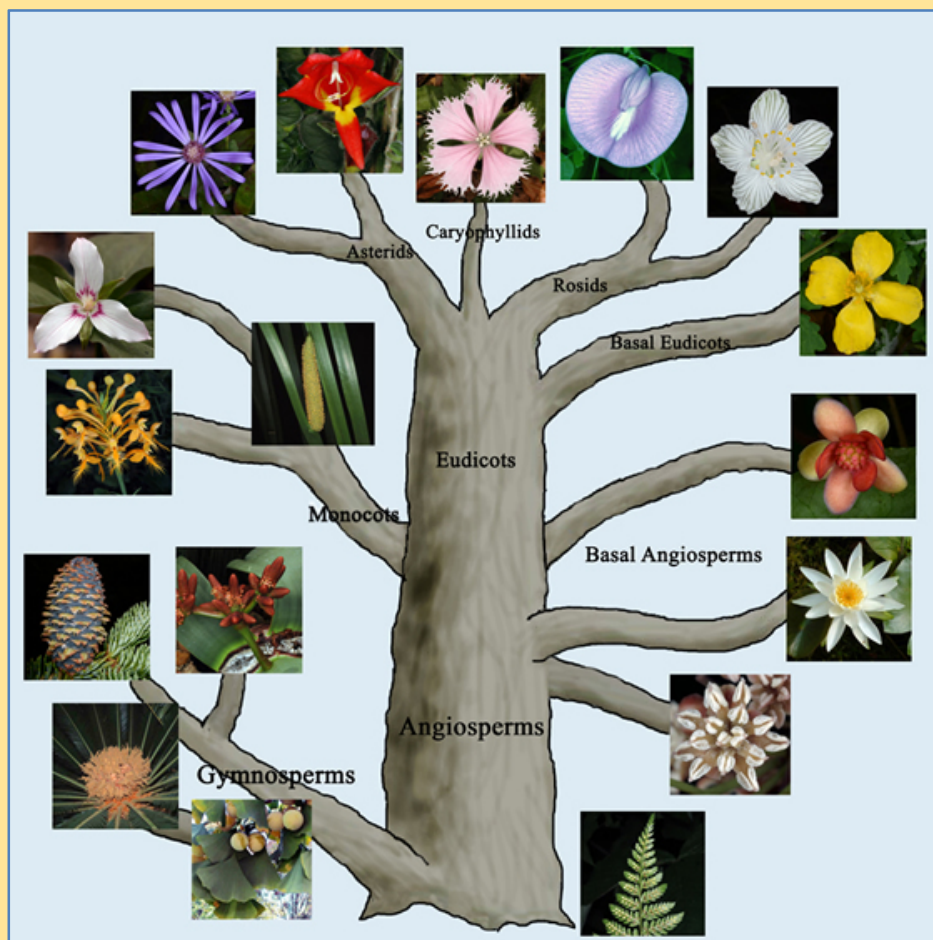


ARULMIGU PALANI ANDAVAR ARTS COLLEGE FOR WOMEN,  
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PG DEPARTMENT OF BOTANY



LEARNING RESOURCES

PLANT TAXONOMY

## **Family Annonaceae**

The Annonaceae are a family of flowering plants consisting of trees, shrubs, or rarely lianas commonly known as the custard apple family or soursop family. With 108 accepted genera and about 2400 known species, it is the largest family in the Magnoliales. Several genera produce edible fruit, most notably *Annona*, *Anonidium*, *Asimina*, *Rollinia*, and *Uvaria*. Its type genus is *Annona*. The family is concentrated in the tropics, with few species found in temperate regions. About 900 species are Neotropical, 450 are Afrotropical, and the remaining are Indomalayan.

### **Description**

The species are mostly tropical, some are mid-latitude, deciduous or evergreen trees and shrubs, with some lianas, with aromatic bark, leaves, and flowers.

### **Stems, stalks and leaves**


Bark is fibrous and aromatic. Pith septate (fine tangential bands divided by partitions) to diaphragmed (divided by thin partitions with openings in them). Branching distichous (arranged in two rows/on one plane) or spiral. Leaves are alternate, two-ranked, simple, pinnately veined, and have leaf stalks. Stipules absent.

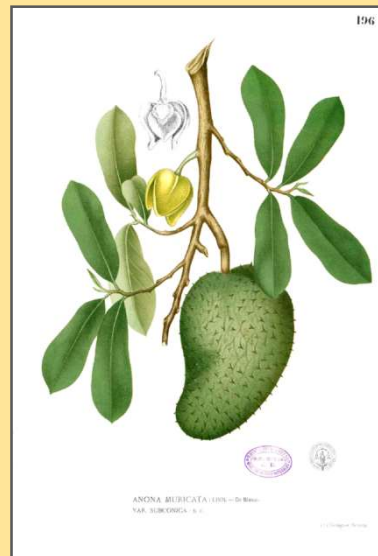
### **Flowers**

Flower stalks are axillary to (on the opposite side of shoot from) leaf scars on old wood and sometimes from leaves on new shoots. The flowers are usually trimerous; borne singly or in compound inflorescences; bisexual and rarely unisexual. The receptacle might become enlarged, elevated or flat. The outer whorls are inserted below the ovaries, and have valvate (overlapping) or imbricate (nonoverlapping) segments. Usually two to four persistent sepals that are distinct or connate (fused) at the base. Six petals in two unequal whorls of three with larger outer whorls and fleshier inner whorls that might share the same nectar glands, or six to fifteen petals, with impressed veins on their inner face. Ten to twenty (or many more) stamens inserted below the ovary, spirally arranged and forming a ball or flat-topped mass with short and stout filaments and linear to oblong anthers which face outward and open longitudinally. Each flower can have from one to many pistils, distinct to connate, with stigmas distinct. Marginal placentation, each pistil bearing one locule, with one to many ovules. Style short and thick, with terminal stigma.

## Fruits and seeds

Fruits are single berries or coalesce from several pistils (into aggregate fruit, syncarps). Seeds are one to many per pistil; have a fleshy and usually brightly colored cover, have ruminant endosperm (nutritive tissue surrounding the embryo) and are oily.

Scientific classification 	
Kingdom:	Plantae
Clade:	Tracheophytes
Clade:	Angiosperms
Clade:	Magnoliids
Order:	Magnoliales
Family:	Annonaceae Juss.
Type genus	
<i>Annona</i>	



## Family Rutaceae

The **Rutaceae** is a family, commonly known as the rue or citrus family, of flowering plants, usually placed in the order Sapindales.

Species of the family generally have flowers that divide into four or five parts, usually with strong scents. They range in form and size from herbs to shrubs and large trees.

The most economically important genus in the family is *Citrus*, which includes the orange (*C. × sinensis*), lemon (*C. × limon*), grapefruit (*C. × paradisi*), and lime (various, mostly *C. aurantifolia*, the key lime). *Boronia* is a large Australian genus, some members of which are plants with highly fragrant flowers and are used in commercial oil production. Other large genera include *Zanthoxylum*, several species of which are cultivated for Sichuan pepper, *Melicope*, and *Agathosma*. About 160 genera are in the family Rutaceae.

### Characteristics

Most species are trees or shrubs, a few are herbs (the type genus *Ruta*, *Boenninghausenia* and *Dictamnus*), frequently aromatic with glands on the leaves, sometimes with thorns. The leaves are usually opposed and compound, and without stipules. Pellucid glands, a type of oil gland, are found in the leaves responsible for the aromatic smell of the family's members; traditionally they have been the primary synapomorphic characteristic to identify the Rutaceae.

Flowers are bractless, solitary or in cyme, rarely in raceme, and mainly pollinated by insects. They are radially or (rarely) laterally symmetric, and generally hermaphroditic. They have four or five petals and sepals, sometimes three, mostly separate, eight to ten stamen (five in *Skimmia*, many in *Citrus*), usually separate or in several groups. Usually a single stigma with 2 to 5 united carpels, sometimes ovaries separate but styles combined.

