Manual of
Flowering Plant Terminology
for Pacific Islands' Botany

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INTRODUCTION

One of the most important aspects of botany is the identification of plant species. There is a need in many fields of science to know the name of a plant upon which the scientist or layman is working. Conservationists must be able to identify the plants in the areas they study, especially the rare species. Farmers must be able to identify the weeds that infect their crops so they can select the most suitable herbicides. Native healers must be able to identify the plants they use for medicine. And gardeners want to know the name of the plants that grow in their garden. However, the process of plant identification is sometimes difficult and inaccurate. Most people can only identify the plants they see and interact with regularly—mostly food plants and ornamentals, which are rarely a problem for identification. It is the weeds and the species native to an area that are the most difficult to identify.

There are a number of methods for identifying unknown plants, some of them accurate, some of them not so accurate. The easiest method for most people is to ask someone else who may know the answer. This has its pitfalls, however, because the one asked may not know the plant and give an incorrect identification. So the answer obtained is only as good as the knowledge of the person asked. A second method is to look up the unknown plant in a book that has photos or drawings. This can be very accurate if the plant is pictured, but often it is not. The main problem with this is that many plants are not pictured in books, and the right books may not be available. In Samoa, most of the lowland trees are pictured in *Rainforest Trees of Samoa*, but there are many photos to view, and this method is best done when the researcher already has an idea of what the unidentified plant is, i.e., the method works best when one is checking a previously learned identification. Most of the Pacific Islands lack comprehensive books with useful photographs or drawings.

The most accurate way to identify a species, with or without a photograph or drawing, is to compare the plant with a botanical description, assuming that the researcher has knowledge of the terms used to describe plants. Also useful are taxonomic keys, which are written devices used to distinguish somewhat similar species from each other. Taxonomic keys begin with a question about the plant. For instance, does the plant have some particular structure or not? Does it have one flower color or another? Are its flowers one cm or two cm long? Once a choice is made, the researcher goes to another pair of questions to which he/she is directed, and again reads the two choices. The best one is picked, and the process is repeated until a species is reached. Most floras (books about the plants in an area) include these taxonomic keys and descriptions.

Another good method of identifying a plant is to match a collected plant with a preserved specimen found in a herbarium, which is a collection of correctly identified dried plant specimens usually housed in cabinets in a special room or building. The trouble with this method is that most places in the Pacific do not have herbaria, or if they do, they are not very accessible.

The last method of plant identification to be mentioned is the Internet, which has revolutionized the identification of unknown plants in the Pacific (and elsewhere). If the researcher thinks he or she knows the name of the plant, a visit to a search engine like Google may turn up photos of the plant. This does not work very well on species restricted to the Pacific Islands, however, but hopefully the situation will be improved in the near future. Regardless of the method used, it is important to be able to read a botanical description.

The following manual was written to help people, with at least some science background, identify unknown plant species. One of the most important needs for identifying plants from description is terminology. People who do not know the terminology and cannot read and understand a botanical description will have great difficulty identifying plants by this method. Once someone understands all the important terminology and can recognize the variation in plants, diagnostic characteristics that facilitate identification will be easier to spot.

Organization of the Material

The plant parts used in identification in this manual are arranged in an orderly fashion. The parts concerned with growth and respiration are referred to as vegetative parts; those concerned with reproduction via sexual means (i.e., pollination and fertilization) are referred to as reproductive parts. The first two sections, Habit and Longevity, fit somewhat into both categories, but are included here in the vegetative category. The vegetative parts are arranged in the categories Roots, Stems, and Leaves. The reproductive parts are arranged in the categories Calyx, Corolla, Stamens, Pistil, Inflorescence, and Fruit. These are followed by a miscellaneous section that includes terms not covered in the previous sections. Each section has its own glossary, and these are combined into a comprehensive Glossary at the end of the manual.

Vegetative Parts

1. HABIT

One of the first things a botanist notices about an unknown plant is its **habit**. Habit is the gross physical form of the plant. The four general categories of habit are tree, shrub, vine, and herb, and variations can be distinguished in each of these categories. In plant descriptions, the first line usually includes the habit, e.g., "Large tree up to 20 m in height…" or "Understory tree up to 4 m in height…"

A **tree** is a relatively large woody plant with a single stem. Tropical rainforests often have a tall, fairly even layer called a canopy, where the largest trees have most of their leaves (they usually have tall trunks that branch only near the top of the tree). The trees with their tops in this layer are called **canopy trees**. In some tropical rainforests, scattered trees emerge and extend above the canopy; these are called **emergent trees**. It is often difficult in the field to distinguish between these two types (which sometimes blend into each other), especially since the collectors are on the ground and cannot see on top of the canopy. So in practice very large trees are often referred to just as "large trees" in plant descriptions.

In some tropical rainforests there is a distinct group of trees whose crowns do not reach the canopy. These are called **subcanopy trees**. However, if the large trees have been removed from the forest, as when selective logging occurs, the tops of these trees may be in, or form, the canopy layer. **Understory trees** are small species that occur in the forest, and may range in height from 2 to 10 m or more in height. Understory trees usually do not form a distinct layer, but occur scattered in the forest.

