

ANGIOSPERM CLASSIFICATION

The classification of angiosperms is still very controversial, and two schemes are presented here – the first (B&H) as a means to LEARNING the families, the second (APG) as a presentation of the rudiments of an agreed EVOLUTIONARY TREE.

Historically a number of schemes have been produced. Bentham & Hooker's *Genera Plantarum* (1862-1883) – comprising 200 families and 7,569 genera – pre-dated the publication of Charles Darwin's *Origin of Species*, so this is essentially a non-evolutionary scheme. However, the arrangement of families was based on characters which provided a sequence from what they took as the most primitive to the most derived families – the *Scalae Naturae*. The classification was based on few, essential characters, and as a result is highly predictive – examination of these characters will place an unknown specimen into a particular category.

The Angiosperm Phylogeny Group (APG): Systematic research over the past 150 years has changed our view of plant classification, especially in the last 10 years, when major advances in DNA sequencing have provided a completely new avenue of approach. Numerous classifications and schemes have been published: Hutchinson (328 families), Cronquist (388), Takhtajan (592) Dahlgren (477), Thorne (454) Brummitt (445), and Reveal (612), each differ in the recognition of families and the overall scheme. As a result, families, orders and sub-classes are not comparable between any of these systems. Molecular studies are by no means final, and, contrary to what many reference books and journals might imply, a modern synthesis is far from stabilised. However, a consensus is now beginning to emerge. The combined work of many scientists under an umbrella grouping known as the Angiosperm Phylogeny Group (APG) has produced the rudiments of an agreed evolutionary tree.

BENTHAM & HOOKER CLASSIFICATION

1. DICOTYLEDONS – 2 cotyledons, Exogenous growth.

1.1. POLYPETALAE – *petals separate*

1) THALAMIFLORAE – Sepals, Petals and Stamens all attached to receptacle.

a) Ranales – Gynoecium apocarpous.

1. RANUNCULACEAE; 2. DILLENIACEAE; 3. CALYCANTHACEAE;

4. MAGNOLIACEAE; 5. ANNONACEAE; 6. MENISPERMACEAE; 7. BERBERIDACEAE;

8. NYMPHACEAE.

b) Parietales – Parietal placentation. [NOT Natural. Convergent evolution:

Papaveraceae close to Ranales; remainder scattered amongst Rosids]

9. SARRACENIACEAE; 10. PAPAVERACEAE; 11. CRUCIFERAE; 12. CAPPARACEAE;

13. RESEDACEAE; 14. CISTACEAE; 15. VIOLACEAE; 16. CANELLACEAE;

17. BIXACEAE.

c) Polygalineae – Ovary 2-3 septate.

18. PITTOSPORACEAE; 19. TREMANDRACEAE; 20. POLYGALACEAE.

d) Caryophyllineae – Axile placentation.

21. FRANKENIACEAE; 22. CARYOPHYLLACEAE; 23. PORTULACACEAE;

24. TAMARICACEAE.

e) Guttiferales – Stamens numerous; Calyx imbricate.

25. ELATINACEAE; 26. HYPERICACEAE; 27. GUTTIFERAE; 28. THEACEAE;

29. DIPTEROCARPACEAE; 30. SARCOLAENACEAE.

f) Malvales – Stamens numerous; Calyx valvate.

31. MALVACEAE; 32. STERCULIACEAE; 33. TILIACEAE.

2) DISCIFLORAE – Ovary superior, immersed in disk of flower.

a) Geraniales – Ovule pendulous, raphe ventral.

34. LINACEAE; 35. HUMIRIACEAE; 36. MALPIGHIACEAE; 37. ZYGOPHYLLACEAE;

38. GERANIACEAE; 39. RUTACEAE; 40. SIMAROUBACEAE; 41. OCHNACEAE;

42. BURSERACEAE; 43. MELIACEAE; 44. DICHAPETALACEAE.

- b) Olacales – Ovule pendulous, raphe dorsal.
45. OLACACEAE; 46. AQUIFOLIACEAE.
- c) Celastrales – Ovule erect, raphe ventral.
47. CELASTRACEAE; 48. STACKHOUSIACEAE; 49. RHAMNACEAE; 50. VITACEAE.
- d) Sapindales – Ovule ascending, raphe ventral to reversed.
51. SAPINDACEAE; 52. MELIOSMACEAE (=Sabiaceae); 53. ANACARDIACEAE;
54. CORIARIACEAE; 55. MORINGACEAE.