The fruit of the Rutaceae are very variable: berries, drupes, hesperidia, samaras, capsules, and follicles all occur. Seed number also varies widely.

### Taxonomy

The family is closely related to the Sapindaceae, Simaroubaceae, and Meliaceae, and all are usually placed into the same order, although older systems separate that order

into Rutales and Sapindales. The families Flindersiaceae and Ptaeroxylaceae are sometimes kept separate, but nowadays generally are placed in the Rutaceae, as are the former Cneoraceae.

The family is of great economic importance in warm temperate and subtropical climates for its numerous edible fruits of the genus *Citrus*, such as the orange, lemon, calamansi, lime, kumquat, mandarin and grapefruit. Non-citrus fruits include the white sapote (*Casimiroa edulis*), orangeberry (*Glycosmis pentaphylla*), limeberry (*Triphasia trifolia*), and the bael (*Aegle marmelos*).

The curry tree, *Murraya koenigii*, is of culinary importance in the Indian subcontinent and elsewhere, as its leaves are used as a spice to flavour dishes. Spices are also made from a number of species in the genus *Zanthoxylum*, notably Sichuan pepper.

Other plants are grown in horticulture: *Murraya* and *Skimmia* species, for example. *Ruta*, *Zanthoxylum* and *Casimiroa* species are medicinals. Several plants are also used by the perfume industry, such as the Western Australian *Boronia megastigma*.

The genus *Pilocarpus* has species (*P. jaborandi*, and *P. microphyllus* from Brazil, and *P. pennatifolius* from Paraguay) from which the medicine pilocarpine, used to treat glaucoma, is extracted.





Leaves alternate



Diagnostic characters

Leaves dotted with glands



Petals 5, free



Hesperidium (modified berry)



Ovary superior



Fruit deeply lobed

*kimmia japonica*

#### Scientific classification

Kingdom:	Plantae
Clade:	Tracheophytes
Clade:	Angiosperms
Clade:	Eudicots
Clade:	Rosids
Order:	Sapindales
Family:	Rutaceae

### Characteristics of the Rutaceae

- Dicot (netted leaf veins, flower parts in 4s or 5s)
- Found worldwide, mostly warmer climates
- Mostly trees, some shrubs
- Leaves with aromatic pellucid oil glands, opposite
- Flowers radially symmetric, twice as many stamens as petals
- Fruits are varied: berries, drupes, samaras, hesperidium, capsules
- Economically important: Oranges, lemon, grapefruit, lime, kumquat, mandarin.

## Family Caesalpiniaceae

**Caesalpinioideae** is a botanical name at the rank of subfamily, placed in the large family Fabaceae or Leguminosae. Its name is formed from the generic name *Caesalpinia*. It is known also as the peacock flower subfamily. The Caesalpinioideae are mainly trees distributed in the moist tropics, but include such temperate species as the honeylocust (*Gleditsia triacanthos*) and Kentucky coffee tree (*Gymnocladus dioica*). It has the following clade-based definition. The most inclusive crown clade containing *Arcoa gonavensis* Urb. and *Mimosa pudica* L., but not *Bobgunnia fistuloides* (Harms) J. H. Kirkbr. & Wiersema, *Duparquetia orchidacea* Baill., or *Poeppegia procera* C.Presl

In some classifications, for example the Cronquist system, the group is recognized at the rank of family, Caesalpiniaceae.

### Characteristics

- Specialised extrafloral nectaries often present on the petiole and/or on the primary and secondary rachises, usually between pinnae or leaflet pairs
- Leaves commonly bipinnate
- Inflorescences globose, spicate
- aestivation valvate
- Anthers often with a stipitate or sessile apical gland
- Pollen commonly in tetrads, bitetrads or polyads
- Seeds usually with an open or closed pleurogram on both faces
- Root nodules variably present and indeterminate
- 10 Stamens, aside from various core mimosoid genera bearing a few factors more





#### Scientific classification

Kingdom:	Plantae
Clade:	Tracheophytes
Clade:	Angiosperms
Clade:	Eudicots
Clade:	Rosids
Order:	Fabales
Family:	Fabaceae
Subfamily:	Caesalpinioideae

#### Type genus

*Caesalpinia*



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## Family Cucurbitaceae

The **Cucurbitaceae** also called **cucurbits** or the **gourd family**, are a plant family consisting of about 965 species in around 95 genera.<sup>[2]</sup> Those most important to humans are the following:

- *Cucurbita* – squash, pumpkin, zucchini or courgette, some gourds
- *Lagenaria* – calabash, and others that are inedible
- *Citrullus* – watermelon (*C. lanatus*, *C. colocynthis*) and others
- *Cucumis* – cucumber (*C. sativus*), various melons and vines
- *Momordica* – bitter melon
- *Luffa* – the common name is also luffa, sometimes spelled loofah (when fully ripened, two species of this fibrous fruit are the source of the loofah scrubbing sponge)
- *Cyclanthera* – Caigua

The plants in this family are grown around the tropics and in temperate areas, where those with edible fruits were among the earliest cultivated plants in both the Old and New Worlds. The family Cucurbitaceae ranks among the highest of plant families for number and percentage of species used as human food. The name *Cucurbitaceae* comes to international scientific vocabulary from Neo-Latin, from *Cucurbita*, the type genus, + *-aceae*. a standardized suffix for plant family names in modern taxonomy. The genus name comes from the Classical Latin word *cucurbita*, meaning "gourd".

### Description

Most of the plants in this family are annual vines, but some are woody lianas, thorny shrubs, or trees (*Dendrosicyos*). Many species have large, yellow or white flowers. The stems are hairy and pentangular. Tendrils are present at 90° to the leaf petioles at nodes. Leaves are exstipulate, alternate, simple palmately lobed or palmately compound. The flowers are unisexual, with male and female flowers on different plants (dioecious) or on the same plant (monoecious). The female flowers have inferior ovaries. The fruit is often a kind of modified berry called a pepo.

### Fossil History

One of the oldest fossil cucurbits so far is †*Cucurbitaciphyllum lobatum* from the Paleocene epoch, found at Shirley Canal, Montana. It was described for the first time in 1924

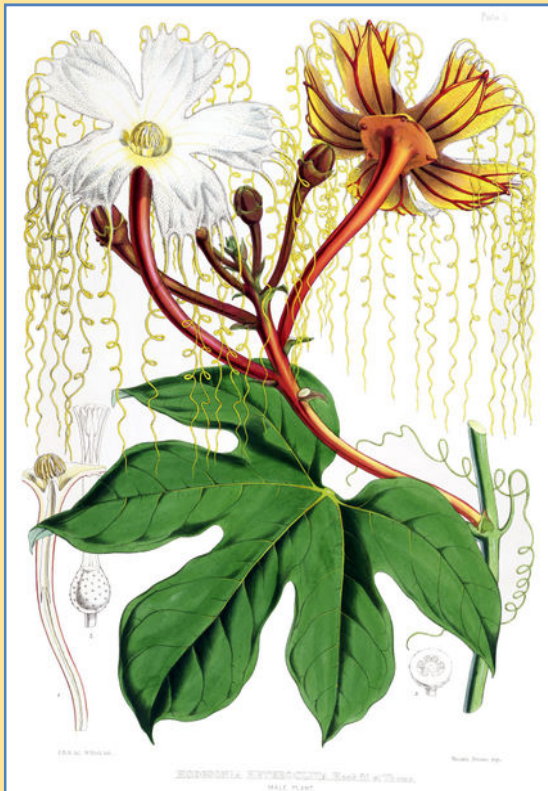
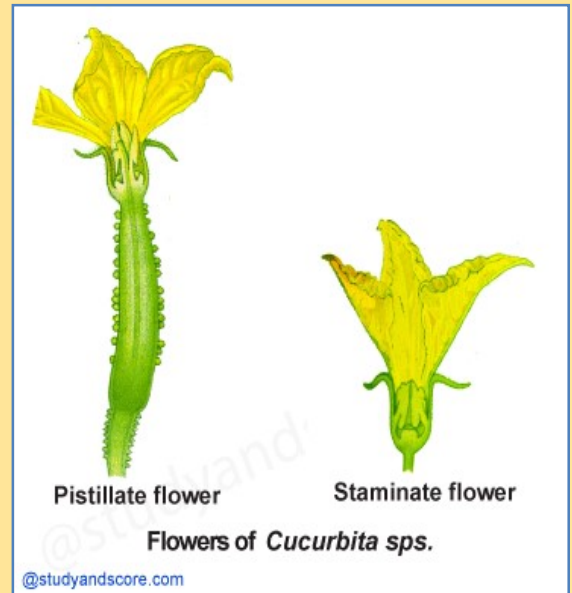
by the paleobotanist Frank Hall Knowlton. The fossil leaf is palmate, trilobed with rounded lobal sinuses and an entire or serrate margin. It has a leaf pattern similar to the members of the genera *Kedrostis*, *Melothria* and *Zehneria*.

