization for Plant Information (IOPI) Authorized WWW server Species Plantarum page. K. Wilson (editor). Last modified: 1 April 1997

- Linnaeus (1729)

  The flowers' leaves. . . serve as bridal beds which the Creator has so gloriously arranged, adorned with such noble bed curtains, and perfumed with so many soft scents that the bridegroom with his bride might there celebrate their nuptials with so much the greater solemnity. . .

One of many of Linnaeus's critics:
Johann Georg Siegesbeck (1686-1755), botanical garden in St. Petersburg

Objections seemed to have been two-fold:
1. Artificial.
2. Sexual System and his metaphors:
   e.g., Class Pentandria and order Monogynia was described as "5 husbands in the same marriage"

Siegesbeck wrote that such
"loathsome harlotry as several males with one female would not be permitted in the vegetable kingdom by the Creator!"

Also:
"Who would have thought that bluebells and lillies and onions could be up to such immorality?
How could so licentious a method be taught to the young without offense?"

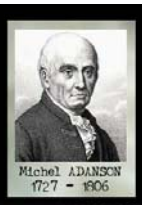
One of many of Linnaeus's critics:
Johann Georg Siegesbeck (1686-1755), botanical garden in St. Petersburg

In response Linnaeus named a foul-smelling weed after one of his more vocal critics. He called it *Siegesbeckia*.

Source of photo: Cyber Herb Medicine Simulation Room

V. The French

A. Adanson



Adanson (1727-1806)

Familles des Plantes

V. The French

B. De Jussieu

de Jussieu (1748-1836)

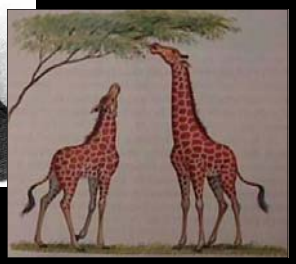
Genera Plantarum

V. The French

C. Lamarck

Lamarck (1744-1829)

Flora Francoise



V. The French

C. Lamarck

Lamarck (1744-1829)

Flora Francoise

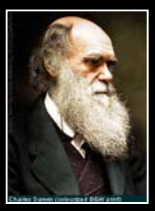
ANALYSE.

Fleurs dont les étamines & pistils peuvent aisément se distinguer. 1.	Fleurs dont les étamines & pistils sont nuls, ou ne peuvent se distinguer. 16.
1. *Fleurs dont les étamines & pistils peuvent aisément se distinguer*	Fleurettes nombreuses, réunies dans un calice commun . . . . . 2 Fleurs libres & non réunies dans un calice commun 9
2. *Fleurettes nombreuses, réunies dans un calice commun*	Fleurettes de même sorte ; elles sont toutes en cornet, ou toutes en languette. . . . . 3 Fleurettes de deux sortes, les unes en cornet, & les autres en languette . . . 6
3. *Fleurettes de même sorte*	Fleurettes toutes en cornet. . . . . 4 Fleurettes toutes en languette 5
4. Fleurettes toutes en cornet. *Cardaus marianus.*	
5. Fleurettes toutes en languettes. *Hieracium murorum.*	

http://www.lamarck.cnrs.fr/

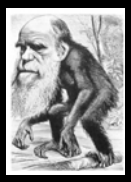
VI. Evolutionary Taxonomy

A. Darwin



Darwin (1809-1882)

Origin of Species 1859



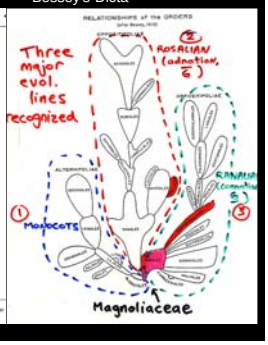
VI. Evolutionary Taxonomy

B. Engler (1844-1930): *Die Natürlichen Pflanzenfamilien*

Adolf Engler, 1883, Photographie (Archiv: BGBM)

C. Bessey (1845-1915)

"Bessey's Dicta"



