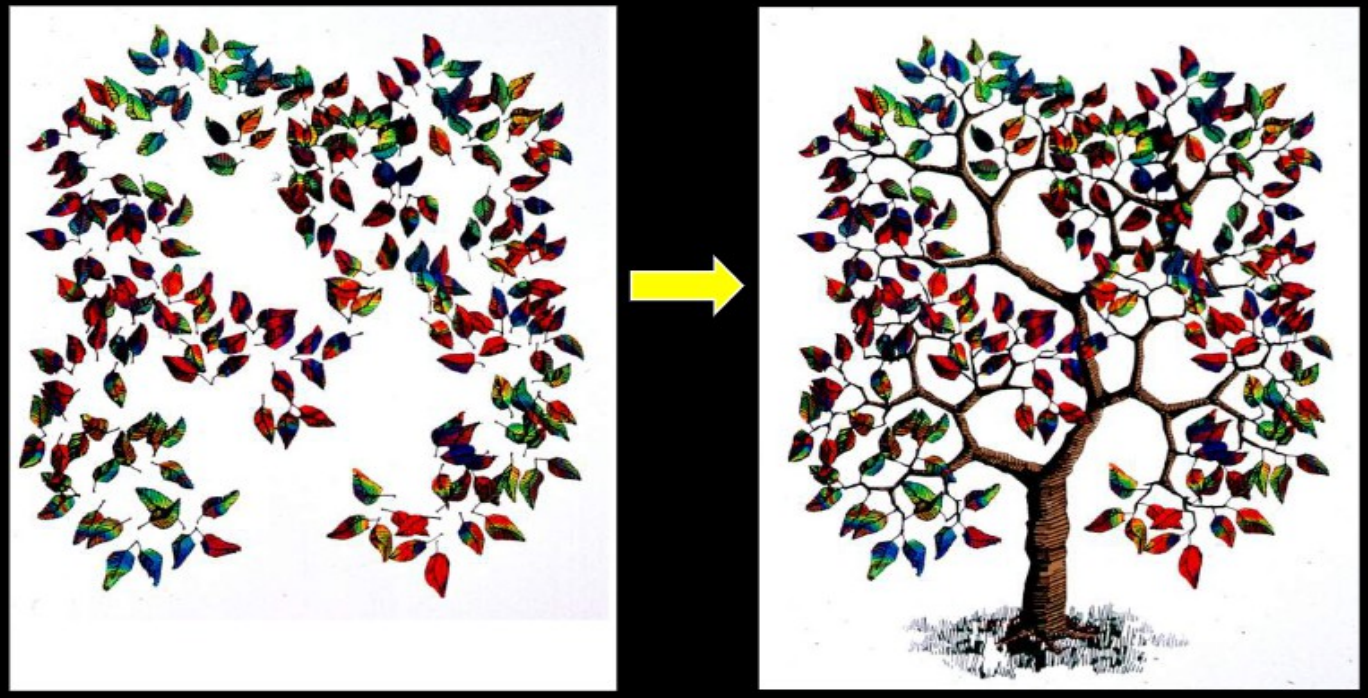
CORSO DI BOTANICA SISTEMATICA

LEZIONE 44

Sistematica e filogenesi

Phylogenetics

Phylogenetics is the estimation of the "tree" through "time" knowing only the "leaves"

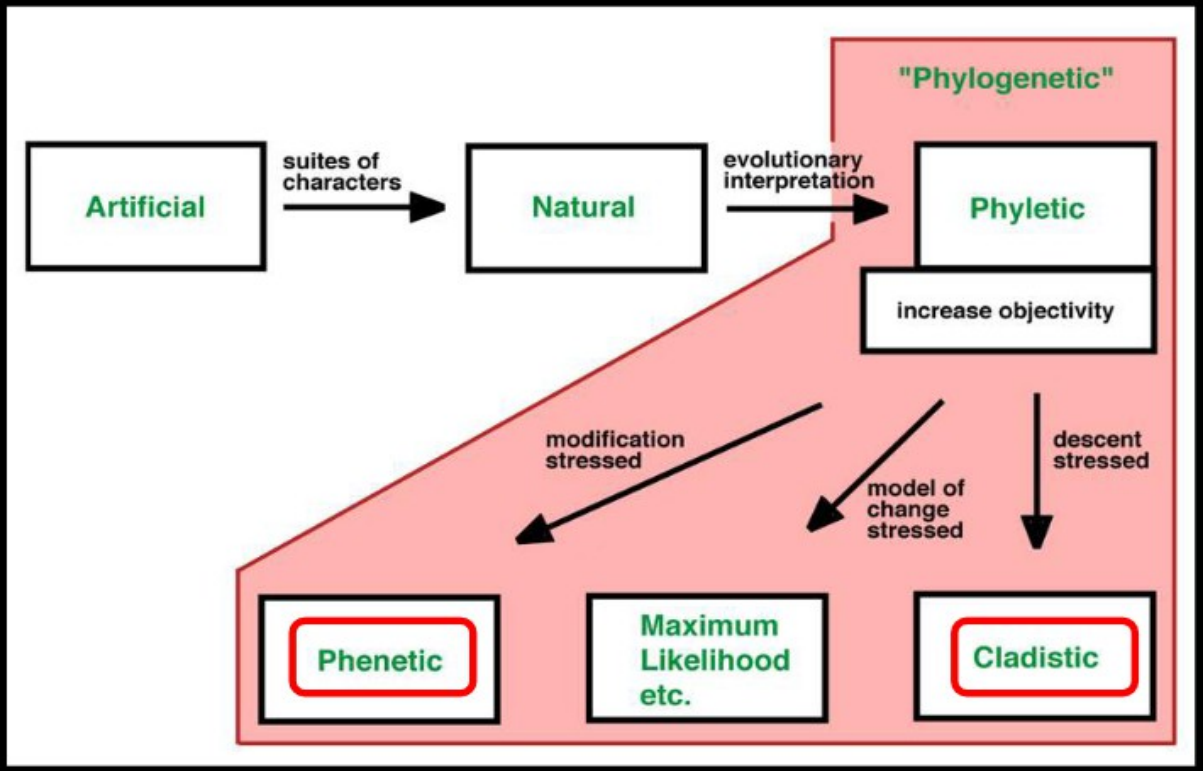


Phylogenetics

However, the "leaves" are scattered over "space". Some areas have related "leaves", others have unrelated "leaves". Thus, phylogenetics is compounded by issues of both "time" and "space".

