ANGIOSPERMS: The flowering plants

A chart of flowering plant families

This chart depicts a phylogeny of all existing flowering plants. The disks represent families (suffix -aceae) of plants. Groups of related families are indicated by a hierarchy of regions. Some of these groups are named. Insets below explain how to interpret the chart and describe the information associated with each family.

For more than 250 years, families of flowering plants and relationships between families were determined primarily by morphology (the structure, shape and number of plant parts). Since the early 1990s, genetic information has become available and now the affinity of species, genera and families is based primarily on this molecular evidence. The previous morphological classifications were, to some extent, supported by the molecular analysis. However, major changes have been necessary both to the circumscription of some families and to the placement of families relative to each other and to the corresponding higher groupings.

This chart is based on the work of the Angiosperm Phylogeny Group (see the sources listed below), updated with more recent evidence as it becomes available. It depicts a phylogenetic tree in terms of a hierarchical grouping of families. Many of these placements are now well-established, but uncertainties remain - these we have tried to indicate on the chart (see the inset below for details).

The aim of the chart is to present some of the exciting recent work in plant phylogeny in an attractive and easily assimilable form and, at the same time, to provide a map of flowering plant families with brief notes on each family. We hope that this will provide a useful resource. Conservation of all biodiversity is both highly important and urgent. Many of the plant species of great significance in phylogeny are particularly endangered.

Amborella trichopoda: An isolated species, sister to all other flowering plants.

NYMPHAEALES Aquatics of diverse flower structure whose origins appear to lie early in the history of flowering plants. (1) highly anomalous in characters.

MAGNOLIIDS

MAGNOLIALES

LAURALES

PIPERALES

CANELLALES

Position unclear, possibly sister to the Magnoliids.

ALISMATALES Mainly families of aquatic plants, except (1) and (2), with the only truly marine flowering plants. (3) includes Lilaceae.

AUSTRO-BAILEYALES

PANDANALES

LILIALES

DIOSCOREALES

COMMELINALES

ZINGIBERALES

ASPARAGALES Position of (1) uncertain. (2) includes Asphodelaceae and Hemerocallidaceae, (3) Amaryllidaceae and Agapanthaceae, and (4) Agavaceae, Aphyllanthaceae, Hyacinthaceae, Laxmanniaceae, Themidaceae and Ruscaceae.

Position uncertain

Position uncertain, possibly sister to the Eudicots.

Age: 125 Mya (tricolpate pollen appears).

EUDICOTS

CORE EUDICOTS

RANUNCULALES

PROTEALES

BUXALES

GUNNERALES

GERANIALES (1) includes Hypseocharis, (2) Fraco-aceae and Greyia, (3) Rhynchothecа.

ZYGOPHYLLALES

CELASTRALES

MALPIGHIALES Plants of varied habitat, including an important component of tropical rainforest understorey. (1) includes Turneraceae, Malesherbiaceae and Medusandraceae, (2) Dichapetalaceae, Euphorbiaceae and Trigoniaceae, (3) Hugoniaceae, (4) Medusagyne and Quiinaceae, (5) Erythroxylaceae, (6) Scyphostegiaceae, (7) Rhizophoraceae, (8) possibly embedded in (9). Family relationships mostly weakly supported or unresolved.

SAXIFRAGALES (1) includes Penthorum and Tetracarpaea.

SANTALALES (1) includes Viscaceae and Eremolepidaceae. Family limits unclear, especially (2), (3) position uncertain.

CROSSOSOMATALES Possibly close to Malvids.

BERBERIDOPSIDALES

MYRTALES (1) includes Heteropyxidaceae and Psiloxylaceae, (2) Memecylaceae.

OXALIDALES

FAGALES

CUCURBITALES

FABIDS Relationship between some orders, especially near Rosales, is unclear.

Some families are possibly associated with Normapolles-type pollen, originating 98-94 Mya.

ROSALES (1) includes Cecropiaceae, (2) Celtidaceae.

FABALES

ROSIDS

ASTERIDS

CARYOPHYLLALES Evidence suggests sister to Asterids. Possibly related to Dilleniaceae. (1) includes Chenopodiaceae. (2) ,(3) and (4) may be dismantled. (2) includes Montiaceae and Talinaceae. (3) includes Giseкia, Agdestis and Petiveria.

CORNALES Family relationships, unclear. (1) enigmatic genus of uncertain position. (2) includes Alangium.

EUASTERIDS

LAMIIDS

GARRYALES

GENTIANALES (1) includes Asclepiadaceae, (2) Dialypetalanthaceae.

LAMIALES Family limits and relationships unclear, even those indicated. (1) includes Buddlejaceae and Myoporaceae, (2) Avicenniaceae, and (3) Nesogenaceae.

SOLANALES (1) includes Nolanaceae, Goetzeaceae, and Duckeodendraceae.

