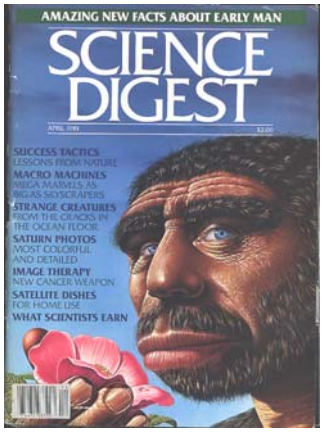
I. The Early Days

A. Folk Taxonomy



I. The Early Days

B. Theophrastus (ca. 371-286 BC)

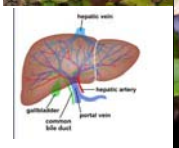
1. *De Historia Plantarum*
2. *De Causis Plantarum*

II. Herbalists

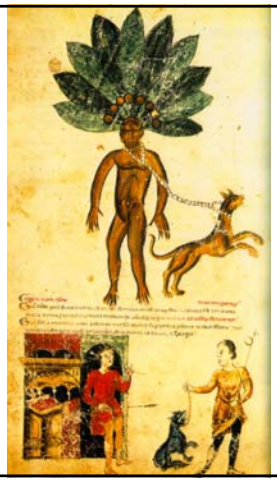
A. Herbals

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

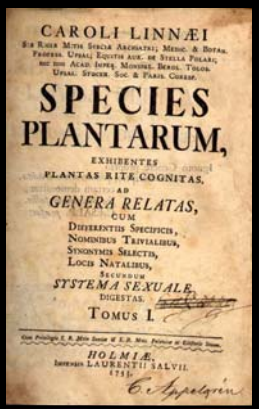
A. Carl von Linné (1707-1778 AD)

Species Plantarum (1753)

Download high resolution version (2126x1395, 3733 KB)
Swedish 100 kronor bill, released by The Swedish national bank as press photos [1]

IV. Linnaeus

Species Plantarum (1753)


CAROLI LINNÆI

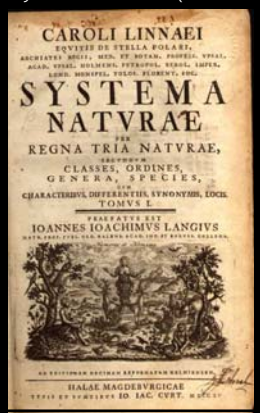
SPECIES PLANTARUM,

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.

Systemae Naturae (1735-1758)


CAROLI LINNÆI

SYSTEMA NATVRÆ

PER REGNA TRIA NATVRAE, SECUNDUM CLASSES, ORDINES, GENERA, SPECIES, CUM CHARACTERIBUS, DIFFERENTIIS, SYNONYMIS, LOCIS.

TOMUS I.

PRÆFATVS EST IOANNES IOACHIMVS LANGIVS

HALAE MAGDEBVRGICAE

IV. Linnaeus

Species Plantarum (1753)	*Systemae Naturae* (1758; 10th Ed.)
-binomial	-binomial for animals
-synonymy	-synonymy
-hierarchical	-hierarchical
-4400 species	-7700 animals