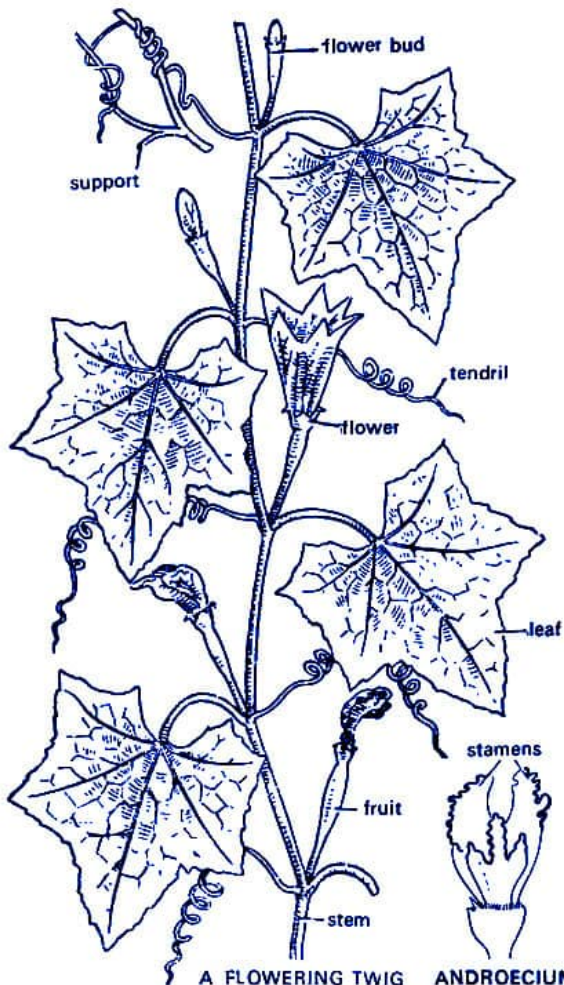
**Scientific classification**

Kingdom:	Plantae
Clade:	Tracheophytes
Clade:	Angiosperms
Clade:	Eudicots
Clade:	Rosids
Order:	Cucurbitales
Family:	Cucurbitaceae

**Type genus**

*Cucurbita*

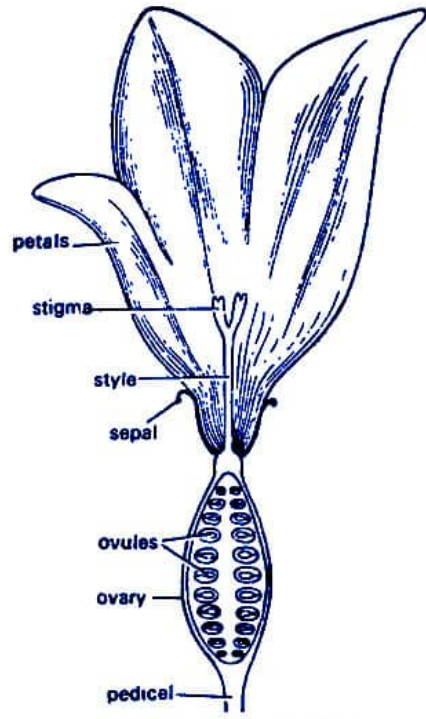




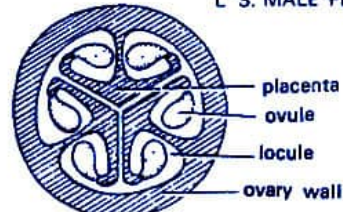
A FLOWERING TWIG (FEMALE PLANT)



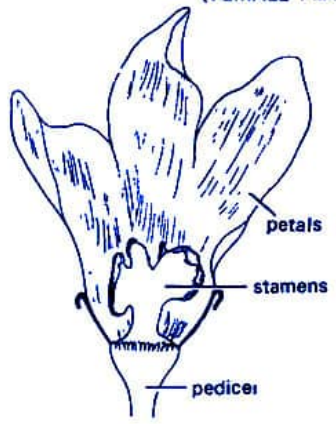
ANDROECIUM



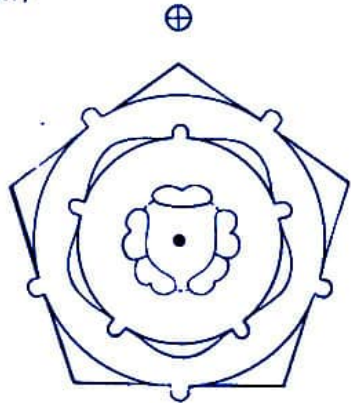
L. S. MALE FLOWER



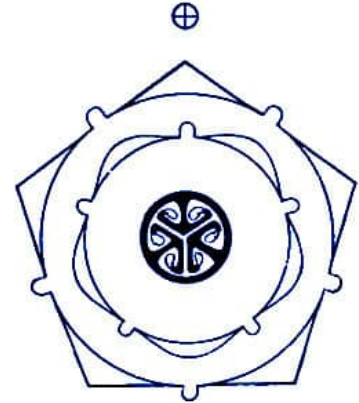
T. S. OVARY



L. S. MALE FLOWER



FLORAL DIAGRAM (male)



FLOWER DIAGRAM (female)

*Coccinia cordifolia*

## Family Lamiaceae

The **Lamiaceae** or **Labiatae** are a family of flowering plants commonly known as the **mint, deadnettle** or **sage** family. Many of the plants are aromatic in all parts and include widely used culinary herbs like basil, mint, rosemary, sage, savory, marjoram, oregano, hyssop, thyme, lavender, and perilla, as well as other medicinal herbs such as catnip, salvia, bee balm, wild dagga, and oriental motherwort. Some species are shrubs, trees (such as teak), or, rarely, vines. Many members of the family are widely cultivated, not only for their aromatic qualities, but also their ease of cultivation, since they are readily propagated by stem cuttings. Besides those grown for their edible leaves, some are grown for decorative foliage. Others are grown for seed, such as *Salvia hispanica* (chia), or for their edible tubers, such as *Plectranthus edulis*, *Plectranthus esculentus*, *Plectranthus rotundifolius*, and *Stachys affinis* (Chinese artichoke). Many are also grown ornamentally, notably coleus, *Plectranthus*, and many *Salvia* species and hybrids.