A **shrub** is a relatively small woody plant with more than one stem from the base. The difference between a small tree and a large shrub is sometimes difficult to define, but the two are best distinguished by whether the trunk branches at the base or higher up (some species seem to be intermediate!). Shrubs are relatively uncommon in the tropical rainforest, but are more common in open vegetation. Some (but few) vines have long flexible stems, and when they occur in forest, the stems sometimes lean over tree branches and grow up towards the canopy. These are called **scandent shrubs**, which are halfway between a shrub and a liana. **Herbs** are generally small plants lacking any woody tissue. They are sometimes divided into categories such as grass, sedge, forb, etc. Species that are intermediate between shrubs and herbs are often called **subshrubs**. Herbs that grow on the ground are called **terrestrial herbs**, while those that grow on tree trunks or branches are called **epiphytes**.

Vines are relatively weak-stemmed plants that either grow prostrate along the ground or by several different means climb into trees and grow up towards the canopy or the tops of other plants where they can get the light they need. Several different variations can be

recognized. **Prostrate vines** grow along the ground without rooting at the nodes, and have no specialized means of climbing onto other vegetation. They usually occur in sunny places, especially in harsh environments that eliminate most other plant species from growing there (e.g., beaches).

Climbing vines are plants that have specialized means of climbing onto adjacent trees or shrubs, sometimes extending far up into the canopy. **Herbaceous climbing vines** usually climb onto vegetation by means of stem tips that grow in a circling motion noted above, which allows them to wrap around adjacent stems or branches and from there grow up to the top of the plant. The other common method of climbing used by herbaceous climbing vines is by means of **tendrils** (also see the Leaves section). This is typically a modified stem, leaf, or stipule that forms thread-like ends that have the same twining motion growth that allows them to latch onto nearby plants. If the vine is woody, and thus able to live longer and climb up into the canopy, it is called a **liana**. The last type of vine found in Samoa is called a **trunk climber**. These plants ascend straight up a tree trunk, to which they adhere by means of **adventitious roots** (roots forming at places other than the bottom of the stem, in this case, at the nodes; see Roots section and Fig. 1).

Glossary for Habit

Adventitious roots—Roots appearing on the plant in places other than the stem base.

Canopy tree—A large tree whose crown occurs in a more or less discrete layer (the canopy) made by the foliage of tallest trees in the forest.

Emergent tree—A very large tree scattered in the forest with its crown conspicuously emerging above the canopy.

Epiphyte—A plant, usually herbaceous, that grows on another plant. It uses the "host plant" as a place to live, does not harm it like parasites do.

Habit—The physical form of a plant, e.g., tree, shrub, etc.

Herb—A non-woody plant, usually small. Compare shrub.

Herbaceous climbing vine—A weak-stemmed vine that climbs onto vegetation rather than growing prostrate on the ground.

Liana—A woody vine that often climbs up into the canopy.

Prostrate vine—A weak-stemmed plant that lacks the ability to climb and hence grows along the ground.

Scandent shrub—A shrub with weak stems that can ascend into trees. It is intermediate between a shrub and a vine.

Shrub—A relatively short, woody plant with branches forming near to the ground.

Subcanopy tree—A tree whose crown grows in a zone (the subcanopy) below that formed by the tallest trees (canopy trees).

Subshrub—A plant intermediate between a shrub and an herb.

Tendril—A thread-like plant organ that by its rotating growth allows a plant to become attached to another plant for support. (Fig. 2)

Terrestrial herb—Herbaceous plant that grows on the ground.

Tree—A woody plant with a single trunk and without branches near the base. Compare shrub.

Trunk climber—A vine that climbs trees by means of adventitious roots that allow the plant to adhere to its host. (Fig. 3)

Understory tree—A relatively small tree whose crown does not reach the forest canopy.

Vine—A woody or herbaceous plant with weak stems that either grows along the ground or has specialized structures or growth characteristics that allow it to climb onto taller plants.

2. LONGEVITY

In addition to plants having a variety of different physical forms (habit), they also have different survival strategies based on how long they live. The usual condition for flowering plants, especially woody ones, is **perennial**, which means long living. However, in some habitats, a long life is harmful to the survival of the species. For example, in very arid deserts with little rainfall, most of the species present are **annuals**, i.e., plants that live one year (technically, one season) to avoid the hot dry season. Annuals are always herbaceous, never woody since they do not live long enough to form wood. After a rainstorm or rainstorms, usually in the "wet season" of the area, the plants' seeds rapidly germinate to form the seedlings, which then grow, flower, fruit, and then die before the soil dries up. If these annuals are taken out of their normal habitat and moved into an area where the soil is moist enough for survival throughout the year, they may live much longer, which can blur the distinction between perennial and annual. There is also an intermediate form between the two. Some plants (**biennials**), particularly in cold or temperate areas, live for two years; the first year is devoted to vegetative growth, after which the plant may die back to the root. When the second growing season starts, the plant makes new leaves, and at the same time flowers and fruits, dying at the end of the second growing season. Biennials are virtually unknown in the warm tropics, to which their lifestyle is unsuited.

Another characteristic of some plants is the loss of their leaves during an unfavorable time of the year. This is called **deciduous**. This is characteristic of whole forests in temperate areas (deciduous forests). There is often a time of the year, the fall, when, over a short period of time, most or all of the trees comprising the forest lose their leaves. The leaves often change to attractive red or yellow colors, and result in a beautiful phenomenon, "fall colors," that may extend across wide areas of forest.