IV. Linnaeus

Species Plantarum (1753)	*Systemae Naturae* (1758; 10th Ed.)
-binomial	-binomial for animals
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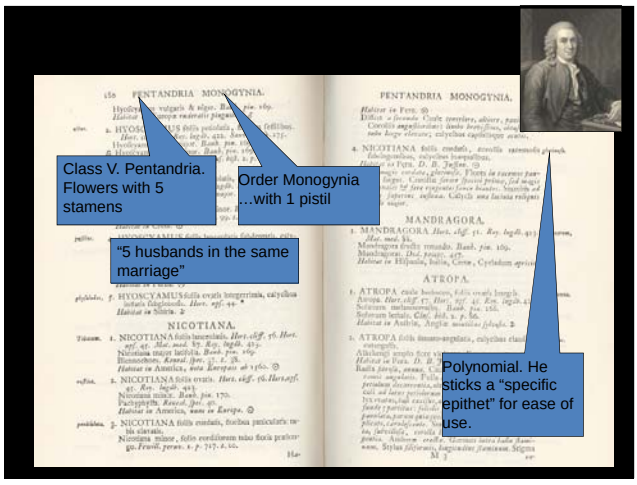
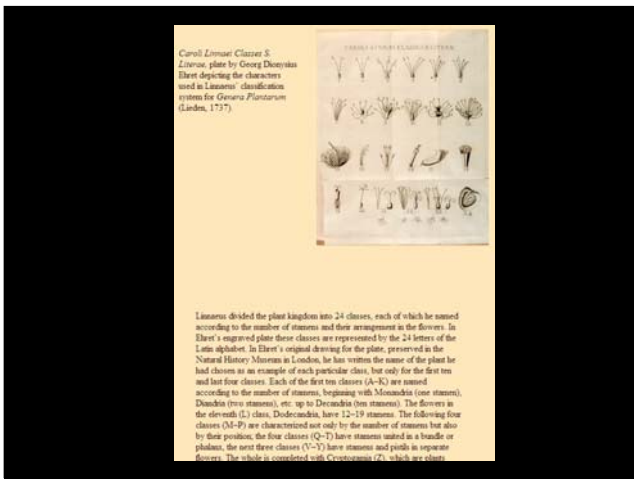
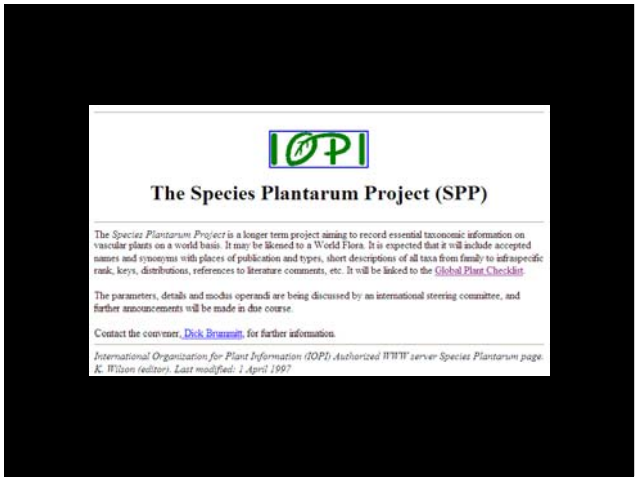






- Linnaeus (1729)

  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?"

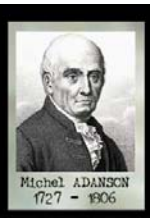
One of many of Linnaeus's critics:
Johann Georg Siegesbeck (1686-1755), botanical garden in St. Petersburg

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)

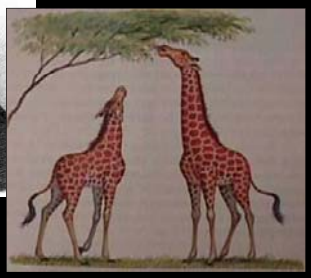
Genera Plantarum

V. The French

C. Lamarck

Lamarck (1744-1829)

Flora Francoise



V. The French

C. Lamarck

Lamarck (1744-1829)

Flora Francoise

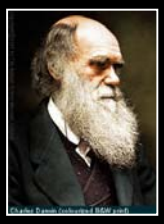
ANALYSE.