APIALES (1) includes Araliaceae, Melanophyllaceae, (2) Mackinlayaceae.

DIPSACALES (1) includes Linnaeaceae, Diervillaceae, Morinaceae, Dipsacaceae and Valerianaceae.

(A) and (B) positions uncertain. (A) includes Hydrophyllaceae.

(1) includes Desfontainia.

CAMPANULIDS Internal relationships need further resolution.

AQUIFOLIALES

ASTERALES (1) includes Donatiaceae.

MALVIDS Relationship of orders tentative.

SAPINDALES (1) includes Aceraceae and Hippocastanaceae.

HUERTEALES

MALVALES (1) includes Tiliaceae, Sterculiaceae and Bombacaceae, (2) Tepuianthus, and (3) Cochlospermaceae and Diegodendraceae. Family relationships remain unclear, especially (4).

BRASSICALES (1) includes Bretschneidera, (2) Oleomaceae and Capparaceae.

MONOCOTS Relationship with Magnoliids and Eudicots: possibly sister to Eudicots.

POALES (1) includes Sparganiaceae.

COMMELINIDS Relationship of orders uncertain.

Age: 60-55 Mya (grass pollen).

Position uncertain

INTERPRETING THE CHART

The chart corresponds to a phylogenetic tree. Regions on the chart, delimited by boundaries or shaded areas, correspond to nodes in a tree, and families, as disks on the chart, are leaves of the tree. In trees, proximity of two families is represented by the depth of the root of the smallest subtree containing the two families. Here it is represented by a shared region. Proximity does not cross boundaries: families close on the chart but separated by a boundary are no closer than their common region indicates. Boundaries are depicted with varying styles and colours - this is merely to aid the eye and has no phylogenetic significance. Sometimes, two families adjoin. In this case, they may alternatively be considered as one family with the name in bold.

Uncertainties: Many of the placements of families are now well-established. However, uncertainties remain. The chart is *not* intended to be a resolution of these. Where evidence is poor, we have either (a) left relationships unresolved (as a 'polytomy'), or (b) chosen the best supported on current evidence, or (c) indicated alternative placements. As new evidence appears, new versions of the chart will be published.

Nomenclature: A classification would normally allocate names to groups ('taxa') in a hierarchy in a systematic way, e.g. collecting all families into orders (naming them with suffix '-ales'). We have not done this here, although (with much invention of names) it could be done. Instead, we name only those group where a name has proved useful to identify a group, e.g. Monocots, Asterids, etc. and names of orders. This follows recent practice in plant phylogeny.

Statistics: There are 388 families of flowering plants in the phylogeny depicted here, approximately ???? genera and ?????? species. The predominence of the tropics in flowering plant diversity is evident, as is the role of certain areas amongst whose endemics are species which are highly significant or anomalous in phylogeny. Such areas are concentrated in the tropics and substropics, but also include isolated Gondwanaland fragments and areas of diversity in the North temperate zone.

SOURCES

The chart is based on 'APG II':
Angiosperm Phylogeny Group. 2003. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants. *Botanical Journal of the Linnean Society*. 141:399-436.
More recent developments and considerable detail are based on:
Soltis. E.S., Soltis,P.S., Endress, P.K. and Chase, M.W. *Phylogeny and Evolution of Angiosperms*. Sinauer Associates, Sunderland. 2005.
The Angiosperm Phylogeny Website of P. F. Stevens (2001) at http://www.mobot.org/MOBOT/research/APweb
is a valuable and detailed resource which is updated when new results become available. It should be consulted for details of the families and relationships on this chart. In addition, many published papers in the area have been consulted. This chart was designed by David E. Rydeheard (2009). It is available from the website http://www.cs.manchester.ac.uk/flora, which will be updated as new evidence appears. The chart was prepared using Framemaker™.

UNPLACED

1:2 Cynomoriaceae Root parasites Med-C As

Possibly in Saxifragales, though evidence is equivocal.

1:2 Hoplestigmataceae WC Af Trees

Unplaced genera:

FAMILY KEY

Approx. number of genera :
Approx. number of species
Family name
Some plants and products
Distribution
Range of growth forms

90:2520 **Rosaceae** Rose,Strawberry, Cherry, Bramble, Apple, Spiraea, etc Cosmopolitan, *N temperate* Herbs, trees, shrubs

The size of the disk indicates the number of species in ranges:
1-10
10-100
100-1000
1000-10000
10000+

Phrases in italics are to be read as 'mainly/predominantly' and include 'centres of distribution'. (Sub)tropics = tropics and subtropics. NSEW=North/South/East/West, C=Central, SE Asia includes the islands between mainland Asia and Austr. C Am includes the Caribbean islands. OW=Old World.

Designed by David E. Rydeheard, University of Manchester, UK.
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