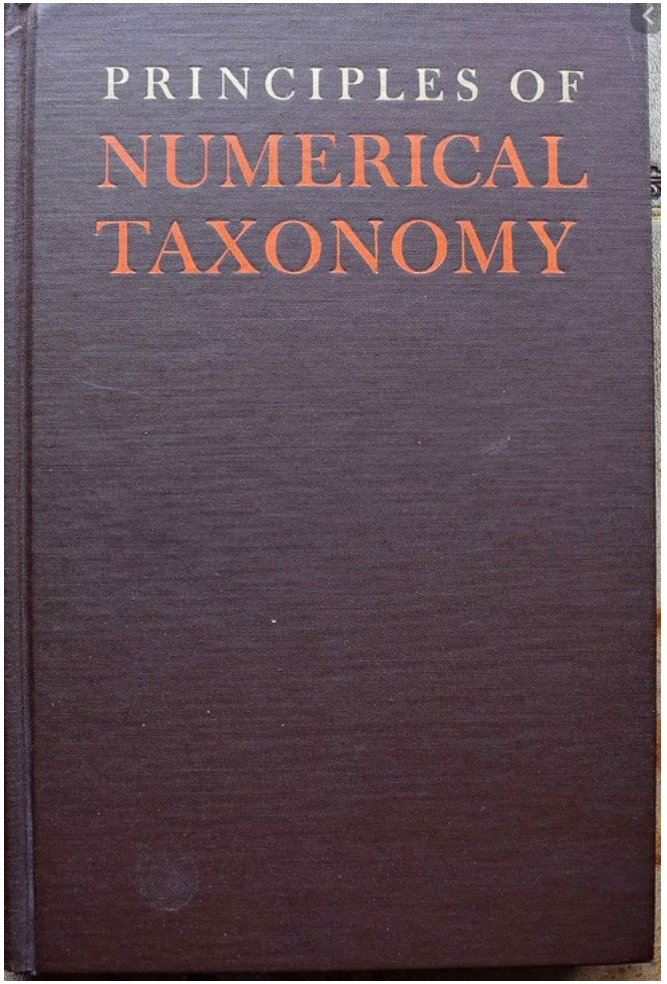
Phylogenetics

In the 1960s, two main groups of systematists became dissatisfied with the phyletic approach and developed more objective methods: phenetic and cladistic



P.W. Bridgman (1882-1961)

R.R. Sokak & P.H.A. Sneath



1963

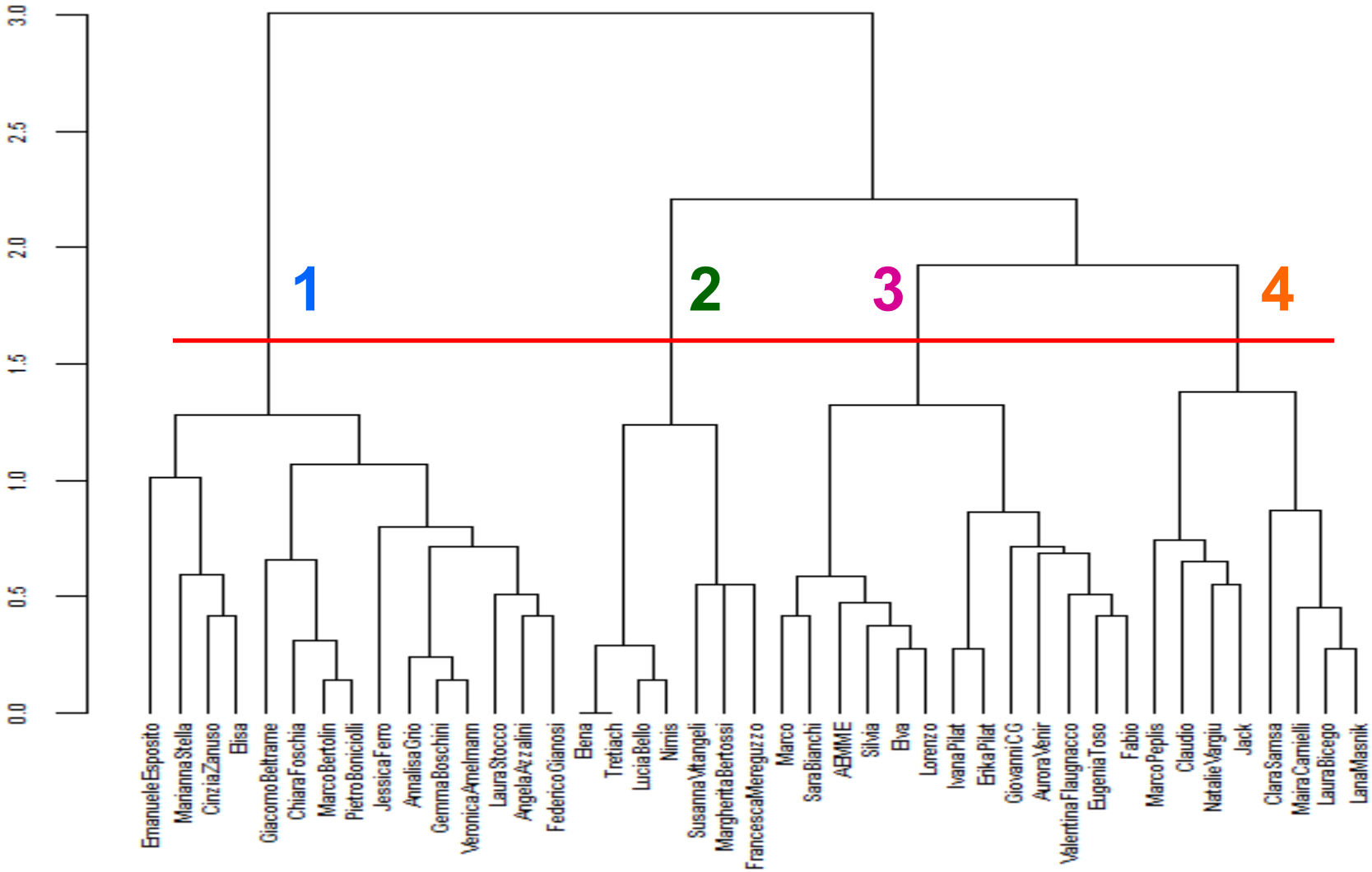
Votanti

Musicisti

	GemmaBoschini	NatalieVargiu	ClaraSamsa	GiovanniCG	Marco	SaraBianchi	JessicaFerro	EugeniaToso	EmanueleEsposito	MarcoBertolin	MargheritaBertossi	LauraBicego	CinziaZanuso	MariannaStella	VeronicaAmelmann	LuciaBello	FrancescaMereguzzo	IvanaPilat	AnnalisaGrio	SusannaVitangeli	AngelaAzzalini	ChiaraFoschia	FedericoGianosi	MairaCarnielli	GiacomoBeltrame	PietroBoniciolli	LanaMasnik	LauraStocco	AuroraVenir	ErikaPilat	ValentinaFlaugnacco	MarcoPeplis	Claudio	Elva	Elena	Tretiach	Silvia	Fabio	Lorenzo	Elisa	Nimis	AEMME	Jack
Wagner					1	1										1																1		1	1	1		1		1		1
Rossini				1												1																			1	1					1			
Vivaldi								1								1		1		1													1	1	1					1	1		
Doors				1	1	1	1	1										1											1	1		1		1		1	1	1			1		
PesteNoir																																1											
DeAndre	1		1		1	1		1			1		1			1	1			1											1	1		1	1	1	1		1		1	1	
TheKillers		1										1	1											1			1			1			1							1			1
Currents																									1																		
Ramones		1	1	1				1										1												1		1	1	1			1		1				1
ModenaCityRamblers				1	1				1		1									1					1											1							
Mannarino			1		1						1						1							1																			
Elisa	1						1			1					1	1			1		1	1				1		1						1	1					1	1		
LedZeppelin		1	1	1	1	1	1	1										1						1						1	1		1			1	1	1			1	
Oasis		1	1									1		1			1	1		1	1		1	1	1		1		1	1							1		1			
LinkinPark		1	1						1	1		1									1	1	1		1	1		1	1		1	1	1				1					1
Nickelback		1											1															1	1										1				
ImagineDragons	1		1				1		1	1	1		1	1	1				1	1	1	1	1		1	1						1							1				
EdSheeran	1						1	1	1	1	1		1	1	1			1	1	1	1	1	1		1	1		1			1						1		1				
FlorenceTheMachine			1				1				1	1		1										1			1								1							
Rihanna	1								1						1				1		1	1	1					1			1		1									
PinkFloyd		1			1	1				1	1					1	1	1				1	1	1		1			1	1	1	1		1			1	1	1		1	1	1
Ultimo							1							1	1				1		1		1				1	1									1					
LilPeep									1																																		
Queen	1	1		1	1	1		1		1	1	1	1	1	1	1	1	1	1		1	1		1	1	1	1		1	1	1		1	1	1	1	1	1	1		1	1	1
ArcticMonkeys		1		1					1			1	1	1										1			1					1	1			1			1	1			1
ThirtySecondsToMars							1			1		1										1		1	1	1	1	1	1			1											
Mozart									1							1	1			1															1	1					1	1	1	
Soad						1																		1					1		1	1										1
GunsNRoses			1	1				1				1		1				1				1	1				1		1	1	1					1		1				1
Ligabue	1										1				1		1	1	1	1	1		1			1	1	1		1				1	1					1			
Emma	1						1								1						1							1															
MichaelJackson	1			1		1			1	1			1		1				1										1		1		1	1	1				1		1		
Coldplay	1	1				1	1			1	1		1	1	1	1	1		1	1		1	1		1	1		1											1	1		1		
DeepPurple				1	1	1		1									1												1		1						1						
Hozier			1							1		1	1	1					1					1		1	1																
Morricone					1			1	1			1				1	1			1													1	1	1	1	1	1	1		1	1		

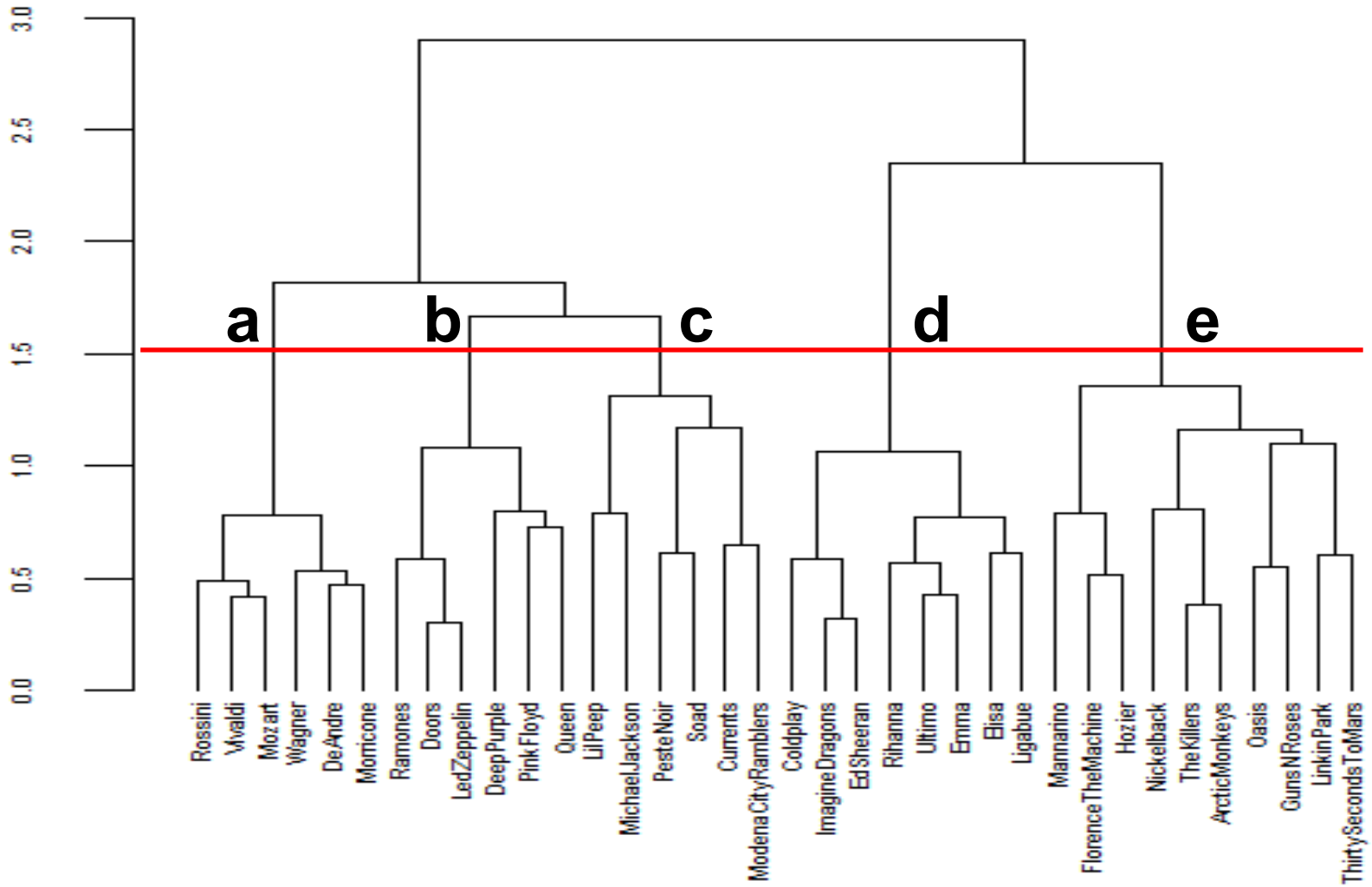
Classificazione

Dendrogramma votanti – coefficiente di correlazione – minimum variance



Classificazione

Dendrogramma musicisti – coefficiente di correlazione – minimum variance



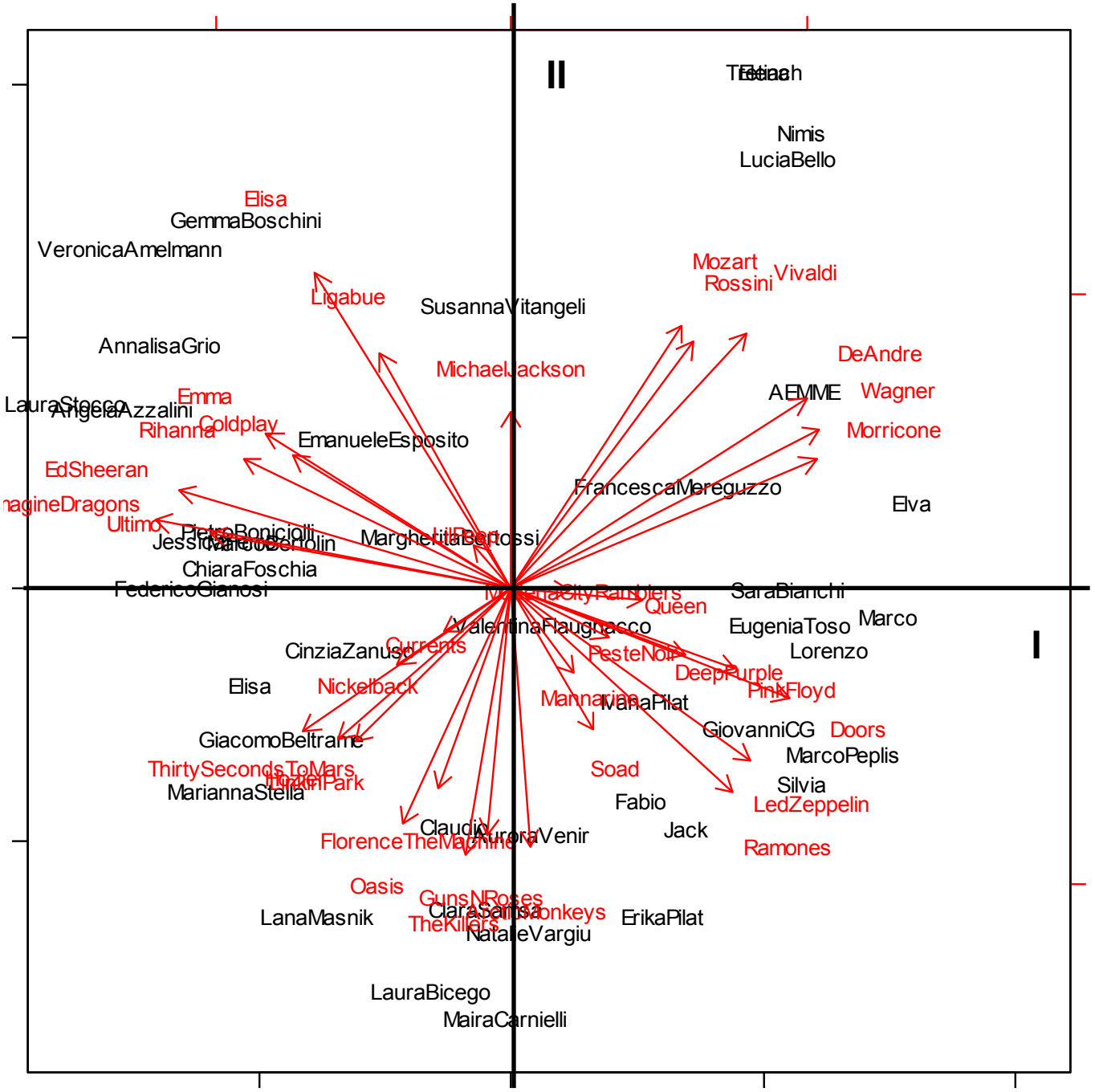
Classificazione

Tabella ordinata

		Rossini	Vivaldi	Mozart	Wagner	DeAndre	Morricone	Ramones	Doors	LedZeppelin	DeepPurple	PinkFloyd	Queen	LilPeep	MichaelJackson	PesteNoir	Soad	Currents	ModenaCityRamblers	Coldplay	ImagineDragons	EdSheeran	Rihanna	Ultimo	Emma	Elisa	Ligabue	Mannarino	FlorenceTheMachine	Hozier	Nickelback	TheKillers	ArcticMonkeys	Oasis	GunsNRoses	LinkinPark	ThirtySecondsToMars
	EmanueleEsposito			1			1							1	1				1		1	1	1										1			1	
	MariannaStella												1							1	1	1		1					1	1			1	1	1		
	CinziaZanuso					1							1		1					1	1	1								1	1	1	1				
	Elisa														1					1	1	1				1					1	1	1	1	1		
	GiacomoBeltrame												1				1	1	1	1	1	1												1		1	1
	ChiaraFoschia											1	1							1	1	1	1			1									1	1	1
1	MarcoBertolin											1	1		1					1	1	1				1				1						1	1
	PietroBoniciolli											1	1							1	1	1				1	1			1						1	1
	JessicaFerro								1	1										1	1	1		1	1	1			1								1
	AnnalisaGrio												1		1					1	1	1	1	1		1	1			1							
	GemmaBoschini					1							1		1					1	1	1	1		1	1	1										
	VeronicaAmelmann												1		1					1	1	1	1	1	1	1	1										
	LauraStocco																			1		1	1	1	1	1	1				1				1	1
	AngelaAzzalini												1								1	1	1	1	1	1	1						1		1	
	FedericoGianosi											1								1	1	1	1	1			1						1	1	1	
	Elena	1	1	1	1	1	1						1		1											1	1									
	Tretiach	1	1	1	1	1	1						1		1											1	1									
2	LuciaBello	1	1	1	1	1	1					1	1							1						1										
	Nimis	1	1	1	1	1	1					1	1													1	1									
	SusannaVitangeli		1	1		1	1												1	1	1	1					1							1			
	MargheritaBertossi					1						1	1						1	1	1	1					1	1	1								
	FrancescaMereguzzo			1		1	1				1	1	1							1							1	1						1			
	Marco				1	1	1		1	1	1	1	1						1									1									
	SaraBianchi				1	1			1	1	1	1	1		1		1			1																	
	AEMME		1	1		1	1		1	1		1	1		1					1																	
	Silvia					1	1	1	1	1		1	1						1										1				1				
	Elva		1		1	1	1	1	1	1		1	1		1																					
	Lorenzo				1	1	1	1	1	1		1	1							1													1				
3	IvanaPilat		1					1	1	1		1	1									1					1							1	1		
	ErikaPilat							1	1	1		1	1				1										1					1		1	1		
	GiovanniCG	1						1	1	1	1		1		1				1														1		1		
	AuroraVenir								1		1	1	1		1																1			1	1	1	1
	ValentinaFlaugnacco					1				1	1	1	1		1							1	1												1	1	
	EugeniaToso		1			1	1	1	1	1	1		1									1													1		
	Fabio						1		1	1	1	1	1									1												1	1	1	
	MarcoPeplis				1	1	1	1	1			1				1	1																1			1	
	Claudio						1	1					1				1				1		1									1	1			1	1
	NatalieVargiu							1		1		1	1							1											1	1	1	1		1	
4	Jack			1	1			1				1	1				1															1	1		1	1	
	ClaraSamsa					1		1		1											1							1	1	1				1	1	1	
	MairaCarnielli									1		1	1															1	1	1		1	1	1			1
	LauraBicego						1						1																1	1		1	1	1	1	1	1
	LanaMasnik												1											1			1		1	1		1	1	1	1		1

Ordinamento biplot votanti e musicisti

varianza I asse: 17%
varianza II asse: 13%



Ordinamento biplot votanti e musicisti

varianza I asse: 17%
varianza II asse: 13%

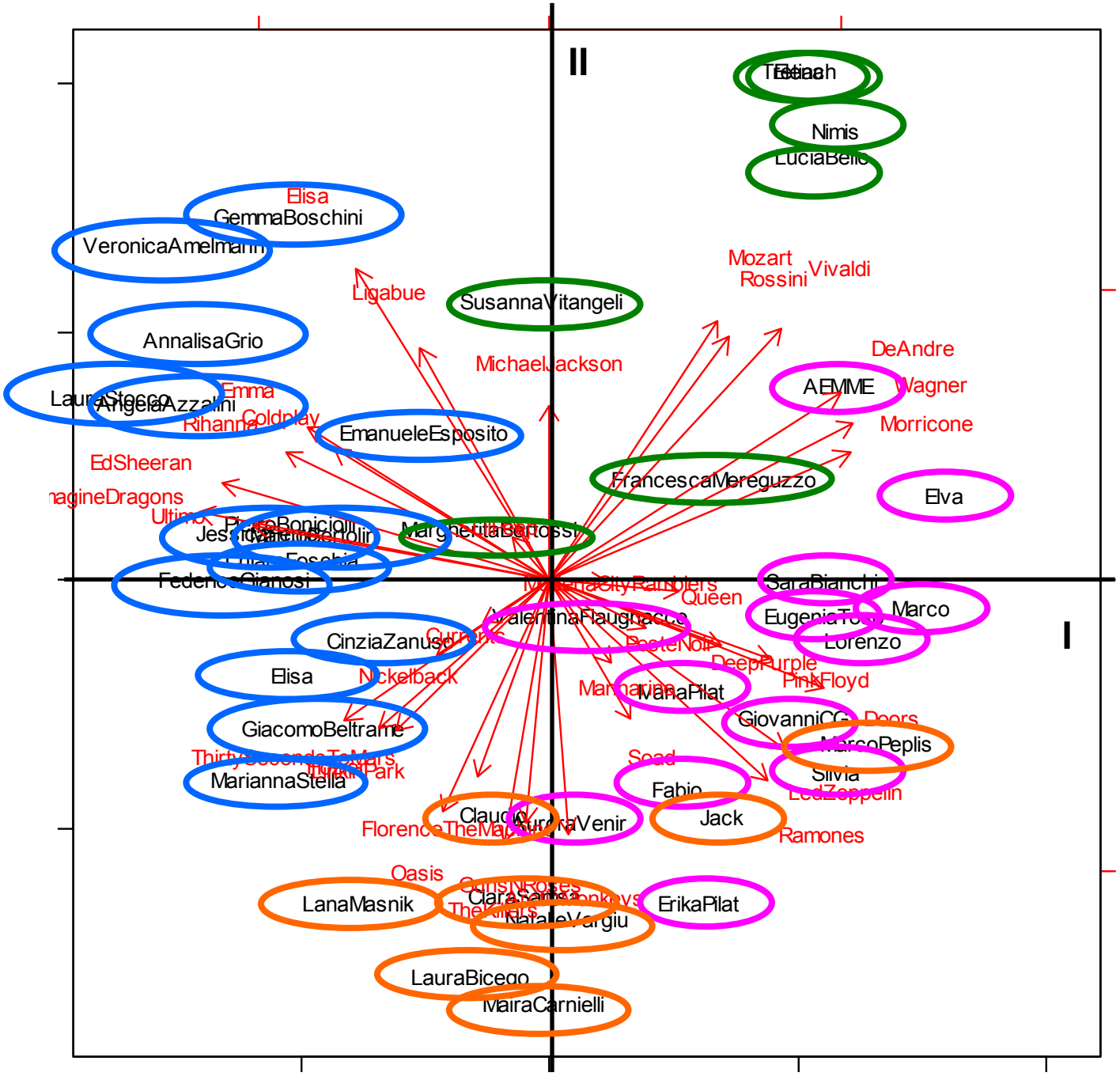
Gruppi derivanti dalla classificazione:

1

2

3

4



Ordinamento biplot

Tabella ordinata (I asse)

	ImagineDragons	EdSheeran	Ultimo	Rihanna	Emma	Coldplay	ThirtySecondsToMars	Elisa	Hozier	LinkinPark	Ligabue	Nickelback	Oasis	FlorenceTheMachine	Currents	TheKillers	LilPeep	GunsNRoses	MichaelJackson	ArcticMonkeys	ModenaCityRamblers	Mannarino	Soad	PesteNoir	Queen	Mozart	DeepPurple	Rossini	Ramones	PinkFloyd	Vivaldi	LedZeppelin	Doors	DeAndre	Morricone	Wagner
LauraStocco		1	1	1	1	1	1	1		1	1	1																								
AngelaAzzalini	1	1	1	1	1			1		1	1		1												1											
VeronicaAmelmann	1	1	1	1	1	1		1			1								1						1											
AnnalisaGrio	1	1	1	1		1		1	1		1								1						1											
FedericoGianosi	1	1	1	1		1				1	1		1					1												1						
JessicaFerro	1	1	1		1	1	1	1						1																		1	1			
MariannaStella	1	1	1			1			1				1	1				1		1					1											
GemmaBoschini	1	1		1	1	1		1			1								1						1									1		
PietroBoniciolli	1	1				1	1	1	1	1	1														1					1						
Elisa	1	1				1		1				1	1			1		1	1	1																
ChiaraFoschia	1	1		1		1	1	1		1								1							1					1						
MarcoBertolin	1	1				1	1	1	1	1									1						1					1						
GiacomoBeltrame	1	1				1	1			1			1		1						1		1		1											
LanaMasnik			1				1		1		1		1	1		1		1		1					1											
CinziaZanuso	1	1				1			1			1				1			1	1					1									1		
EmanueleEsposito	1	1		1						1							1		1	1	1					1									1	
LauraBicego							1		1	1			1	1		1		1		1					1										1	
MargheritaBertossi	1	1				1					1			1							1	1			1					1				1		
Claudio	1			1			1			1						1				1			1		1				1					1		
ClaraSamsa	1								1	1			1	1				1				1							1			1		1		
SusannaVitangeli	1	1				1					1		1								1					1					1			1	1	
MairaCarnielli							1		1				1	1		1				1		1			1					1		1				
NatalieVargiu						1				1		1	1			1				1					1				1	1		1				
AuroraVenir							1			1		1	1					1	1						1		1			1			1			
ValentinaFlaugnacco		1		1						1								1	1						1		1			1		1		1		
Fabio		1								1			1					1							1		1			1		1	1		1	
IvanaPilat		1									1		1					1							1				1	1	1	1	1			
ErikaPilat											1		1			1		1					1		1				1	1		1	1			
FrancescaMereguzz						1					1		1									1			1	1	1			1				1	1	
Jack										1						1		1		1			1		1	1			1	1						1
GiovanniCG																		1	1	1	1				1		1	1	1			1	1			
Elena								1			1								1						1	1		1			1			1	1	1
Tretiach								1			1								1						1	1		1			1			1	1	1
SaraBianchi						1													1				1		1		1			1		1	1	1		1
LuciaBello						1		1																	1	1		1		1	1			1	1	1
EugeniaToso		1																1							1		1		1		1	1	1	1		
Silvia														1						1	1				1				1	1		1	1	1	1	
Nimis								1			1														1	1		1		1	1			1	1	1
AEMME						1													1						1	1				1	1	1	1	1	1	
Lorenzo						1														1					1				1	1		1	1	1	1	1
MarcoPeplis										1										1			1	1					1	1			1	1	1	1
Marco																					1	1			1		1			1		1	1	1	1	1
Elva																			1						1				1	1	1	1	1	1	1	1

Cladistics

Issue #1- ordering or polarizing character states (primitive or derived)

vessels (+) → no vessels (-)

OR

no vessels (-) → vessels (+)

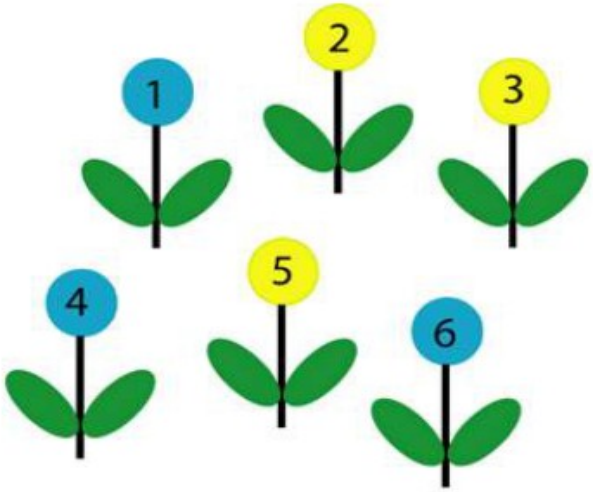
	vessels
1. *Magnolia*	+
2. *Nymphaea*	-
3. *Rosa*	+
4. *Primula*	+
5. *Gentiana*	+
6. *Aster*	+

- can be subjective
- fossil record
- development, ontogeny
- look at groups most closely related to your group of interest (outgroup)

Cladistics

Issue #1- ordering or polarizing character states (primitive or derived)

plesiomorph - primitive state apomorph - derived state



Are blue flowers derived (apomorphic), or are yellow flowers derived?

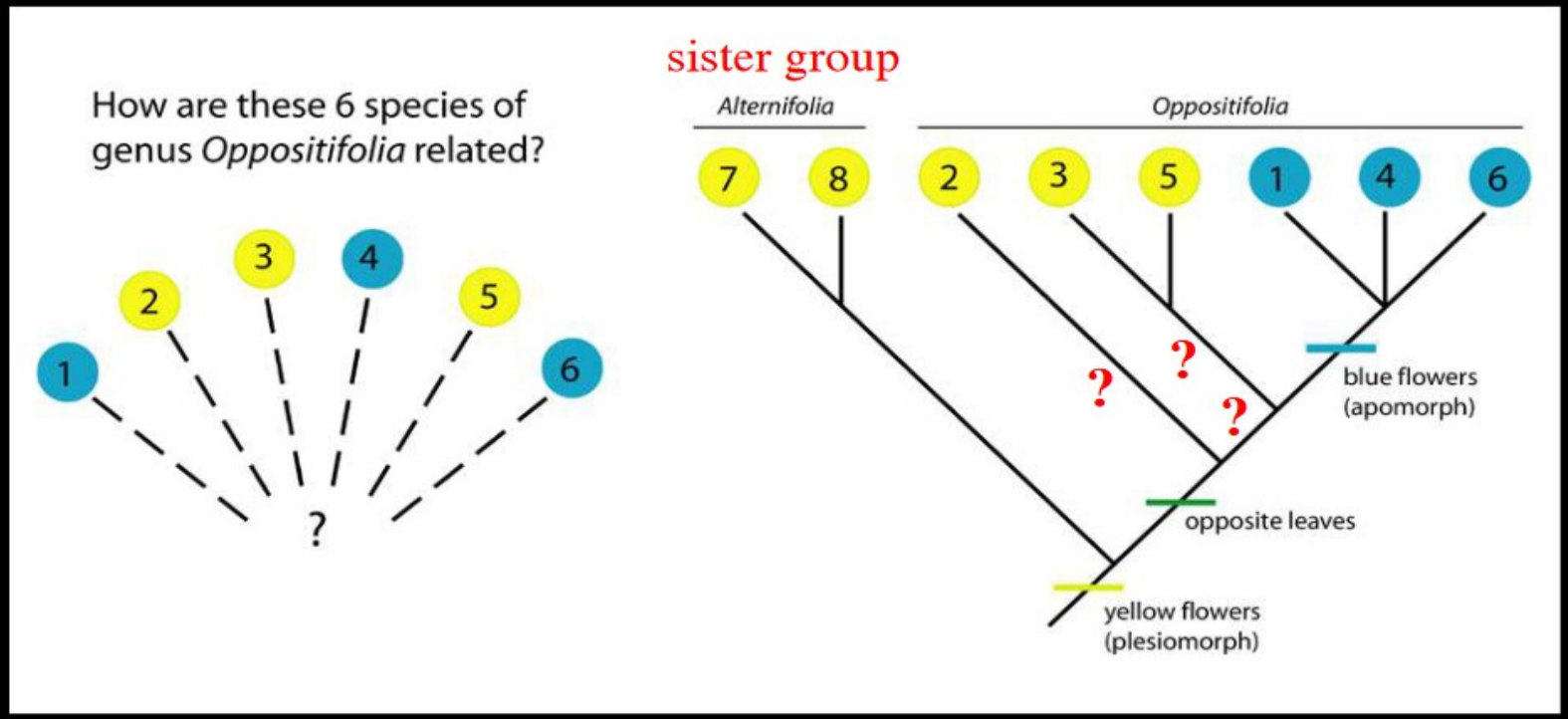
- use outgroups

Use closely related genus *Alternifolia* as outgroup - yellow flowers are primitive or plesiomorphic

Cladistics

Issue #1- ordering or polarizing character states (primitive or derived)

Blue flowers = synapomorph - shared derived state



Cladistics

Primitive 0

Derived 1

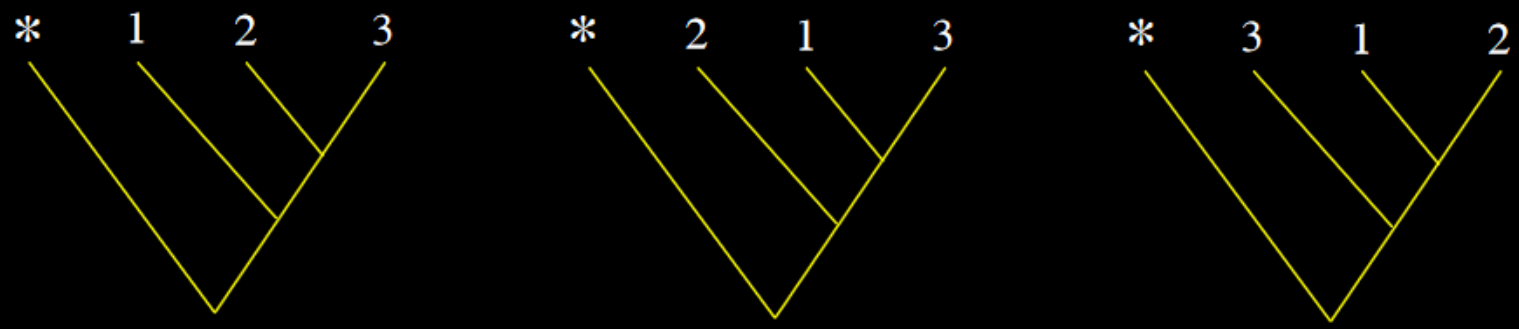
	No vessels - vessels	Apocarpy - syncarpy	Polypetaly - sympetaly	Free stamens - epipetaly	Trees - herbs	Hypogyny - epigyny	beetle poll. - other poll.	Tepals - sepals + peals	Various carpels - bicarpellate	Homostyly - heterostyly
Amborella	0	0	0	0	0	0	0	0	0	0
1. *Magnolia*	1	0	0	0	0	0	0	0	0	0
2. *Nymphaea*	0	0	0	0	1	0	0	0	0	0
3. *Rosa*	1	0	0	0	1	0	1	1	0	0
4. *Primula*	1	1	1	1	1	0	1	1	0	1
5. *Gentiana*	1	1	1	1	1	0	1	1	1	0
6. *Aster*	1	1	1	1	1	1	1	1	1	0

"shared derived" character states

Cladistics

Issue #2 - how do you select the "best" tree?

- with 3 ingroup species and one outgroup (*), there are 3 trees possible

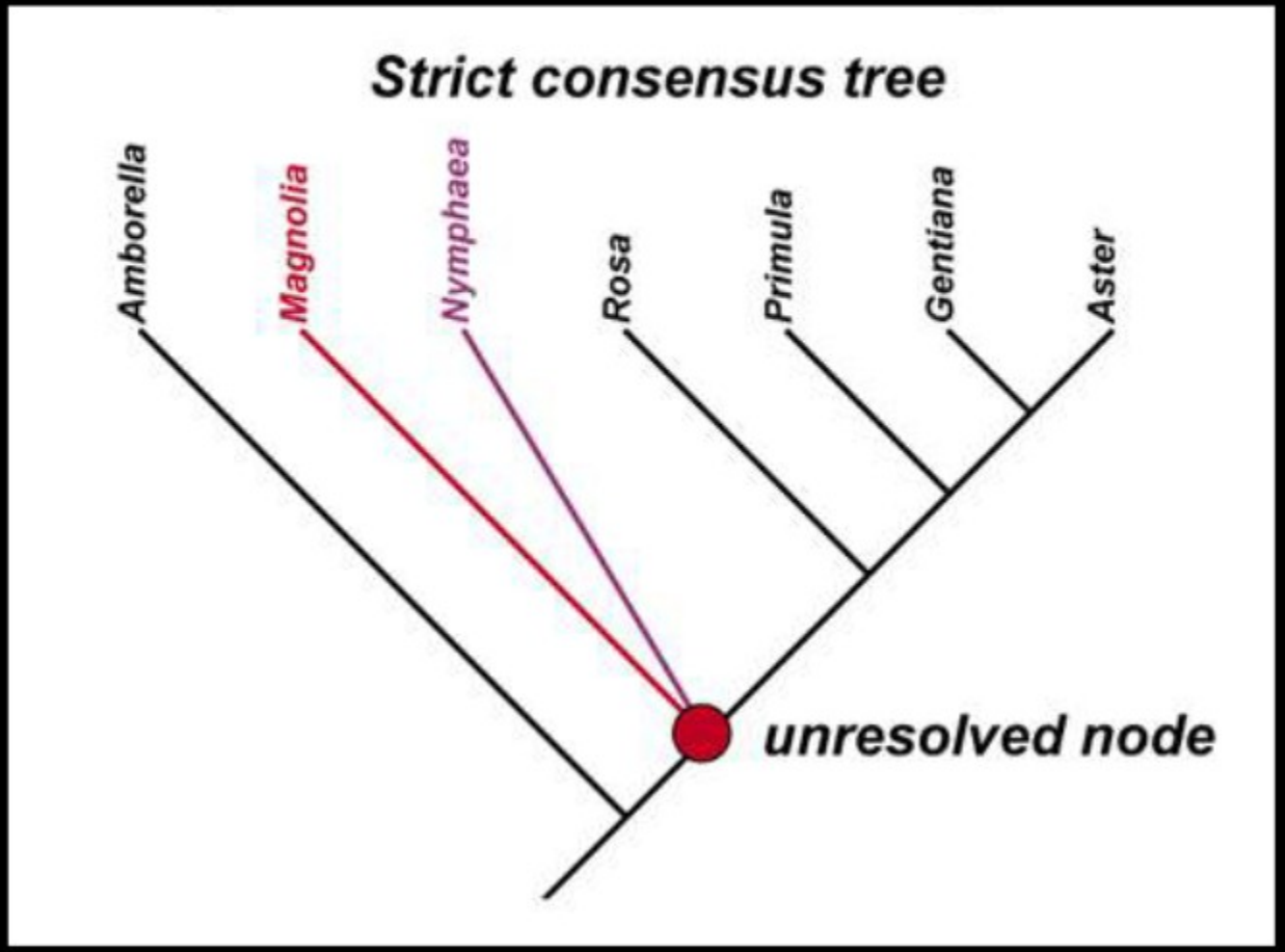


Cladistics

Issue #2 - how do you select the "best" tree?

- in the context of evolution, maximum parsimony = choosing the tree that requires the fewest number of evolutionary changes (apomorphies)
- choose the tree with the least amount of homoplasy - convergences or reversals or character conflict
- choose the shortest, simplest, most efficient tree

- a consensus tree depicts the maximum information possible from all most parsimonious trees (note: not equal to phenogram)



Cladistics

Issue #2 - how do you select the "best" tree?

http://evolution.genetics.washington.edu/phylip/software.html

- 36 of the around 370 phylogenetic software programs available!
- many can be used on about 50 free web servers (including supercomputers or tera-grids)

Phylogenetics

Phylogenetics is the estimation of the "tree" through "time" knowing only the "leaves"