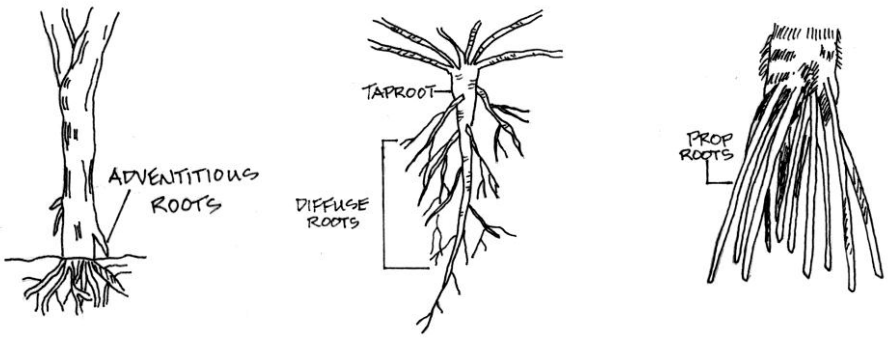
Glossary for Longevity

Annual—A plant having a life span of a single year or season. Compare perennial.
Biennial—A plant that lives two years or seasons, using the first growing season to produce stored food, and the second to produce flowers and fruits.
Deciduous—Said of a plant that sheds its leaves for part of the year.
Perennial—A plant living more than one season or year. Compare annual.

3. ROOTS

The roots of a plant are used to anchor it into position (usually in the soil) and absorb minerals and water needed for the growth. Roots are typically underground, but some may be aerial and adapted for other uses. Two standard types of underground roots are recognized: tap roots and diffuse roots. **Taproots** (Fig. 1) are roots with a main thickened axis, and are characteristic of many dicot plants. A carrot is a good example of a taproot. **Diffuse roots** (Fig. 1) are ones that divide numerous times. Nearly all monocots, e.g., grasses, as well as many dicots, have only diffuse roots (i.e., they lack tap roots).

Sometimes roots form in unusual places, i.e., places other than the bottom of the stem. These are called **adventitious roots** (Fig. 1), examples of which include the **prop roots** (Fig. 1) of screwpine and the adhering roots that form at the stem nodes of *Freycinetia* spp. that allow the plant to grow on and climb up tree trunks. Roots are not typically used in identifying plants, since they are usually underground and not found on collected specimens.



Glossary for Roots

Adventitious roots—Roots appearing on a plant in places other than the stem base. See Fig. 1.

Diffuse roots—Roots that repeatedly divide rather than forming one main root, as in nearly all monocots. Compare taproot. See Fig. 1.

Prop root—A type of adventitious root that forms above ground and serves to support the plant, like those of screwpines. See Fig. 1

Taproot—A thickened, usually solitary root of some dicot plants, such as carrots. Compare diffuse root. See Fig. 1.

4. STEMS

A stem is the part of the plant that connects the roots to the branches and leaves. Some plants lack stems (or the stem is so condensed that it is not obvious), but most have them. A woody stem of a tree is called a **trunk**. Stems have several characteristics that can help to identify species. Most stems are round in cross-section, a condition referred to as **terete**. Others are **square stems**, which are characteristic of some groups of dicots, particularly the Mint Family Lamiaceae. Some plants have triangular stems 3-angled in cross-section, a characteristic feature of members of the Sedge Family Cyperaceae. The angles of a stem or other plant structure can be simple, or they may be in the form of wing-like processes called wings (**winged stems**). Such stems are referred to as **alate**. Stems of grasses and sedges are called **culms** (Fig. 4).

The stem itself is divided into the internodes and nodes. A **node** (Fig. 3) is the point of attachment of a leaf. One, two, or even more leaves may be found at the node (see the Leaf Arrangement section). The portion of the stem between nodes is called the **internode** (see Fig. 3). The most conspicuous characteristic of some stems is the presence of spines, prickles, and thorns. These terms are often used synonymously, but there are technical differences between them. **Spines** are formed from modified petioles or stipules; **thorns** are formed from modified leaves; and **prickles** are spine-like outgrowths from the epidermis (like rose "thorns," which are not technically thorns). These three types differ in origin, but without seeing their development, it is sometimes difficult to distinguish between them. Most are straight, but some are **recurved**, which makes them difficult to remove from the skin without further injury.

Some plants have **tendrils** (Fig. 2) that assist in climbing. These are usually thread-like and grow in a rotating pattern to wrap around other stems, allowing the climbing plant to

cling to the host. The main stem, branches, leaves, or even stipules may be the source of the tendril. Other obvious distinguishing characteristics of stems include the presence or absence of hairs, the color, and the presence or absence of **striations**, which are fine parallel grooves. Some stems have obvious spots on them, called **lenticels**, which are corky outgrowths that allow gases (oxygen, water, carbon dioxide) into and out of the stem (the rest of the surface is often coated with a waxy layer impermeable to gases).

Some stems are highly modified and don't even look like stems. A potato is a modified stem (the "eyes" are the branch buds). Such a modified swollen, underground root is called a **tuber**. If the thickened underground stem is covered with dry, scale-like leaves and serves for food storage, it is called a **corm** (as in taro). Similar to these is a **bulb**, which comprises swollen food-storing leaves, e.g., onions. Some stems are modified for spreading across the ground, often rooting at the nodes. These modified stems are called **stolons** (Fig. 2) when they go along the surface of the ground, and **rhizomes** (Fig. 2) when they grow beneath the soil surface. Stems may be solitary, but sometimes they come out from the roots in clusters, a condition referred to as **tufted**.