The family has a cosmopolitan distribution. The enlarged Lamiaceae contain about 236 genera and have been stated to contain 6,900 to 7,200 species, but the World Checklist lists 7,534. The largest genera are *Salvia* (900), *Scutellaria* (360), *Stachys* (300), *Plectranthus* (300), *Hyptis* (280), *Teucrium* (250), *Vitex* (250), *Thymus* (220), and *Nepeta* (200). *Clerodendrum* was once a genus of over 400 species, but by 2010, it had been narrowed to about 150.

The family has traditionally been considered closely related to the Verbenaceae in the 1990s, phylogenetic studies suggested that many genera classified in the Verbenaceae should be classified in the Lamiaceae or to other families in the order Lamiales.



*Salvia jurisicii*

The alternative family name Labiatae refers to the flowers typically having petals fused into an upper lip and a lower lip (*labia* in Latin). The flowers are bilaterally symmetrical with five united petals and five united sepals. They are usually bisexual and verticillastrate (a flower cluster that looks like a whorl of flowers, but actually consists of two crowded clusters). Although this is still considered an acceptable alternative name, most botanists now use the name Lamiaceae in referring to this family. The leaves emerge oppositely, each pair at right angles to the previous one (decussate) or whorled. The stems are frequently square in cross section, but this is not found in all members of the family, and is sometimes found in other plant families.

*Leucas aspera*



*Orthosiphon thymiflorus*



*Lamium purpureum*



*Tetradenia riparia*



## Family Apiaceae

**Apiaceae** or **Umbelliferae** is a family of mostly aromatic flowering plants named after the type genus *Apium* and commonly known as the **celery, carrot or parsley family**, or simply as **umbellifers**. It is the 16th-largest family of flowering plants, with more than 3,800 species in about 446 genera, including such well-known and economically important plants as ajwain, angelica, anise, asafoetida, caraway, carrot, celery, chervil, coriander, cumin, dill, fennel, lovage, cow parsley, parsley, parsnip and sea holly, as well as silphium, a plant whose identity is unclear and which may be extinct. The family Apiaceae includes a significant number of phototoxic species, such as giant hogweed, and a smaller number of highly poisonous species, such as poison hemlock, water hemlock, spotted cowbane, fool's parsley, and various species of water dropwort.

### Description

Most Apiaceae are annual, biennial or perennial herbs (frequently with the leaves aggregated toward the base), though a minority are woody shrubs or small trees such as *Bupleurum fruticosum*. Their leaves are of variable size and alternately arranged, or with the upper leaves becoming nearly opposite. The leaves may be petiolate or sessile. There are no stipules but the petioles are frequently sheathing and the leaves may be perfoliate. The leaf blade is usually dissected, ternate, or pinnatifid, but simple and entire in some genera, e.g. *Bupleurum*. Commonly, their leaves emit a marked smell when crushed, aromatic to fetid, but absent in some species. The defining characteristic of this family is the inflorescence, the flowers nearly always aggregated in terminal umbels, that may be simple or more commonly compound, often umbelliform cymes. The flowers are usually perfect (hermaphroditic) and actinomorphic, but there may be zygomorphic flowers at the edge of the umbel, as in carrot (*Daucus carota*) and coriander, with petals of unequal size, the ones pointing outward from the umbel larger than the ones pointing inward. Some are andromonoecious, polygamomonoecious, or even dioecious (as in *Acronema*), with a distinct calyx and corolla, but the calyx is often highly reduced, to the point of being undetectable in many species, while the corolla can be white, yellow, pink or purple. The flowers are nearly perfectly pentamerous, with five petals and five stamens. There is often variation in the functionality of the stamens even within a single



inflorescence. Some flowers are functionally staminate (where a pistil may be present but has no ovules capable of being fertilized) while others are functionally pistillate (where stamens are present but their anthers do not produce viable pollen). Pollination of one flower by the pollen of a different flower of the same plant (geitonogamy) is common. The gynoecium consists of two carpels fused into a single, bicarpellate pistil with an inferior ovary. Stylopodia support two styles and secrete nectar, attracting pollinators like flies, mosquitoes, gnats, beetles, moths, and bees. The fruit is a schizocarp consisting of two fused carpels that separate at maturity into two mericarps, each containing a single seed. The fruits of many species are dispersed by wind but others such as those of *Daucus* spp., are covered in bristles, which may be hooked in sanicle *Sanicula europaea* and thus catch in the fur of animals. The seeds have an oily endosperm and often contain essential oils, containing aromatic compounds that are responsible for the flavour of commercially important umbelliferous seed such as anise, cumin and coriander. The shape and details of the ornamentation of the ripe fruits are important for identification to species level.

## Uses

Many members of this family are cultivated for various purposes.

Parsnip (*Pastinaca sativa*), carrot (*Daucus carota*) and Hamburg parsley (*Petroselinum crispum*) produce tap roots that are large enough to be useful as food. Many species produce essential oils in their leaves or fruits and as a result are flavourful aromatic herbs. Examples are parsley (*Petroselinum crispum*),

Coriander (*Coriandrum sativum*), culantro, and dill (*Anethum graveolens*). The seeds may be used in cuisine, as with coriander (*Coriandrum sativum*), fennel (*Foeniculum vulgare*), cumin (*Cuminum cyminum*), and caraway (*Carum carvi*).

Other notable cultivated Apiaceae include chervil (*Anthriscus cerefolium*), angelica (*Angelica* spp.), celery (*Apium graveolens*), arracacha (*Arracacia xanthorrhiza*), sea holly (*Eryngium* spp.), asafoetida (*Ferula asafoetida*), galbanum (*Ferula gummosa*), cicely (*Myrrhis odorata*), anise (*Pimpinella anisum*), lovage (*Levisticum officinale*), and hacquetia (*Sanicula epipactis*).

## **Cultivation**

Generally, all members of this family are best cultivated in the cool-season garden; they may not grow at all if the soils are too warm. Almost every widely cultivated plant of this group is a considered useful as a companion plant. One reason is that the tiny flowers, clustered into umbels, are well suited for ladybugs, parasitic wasps, and predatory flies, which drink nectar when not reproducing. They then prey upon insect pests on nearby plants. Some of the members of this family considered "herbs" produce scents that are believed to mask the odours of nearby plants, thus making them harder for insect pests to find.

## **Other uses**

The poisonous members of the Apiaceae have been used for a variety of purposes globally. The poisonous *Oenanthe crocata* has been used as an aid in suicides, and arrow poisons have been made from various other family species.

*Daucus carota* has been used as coloring for butter

*Dorema ammoniacum*, *Ferula galbaniflua*, and *Ferula moschata* (sumbul) are sources of incense.

The woody *Azorella compacta* Phil. has been used in South America for fuel.

## **Toxicity**

Many species in the family Apiaceae produce phototoxic substances (called furanocoumarins) that sensitize human skin to sunlight. Contact with plant parts that contain furanocoumarins, followed by exposure to sunlight, may cause phytophotodermatitis, a serious skin inflammation. Phototoxic species include *Ammi majus*, *Notobubon galbanum*, the parsnip (*Pastinaca sativa*) and numerous species of the genus *Heracleum*, especially the giant hogweed (*Heracleum mantegazzianum*). Of all the plant species that have been reported to induce phytophotodermatitis, approximately half belong to the family Apiaceae.

The family Apiaceae also includes a smaller number of poisonous species, including poison hemlock, water hemlock, spotted cowbane, fool's parsley, and various species of water dropwort.

Some members of the family Apiaceae, including carrot, celery, fennel, parsley and parsnip, contain polyynes, an unusual class of organic compounds that exhibit cytotoxic effects.

### Scientific classification

Kingdom:	Plantae
<i>Clade:</i>	Tracheophytes
<i>Clade:</i>	Angiosperms
<i>Clade:</i>	Eudicots
<i>Clade:</i>	Asterids
Order:	Apiales
Family:	Apiaceae Lindl.

### Type genus

*Apium* L.