3) CALYCIFLORAE – Stamens fused to Calyx of flower

- a) Rosales – Ovaries separate, rarely united. [NOT Natural: Saxifragales as Eudicots, Eurosids I, some Asterids]
56. CONNARACEAE; 57. LEGUMINOSAE; 58. ROSACEAE; 59. SAXIFRAGACEAE;
60. CRASSULACEAE; 61. DROSERACEAE; 62. HAMAMELIDACEAE; 63. BRUNIACEAE;
64. HALORAGACEAE.
- b) Myrtales – Ovary syncarpous; divided into locules.[still form a natural group at the base of the Rosids]
65. RHIZOPHORACEAE; 66. COMBRETACEAE; 67. MYRTACEAE;
68. MELASTOMATAACEAE; 69. LYTHRACEAE; 70. ONAGRACEAE.
- c) Passiflorales – Ovary syncarpous; Parietal placentation [more or less natural in the Eurosids I]
72. LOASACEAE; 73. TURNERACEAE; 74. PASSIFLORACEAE; 75. CUCURBITACEAE;
76. BEGONIACEAE; 77. DATISCEAE.
- d) Ficoidales – Ovary syncarpous; sub-basal placentation [the basal placentation is critical in placing these families among the Caryophyllids]
78. CACTACEAE; 79. AIZOACEAE.
- e) Umbellales – Ovary syncarpous; 1 ovule per locule. [not wholly natural; these families belong amongst the basal Asterids]
80. UMBELLIFERAE; 81. ARALIACEAE; 82. CORNACEAE.

1.2. GAMOPETALAE – petals fused

1) INFERRAE – Ovary inferior; stamen no. = petal no.

- a) Rubiales – Stamens epipetalous; locules 2-many; ovules 1-many.
83. CAPRIFOLIACEAE; 84. RUBIACEAE.
- b) Asterales – Stamens epipetalous; locule 1; ovule 1.
85. VALERIANACEAE; 86. DIPSACACEAE; 87. CALYCERACEAE; 88. COMPOSITAE.
- c) Campanulales – Stamens free; locules 2-6; ovules many.
89. STYLIDACEAE; 90. GOODENIACEAE; 91. CAMPANULACEAE.

2) HETEROMERAE – Ovary superior; stamens opposite petals or double the petal no.

- a) Ericales – Stamens double petal no.; Ovary 2-many locules.
93. ERICACEAE; 93. CLETHRACEAE; 95. EPACRIDACEAE (=Ericaceae);
96. DIAPENSIACEAE; 97. LENNOACEAE (=Boraginaceae).
- b) Primulales – Stamens opposite petals; Ovary 1-locule; Axile placentation.
98. PLUMBAGINACEAE; 99. PRIMULACEAE; 100. MYRSINACEAE.
- c) Ebenales – Stamens opposite petals; Few large seeds.
101. SAPOTACEAE; 102. EBENACEAE; 103. STYRACACEAE.

3) BICARPELLATAE – Ovary superior, with 2 carpels.

- a) Gentianales – Corolla regular; leaves opposite.
104. OLEACEAE; 105. SALVADORACEAE; 106. APOCYNACEAE;
107. ASCLEPIADACEAE; 108. LOGANIACEAE; 109. GENTIANACEAE.
- b) Polemoniales – Corolla regular; leaves alternate.
110. POLEMONIACEAE; 111. HYDROPHYLLACEAE; 112. BORAGINACEAE;
113. CONVULVACEAE; 114. SOLANACEAE.
- c) Personiales – Corolla irregular to oblique; ovules many.

115. SCROPHULARIACEAE; 116. GLOBULARIACEAE (=Plantaginaceae);
117. LENTIBULARIACEAE; 119. GESNERIACEAE; 120. BIGNONIACEAE;
121. PEDALIACEAE; 122. ACANTHACEAE.

d) Lamiales – Corolla irregular to oblique; 1-2 ovules.