One other characteristic often important in identification of unknown plants should also be mentioned: the presence of **milky sap**. This characteristic is found only in certain families. Some plant families (e.g., the Milkweed Family Asclepiadaceae) have milky sap in nearly all of its members, while in other families (e.g., the Aster Family Asteraceae or Spurge Family Euphorbiaceae) only some of its members have this characteristic.

Glossary For Stems

Alate—Winged, said of stems.

Bulb—Structure formed when swollen leaves surround an underground stem and serve for food storage. Compare corm and tuber.

Corm—A swollen underground stem covered with dry scales and serving for food storage. Compare tuber and bulb.

Culm—The stem of a grass or sedge. (See Fig. 4)

Internode—The part of a stem between the nodes or points of attachment of leaves. (See Fig. 3)

Lenticels—Tiny holes on a stem serving for aeration of the internal tissues. Stems marked by these conspicuous dots are referred to as lenticellate.

Milky sap—The presence of a milky latex in the phloem of some species in some families, like the Milkweed Family Asclepiadaceae.

Node—Point of attachment of a leaf on a stem. (See Fig. 3)

Prickle—A sharp-tipped outgrowth from a stem. A rose "thorn" is actually a prickle. Compare thorn and spine.

Recurved—Bent backward, often said of prickles with a short terminal hook.

Rhizome—An underground stem, usually with nodes and buds. Rhizomatous means bearing rhizomes. (Fig. 2)

Spine—A stiff, woody, sharp-tipped structure formed from a petiole or stipule. Compare prickle and thorn.

Square stem—Stem that is square in cross section, as in the Mint Family Lamiaceae.

Stolon—A horizontal stem rooting at the nodes or producing a new plant at its tip. (Fig. 2)

Striation—A fine groove, as on some stems. The adjective form is striate.

Tendril—A thread-like plant organ that by its rotating growth allows a plant to become attached to another plant for support. (Fig. 2)

Terete—Round in cross-section, said of stems.

Thorn—A stiff, woody, sharp-pointed structure formed from a modified leaf. Rose "thorns" are actually prickles. Compare spine and prickle.

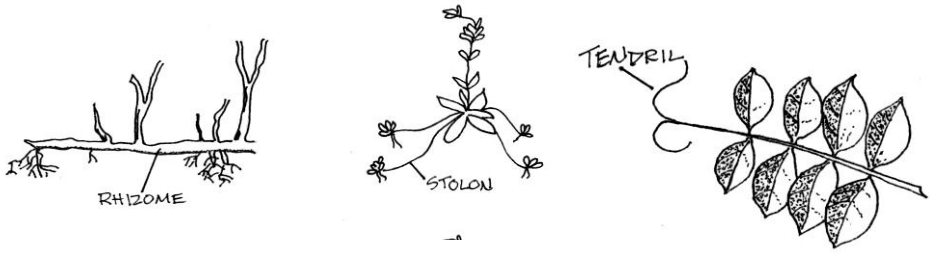
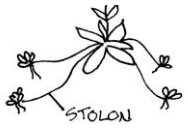


Fig. 2. Stem Characters



Trunk—A thick woody stem, s
Tuber—An underground, swoll ants.
Tufted—Said of plants with the cially grasses.
Winged stems—Stems with wings or longitudinal ridges running down it and/or the petiole.

5. LEAF PARTS

Leaves (singular: **leaf**) are the principle photosynthetic and transpiring organs of vascular plants. Most plants have leaves, but some have lost them, with their functions taken over by roots, stems, or other structures. Plants lacking leaves are referred to as **leafless**. Leaves have several basic parts. The **blade** or **lamina** (Fig. 3) is the expanded photosynthetic portion of the leaf, and is usually borne on a stalk called the **petiole** (Fig. 3). The upper leaf surface (called **axial surface**) often differs from the lower surface (**abaxial surface**) in color and degree of hairiness. The angle between the upper leaf surface and the stem is called the **axil** (Fig. 3). The leaf axil of nearly all dicot plants bears an **axillary bud** (Fig. 3) that may or may not develop into a branch or inflorescence. This bud serves to distinguish a simple leaf from a compound leaf (see below). The petiole extends into the blade to its tip; this portion of the blade is called the **midrib** (Fig. 3) or **midvein**, which contains the xylem and phloem tissue that transports water and minerals into and sugar out of the leaf. The midrib branches into smaller veins (also sometimes called **nerves**) called **secondary veins** (Fig. 3). The secondary veins further branch into **tertiary veins** (Fig. 3). The tip of the leaf is called the **apex** (Fig. 3).

Several other minor parts of leaves should be mentioned. Leaves often have a pair of tiny structures called **stipules** on either side of the base of the petiole. These have no known function (except when they are evolutionarily modified for something else), but they are often helpful in identifying unknown species because plant families are often stipulate (having stipules) or estipulate (lacking stipules), but not both. The Madder Family Rubiaceae is often easily recognized by the stipules that form a sheath across the node, a condition known as an **interpetiolar stipule** (Fig. 4). Grasses often have the base of the leaf forming a **sheath** (Fig. 4) around the stem. At the top where the blade joins the sheath, there is typically a structure called a **ligule** (Fig. 4), usually a membrane or row of hairs, that is helpful in differentiating species (which is difficult in grass specimens lacking flowers).