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. *Carduus marianus.*	
5. Fleurettes toutes en languettes. *Hieracium murorum.*	

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

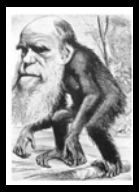
VI. Evolutionary Taxonomy

A. Darwin



Darwin (1809-1882)

Origin of Species 1859



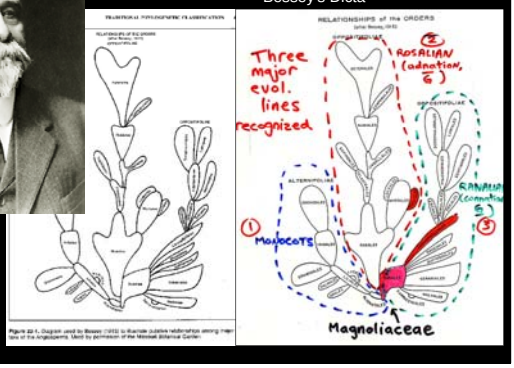
VI. Evolutionary Taxonomy

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

Adolf Engler, 1863, Photographie (Archiv, BGBM)

C. Bessey (1845-1915)

"Bessey's Dicta"



D. Takhtajan (1910-)

Diversification & Classification of Flowering Plants (1997)

E. Cronquist (1919-1992)

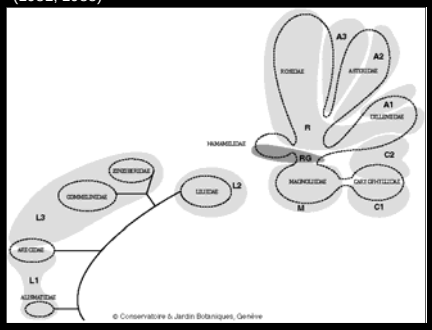
An Integrated System of Classification of Flowering Plants (1981, 1988)

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 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 similiarity (overall similarity)

A. Adanson

B. Sneath & Sokal

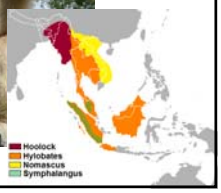
Sneath & Sokal. 1973. Numerical taxonomy: The Principles and Practice of Numerical Classification.

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

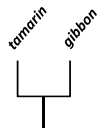
Record using a pairwise similarity matrix

	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

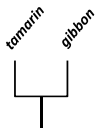


1. Group most similar taxa first

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

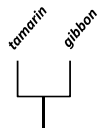
Human – tamarin: 0.00
Human – gibbon: 0.25
Average similarity of human to gibbon/tamarin group 0.13

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



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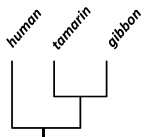
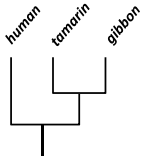


2. Add next most similar taxon (average similarity may have to calculated)

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

4. Classify



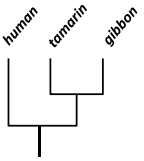
Hylobatidae: *Hylobates* (gibbon)
+ *Leontopithecus* (tamarin)

Hominidae: *Homo* (human)

VII. Phenetic Approaches to Classification

D. Considerations

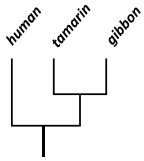
1.) Why did phenetics florish after 1950's?



VII. Phenetic Approaches to Classification

D. Considerations

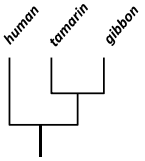
2.) Pros?



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)

What would Hennig say about this classification?

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

Hominidae: *Homo* (human)

Hylobatidae based on shared hairiness, arborealness, 4-pedalism.

	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)

What would Hennig say about this classification?)

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

Hominidae: *Homo* (human)

Hylobatidae based on shared hairiness, arborealness, 4-pedalism.

Other mammals sharing some or all of these states:
- all states: tree sloth, bear, koala
- 2/3 states: mice, dog, cat, mammoth

What would Hennig say about this classification?)

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

Hominidae: *Homo* (human)

Hylobatidae based on shared hairiness, arborealness, 4-pedalism.

Other mammals sharing some or all of these states:
- all states: tree sloth, bear, koala
- 2/3 states: mice, dog, cat, mammoth

Shared primitive states (symplesiomorphies) do not indicate relative recency of common ancestry.

Problem w/ symplesiomorhies:
eg. The 2-taxon 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-taxon scheme below?