123. MYOPORACEAE; 125. VERBENACEAE; 126. LABIATAE; 127. PLANTAGINACEAE.

1.3. MONOCHLAMYDEAE – only 1 kind of perianth (not petals + sepals)

This division was never intended to be natural – it was merely to help identify these single-perianthed plants. Some are basal families (*Aristolochia*, *Piper*) with unusual flower structures, whilst others are highly derived, with sepals or petals lost during evolution. Biochemistry solved the question of the placement of many of these families.

1) Curved embryos [The curved embryos & seeds make these part of the Caryophyllids]

128. NYCTAGINACEAE; 130. AMARANTHACEAE; 131. CHENOPODIACEAE;
133. BATIDACEAE; 134. POLYGONACEAE.

2) Many-seeded aquatics (→ Caryophyllids / Palaeoherbs)

135. PODOSTEMACEAE; 136. NEPENTHACEAE; 137. RAFFLESIACEAE.

3) Microscopic seeds (→ Paleotrees/Palaeoherbs)

138. ARISTOLOCHIACEAE; 139. PIPERACEAE; 140. CHLORANTHACEAE;
141. MYRISTICACEAE; 142. MONIMIACEAE.

4) Daphnales (→ Paleotrees/Eudicots/Rosids)

143. LAURACEAE; 143. HERNANDIACEAE; 144. PROTEACEAE;
145. THYMELAEACEAE; 146. PENAEACEAE; 147. ELAEGNACEAE.

5) Achlamydosporaceae (→ Eudicots/Asterids)

148. LORANTHACEAE; 149. SANTALACEAE; 150. BALANOPHORACEAE.

6) Unisexulales (→ Eudicots/Rosids)

151. EUPHORBIACEAE; 152. BALANOPACEAE; 153. URTICACEAE;
154. PLATANACEAE; 155. LEITNERIACEAE; 156. JUGLANDACEAE; 157. MYRICACEAE;
158. CASUARINACEAE; 159. BETULACEAE.

7) Ordines anomalus (→ Paleoherbs/Rosids)

160. SALICACEAE; 162. EMPETRACEAE; 163. CERATOPHYLLACEAE.

2. MONOCOTYLEDONS – 1 cotyledon, Endogenous growth.

1) Microscopic seeds

167. HYDROCHARITACEAE; 168. BURMANNIACEAE; 169. ORCHIDACEAE.

2) Inferior ovaries

170. ZINGIBERACEAE; 171. BROMELIACEAE; 172. HAEMODORACEAE;
173. IRIDACEAE; 174. AMARYLLIDACEAE; 175. VELLOZIACEAE;
176. DIOSCOREACEAE.

3) Corolla-like flowers

177. STEMONACEAE; 178. LILIACEAE; 179. PONTEDERIACEAE; 180. PHILYDRACEAE;
181. XYRIDACEAE; 182. MAYACACEAE; 183. COMMELINACEAE; 184. RAPATEACEAE.