D. Takhtajan (1910-)

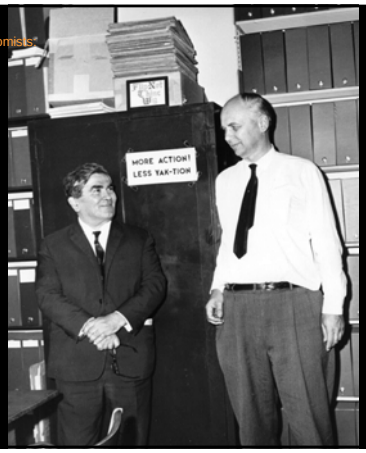
Diversification & Classification of Flowering Plants (1997)

E. Cronquist (1919-1992)

An Integrated System of Classification of Flowering Plants (1981, 1988)

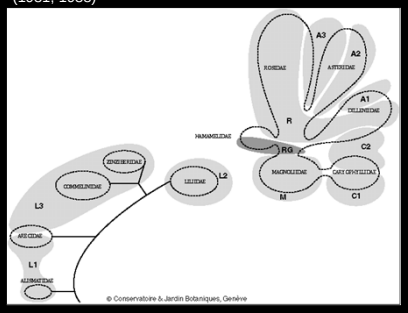
Evolutionary Taxonomists"
Armen Tahktajan
&
Arthur Cronquist

NYBG ca. 1985



Cronquist (1919-1992)

An Integrated System of Classification of Flowering Plants (1981, 1988)



VII. Phenetics (Phenetic Approaches to Classification)
Recognize taxa based on similarity (overall similarity)

Characteristics of:

1. Many characters used (morphological, genetic, etc.)
2. Computational (computers & similarity metric)
3. Objective
4. Repeatable

VII. Phenetics (Phenetic Approaches to Classification)
Recognize taxa based on similarity (overall similarity)

A. Adanson

B. Sneath & Sokal

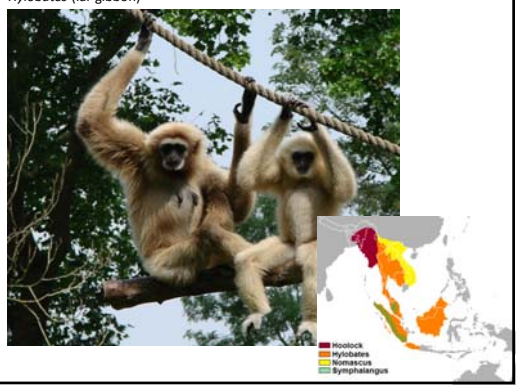
Sneath & Sokal. 1973. Numerical taxonomy: The Principles and Practice of Numerical Classification.

Example: Let's classify the following three primate genera into two separate families.

Leontopithecus (tamarin)
Hylobates (gibbon)
Homo (human, man)

Leontopithecus (golden lion tamarin)

Hylobates (lar gibbon)



Homo (human, man)
Homo erectus

Example: Let's classify the following three primate genera into two separate families.

1. Makes observations, collect data.

	Hairiness	Habit	Tail	Pedalism
***Leontopithecus* (tamarin)**	high (0)	arboreal (0)	yes (0)	4-ped (0)
***Hylobates* (gibbon)**	high (0)	arboreal (0)	no (1)	4-ped (0)
***Homo* (human, man)**	low (1)	terrestrial (1)	no (1)	2-ped (1)

Example: Let's classify the following three primate genera into two separate families.

2. Calculate similarities (states shared/Max possible)

	Hairiness	Habit	Tail	Pedalism
***Leontopithecus* (tamarin)**	0	0	0	0
***Hylobates* (gibbon)**	0	0	1	0
***Homo* (human, man)**	1	1	1	1

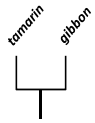
Record using a pairwise similarity matrix

	tamarin	*gibbon*	*human*
tamarin	1.00	0.75	0.00
gibbon	-----	1.00	0.25
human	-----	-----	1.00

Example: Let's classify the following three primate genera into two separate families.

3. Construct phenogram (type of dendrogram)

	tamarin	*gibbon*	*human*
tamarin	1.00	0.75	0.00
gibbon	-----	1.00	0.25
human	-----	-----	1.00

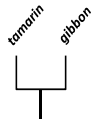


1. Group most similar taxa first

Example: Let's classify the following three primate genera into two separate families.