The arrangement of the veins, called **venation**, is often characteristic of different groups of plants. The secondary veins may be arranged in feather-like fashion (**pinnate venation**; pinna is the Latin word for feather) or they may branch irregularly (**reticulate** or **netted venation**). This is characteristic of **dicots. Monocots** (which include palms, grasses, and orchids) typically have all the veins arranged parallel to each other (**parallel venation**), either originating at the base and extending the length of the leaf, or originating from a midrib.

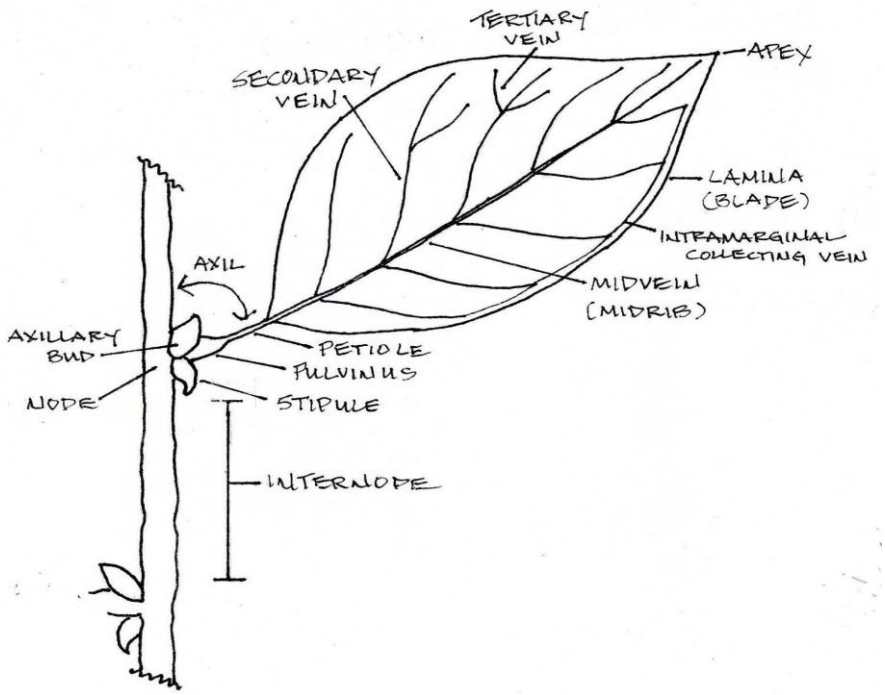


Fig. 3. Leaf Parts

Monocots virtually never have reticulate venation. Some plants, particularly members of the Myrtle Family Myrtaceae, have a vein, called an **intramarginal collecting vein**, running along the leaf margin. Other species have the veins near the surface appearing translucent; these are referred to as **aqueous veins**. Most leaves are **stalked**, but some lack a petiole and are called **sessile**. In some leaves, the petiole may be extremely short, in which case the leaf is referred to as being **subsessile**. The petiole may be smooth, but many have a small groove on the upper surface; such petioles are referred to as **canaliculate**. Some leaves have the base of the petiole enlarged, especially members of the Pea Family Fabaceae. This enlarged base is called a **pulvinus** (Fig. 3).

Glossary for Leaf Parts

Abaxial surface—The side of the organ away from the axis, e.g., the lower leaf surface.
Apex—The tip (e.g., of a leaf). (Fig. 3)
Aqueous veins—Veins that appear to be translucent on the leaf surface rather than opaque.
Axial surface—The upper leaf surface.
Axil—The upper angle between a leaf petiole and stem, and site of the axillary bud. Flowers situated in the axil are referred to as being axillary. (Fig. 3)
Axillary bud—The bud in a leaf axil that can develop into a branch or inflorescence. (Fig. 3)
Blade—The expanded photosynthetic portion of the leaf. Also called lamina. (Figs. 3, 4)
Canaliculate—Having a small channel or groove, as on the upper side of some petioles.

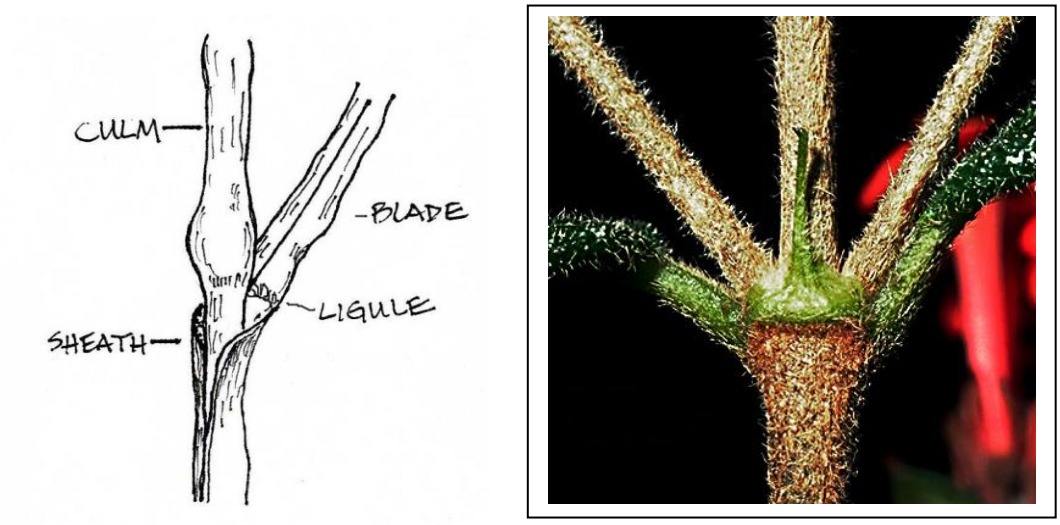


Fig. 4. Specialized Leaf Parts (Culm and Interpetiolar Stipules).