4) Calyx-like flowers

185. FLAGELLARIACEAE; 186. JUNCACEAE; 187. PALMAE.

5) Perianth-less flowers

188. PANDANACEAE; 189. CYCLANTHACEAE; 190. TYPHACEAE; 191. ARACEAE;
192. LEMNACEAE.

6) Apocarpous

193. TRIURIDACEAE; 194. ALISMACEAE; 195. JUNCAGINACEAE.

7) Glumaceous flowers

196. ERIOCAULACEAE; 197. CENTROLEPIDACEAE; 198. RESTIONACEAE;
199. CYPERACEAE; 200. GRAMINEAE.

ANGIOSPERM PHYLOGENY GROUP

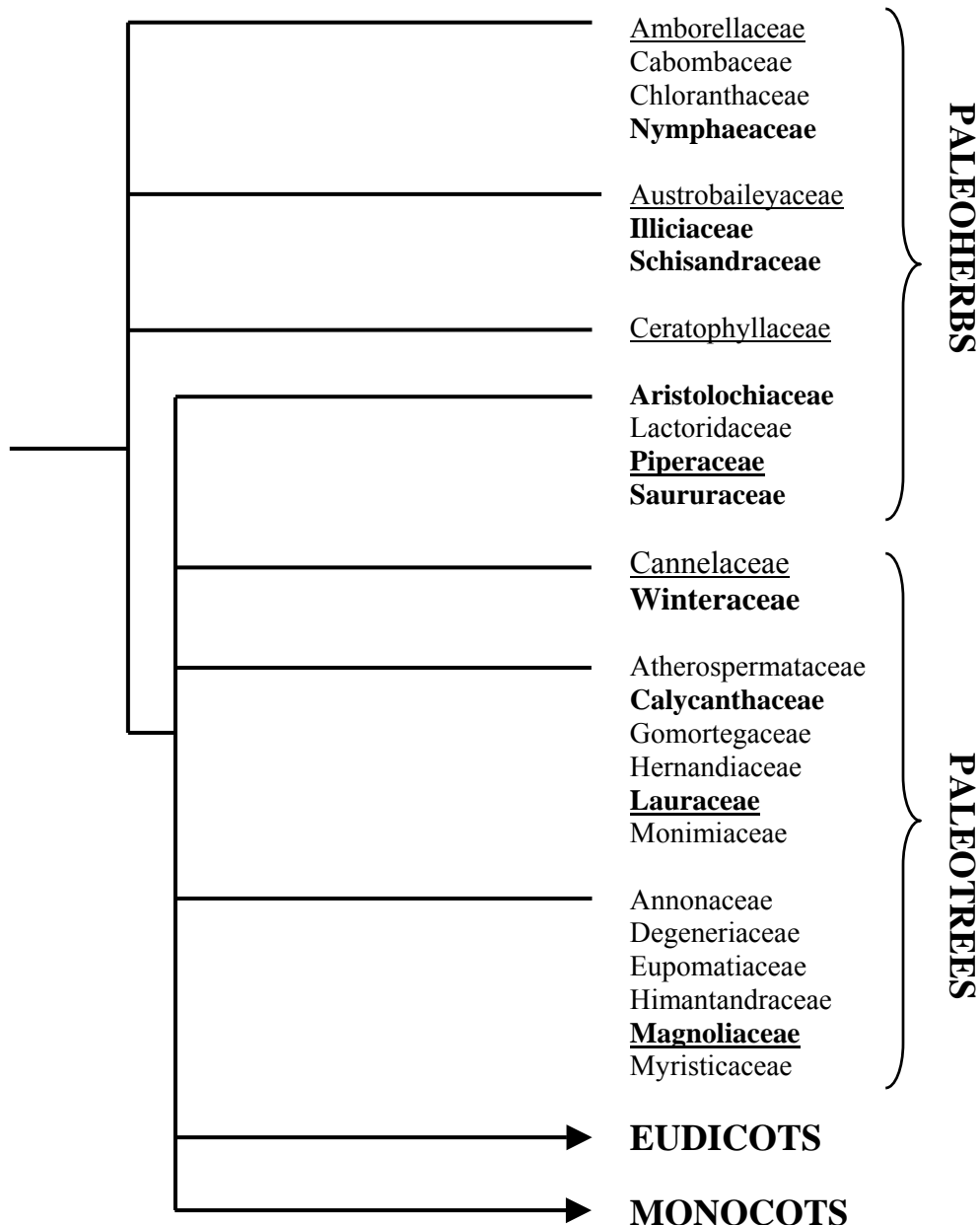
AN APPROXIMATE EVOLUTIONARY TREE

The branching lines demonstrate how closely related different families are. Each group of families are arranged alphabetically, those **families in bold are grown at Glasnevin**, those underlined represent order names (which end in -ales). Arrows indicate continuations to other pages.