3. Construct phenogram (type of dendrogram)

	tamarin	*gibbon*	*human*
tamarin	1.00	0.75	0.00
gibbon	-----	1.00	0.25
human	-----	-----	1.00



1. Group most similar taxa first

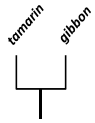
Human – tamarin: 0.00
Human – gibbon: 0.25
Average similarity of human to gibbon/tamarin group 0.13

2. Add next most similar taxon (average similarity may have to calculated)

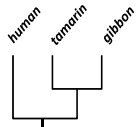
Example: Let's classify the following three primate genera into two separate families.

3. Construct phenogram (type of dendrogram)

	tamarin	*gibbon*	*human*
tamarin	1.00	0.75	0.00
gibbon	-----	1.00	0.25
human	-----	-----	1.00



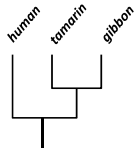
1. Group most similar taxa first



2. Add next most similar taxon (average similarity may have to calculated)

Example: Let's classify the following three primate genera into two separate families.

4. Classify



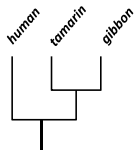
Hylobatidae: *Hylobates* (gibbon)
+ *Leontopithecus* (tamarin)

Hominidae: *Homo* (human)

VII. Phenetic Approaches to Classification

D. Considerations

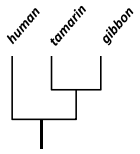
1.) Why did phenetics florish after 1950's?



VII. Phenetic Approaches to Classification

D. Considerations

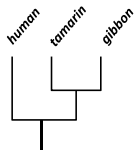
2.) Pros?



VII. Phenetic Approaches to Classification

D. Considerations

3.) Cons?



VIII. Cladistic Approaches to Classification

A. Willi Hennig (German; 1913-1976)

Grundzüge einer Theorie der Phylogenetischen Systematik (Hennig, 1950).

Phylogenetic Systematics (Hennig, 1966)

VIII. Cladistic Approaches to Classification

B. Hennigian Principles

1. Classification consistent w/ phylogeny

i.e., named taxa above sp-level are clades or are monotypic

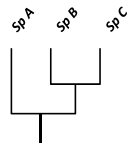
VIII. Cladistic Approaches to Classification

B. Hennigian Principles

1. Classification consistent w/ phylogeny

i.e., named taxa above sp-level are clades or are monotypic

a. Clade (monophyletic group) = grp. incl. a common ancestor and all of its descendants.



Cladogram depicting phylogeny of 3 taxa

VIII. Cladistic Approaches to Classification

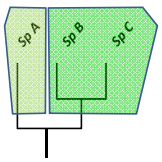
B. Hennigian Principles

1. Classification consistent w/ phylogeny

i.e., named taxa above sp-level are clades or are monotypic

a. Clade (monophyletic group) = grp. incl. a common ancestor and all of its descendants.

Good:
Genus 1: Sp B and C.
Genus 2: Sp A.



VIII. Cladistic Approaches to Classification

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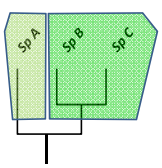
a. Clade (monophyletic group) = grp. incl. a common ancestor and all of its descendants.

Good:
Genus 1: Sp B and C.
Genus 2: Sp A.

- B and C comprise a clade.
- B & C share a more recent common ancestor than either does w/ A.



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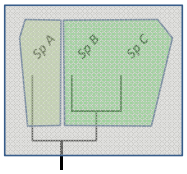
i.e., named taxa above sp-level are clades or are monotypic

a. Clade (monophyletic group) = grp. incl. a common ancestor and all of its descendants.

Good:
Genus 1: Sp B and C.
Genus 2: Sp A.
Family: Genus 1 & 2



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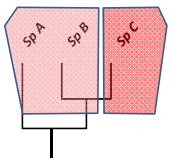
B. Hennigian Principles

1. Classification consistent w/ phylogeny

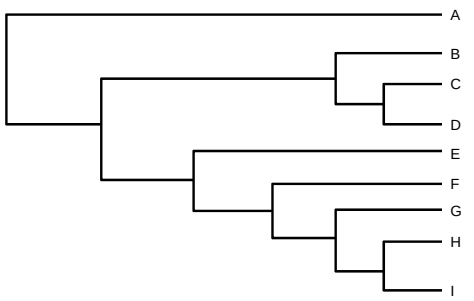
i.e., named taxa above sp-level are clades or are monotypic

a. Clade (monophyletic group) = grp. incl. a common ancestor and all of its descendants.