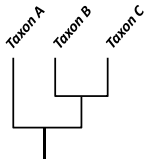
Taxon 1	Taxon 2
E. Coli	human
Fish	gibbon
Snail	tamarin
Magnolia	

VIII. Cladistic Approaches to Classification

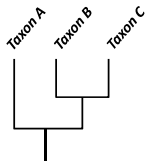
B. Hennigian Principles

1. Classification should reflect phylogenetic relationship.
e.g., assume we want a two family classification and base it on the cladogram (not phenogram) below.

Family 1: Taxon B and C.
Family 2: Taxon A.



Family 1: Taxon B and C.
Family 2: Taxon A.



Justification:

- B & C are more closely related to one another than they are to A.
- B & C share a more/most recent common ancestor.
- B & C are sister species/sister lineages.
- B & C comprise a clade.
- A, B, & C also comprise a clade, but that clade includes the smaller clade, B-C.

VIII. Cladistic Approaches to Classification

B. Hennigian Principles

2. Recency of common ancestry inferred by synapomorphy, not symplesiomorphy or presence or absence of autapomorphy.

Apomorphy = derived character state.
Plesiomorphy = primitive character state

Apomorphy = derived character state.
Plesiomorphy = primitive character state

e.g., among extant mammals, low hairiness is derived from high.
e.g., among primates, terrestrial habit is derived from arboreal.
e.g., within tetrapods, bipedalism is derived from quadrupedalism.
e.g., within vertebrates, no tail (i.e., loss) is derived from having a tail.

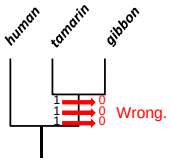
	Hairiness	Habit	Tail	Pedalism
tamarin	high (0)	arboreal (0)	yes (0)	4-ped (0)
gibbon	high (0)	arboreal (0)	no (1)	4-ped (0)
human	low (1)	terrestrial (1)	no (1)	2-ped (1)

2. Recency of common ancestry inferred from synapomorphy, not symplesiomorphy or presence or absence of autapomorphy.

Symplesiomorphy = shared primitive state.

Thus, the states in red aren't evidence that gibbon and tamarin are most recently (closely) related. Because these are not the most recently derived states.

	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)



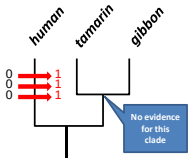
Wrong.

2. Recency of common ancestry inferred from synapomorphy, not symplesiomorphy or presence or absence of autapomorphy.

Autapomorphy = unshared derived state.

Thus, characters and states in red yield no grouping information.

	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)



2. Recency of common ancestry inferred from synapomorphy, not symplesiomorphy or presence or absence of autapomorphy.

Synapomorphy = shared derived state.

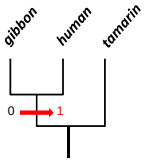
Thus, loss of tail recognizes gibbon and humans – apes – as a clade.

The cladogram and classification should be changed as follows:

Hominidae: *Homo* (human) + *Hylobates* (gibbon)

Leontopithidae: *Leontopithecus* (tamarin)

	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)

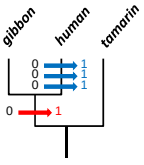


2. Recency of common ancestry inferred from synapomorphy, not symplesiomorphy or presence or absence of autapomorphy.

Autapomorphies can accumulate.

No matter how different humans become, that will never change their relationship to gibbons or their membership in the ape clade.

	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)



Cronquist vs. Hennig:

1. Both were evolutionary.

2. Both based on lots of data, but Cronquists methodology was subjective (authoritarian, not necessary repeatable) and not as objective or repeatable as Hennigs.

3. Both used tree-like diagrams to represent how they presume taxa are related. (Though Cronquist's Besseygrams are less precise than a cladogram)

3. Cronquist was okay that some members of his Magnoliidae might actually be more closely related to members of other subclasses. Hennig would not have been okay with that.