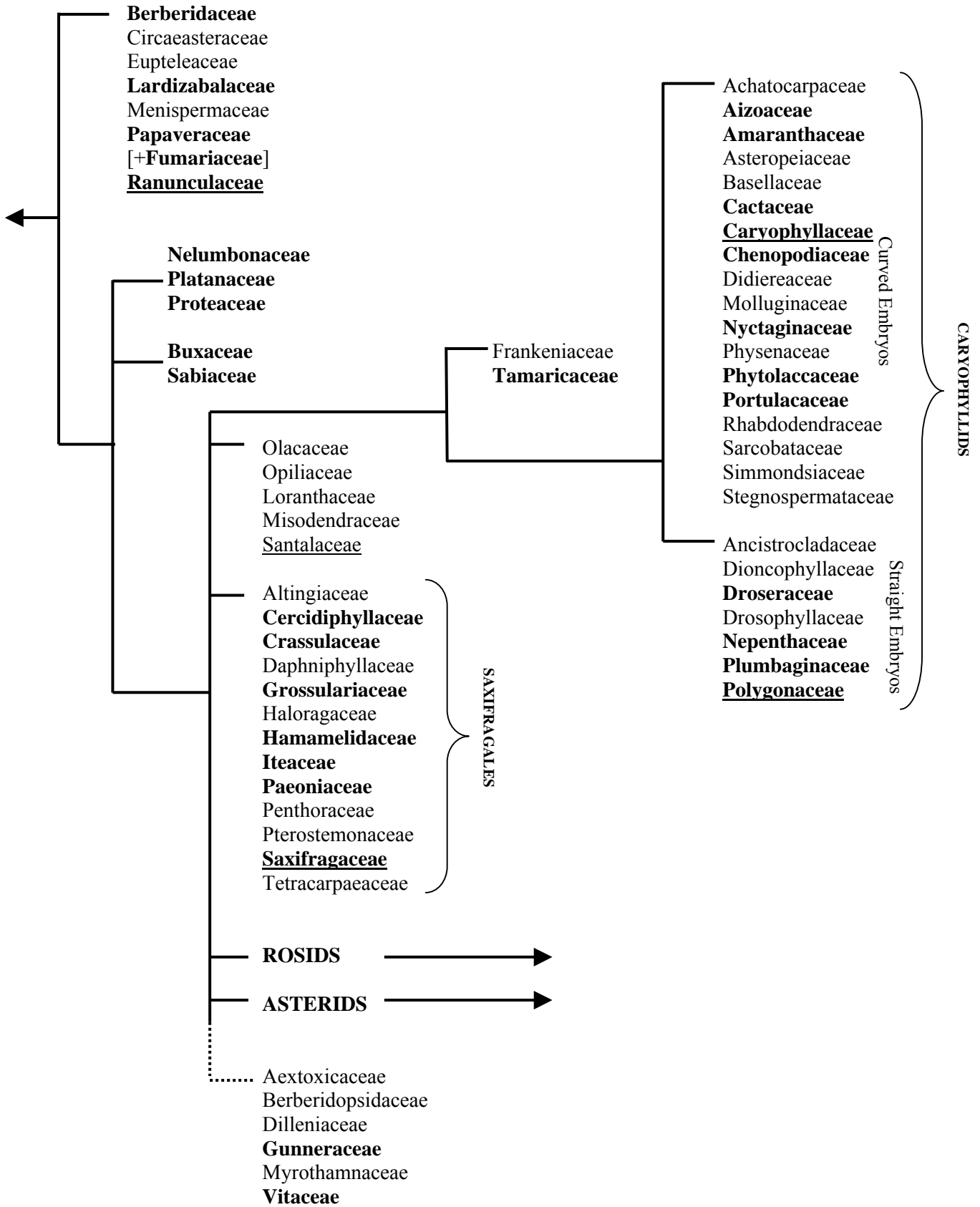
One important revelation of the new synthesis is that there are not just Monocots and Dicots as two classes of Angiosperms, rather the earliest evolution of flowering plants led to four basic lineages:–

- PALEOHERBS, represented by Waterlilies, Aristolochiaceae, Piperaceae, Schisandra.
- PALEOTREES, represented by Magnoliaceae, Winteraceae, Lauraceae.
- MONOCOTS, the traditional Monocots.
- EUDICOTS, so called because they are ‘proper’ or ‘true’ dicots without the paleo-s above.

A pattern of groupings is discernible within the Eudicots: The most ancient grouping in this lineage are indeed the Ranunculaceae, which have always been traditionally viewed as the progenitors of all other flowering plants, then a number of distinct basal groups such as the Caryophyllids and Saxifragales can be distinguished, followed by two very distinctive groups, the Rosids and Asterids. Within these latter two groups we can recognise a similar pattern of evolutionary ‘left-overs’ – basal groups – and distinguished more clearly from these, clusters of closely-related families, which are termed Eu-Rosids and Eu-Asterids respectively.

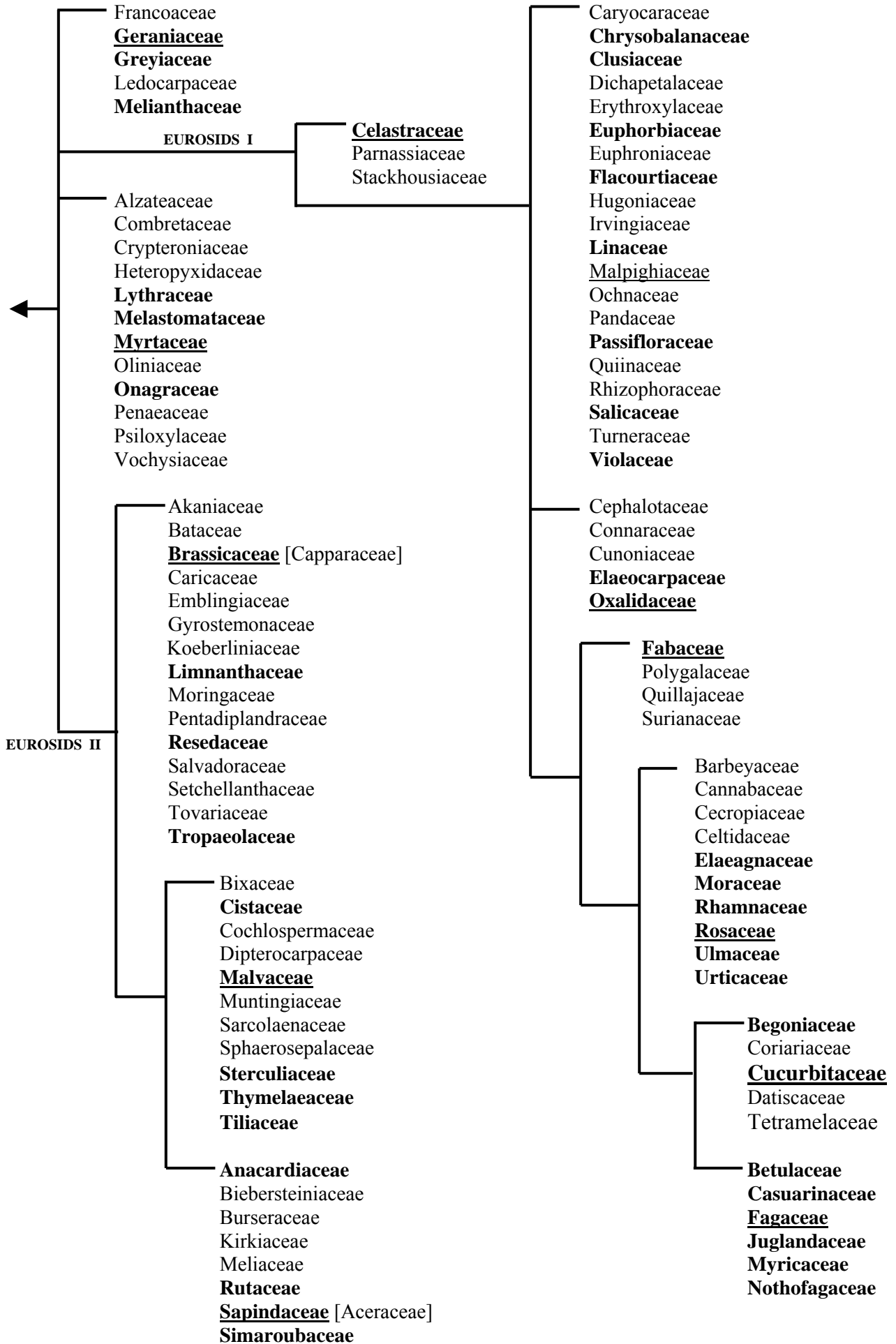


EUDICOTS (Tricolpate Pollen)

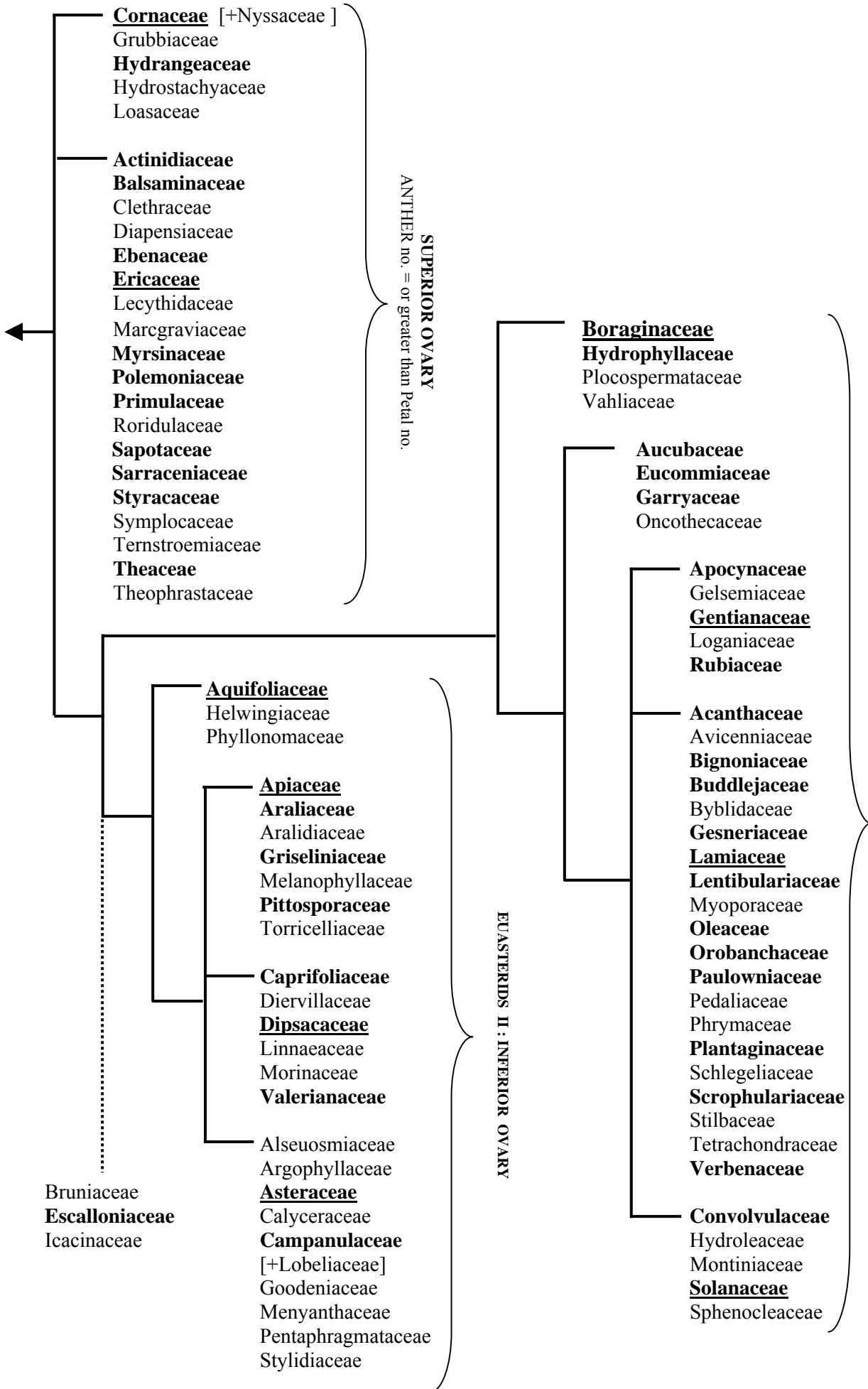


Note: Underlined family names represent Order names for the groups. i.e. Caryophyllales, Saxifragales etc.

ROSIDS



ASTERIDS



MONOCOTS