Bad:
Genus 1: Sp B and A.
Genus 2: Sp C.



How many clades are represented here?



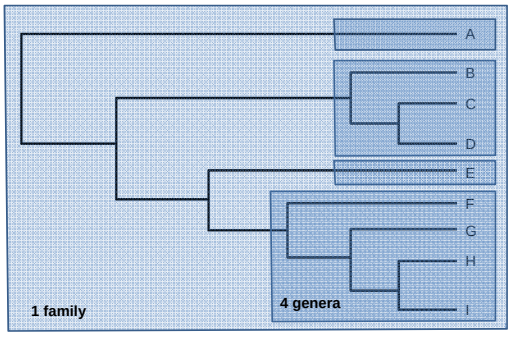
VIII. Cladistic Approaches to Classification

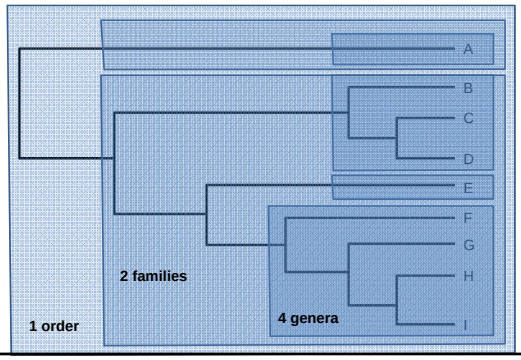
B. Hennigian Principles

1. Classification consistent w/ phylogeny

i.e., named taxa above sp-level are clades or are monotypic

a. Clade (monophyletic group) = grp. incl. a common ancestor and all of its descendants.
b. Not all clades have to be named. Ranks applied are arbitrary.





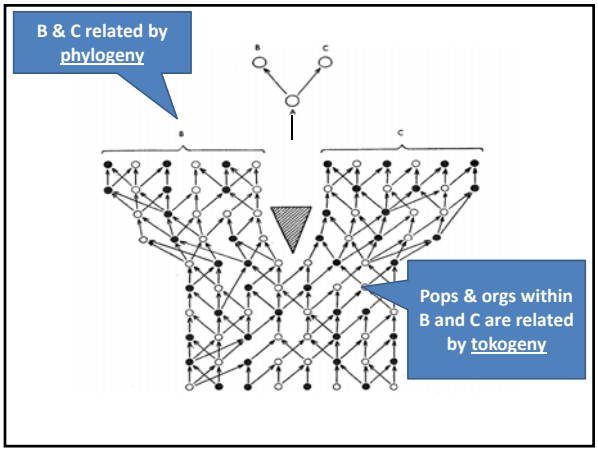
VIII. Cladistic Approaches to Classification

B. Hennigian Principles

1. Classification consistent w/ phylogeny

i.e., named taxa above sp-level are clades or are monotypic

a. Clade (monophyletic group) = grp. incl. a common ancestor and all of its descendants.
b. Not all clades have to be named. Ranks applied are arbitrary.
c. Phylogenetic inference usu not appropriate below species.



VIII. Cladistic Approaches to Classification

B. Hennigian Principles

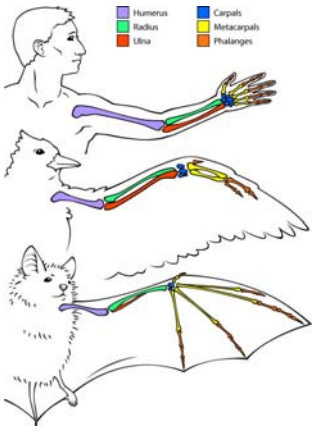
2. Clades marked by synapomorphy(s).
Shared, derived, homologous character state(s)

VIII. Cladistic Approaches to Classification

B. Hennigian Principles

2. Clades marked by synapomorphy(s).
Shared, derived, homologous character state(s)

a. Homology vs. Non-homology & Analogy



Homologous character states:
Forelimbs & bones within

Non-homologous states:
Wings

Homologous character states:
Presence of stems, leaves, flowers, etc.