## Family Euphorbiaceae

Euphorbiaceae the spurge family, is a large family of flowering plants. In English, they are also commonly called euphorbias, which is also the name of the type genus of the family. Most spurges, such as *Euphorbia paralias*, are herbs, but some, especially in the tropics, are shrubs or trees, such as *Hevea brasiliensis*. Some, such as *Euphorbia canariensis*, are succulent and resemble cacti because of convergent evolution. This family has a cosmopolitan global distribution. The greatest diversity of species is in the tropics; however, the Euphorbiaceae also have many species in nontropical areas of all continents except Antarctica.

### Description

The leaves are alternate, seldom opposite, with stipules. They are mainly simple, but where compound, are always palmate, never pinnate. Stipules may be reduced to hairs, glands, or spines, or in succulent species are sometimes absent.

The plants can be monoecious or dioecious. The radially symmetrical flowers are unisexual, with the male and female flowers usually on the same plant. As can be expected from such a large family, a wide variety exists in the structure of the flowers. The stamens (the male organs) number from one to 10 (or even more). The female flowers are hypogynous, that is, with superior ovaries.

The genera in tribe Euphorbieae, subtribe Euphorbiinae (*Euphorbia* and close relatives) show a highly specialized form of pseudanthium ("false flower" made up of several true flowers) called a cyathium. This is usually a small, cup-like involucre consisting of fused-together bracts and peripheral nectary glands, surrounding a ring of male flowers, each a single stamen. In the middle of the cyathium stands a female flower, a single pistil with branched stigmas. This whole arrangement resembles a single flower.

The fruit is usually a schizocarp, but sometimes a drupe. A typical schizocarp is the regma, a capsular fruit with three or more cells, each of which splits open explosively at maturity, scattering the small seeds.

The family contains a large variety of phytotoxins (toxic substances produced by plants), including diterpene esters, alkaloids, and cyanogenic glycosides (e.g. root tubers of cassava). The

seeds of the castor oil plant *Ricinus communis* contain the highly toxic carbohydrate-binding protein ricin.

A milky latex is a characteristic of the subfamilies Euphorbioideae and Crotonoideae, and the latex of the rubber tree *Hevea brasiliensis* is the primary source of natural rubber. The latex is poisonous in the Euphorbioideae, but innocuous in the Crotonoideae. White mangrove, also known as blind-your-eye mangrove latex (*Excoecaria agallocha*), causes blistering on contact and temporary blindness if it contacts the eyes, hence its name. The latex of spurge was used as a laxative.

Twenty first century molecular studies have shown that the enigmatic family Rafflesiaceae, which was only recently recognized to belong to order Malpighiales, is derived from within the Euphorbiaceae.

Euphorbiaceae are monoecious and open pollinated and so self-incompatibility is rare - although it has been reported in the past, apparently this was in error. It is confirmed to be absent or incomplete in herbaceous *Chamaesyce* by Ehrenfeld 1976, *Hevea* by Bouharmont 1962, and *Manihot* by Jennings 1963 and George & Shifriss 1967

### **Taxonomy**

The family Euphorbiaceae is the fifth-largest flowering plant family and has about 7,500 species organised into 300 genera, 37 tribes, and three subfamilies: Acalyphoideae, Crotonoideae and Euphorbioideae. Amongst the oldest fossils of the group include the permineralised fruit *Euphorbiotheca deccanensis* from the Intertrappean Beds of India, dating to the late Maastrichtian at the end of the Cretaceous, around 66 million years ago.

### **Uses and Toxicity**

Some species of Euphorbiaceae have economic significance, such as cassava (*Manihot esculenta*), castor oil plant (*Ricinus communis*), Barbados nut (*Jatropha curcas*), and the Pará rubber tree (*Hevea brasiliensis*). Many are grown as ornamental plants, such as poinsettia (*Euphorbia pulcherrima*) or garden croton (*Codiaeum variegatum*). Leafy spurge (*Euphorbia esula*) and Chinese tallow (*Triadica sebifera*) are invasive weeds in North America.

Seeds of the castor oil plant (*Ricinus communis* L.) contain the extremely potent toxin, ricin.

Although some species of the Euphorbiaceae have been used in traditional medicine, as of 2019, there is no rigorous clinical evidence that euphorbia extracts are effective for treating any disease.

There is evidence that euphol, a tetracyclic triterpene alcohol, and the main constituent of the sap of the medicinal plant *Euphorbia tirucalli*, has anti-cancer activity. Analysis of toxicological screening of the inhibitory effect and bioactivity of euphol has shown concentration-dependent cytotoxic effects on cancer cell lines, with more than a five-fold difference in the IC<sub>50</sub> values in some cell lines. Euphol treatment had a higher selective cytotoxicity index (0.64-3.36) than temozolomide (0.11-1.13) and reduced both proliferation and cell motility. Euphol also exhibited antitumoral and antiangiogenic activity in vivo, using the chicken chorioallantoic membrane assay, with synergistic temozolomide interactions in most cell lines. In conclusion, euphol exerted in vitro and in vivo cytotoxicity against glioma cells, through several cancer pathways, including the activation of autophagy-associated cell death.

Numerous Euphorbiaceae species are listed on the poisonous plant database of the US Food and Drug Administration mainly because of the toxic sap.

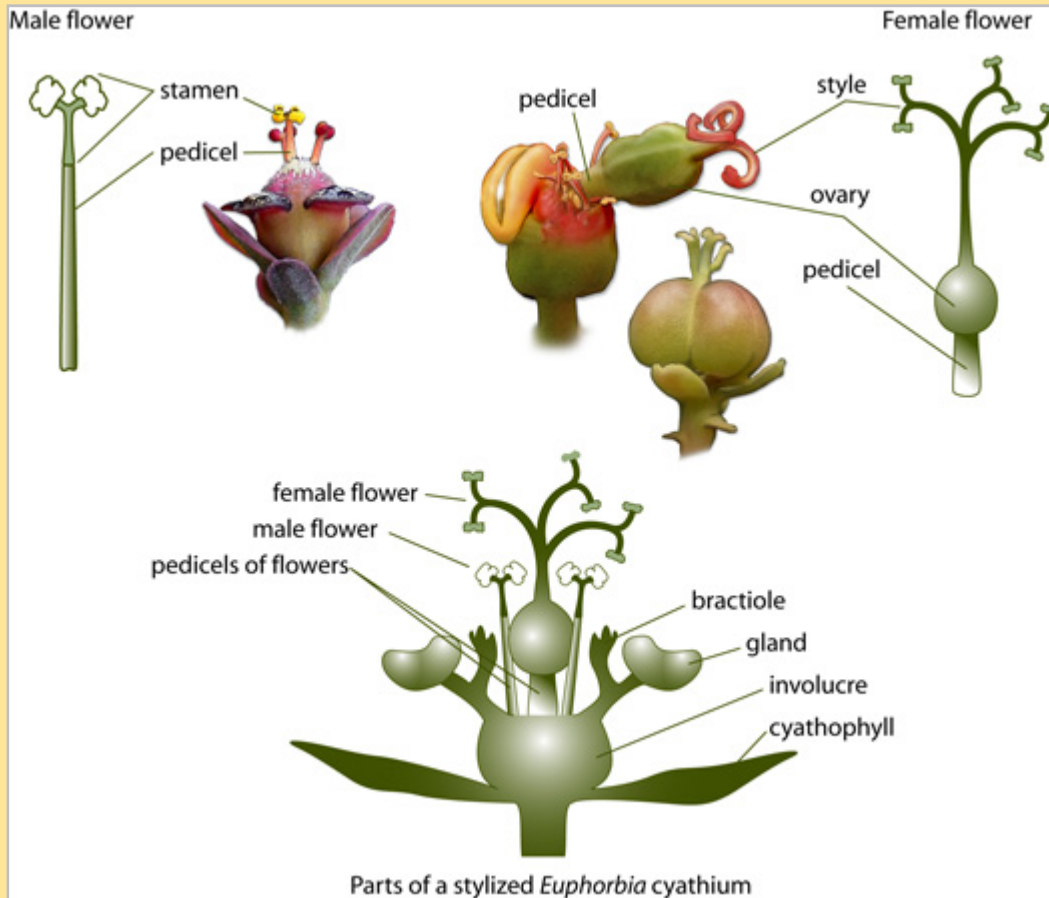
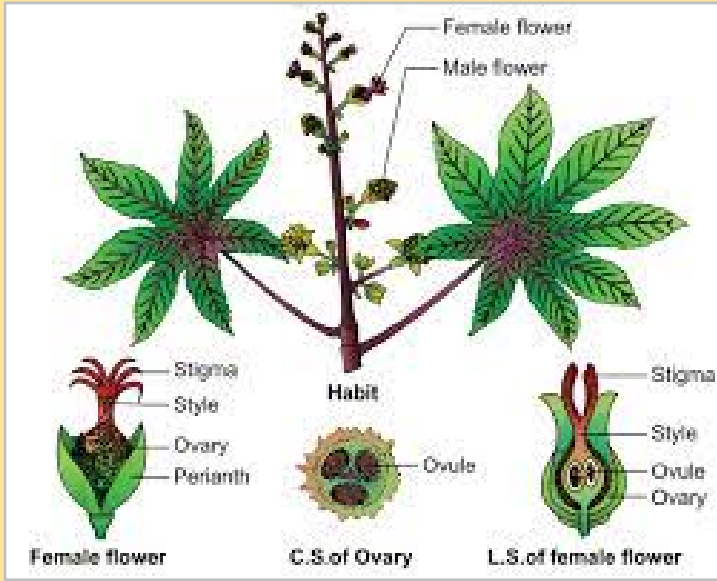
### **Phytochemistry**

