

Monocots were once believed to be the sister group to dicots; actually, monocots are one of three major lineages branching off above the ANITA grade (the other two being magnoliids and eudicots) and the only one of the three that has long been recognized, as currently circumscribed, as a taxon.

Monocots constitute approximately 25% of angiosperm species worldwide (ranging from about 9--35% of flowering plant species in any given area).

Monocot life-form diversity is low, in part because they are incapable of producing true wood. Nevertheless, some are trees (e.g., palms, Joshua trees, dragon trees) and some are capable of unusual types of secondary (thickening) growth. For unknown reasons, annual or ephemeral herbs are rare in monocots except in grasses and other grass-like monocots.

Monocots include the only marine (oceanic) angiosperms -- marine adaptation evolved independently in different lineages of one order (Alismatales) associated with aquatic habitats.

Synapomorphies of monocots:

- One embryonic leaf = one cotyledon (thus, the name monocots)
- Adventitious roots, formed from stem(s); the main root or taproot, formed from the embryonic root (= radicle), dies early in monocots. Root systems of monocots therefore are generally fibrous and not dominated by a main root.
- Diffuse vascular strands in stems; not a ring of strands. Consequently, a true vascular cambium cannot form in monocots (therefore, no true wood).
- Parallel leaf venation (unlike many eudicots, which have net-like or reticulate leaf venation). Some monocots have evidently reverted to reticulate venation.

Symplesiomorphies of monocots

- Uniaperturate pollen (like eumagnoliids but unlike eudicots, which have 3-aperturate pollen typically).
- Flower parts in 3s (trimerous) (like many magnoliids but unlike the vast majority of eudicots, which have floral parts in 4s or 5s).

Phylogeny of monocots

Although the group indeed appears to be monophyletic, relationships within the monocots are now understood to be very different than earlier envisioned (contribution of molecular systematics and the earlier work of R. Dahlgren).

Historically, monocots often treated as either "petaloid" (with showy tepals, insect pollinated) or "graminoid" (grass-like, without showy tepals, often wind-pollinated). This distinction has been recently shown to be evolutionarily misleading; "graminoid" monocots are monophyletic but highly nested within the other monocots. Based on this relationship, the wind-pollinated, small, non-showy inflorescences of "graminoid" groups are derived from animal-pollinated, showy inflorescences.

Early branching lineages of monocots are from groups that often are found in aquatic or semi-aquatic (wetland) habitats: *Acorus* (first) and Alismatales (our representative family from the order is Araceae). May reflect an ecological origin of monocots from wetland ancestors.

Economic plants in Araceae include an important starch plant, taro (*Colocasia*).

Petaloid monocots: Artificial taxonomy of the "lilies"

Past taxonomies of lily-like monocots have tended to either group together all of the lily-like plants in one family, Liliaceae (as in *The Jepson Manual*), or split them into two families -- one with superior ovaries (Liliaceae) and one with inferior ovaries (Amaryllidaceae). We now know that both of these past treatments do not result in monophyletic groups.

Molecular data indicates that some lily-like plants (now placed in Asparagales) are more closely related to irises and orchids than to true lilies; no one is comfortable with lumping the irises and orchids into Liliaceae. Even if they were, the resultant family still may not be monophyletic.

(Rolf Dahlgren's fine-scale morphological work predicted the molecular results on monocots; tragically, he died in an automobile accident in the 1980s, long before his work became as influential as it is today).

Today, we recognize two groups (orders) of lily-like monocots that each comprise several families: Liliales and Asparagales. Asparagales also includes the Iridaceae (irises) and Orchidaceae (orchids). Together, these plants are sometimes now referred to as the "petaloid monocots" (along with another order we won't be covering, Dioscoreales). Both orders have non-starchy endosperm.

Liliales

Herbs (often from bulbs)

Tepals often spotted

Nectaries on bases of tepals or filaments

Seed coat not black and crusty

Superior ovaries

Asparagales

Herbs and also trees with anomalous secondary growth (e.g., *Dracaena*, *Yucca*)

Tepals not spotted

Nectaries on ovaries (in septae)

Seed coat black, crusty (phytomelan) -- lost in orchids

Superior or inferior ovaries

Inferior ovaries have apparently been gained and lost repeatedly during the evolutionary history of Asparagales -- earlier taxonomic emphasis on superior vs inferior ovary was deeply flawed. The superior ovary and some developmental features shared between Liliales and many Asparagales are homoplastic.

Economic plants among Liliales are mostly ornamentals; Asparagales includes many ornamentals, too, as well as onions, garlic, chives, leeks, shallots (all in Alliaceae), vanilla (the *Vanilla* orchid), saffron (*Crocus*, Iridaceae), tequila/mescal (*Agave*, Agavaceae), and asparagus (*Asparagus*).