Non-homologous States:
Arborescent growth.

	Vasculature	Seeds	Flowers
Mosses	0	0	0
Ferns	1	0	0
Conifers	1	1	0
Angios	1	1	1

VIII. Cladistic Approaches to Classification

B. Hennigian Principles

2. Clades marked by synapomorphy(s).
Shared, derived, homologous character state(s)

a. Homology vs. Analogy or Convergence

b. Types of Homology:
- Apomorphy
  - Synapomorphy
  - Autapomorphy
- Plesiomorphy
  - Symplesiomorphy

Apomorphy
Plesiomorphy

	Hairiness	Habit	Tail	Pedalism
tamarin	high (0)	arboreal (0)	yes (0)	4-ped (0)
gibbon	high (0)	arboreal (0)	no (1)	4-ped (0)
human	low (1)	terrestrial (1)	no (1)	2-ped (1)

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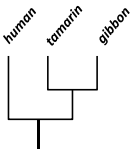
human	low (1)	terrestrial (1)	no (1)	2-ped (1)

Phenogram was based on overall similarity
(plesiomorphies weighted equally to apomorphies)



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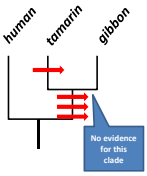
Plesiomorphies are uninformative.



Problem w/ symplesiomorhies:

eg. The 2-Sp classification below is based on the fact that fish share the absence of hair and mammary glands with snails, bacteria, plants, etc.

Where are you more comfortable with the placement of fish in the 2-Sp scheme below?

Order 1	Order 2
E. Coli	human
Fish	gibbon
Snail	tamarin
Magnolia	

Symplesiomorhies are not necessarily absence characters.

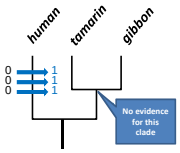
Within Primates

With tails | Without tails

Monkeys	Apes
Tamarin	human
Baboon	chimp
Rhesus	gibbon

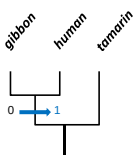
	Hairiness	Habit	Tail	Pedalism
tamarin	high (0)	arboreal (0)	yes (0)	4-ped (0)
gibbon	high (0)	arboreal (0)	no (1)	4-ped (0)
human	low (1)	terrestrial (1)	no (1)	2-ped (1)

Autapomorphies are uninformative.



	Hairiness	Habit	Tail	Pedalism
tamarin	high (0)	arboreal (0)	yes (0)	4-ped (0)
gibbon	high (0)	arboreal (0)	no (1)	4-ped (0)
human	low (1)	terrestrial (1)	no (1)	2-ped (1)

Synapomorphies are informative



	Hairiness	Habit	Tail	Pedalism
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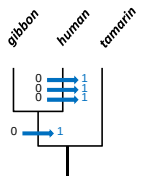
gibbon	high (0)	arboreal (0)	no (1)	4-ped (0)
human	low (1)	terrestrial (1)	no (1)	2-ped (1)

Autapomorphies do not change this.

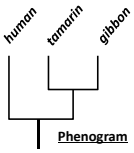


Same data, different groupings (Cladistics vs. Phenetics):

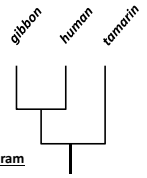
1. Both based on lots of data, repeatable, objective, computational.
2. Both use dendrograms to represent how they presume taxa are related.
3. Phenetics based on overall similarity, cladistics based on special similarity (synapomorphies).