Phytochemicals found in Euphorbiaceae species include diterpenoids, terpenoids, flavonoids, alkaloids, tannins, neriifolins (also found in oleander), cycloartenol, lectin, and taraxerol, among others.

### **Conservation**

Some species of this family are facing the risk of extinction. These include the Euphorbia species *E. apparicana*, *E. attastoma*, *E. crossadenia*, and *E. gymnoclada*.

# Cyathium





## Family Rubiaceae

The Rubiaceae are a family of flowering plants, commonly known as the coffee, madder, or bedstraw family. It consists of terrestrial trees, shrubs, lianas, or herbs that are recognizable by simple, opposite leaves with interpetiolar stipules and sympetalous actinomorphic flowers. The family contains about 13,500 species in about 620 genera, which makes it the fourth-largest angiosperm family. Rubiaceae has a cosmopolitan distribution; however, the largest species diversity is concentrated in the tropics and subtropics. Economically important genera include *Coffea*, the source of coffee, *Cinchona*, the source of the antimalarial alkaloid quinine, ornamental cultivars (e.g., *Gardenia*, *Ixora*, *Pentas*), and historically some dye plants (e.g., *Rubia*)

### Description

The Rubiaceae are morphologically easily recognizable as a coherent group by a combination of characters: opposite or whorled leaves that are simple and entire, interpetiolar stipules, tubular sympetalous actinomorphic corollas and an inferior ovary.

A wide variety of growth forms are present: shrubs are most common (e.g. *Coffea*, *Psychotria*), but members of the family can also be trees (e.g. *Cinchona*, *Nauclea*), lianas (e.g. *Psychotria samoritourei*), or herbs (e.g. *Galium*, *Spermacoce*). Some epiphytes are also present (e.g. *Myrmecodia*). The plants usually contain iridoids, various alkaloids, and raphide crystals are common. The leaves are simple, undivided, and entire; there is only one case of pinnately compound leaves (*Pentagonia osapinnata*). Leaf blades are usually elliptical, with a cuneate base and an acute tip. In three genera (*Pavetta*, *Psychotria*, *Sericanthe*), bacterial leaf nodules can be observed as dark spots or lines on the leaves. The phyllotaxis is usually decussate, rarely whorled (e.g. *Fadogia*), or rarely seemingly alternate resulting from the reduction of one leaf at each node (e.g. *Sabicea sthenula*). Characteristic for the Rubiaceae is the presence of stipules that are mostly fused to an interpetiolar structure on either side of the stem between the opposite leaves. Their inside surface often bears glands called "colleters", which produce mucilaginous compounds protecting the young shoot. The "whorled" leaves of the herbaceous tribe Rubieae have classically been interpreted as true leaves plus interpetiolar leaf-like stipules. The inflorescence is a cyme, rarely of solitary flowers (e.g. *Rothmannia*), and is either terminal or axillary and paired at the nodes. The 4-5-merous (rarely pleiomerous; e.g. six

in *Richardia*) flowers are usually bisexual and usually epigynous. The perianth is usually biseriate, although the calyx is absent in some taxa (e.g. *Theligonum*). The calyx mostly has the lobes fused at the base; unequal calyx lobes are not uncommon, and sometimes (e.g. *Mussaenda*) one lobe is enlarged and coloured (a so-called “semaphyl”). The corolla is sympetalous, mostly actinomorphic, usually tubular, mostly white or creamy but also yellow (e.g. *Gardenia* spp., *Mycelia basiflora*), and rarely blue (e.g. *Faramea calyptrata*) or red (e.g. *Alberta magna*, *Ixora coccinea*). The stamens are alternipetalous and epipetalous. Anthers are longitudinal in dehiscence, but are poricidal in some genera (e.g. *Rustia*, *Tresanthera*). The gynoecium is syncarpous with an inferior ovary (rarely secondarily superior, e.g. *Gaertnera*, *Pagamea*). Placentation is axial, rarely parietal (e.g. *Gardenia*); ovules are anatropous to hemitropous, unitegmic, with a funicular obturator, one to many per carpel. Nectaries are often present as a nectariferous disk atop the ovary. The fruit is a berry, capsule (e.g. *Oldenlandia*), drupe (e.g. *Coffea*, *Psychotria*), or schizocarp (e.g. *Cremocarpon*). Red fruits are fairly dominant (e.g. *Coffea arabica*); yellow (e.g. *Rosenbergiodendron formosum*), orange (e.g. *Vangueria infausta*), or blackish fruits (e.g. *Pavetta gardeniifolia*) are equally common; blue fruits are rather exceptional save in the Psychotriaceae and associated tribes. Most fruits are about 1 cm in diameter; very small fruits are relatively rare and occur in herbaceous tribes; very large fruits are rare and confined to the Gardenieae. The seeds are endospermous.

### **Distribution and Habitat**

Rubiaceae have a cosmopolitan distribution and are found in nearly every region of the world, except for extreme environments such as the polar regions and deserts. The distribution pattern of the family is very similar to the global distribution of plant diversity overall. However, the largest diversity is distinctly concentrated in the humid tropics and subtropics. An exception is the tribe Rubieae, which is cosmopolitan but centered in temperate regions. Only a few genera are pantropical (e.g. *Ixora*, *Psychotria*), many are paleotropical, while Afro-American distributions are rare (e.g. *Sabicea*). Endemic rubiaceae genera are found in most tropical and subtropical floristic regions of the world. The highest number of species is found in Colombia, Venezuela, and New Guinea. When adjusted for area, Venezuela is the most diverse, followed by Colombia and Cuba.

The Rubiaceae consist of terrestrial and predominantly woody plants. Woody rubiaceous shrubs constitute an important part of the understorey of low- and mid-altitude rainforests. Rubiaceae are tolerant of a broad array of environmental conditions (soil types, altitudes, community structures, etc.) and do not specialize in one specific habitat type (although genera within the family often specialize)

### **Flower Biology**

Most members of the Rubiaceae are zoophilous, pollinated mainly by insects. Entomophilous species produce nectar from an epigynous disk at the base of the corolla tube to attract insects. Ornithophily is rare and is found in red-flowered species of *Alberta*, *Bouvardia*, and *Burchellia*. Anemophilous species are found in the tribes Anthospermeae and Theligoneae and are characterized by hermaphroditic or unisexual flowers that exhibit a set of specialized features, such as striking sexual dimorphism, increased receptive surface of the stigmas and pendulous anthers.

Although most Rubiaceae species are hermaphroditic, outbreeding is promoted through sequential hermaphroditism and spatial isolation of the reproductive organs. More complex reproductive strategies include secondary pollen presentation, heterostyly, and unisexual flowers.

Secondary pollen presentation (also known as stylar pollen presentation or ixoroid pollen mechanism) is especially known from the Gardenieae and related tribes. The flowers are proterandrous and the pollen is shed early onto the outside of the stigmas or the upper part of the style, which serve as a pollen receptacle. Increased surface area and irregularity of the pollen receptacle, caused by swellings, hairs, grooves or ridges often ensure a more efficient pollen deposition. After elongation of the style, animals transport the pollen to flowers in the female or receptive stage with exposed stigmatic surfaces. A pollen catapult mechanism is present in the genera *Molopanthera* and *Posoqueria* (tribe Posoquerieae) that projects a spherical pollen mass onto visiting hawk moths.

Heterostyly is another mechanism to avoid inbreeding and is widely present in the family Rubiaceae. The tribes containing the largest number of heterostylous species are Spermaceae and Psychotrieae. Heterostyly is absent in groups that have secondary pollen presentation (e.g. Vanguerieae).

Unisexual flowers also occur in Rubiaceae and most taxa that have this characteristic are dioecious. The two flower morphs are however difficult to observe as they are rather morphologically similar; male flowers have a rudimentary pistil with the ovaries empty and female flowers sterile or rudimentary stamens with empty anthers.<sup>[5]</sup> Flowers that are morphologically hermaphrodite, but functionally dioecious occur in *Pyrostria*.<sup>[10]</sup>

### **Fruit biology**

The dispersal units in Rubiaceae can be entire fruits, syncarps, mericarps, pyrenes or seeds. Fleshy fruit taxa are probably all (endo)zoochorous (e.g. tribes Pavetteae, Psychotrieae), while the dispersal of dry fruits is often unspecialized (e.g. tribes Knoxieae, Spermaceae). When seeds function as diaspores, the dispersal is either anemochorous or hydrochorous. The three types of wind-dispersed diaspores in Rubiaceae are dust seeds (rare, e.g. *Lerchea*), plumed seeds (e.g. *Hillia*), and winged seeds (e.g. *Coutarea*). Long-distance dispersal by ocean currents is very rare (e.g. the seashore tree *Guettarda speciosa*). Other dispersal mechanisms are absent or at least very rare. Some Spermaceae having seeds with elaiosomes are probably myrmecochorous (e.g. *Spermace hepperiana*). Epizoochorous taxa are limited to herbaceous Rubiaceae (e.g. *Galium aparine* fruits are densely covered with hooked bristly hairs).



*Ixora*



*Luculia gratissima*

*Coffea arabica*



## Family Asclepiadaceae



The **Asclepiadoideae** are a subfamily of plants in the family Apocynaceae. Formerly, they were treated as a separate family under the name **Asclepiadaceae**, e.g. by APG II, and known as the milkweed family.

They form a group of perennial herbs, twining shrubs, lianas or rarely trees but notably also contain a significant number of leafless stem succulents. The name comes from the type genus *Asclepias* (milkweeds).

There are 348 genera, with about 2,900 species. They are mainly located in the tropics to subtropics, especially in Africa and South America.

The florally advanced tribe Stapelieae within this family contains the relatively familiar stem succulent genera such as *Huernia*, *Stapelia* and *Hoodia*. They are remarkable for the complex mechanisms they have developed for pollination, which independently parallel the unrelated Orchidaceae, especially in the grouping of their pollen into pollinia. The fragrance from the flowers, often called "carrion", attracts flies. The flies pollinate the flowers.

Many new hybrids have been formed due to the unique fertilization method of the flowers.

### ***General Characters of Asclepiadaceae:***

Plants—perennial herbs or shrubs, or woody climbers (e.g., *Dregea*, *Finlaysonia*, etc.), with milky latex. Leaves—usually opposite and decussate, simple, entire, usually exstipulate. Inflorescence— usually cymose. Flowers—regular, bisexual, hypogynous, gynandrous, either petals or stamens or both may bear appendages of various forms forming a single or double corona.

**Sepals**—(5), very deeply partite, quincuncial.

**Petals**—(5), generally rotate, sometimes campanulate or salver-shaped or funnel-shaped, imbricate, rarely valvate (e.g., *Dregea*). **Stamens**—5, usually adnate to the pistil forming a gynostegium; filaments united into a hollow column enclosing the style; pollen grains united into 1 or 2 pollinia in each antherlobe (in subfamily Cynanchoideae) or remain in tetrads (in subfamily Periplocoideae); the pollinia usually being united in pairs to a gland (retinaculum) on the 5-angular stigma and covered by a membrane (cf. *Orchidaceae*).

**Carpels**—2, united only by their styles and free below; ovary superior with numerous, anatropous and pendulous ovules situated on the ventral suture; styles 2, cohering above and dilating to form a flat, 5-angular or lobed stigmatic head. **Fruit**—of 2 follicles. **Seed**—comose, with bony endosperm and large embryo

**Number and Distribution of Asclepiadaceae:**

This family consists of 280 genera and about 1,800 species which are chiefly tropical.

***Range of Floral Structures in Asclepiadaceae:***

The plan of the flower is remarkably uniform with three regularly alternating pentamerous whorls of sepals, petals and stamens respectively and a bicarpellary pistil crowning the axis. The corolla is usually divided forming a rotate structure but the tube sometimes becomes longer, forming a salver-shaped corolla, as in *Stephanotis*, or pitcher-form corolla, as found in *Ceropegia*.

Flowers are generally regular, but zygomorphic flower is found in *Ceropegia*. There are often found great variations in the form of corona-like petaloid appendages which arise just from the back of the stamens or sometimes from the corolla.

The shapes of the flowers are generally small; but relatively large flowers are found in *Ceropegia*, *Stapelia* and *Stephanotis*.

The five stamens and two carpels have separate origin on the floral axis. The ovaries are generally apocarpous, but the styles uniting to form a swollen stigma-head. It may become flattened, or more or less conical, or beaked.

The anthers are united laterally to form a 5-sided blunt cone which remains attached to the stigma-head. This sort of union of anthers and pistil forms a structure, known as gynostegium.

This family has been divided into 2 subfamilies based on the pollen structure. The first subfamily is Periplocoideae, characterized by the presence of granular pollen tetrads and translators spoon-shaped provided with an adhesive disc. Examples—*Hemidesmus*, *Cryptolepis*, etc.

The second subfamily is Cynanchoideae, characterized by the pollens aggregated in 2-4 wax-like bodies known as pollinia. It contains the following genera, each has different pollinia construction. In genera *Asclepias* and *Calotropis*, pollinia are two in each anther, i.e., 10 in all; in *Secamone* and *Genianthus*, the pollinia are four in each anther, i.e., 20 in all; in genera, such as, *Tylophora* and *Dregea*, pollinia two in each anther but erect. In genus *Gonolobus*, the pollinia are in pairs in each anther but transverse.

***Common Plants of Asclepiadaceae:***

- (1) *Calotropis procera* R. Br., a shrub with purplish flower growing throughout the plains of India.
- (2) *Calotropis gigantea* R. Br.
- (3) Indian sarsaparilla (*Hemidesmus indicus* R. Br.), a twining shrub.
- (4) Milk weed or Silk weed (*Asclepias acida* Roxb. = *Sarcostema acidum* Voigt.).
- (5) *Asclepias curassavica* L., an erect perennial herb found in gardens and waste places near villages.
- (6) *Finlaysonia obovata* Wall. = *F. maritima* Backer, a large climbing plant found in Sundribans.
- (7) *Sarcolobus globosus* Wall., another climbing plant found in Sundribans.
- (8) *Cynanchum callialata* Ham., a twining shrub.
- (9) Wax-plant (*Hoya parasitica* Wall.), a twining epiphyte bearing wax-like leaves and flowers.
- (10) *Daemia extensa* Br. = *Pergularia daemia* Chois., a common climbing plant with spinous follicles.
- (11) *Dischidia rafflesiana* Wall., a stout twiner with pitchers 2-5 inches long, commonly found in Assam.
- (12) Rubber vine (*Cryptostegia grandiflora* R. Br.), a large stout climber in gardens.
- (13) *Pentatropis microphylla* W. & A., a slender twining herb, can be found from the salt lakes southwards to Sundribans.
- (14) *Dregea volubilis* Benth. = *Marsdenia volubilis* T. Cooke, a stout tall climber.
- (15) *Sarcostemma brevistigma* Wight, grows wild.
- (16) *Tylophora asthmatica* W. & A. = *T. indica* Merr., a slender twining herb, very common.
- (17) *Oxystelma esculentum* R. Br., a climbing perennial herb.
- (18) *Cryptolepis buchanani* R. & S., common in hedges and village-shrubberies.
- (19) *Pergularia minor* Andr. = *Telosnia minor* Craib., a glabrous twining undershrub of gardens.



(20) *Marsdenia tenacissima* W. & A., very common.

***Affinity and Economic Importance of Asclepiadaceae:***

This family bears an affinity with families, such as, Oleaceae, Loganiaceae, Gentianaceae and Apocynaceae in the characters of aestivation, in the form and shape of calyx and the number of carpels, but readily distinguished from them by gynandrous flowers, valvate corolla, presence of pollinia and gynostegium.

***Economic Importance of Asclepiadaceae:***

This family is of economic importance. Some plants, such as, *Hemidesmus*, *Calotropis*, *Tylophora*, etc., have medicinal properties. Some species of *Asclepias* are deadly poisonous. The Ceylon milk plant (*Gymnema lactiferum*) is used as an article of food. An inferior quality of rubber is obtained from *Cryptostegia grandiflora*. A few plants are ornamentals, such as, *Asclepias*, *Hoya*, *Stapelia*, *Periploca*, *Ceropegia*, *Cryptostegia*, etc.



*Matelea denticulata*



*Asclepias syriaca*

## Family Poaceae

**Poaceae** or **Gramineae** is a large and nearly ubiquitous family of monocotyledonous flowering plants commonly known as **grasses**. It includes the cereal grasses, bamboos and the grasses of natural grassland and species cultivated in lawns and pasture. The latter are commonly referred to collectively as **grass**.

With around 780 genera and around 12,000 species, the Poaceae is the fifth-largest plant family, following the Asteraceae, Orchidaceae, Fabaceae and Rubiaceae.

The Poaceae are the most economically important plant family, providing staple foods from domesticated cereal crops such as maize, wheat, rice, barley, and millet as well as feed for meat-producing animals. They provide, through direct human consumption, just over one-half (51%) of all dietary energy; rice provides 20%, wheat supplies 20%, maize (corn) 5.5%, and other grains 6%. Some members of the Poaceae are used as building materials (bamboo, thatch, and straw); others can provide a source of biofuel, primarily via the conversion of maize to ethanol.

Grasses have stems that are hollow except at the nodes and narrow alternate leaves borne in two ranks. The lower part of each leaf encloses the stem, forming a leaf-sheath. The leaf grows from the base of the blade, an adaptation allowing it to cope with frequent grazing.

Grasslands such as savannah and prairie where grasses are dominant are estimated to constitute 40.5% of the land area of the Earth, excluding Greenland and Antarctica. Grasses are also an important part of the vegetation in many other habitats, including wetlands, forests and tundra.

Though they are commonly called "grasses", groups such as the seagrasses, rushes and sedges fall outside this family. The rushes and sedges are related to the Poaceae, being members of the order Poales, but the seagrasses are members of order Alismatales. However, all of them belong to the monocot group of plant

### *Description*

Grasses may be annual or perennial herbs, generally with the following characteristics (the image gallery can be used for reference): The stems of grasses, called culms, are usually cylindrical (more rarely flattened, but not 3-angled) and are hollow, plugged at the nodes, where the leaves

are attached. Grass leaves are nearly always alternate and distichous (in one plane), and have parallel veins. Each leaf is differentiated into a lower sheath hugging the stem and a blade with entire (i.e., smooth) margins. The leaf blades of many grasses are hardened with silica phytoliths, which discourage grazing animals; some, such as sword grass, are sharp enough to cut human skin. A membranous appendage or fringe of hairs called the ligule lies at the junction between sheath and blade, preventing water or insects from penetrating into the sheath.



Inflorescence scheme and floral diagram. 1 – glume, 2 – lemma, 3 – awn, 4 – palea, 5 – lodicules, 6 – stamens, 7 – ovary, 8 – styles.

Flowers of Poaceae are characteristically arranged in spikelets, each having one or more florets. The spikelets are further grouped into panicles or spikes. The part of the spikelet that bears the florets is called the rachilla. A spikelet consists of two (or sometimes fewer) bracts at the base, called glumes, followed by one or more florets. A floret consists of the flower surrounded by two bracts, one external—the lemma—and one internal—the palea. The flowers are usually hermaphroditic—maize being an important exception—and mainly anemophilous or wind-pollinated, although insects occasionally play a role. The perianth is reduced to two scales, called *lodicules*, that expand and contract to spread the lemma and palea; these are generally interpreted to be modified sepals. The fruit of grasses is a caryopsis, in which the seed coat is fused to the fruit wall. A tiller is a leafy shoot other than the first shoot produced from the seed.

### **Growth and development**

Grass blades grow at the base of the blade and not from elongated stem tips. This low growth point evolved in response to grazing animals and allows grasses to be grazed or mown regularly without severe damage to the plant. Three general classifications of growth habit present in grasses: bunch-type (also called caespitose), stoloniferous, and rhizomatous. The success of the grasses lies in part in their morphology and growth processes and in part in their physiological

diversity. There are both C3 and C4 grasses, referring to the photosynthetic pathway for carbon fixation.



#### Grass flowers

The C4 grasses have a photosynthetic pathway, linked to specialized Kranz leaf anatomy, which allows for increased water use efficiency, rendering them better adapted to hot, arid environments.

The C3 grasses are referred to as "cool-season" grasses, while the C4 plants are considered "warm-season" grasses.

- Annual cool-season – wheat, rye, annual bluegrass (annual meadowgrass, *Poa annua*), and oat
- Perennial cool-season – orchardgrass (cocksfoot, *Dactylis glomerata*), fescue (*Festuca* spp.), Kentucky bluegrass and perennial ryegrass (*Lolium perenne*)
- Annual warm-season – maize, sudangrass, and pearl millet
- Perennial warm-season – big bluestem, Indiangrass, Bermudagrass and switchgrass.

Although the C4 species are all in the PACMAD clade (see diagram above), it seems that various forms of C4 have arisen some twenty or more times, in various subfamilies or genera. In the *Aristida* genus for example, one species (*A. longifolia*) is C3 but the approximately 300 other species are C4. As another example, the whole tribe of Andropogoneae, which includes maize, sorghum, sugar cane, "Job's tears", and bluestem grasses, is C4. Around 46 percent of grass species are C4 plants.