Commelinoid monocots

Commelinoid monocots are a clade including palms (Arecaceae), gingers and relatives (Zingiberales), bromeliads (Bromeliaceae), spiderworts, kangaroo paws, and water hyacinths (Commelinales), and grasses, sedges, and rushes (next time).

Commelinoid monocots often have bracteate inflorescences (unlike petaloid monocots) and are diagnosed mostly by chemical, microscopic, or molecular features, such as starchy endosperm (except in palms, which are sister to the other commelinoids), a unique wax on the cuticles, and UV-fluorescent cell-wall compounds.

Economic plants include dates, coconuts, palm hearts, palm oil (all in Arecaceae); bananas, ginger (all in Zingiberales), pineapples (Bromeliaceae), and grains and cereals (Poaceae, next time).

Zingiberales very diverse, but united by conspicuous synapomorphies

- herbaceous but large-bodied (often arborescent) plants
- inferior ovary
- generally 1 to 5 staminodes (trend toward loss of stamen fertility)
- pinnate-parallel (not strictly parallel) leaf venation
- colorful bracteate inflorescences

Commelinales heterogeneous but often with closed basal leaf sheath, helicoid cymes.

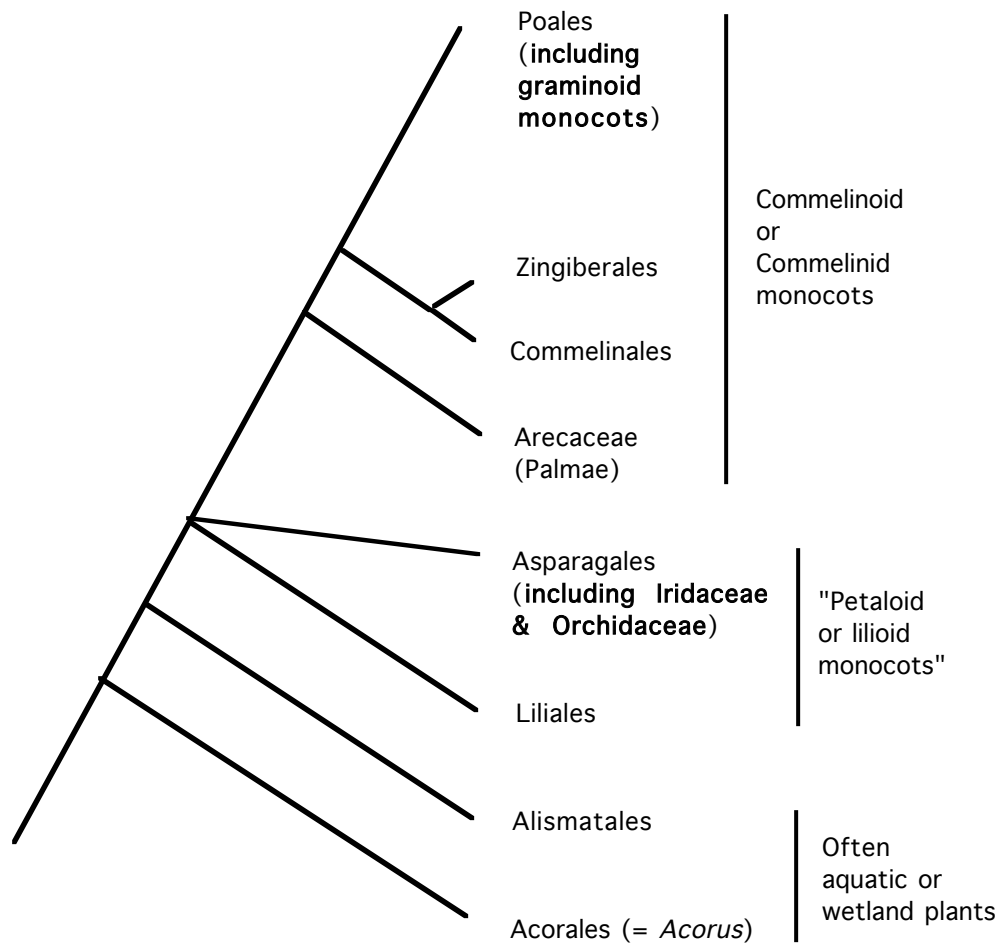
Poales, surprisingly, includes the (florally showy) bromeliads as well as cat-tails (Typha, not covered here), grasses, sedges, and rushes -- all with loss of needle-like calcium oxalate crystals (raphides) in tissues.

Bromeliaceae

Like orchids, mostly tropical epiphytes (grow on surface of other plants).

Can absorb water from peltate trichomes (hairs) on foliage.

Some catch precipitation in tanks (reservoirs) formed in the center of the plant (and a select few of these actually appear to have evolved insectivory, e.g., in *Brocchinia*).



Summary of monocot relationships as inferred from morphological & molecular data