Phenetic classification
Family 1: gibbons & tamarins
Family 2: humans alone

Cladistic classification
Family1: gibbons & humans
Family 2: tamarins alone



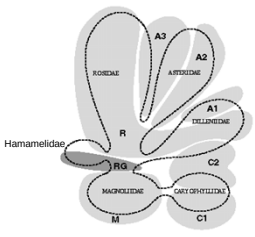
Phenogram



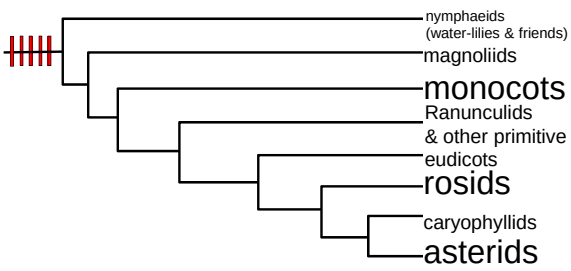
Cladogram

Cronquist vs. Hennig:

1. Both evolutionary.
2. Both based on lots of data, but Cronquist's methodology was subjective (authoritarian) and not as objective or repeatable as Hennig's.
3. Both used tree-like diagrams to represent how they presume taxa are related. (Though Cronquist's Besseygrams are less precise than a cladogram)
4. Cronquist willing to recognize nonmonophyletic (paraphyletic) groups. Hennig not willing.



Angiosperms are monophyletic: therefore, we could recognize as a Sp (e.g., Magnoliophyta or Magnoliopsida)

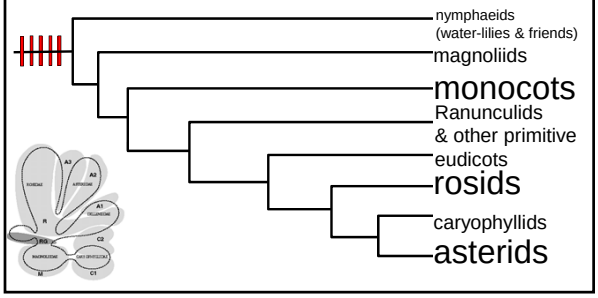


But what about classic subdivision into “monocots” &“dicots?”

e.g., Cronquist (1981)

Which of Cronquist’s classes is not monophyletic?

Magnoliophyta (angiosperms)
Magnoliopsida (dicots)
Liliopsida (monocots)



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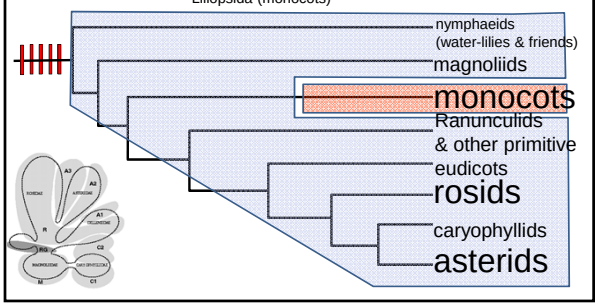
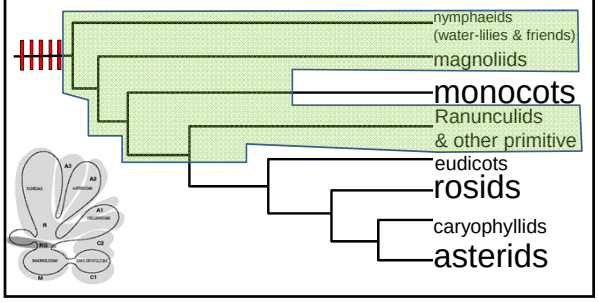
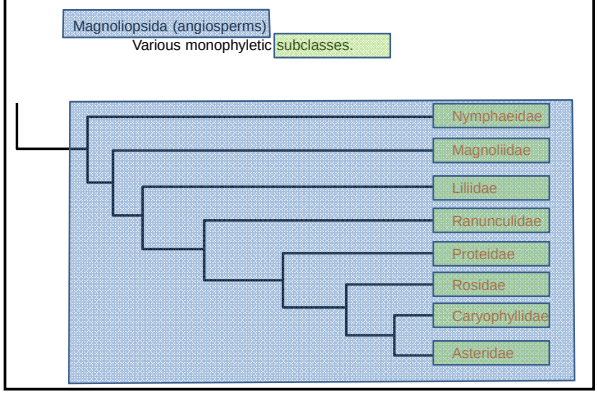


More:
Cronquist's Magnoliidae included water-lilies, Magnoliids, and some primitive eudicots. Emphasis on floral Symplesiomorphies.



Dr. Hardy's classifications of angiosperms: