

Cassini tribe Heliantheae (Compositae)

Today an alliance



South American Compositae Meeting
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CASSINI (1819)



“Hélianthées”: New Word Sunflowers - many characters



Helianthus divaricatus

Key characters

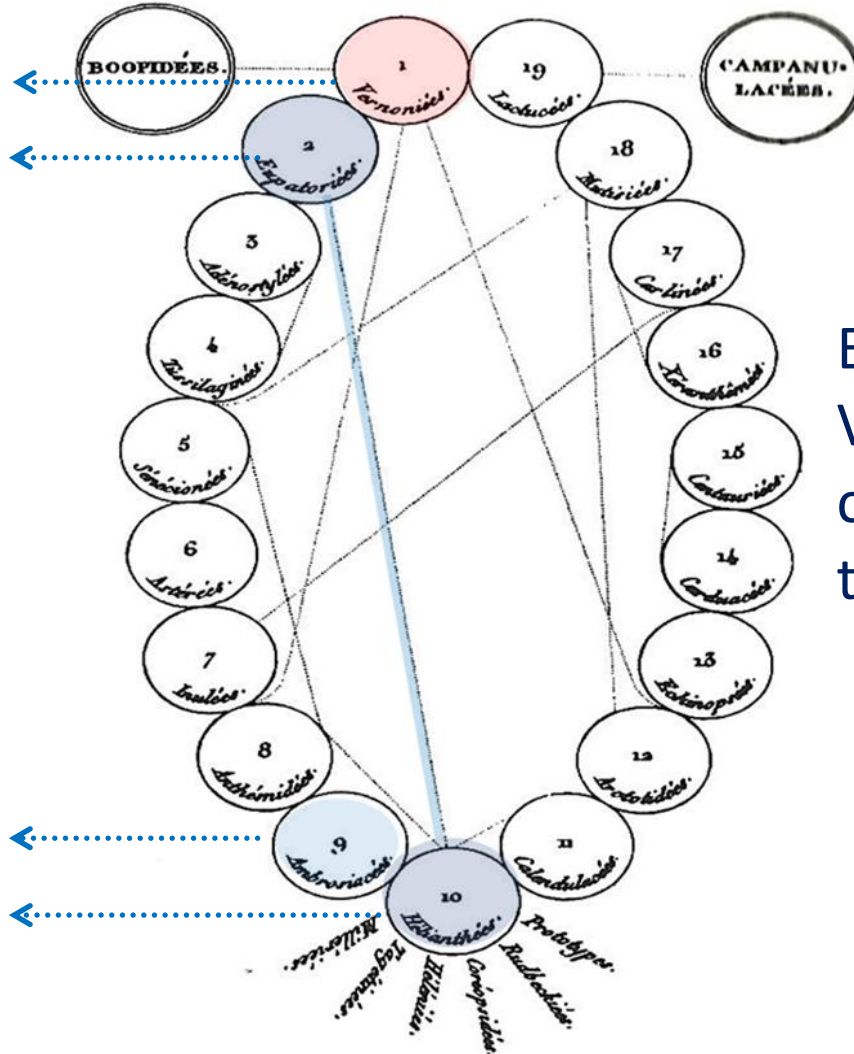
opposite leaves

Yellow flowers

Involucre uni to biseriate

“Synanthérées” – Cassini (1817)

Vernoniées
Eupatoriées

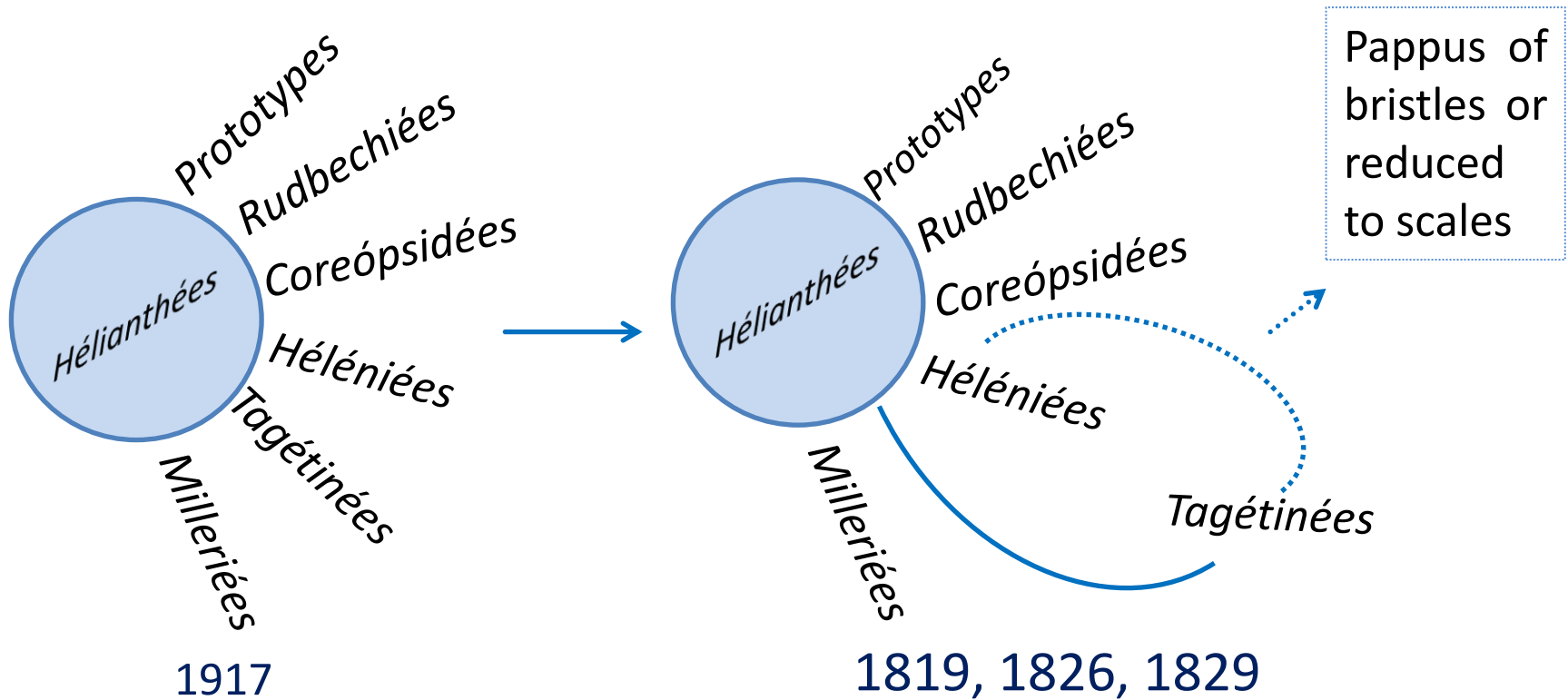


Ambrosiées
Hélianthées

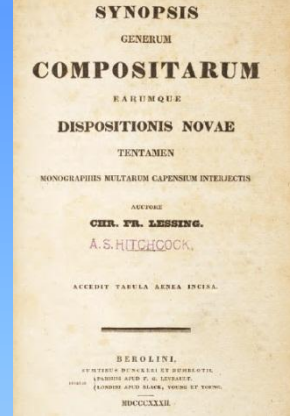
“Affinités”:
Eupatorieae near to
Vernonieae, but with
characters common
to the Heliantheae

Cassini

“Hélianthées” in sections: ovary shape / pappus structure



LESSING (1832)



The most obvious characters

- Helianthées, Ambrosiées e Tagétinées de Cassini: subtribes of “Asteroideae” and “Senecioideae”
- System followed by Candolle (1836) with minor changes



BENTHAM (1873)

Restoring the characteristics employed by Cassini

“Helianthoideae”

Exclusion of groups with epaleate receptacles and with pappus reduced to scales

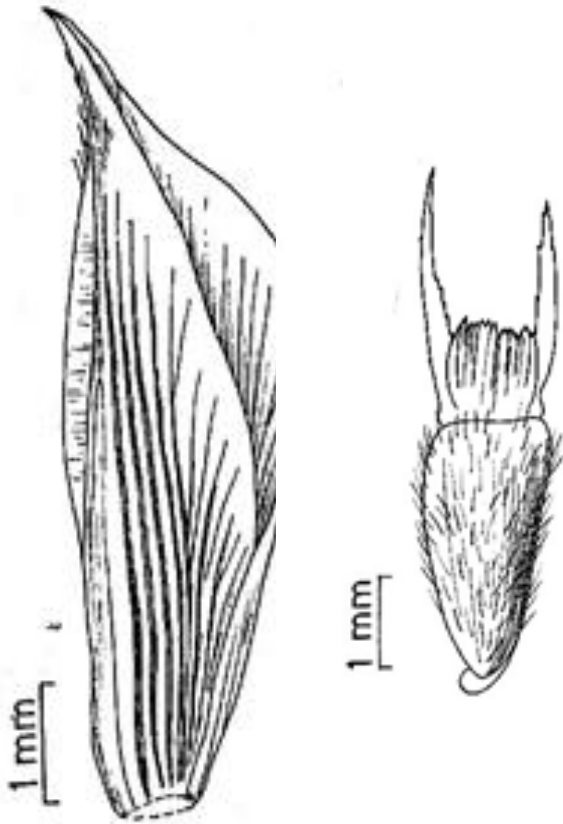
- **Helenoideae** (excluding Tagaetinae), adjacent to Heliantheae:
Helenieae unnatural X natural Heliantheae

Exclusion of genera with bristly pappus

- **Senecionideae**

Helianthoideae

140 genera, 1100 species



Vigiera dentata

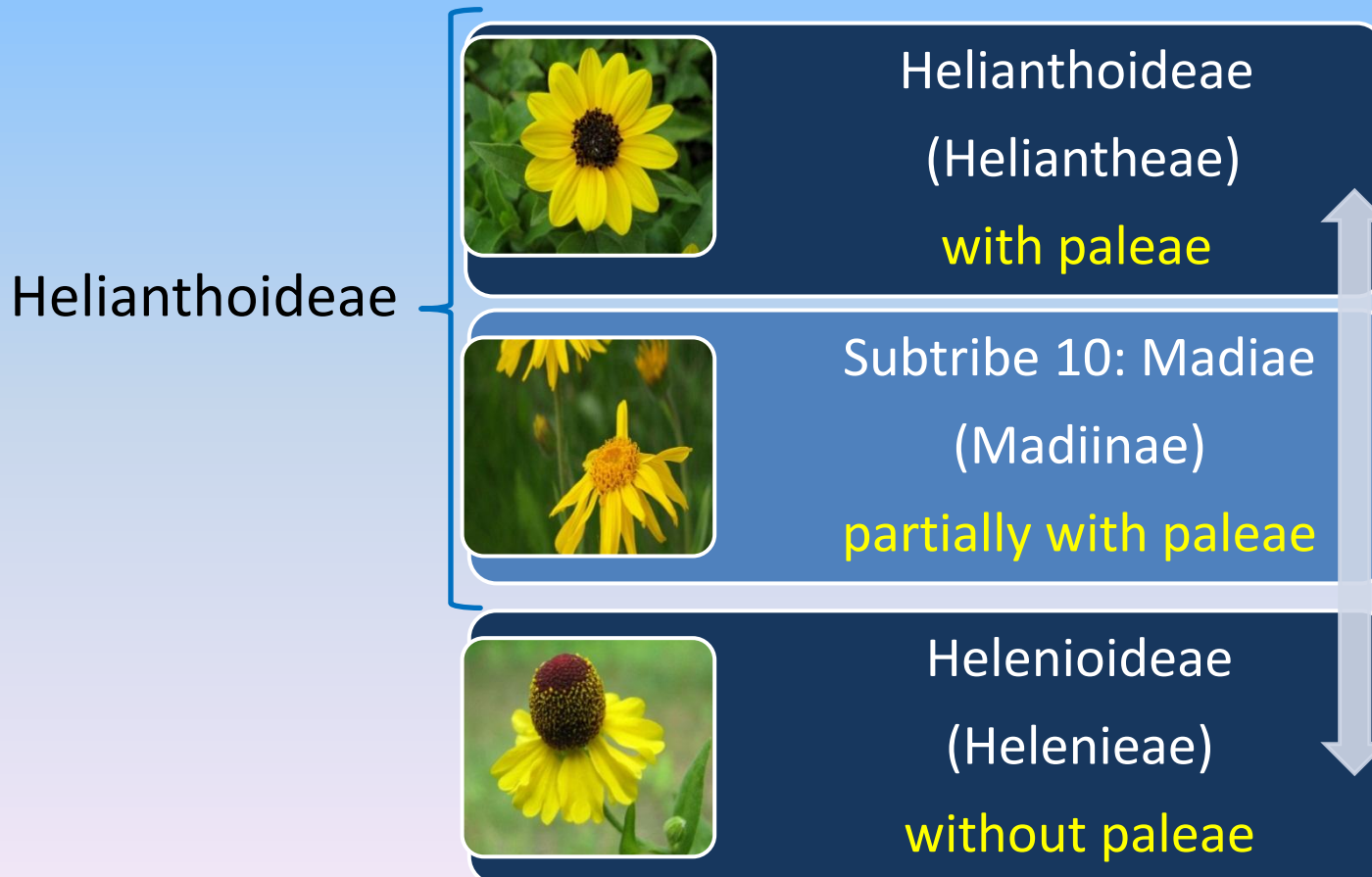
Key characters

- Opposite leaves
- Receptacle with paleae subtending individual florets
- Pappus of a few rigid awns or paleae

HELIANTHOIDEAE

(10 subtribes, Including “Ambrosieae” e “Coreopsideae”)

CONNECTIONS



BENTHAM (1873)

System perpetuated by Hoffmann (1894)

USED FOR MORE THAN A CENTURY

Exception: Helenieae, further treated as part of Heliantheae or other tribes

CRONQUIST (1955, 1977)



- Suggestion to reinclude **Helenieae** in **Heliantheae**



Helienium flexuosum

- Heliantheae pointed out as the **most basal**



Helianthus grosseserratus

oppositae leaves
multiflorous capitula, a few per plant
involucral bracts in many series
yellow corollas



Helianthus annuus

STUESSY (1977)

Symposium on the Biology and Chemistry of the Compositae



Synthesis of Heliantheae

Habit, floral characters and chromosome number

15 subtribes

Dismissed

1. Turner and Powell (1977): tribe Coreopsidae
2. Nordenstam (1977): re-inclusion (provisional) of the taxa without paleae and with pappus of bristles in Heliantheae (Tagaetae Cass. and Helenieae Benth.)

STUESSY (1977)

- Bahiinae and Gaillardinae (Heleniinae of *Helenieae) provisionally in Heliantheae.
- Madiinae in Heliantheae, but connecting with Senecioneae
- Ambrosiinae and Coreopsidinae as subtribes

Cladistic methodology

Evidence

for

relationships

ROBINSON (1981)



Revolutionary review : a large number of characters

- Micro-morphology
- Cytology
- Chemistry

**Significance of
carbonized layer
(phytomelanin)**



ROBINSON (1981)

Primary characters that separate certain groups are inconstant:
recognition of Heliantheae sensu lato

Position of leaves and presence of paleae – minor features

Taxa without paleae
(Senecioneae or Helenieae Bentham)
14 subtribes

*Senecioneae with carbonized cypselae: transferred to Heliantheae

ROBINSON (1981)

- **Madiinae bridges the gap between Heliantheae s.s. and Helenieae**
- Discarding of tribal names Madieae, Coreopsideae, Tagateae and Helenieae

**Heliantheae into 35 subtribes:
260 genera, 3000 species**

ROBINSON (1981)

INULAE

HELIANTHEAE

EUPATORIEAE

Phytomelanin
Base of style with hairs
American distribution

Heterogamous heads

homogamous heads

Polarized thickenings on endothelial cells

Radial thickenings on endothelial cells

Anther appendage with basal constriction

Expanded style appendages



Helianthus



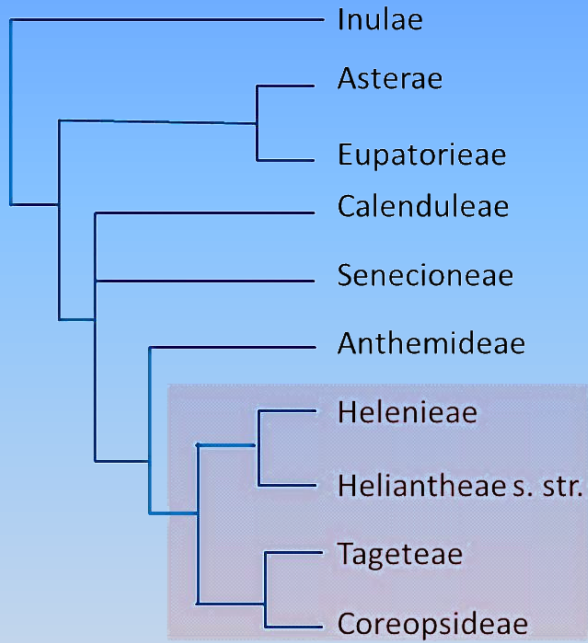
Eupatorium

Ancestral: carbonized achene walls, anther appendages without constricted bases

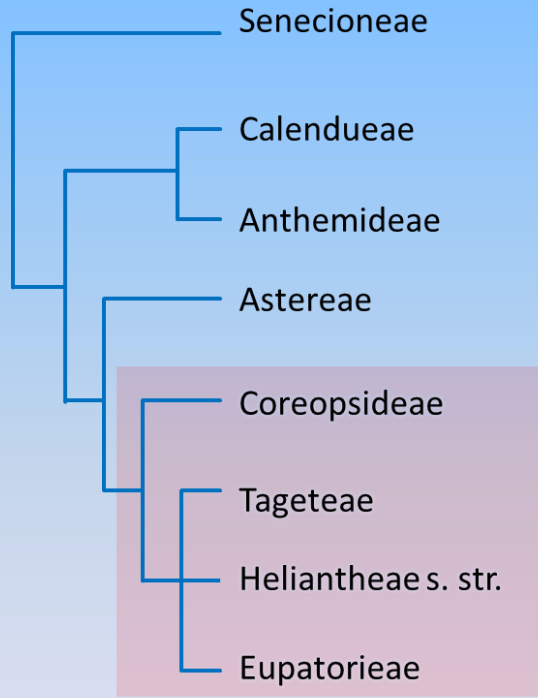
Phylogenetic analysis

Improvement
of Heliantheae alliance
hypotheses

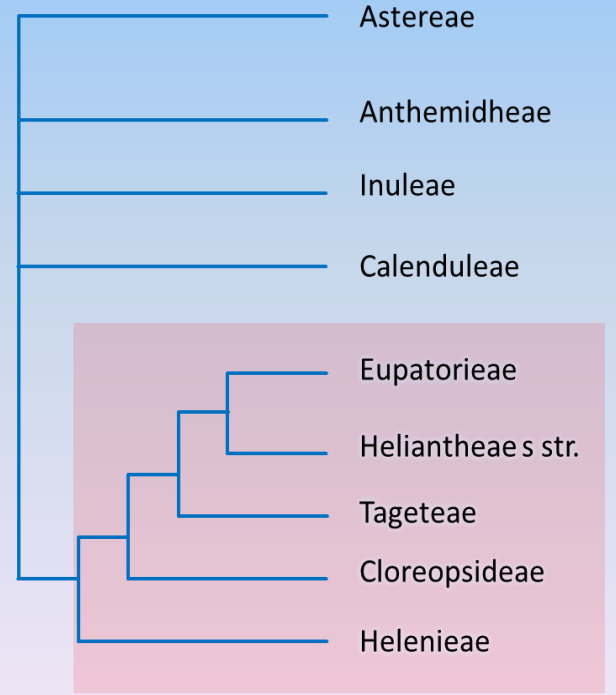
Reduced phylogenetic trees (Bremer *et al.* 1992)



Bremer. (1987): morfol.



Kim *et al.* (1992): rbcL

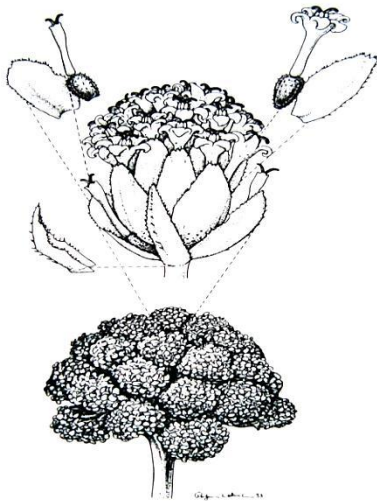


Jansen *et al.* (1990, 1991); Kim *et al.* (1990): cpDNA

KARIS (1993)

morphological data

- Inclusion of *Athroisma* DC. in the analysis



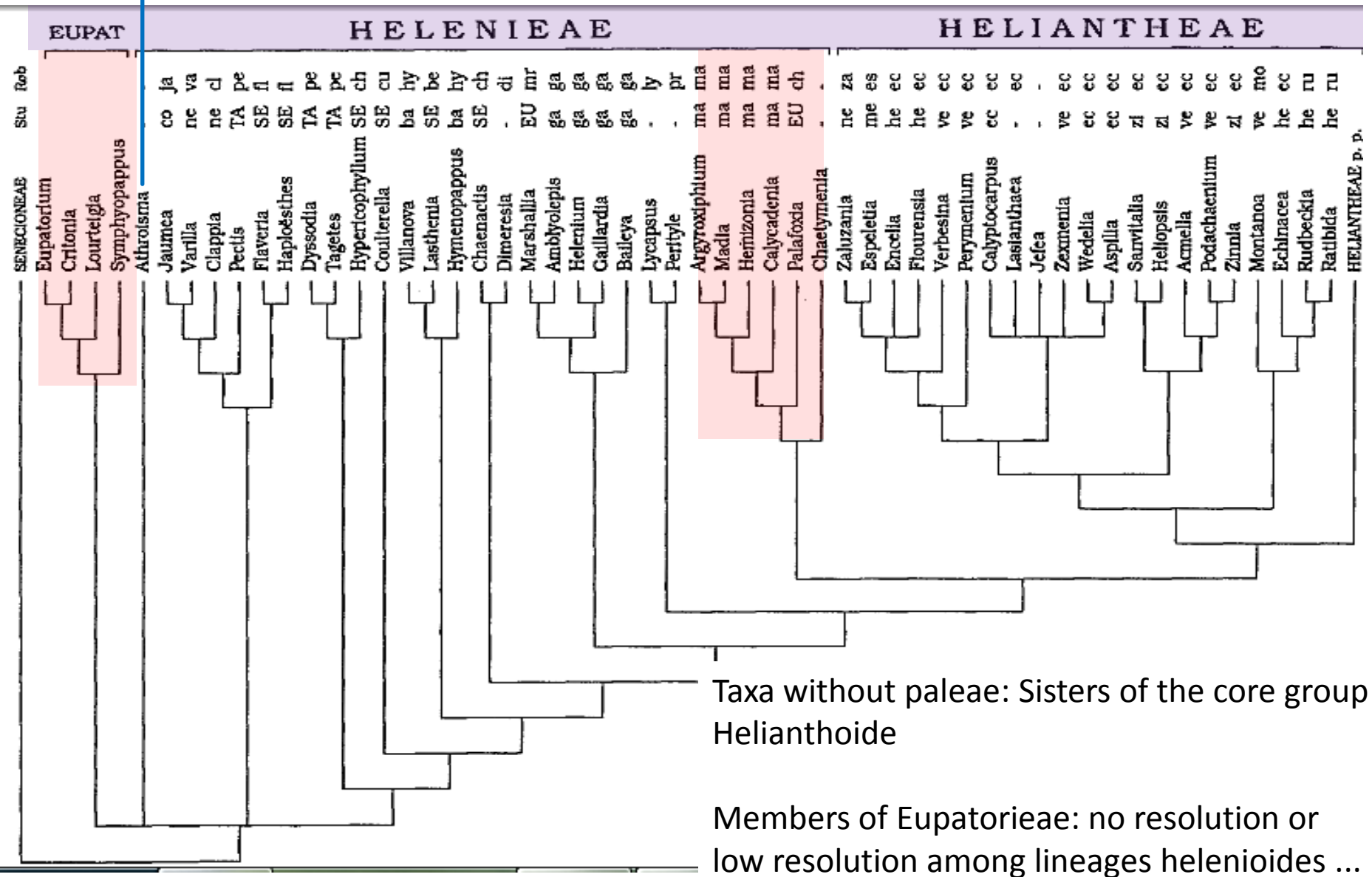
Athroisma latifolium

(Eriksson 1995)

Eriksson (1990, 1991): *Athroisma*,
Blepharispermum e *Leuciblepharis* from
Inulae to Heliantheae (receptacle with
pales and carbonized cypselas)

KARIS (1993)

Athroisma



KARIS (1993)

- Maybe Eupatorieae constitute a sister group of Heliantheae s.l.
- The status of the large Eupatorieae may have to be questioned
- Helenieae must be splitted into smaller units, with some names available: Madieae, Tageteae and Helenieae s.s.

KARIS & RYDING (1994)

Karis (1993) studies formalized

NEW DIVISION: HELIANTHEAE S.S. IN 10 SUBTRIBES

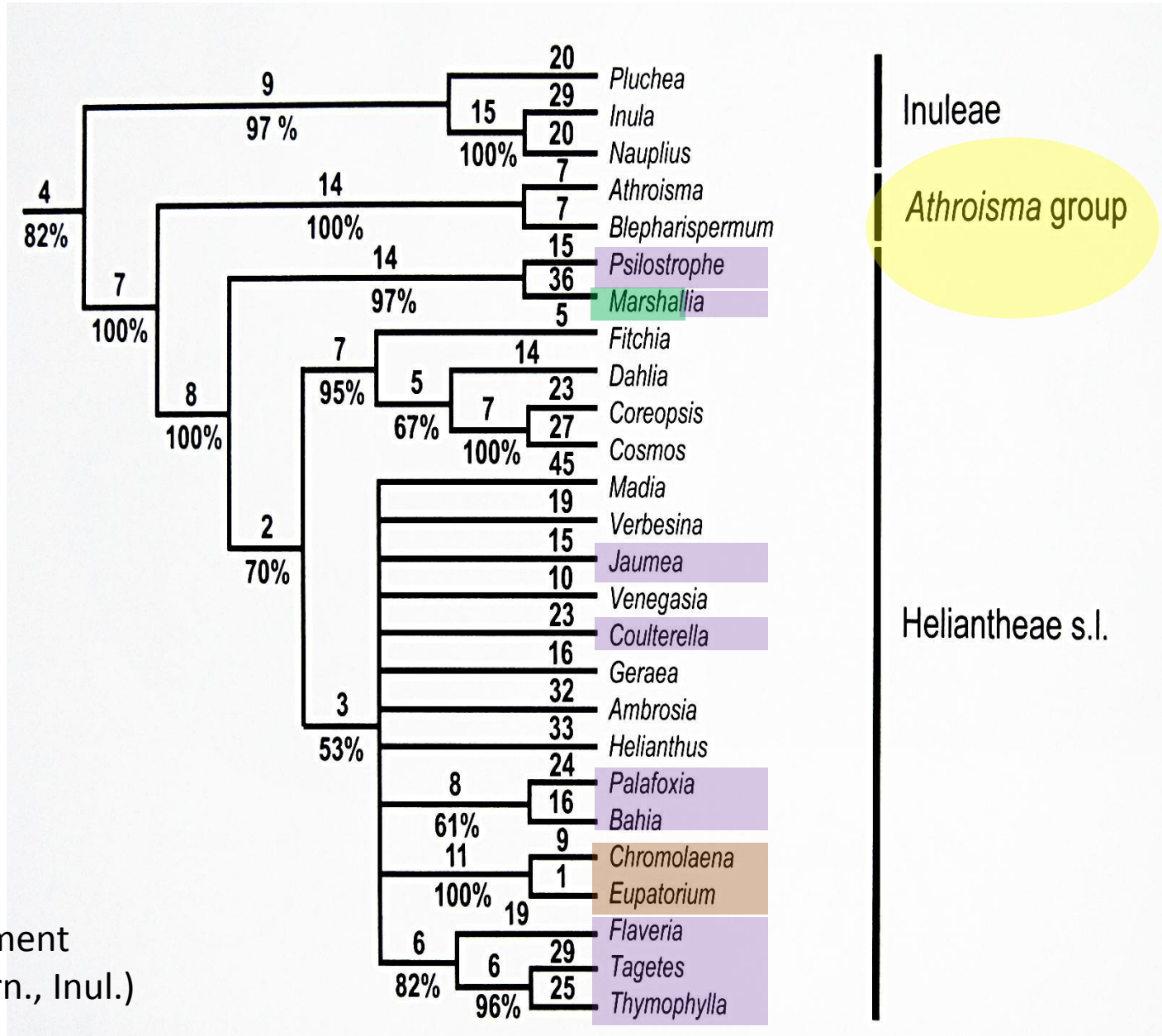
Eupatorieae + *Althroisma*: basal to a series of Helenieae lineages (provisional recognition of the tribe) finishing with a monophyletic Heliantheae s.s.

**NEW
MOLECULAR
STUDIES**

KIM & JANSEN

(1995)

ndhF



Helenieae



Eupatorieae



Difficult placement
(Eup., Hel., Vern., Inul.)

PANERO *et al.* (2001)



1. *Athroisma stuhlmannii*
(*Athroisma* group)



2. *Helenium flexuosum*
(Helenieae)



3. *Eupatorium adenophorum*
(Euparorieae)



4. *Helianthus debilis*
(Heliantheae)

(Heliantheae alliance)

- Images:1. Arne Anderberg (2009)
2. Lisa Brown (2007)
3. Sajam Subedi (2011)
4. Bill Rogers (2008)

BALDWIN *et al.* 2002

Internal Transcribed Spacer (ITS)

- Heliantheae s.s. and Eupatorieae: traditional senses
- Eupatorieae derived from a heleniod lineage; Helenieae s.l. in six tribes: Helenieae s.s., Madieae and Tageteae (expanded), Bahieae, Chaenactideae, and **Perityleae** (new tribes)
- Helenieae s.s.: basal position {
 - without phytomelanin
 - epidermal cells with raphides
 - leaves often in basal rosettes

BALDWIN *et al.* 2002

ITS

- Paleae in Heliantheae s.s. and Madiinae (Helenieae s.l.): homoplasious
- Pappus of bristles or reduced to scales: arisen in various lineages of Heliantheae s.l.

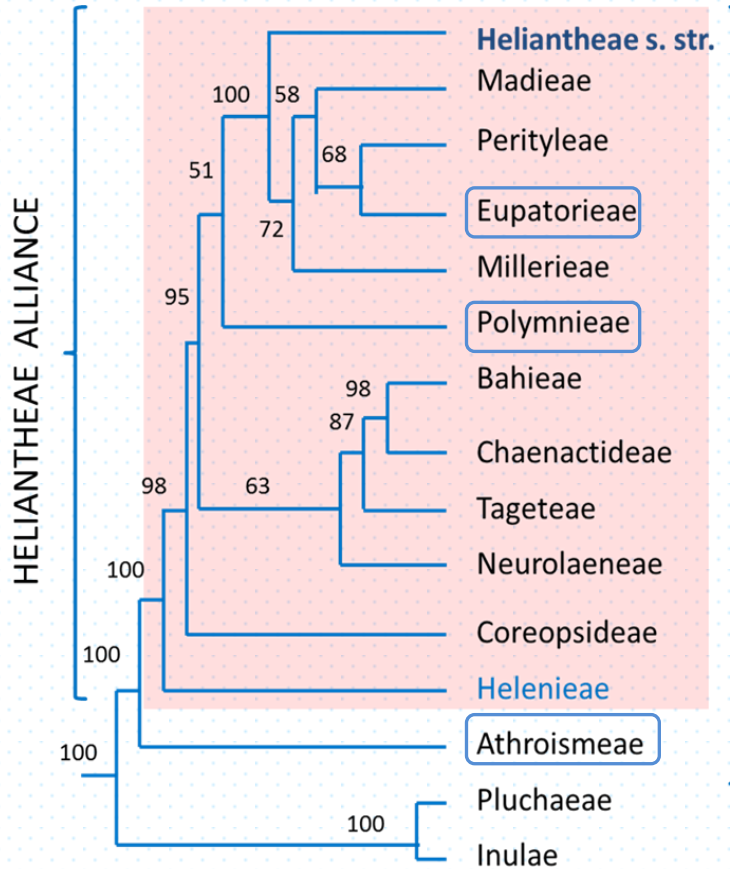
Features received too much weight in previous circumscriptions of suprageneric taxa

HELIANTHEAE ALLIANCE

12 TRIBES

PANERO & FUNK (2002)

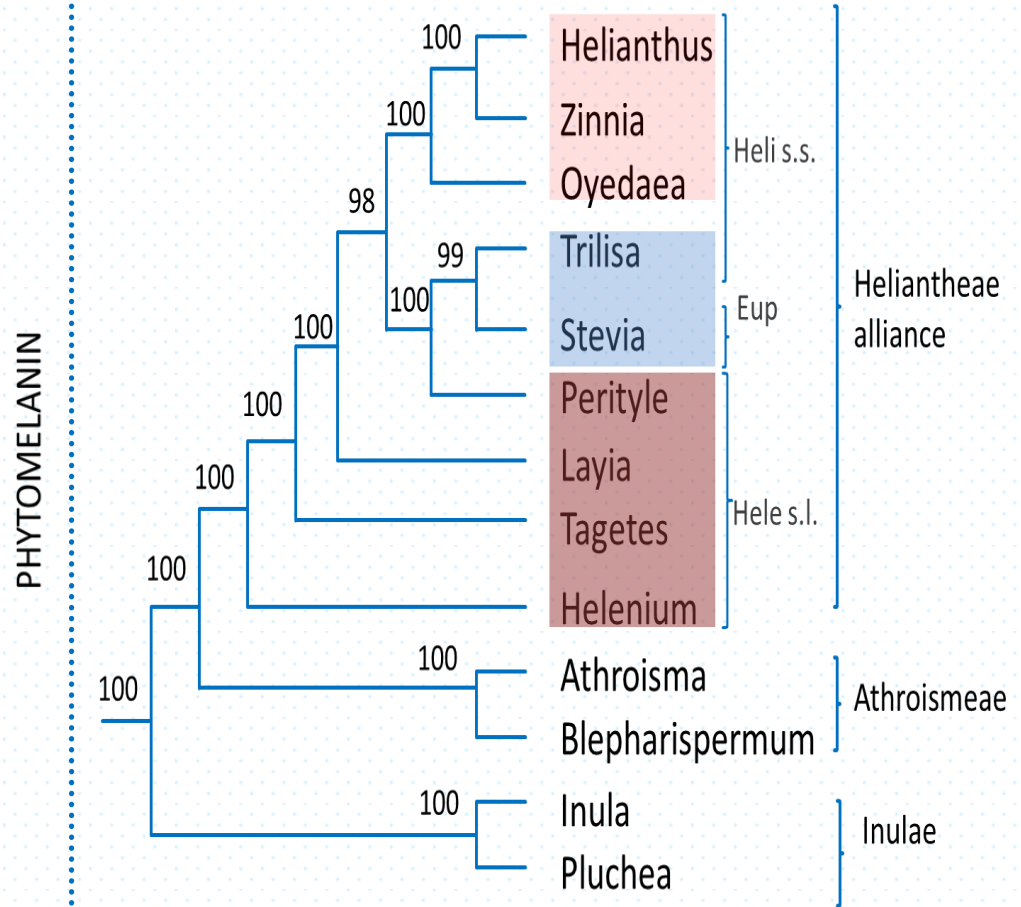
Dna sequence with 10 genes or markers;
matrix of 13.380 pb



SUBTRIBES TO TRIBES

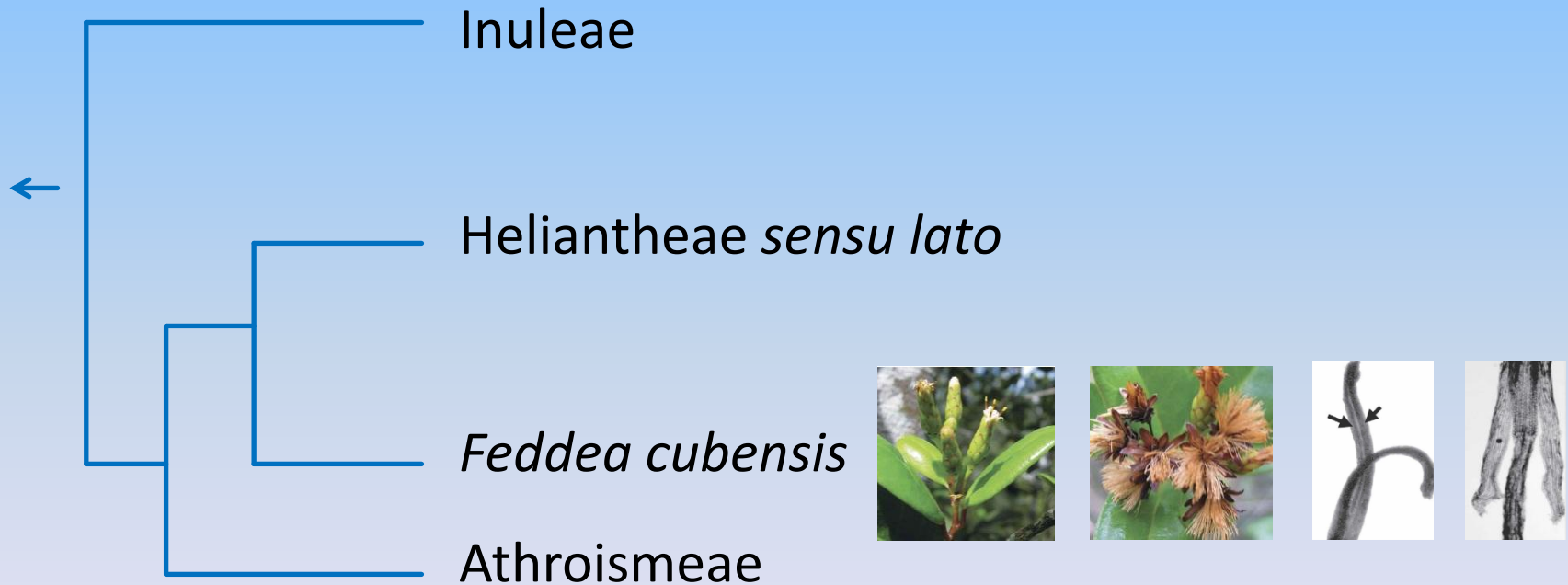
PANERO & FUNK (2008)

combined analyses of 10 cpDNA loci:

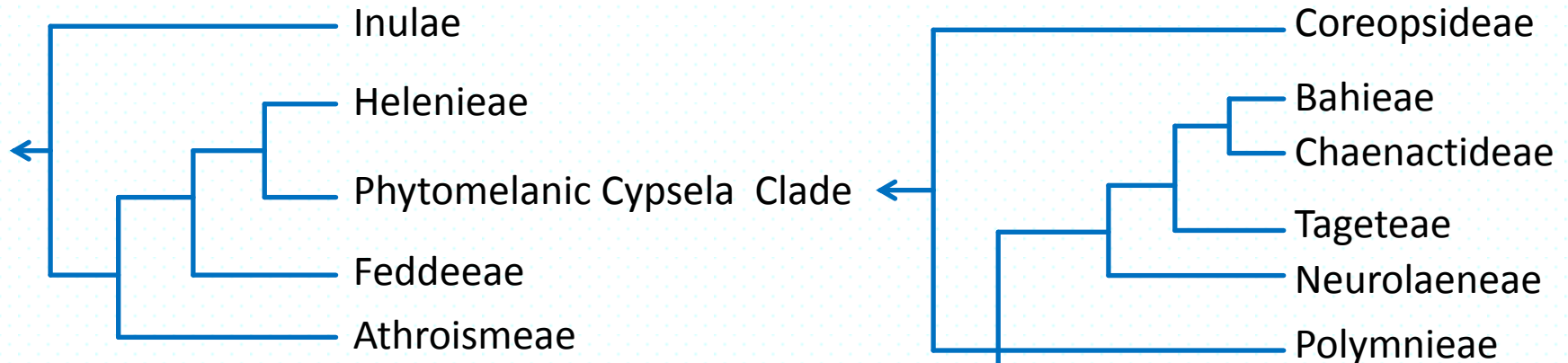


STRONG STATISTICAL SUPPORT

CARIAGA *et al.* (2008)
nucleotides sequences *ndhF*



Supertribe Helianthodae H. Rob (2004)



Cariaga *et al.* (2008) /Panero and Funk (2008)

HELIANTHEAE ALLIANCE: 13 TRIBES
5500 species

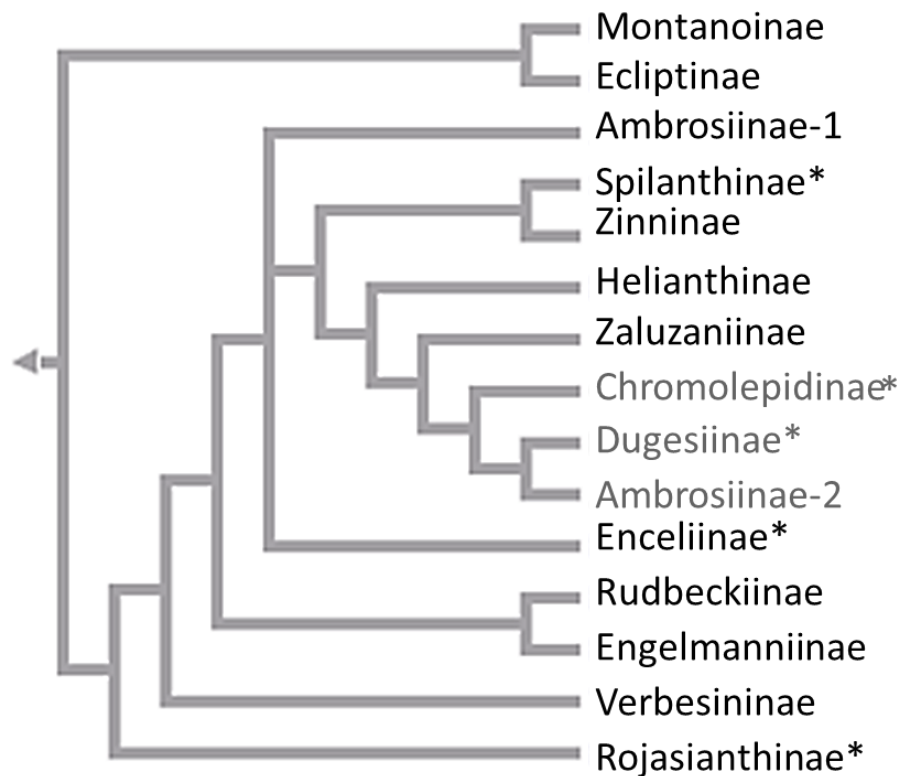
20%-25% of Compositae (Baldwin 2000)

cpDNA Panero (2007)

PANERO (2007) – Heliantheae s.s.

cpDNA: Galinsoginae, Melampodineae and Milleriinae sensu Robinson (1981):
transferred to Millerieae

14 subtribes
13 genera
1500 spp



* New or recent subtribes

Modified from Panero (2008) - Heliantheae s.s. - Tree of Life web project
(<http://tolweb.org/Heliantheae/22924>)

BALDWIN (2009)

HELIANTHEAE ALLIANCE

- Anthers usually blackened with no tail
- styles usually hairy above the bifurcation; mature branches curved
- **Most cypselae with phytomelanin**

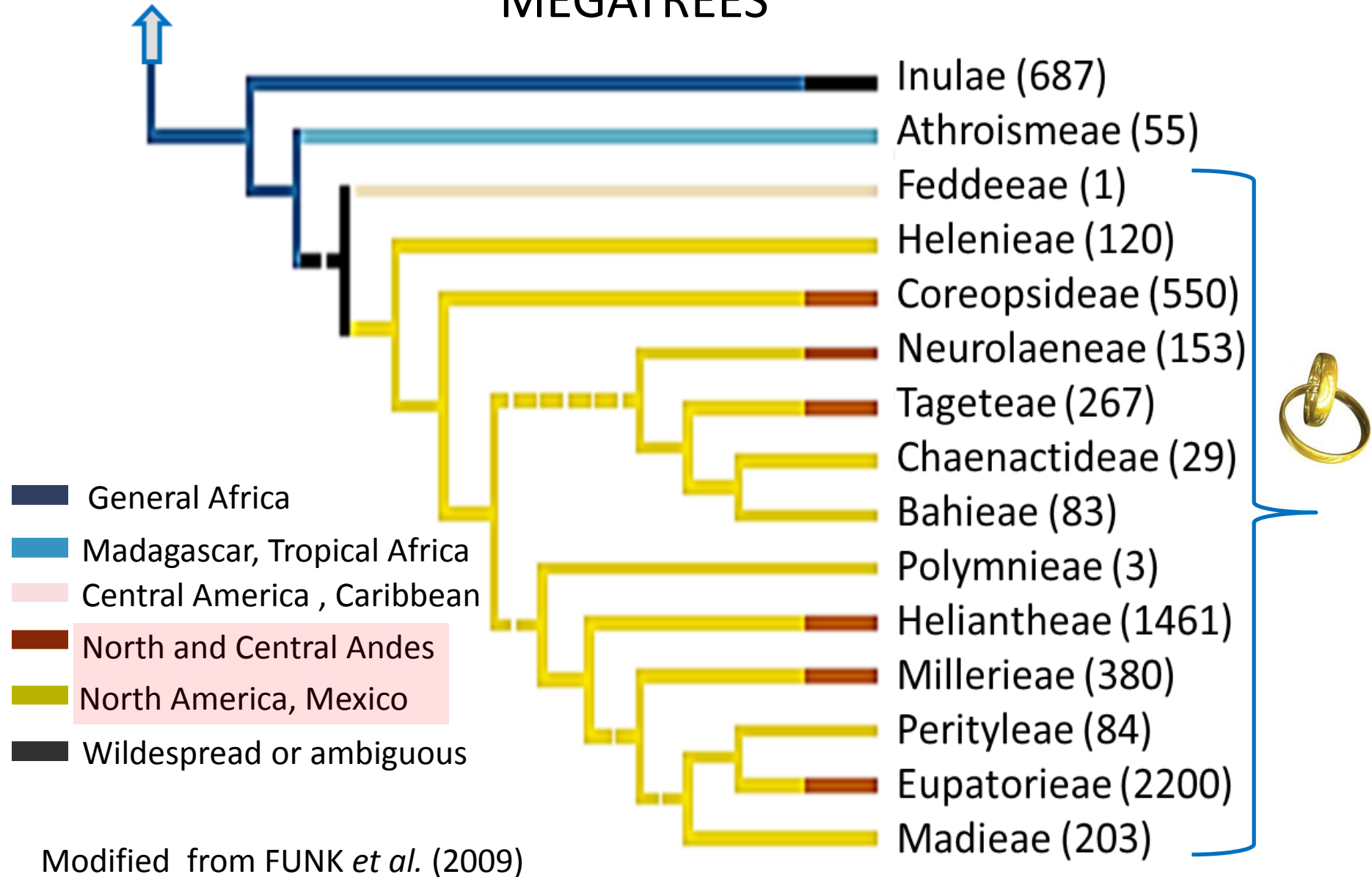
PANERO (2007)

HELIANTHEAE SENSU STRICTO

- Leaves triplinerved
- Receptacle with paleae moderately to strongly conduplicate
- Ray florets with corollas trilobed (sometimes bilobed)
- Cypselas with phytomelanin

FUNK *et al.* (2005, 2009)

MEGATREES



Modified from FUNK *et al.* (2009)

A world map with a topographic and bathymetric appearance. A yellow dashed line with arrowheads at both ends connects the Bering Strait region between Asia and North America to the Feddea region on the northern coast of South America. The Feddea region is circled in yellow. The map includes labels for major continents: ASIA, NORTH AMERICA, SOUTH AMERICA, AFRICA, EUROPE, and ANTARCTICA. Oceanic features like the Bering Sea, Chukchi Sea, and various basins are also labeled.

Bering land-bridge
(Panero & Funk 2005)

Feddea

With the Cuban Feddea at the base of Heliantheae alliance: a direct dispersal must be taken seriously (Panero 2007, Funk 2009)



THANK YOU VERY
MUCH!

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