Dicot—One of the two classes of flowering plants (angiosperms) that includes most flowering plant species. Dicot is short for the group Dicotyledonae, a word based on the characteristic two seed leafs (cotyledons) in the embryo. Compare monocot.

Interpetiolar stipule—The sheathing structure situated on a stem between two petioles of opposite leaves, almost exclusively restricted to all members of the Madder Family Rubiaceae. (Fig. 4)

Intramarginal collecting vein—A vein running parallel to and near the margin, which is joined by or formed from the ends of the secondary veins. (Fig. 3)

Lamina—Blade of a leaf. (Fig. 3)

Leaf—The expanded, photosynthetic organ of a plant.

Leafless—Said of plants that have through evolution lost their leaves.

Ligule—Small appendage comprising a membrane or row of hairs found at the junction of the blade and sheath of members of the Grass Family Poaceae. (Fig. 4)

Midrib (midvein)—The extension of the petiole that runs to the tip of the blade. (Fig. 3)

Monocot—One of the two classes of flowering plants (angiosperms) that includes grasses, sedges, palms, gingers, and many other groups. Monocot is short for the group Monocotyledonae, a word based on the characteristic single seed leaf (cotyledon) in the embryo. Compare dicot.

Nerve—A distinct vein of a leaf.

Netted venation—A diffuse kind of leaf venation characteristic of dicots. See parallel venation. (Fig. 5)

Palmate venation—Venation in which the main veins radiate out from one point, like the fingers on the palm of the hand. (Fig. 5)

Parallel venation—Arrangement of veins in a leaf parallel to each other. Compare pinnate, netted, and reticulate venation. (Fig. 5)

Petiole—The stalk of a leaf. Compare petiolule. (Fig. 3)

Pinnate venation—Venation that is divided in feather-like fashion. Compare palmate. (Fig. 5)

Pulvinus—The enlarged base of some petioles, particularly in the Pea Family Fabaceae. (Fig. 3).

Reticulate (netted) venation—Arrangement of veins in a net-like fashion. (Fig. 5)

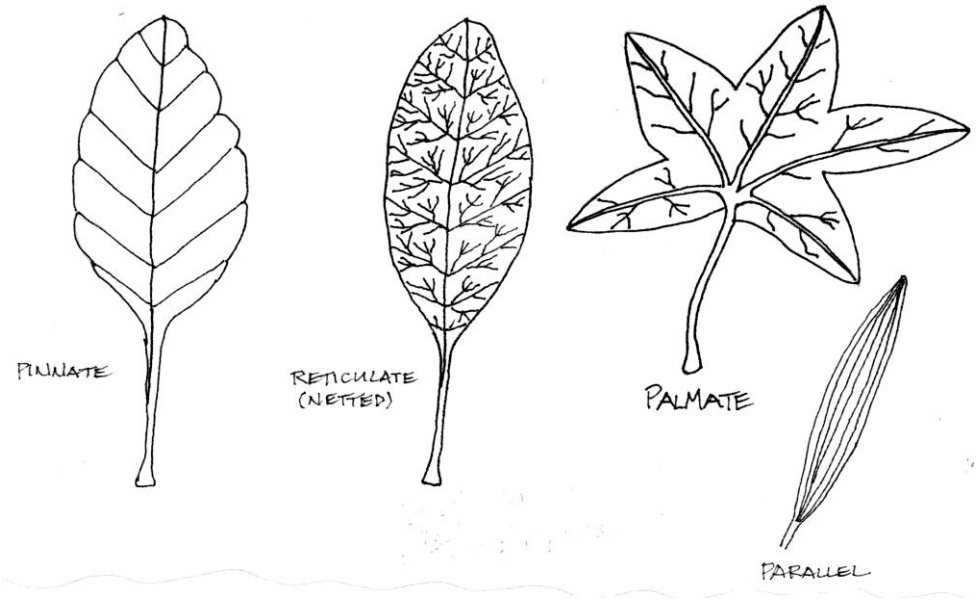


Fig. 5. Leaf Venation

Secondary vein—A vein that branches off from the midrib, and, in dicots in turn branches into tertiary veins. (Fig. 3)

Sessile—Lacking a stalk, said of leaves, flowers, etc.

Sheath—Oblong tubular structure surrounding a plant part, such as a leaf sheath, which is the basal part of a grass leaf that surrounds the stem. (Fig. 4)

Stalked—Said of a leaf, flower, or inflorescence borne on a stalk or petiole. Compare sessile.

Stipules—Paired basal appendages present on the petioles of some plants. Compare stipels in next section. (Fig. 3)

Subsessile—Nearly stalkless or sessile.

Tertiary veins—The small veins into which the secondary veins branch, often forming a netted pattern. (Fig. 3)

Venation—The arrangement of the veins in a leaf.

6. LEAF COMPLEXITY

One of the most recognizable characteristics of leaves is complexity, i.e., whether they are simple or compound. Most leaves comprise a single blade and are referred to as **simple leaves** (Fig. 5). If the blades are divided into several smaller, leaf-like parts, they are called **compound leaves** (Fig. 6). The divisions of a compound leaf are called **leaflets** (Fig. 6) and their stalks are called **petiolules** (Fig. 6). It is sometimes difficult to distinguish between a simple and a compound leaf. The character that serves best to distinguish between the two is the **axillary bud** (Fig. 6) described above. This is a small, incipient branch or inflorescence that occurs in the angle, called the **axil** (Fig. 6), between the stem and the upper leaf surface. The bud often does not develop and remains a bud, but it has the ability to do so under certain conditions. Simple leaves always have this axillary bud in the axil. Compound leaves do not, so the best way to distinguish between the two is to look for the axillary bud.

Compound leaves are found in several variations. If the leaflets are arranged in feather-like fashion (pinnate), the leaf is considered to be **pinnately compound** (Fig. 6). If there is a single unpaired leaf at the end, the leaf is **odd-pinnately compound** (Fig. 6); if the terminal leaflets are paired, the leaf is **even-pinnately compound** (Fig. 6). Sometimes the leaflets are further divided, in which case the leaf is referred to as **bipinnately compound** (Fig. 6). Some leaves are even **tripinnately compound** (Fig. 6). The stalk of a compound leaf is called a **rachis** (Fig. 6). In bipinnately compound leaves, the first division is called the **pinna** (**pinnae** is the plural) (Fig. 6) and the second is called the **leaflet** (Fig. 6).

The second main variation of compound leaves, referred to as **palmately compound** (Fig. 6), is characterized by the leaflets being arranged palmately, as in the palm of the hand (with the leaflets radiating out from one point). Structures that do this are sometimes referred to as **digitate**, like the fingers, or digits, of the hand. If the divisions do not extend to the base of the leaf, then the leaf is said to be **palmately lobed** (Fig. 6). Some compound leaves have only three leaflets, which is common in the Pea Family Fabaceae. This is called **trifoliate** (Fig. 6). (The more technically correct but rarely used term is trifoliolate.) Leaflets, particularly in the Pea Family, often have a thread-like appendage at the base of the petiolule called the **stipel** (Fig. 6) that is comparable to the stipule of a simple leaf.

Leaves do not always fit into neat categories, and sometimes the leaf margins are lobed so much that they make the leaf appear compound. Leaves lobed in a pinnate fashion are referred to as being **pinnately lobed**, or deeply pinnately lobed. Fern **fronds** are typically lobed, in which case they are called **pinnatifid** (or **bipinnatifid** if they are halfway to being doubly lobed—**bipinnately lobed**).

Glossary for Leaf Complexity

Axil—The upper angle between a leaf petiole and stem. Flowers situated in the axil are referred to as being axillary. (Fig. 3)

Axillary bud—The bud in a leaf axil that can develop into a branch or inflorescence. (Figs. 3, 6)

Bipinnately compound—Twice pinnate, the first divisions being further divided into leaflets. (Fig. 6)

Bipinnately lobed—Doubly lobed in feather-like fashion, said of compound leaves with the first division lobed.

Bipinnatifid—Bipinnate compound with the leaflets lobed.

Compound—Said of leaves with the blade further divided into leaflets or pinnae. Compare simple. (Fig. 6)

Digitate—Shaped or arranged like the palm of the hand, said of some plant structures.

Even-pinnately compound—Pinnate with an even number of leaflets, i.e., without a single unpaired leaflet at the tip. Compare odd-pinnately compound. (Fig. 6)

Frond—The leaf of a palm or fern.

Leaflet—The division of a compound leaf. (Fig. 6)

Odd-pinnately compound—Pinnate with an odd number of leaflets, i.e., with an unpaired leaflet at the tip. Compare even-pinnately compound. (Fig. 6)

Palmately compound—Divided in a hand-like fashion all the way to the petiole, usually in reference to leaf blades. (Fig. 6)

Petiolule—The stalk of a leaflet. Compare petiole. (Fig. 6)

Pinna—The first division of a compound leaf; the pinna is further divided into leaflets. Pinnae is the plural.

Pinnately compound—A leaf formed from several leaflets arranged in feather-like fashion. (Fig. 6).

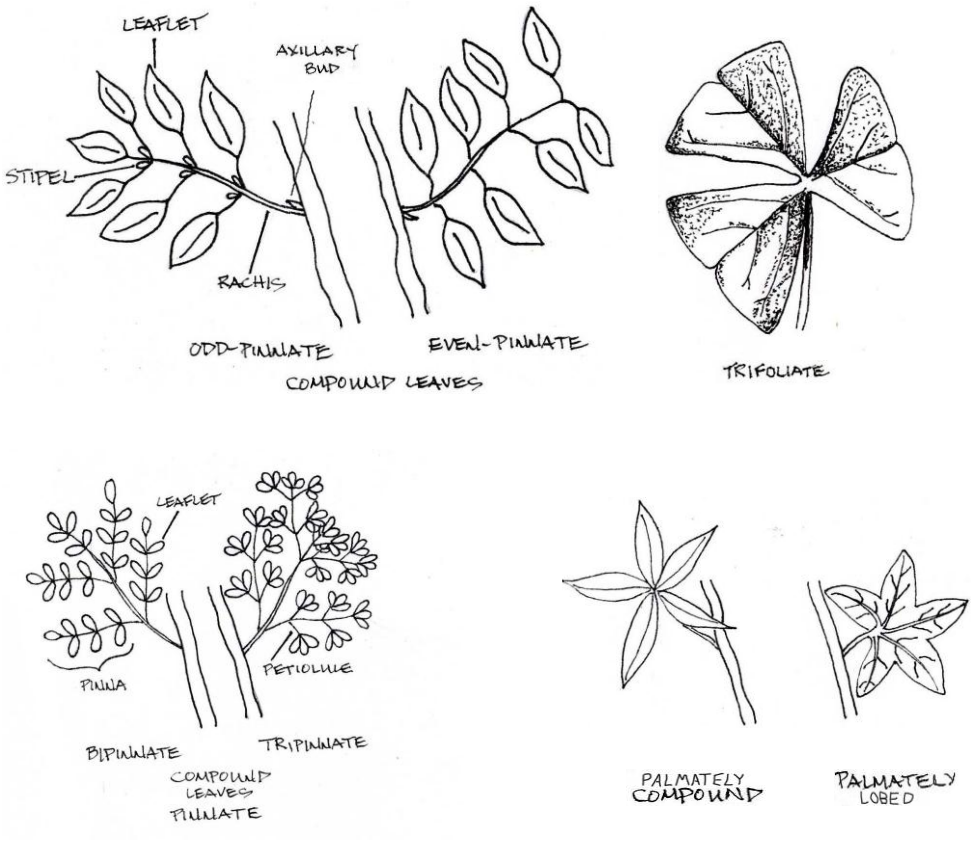


Fig. 6. Leaf Complexity

Pinnately lobed—Lobed in feather-like fashion, as in simple leaves.
Pinnatifid—Deeply cut in pinnate (feather-like) fashion.
Rachis—The axis of a compound leaf or inflorescence. Rachises is the plural. (Fig. 6)
Simple—Said of a leaf or other structure that is not divided into parts. Compare compound.
Stipels—Stipule of a leaflet, usually paired. Compare stipules in previous section. (Fig. 6)
Trifoliate (trifoliolate)—Bearing leaves divided into three leaflets. Also called trifoliolate. (Fig. 6)
Tripinnately compound—Said of a leaf divided three times. Compare bipinnately compound. (Fig. 6)

7. LEAF ARRANGEMENT

Another characteristic important for identification purposes is **leaf arrangement**, i.e., the way the leaves are arranged on the stem. The condition of a single leaf at a node is referred to as **alternate** (Fig. 7); two leaves attached to opposite sides of the node is referred to as **opposite** (Fig. 7). If the opposite leaves are at right angles to the pairs above and below them, the condition is referred to as **decussate** (Fig. 7). If all the opposite leaves are all in the same plane, they are **distichous** (Fig. 7). More than two leaves per node, which is very uncommon, is referred to as **whorled** (Fig. 7). Sometimes all or nearly all the leaves are in a very tight

spiral at the base of the plant, a condition known as a **basal rosette** (Fig. 7). Some families have alternate or opposite leaves exclusively, so this is one of the first characteristics a taxonomist looks at when identifying an unknown species.

Most leaves are thin and serve principally for photosynthesis, but some are modified for other purposes. Some are thick and fleshy for storing water, and are referred to as **succulent** (stems can also be succulent). Others may be modified to store food (see bulb above).

Glossary for Leaf Arrangement

Alternate—Said of leaves arranged one per node. Compare opposite. (Fig. 7)
Basal rosette—The dense, circular cluster of leaves found at the base of some herbs. (Fig. 7)
Decussate—Said of opposite leaves that are at right angles to the pair above and below; such leaves appear in four rows at right angles to each other. Compare distichous. (Fig. 7)
Distichous—Referring to leaves that are all arranged in the same plane of a stem. They can be either alternate or opposite. Compare decussate. (Fig. 7)
Leaf arrangement—The way leaves are arranged on a stem, e.g., opposite or alternate.
Opposite—Referring to leaves borne in pairs at the nodes. Compare alternate. (Fig. 7)
Succulent—Fleshy, used to refer to the stems or leaves of some plants.
Whorled—Said of leaf arrangements having more than two leaves per node. (Fig. 7)

Fig. 7. Leaf Arrangement

8. LEAF SHAPE

The shape (and size) of the leaf is also important in identification of species. The different shapes are not discrete categories since they tend to blend into each other. In some cases a description will use two different shape terms, such as "ovate to cordate." Even though these categories blend into each other, they are still useful in plant identification.

The most common leaf shape is probably **ovate** (Fig. 8), which means to be shaped like a hen's egg, i.e., oval with one end, the basal end, wider than the other. Less commonly the apical end of the leaf is wider, a shape referred to as **obovate** (Fig. 8). The addition of the prefix "**ob-**" to the leaf shape means that the broadest end is towards the tip rather than the more common condition of being widest near the base. Another common shape is **lanceolate** (Fig. 8), i.e., shaped like a lance, with the blade being at least about 2.5 times as long as wide.

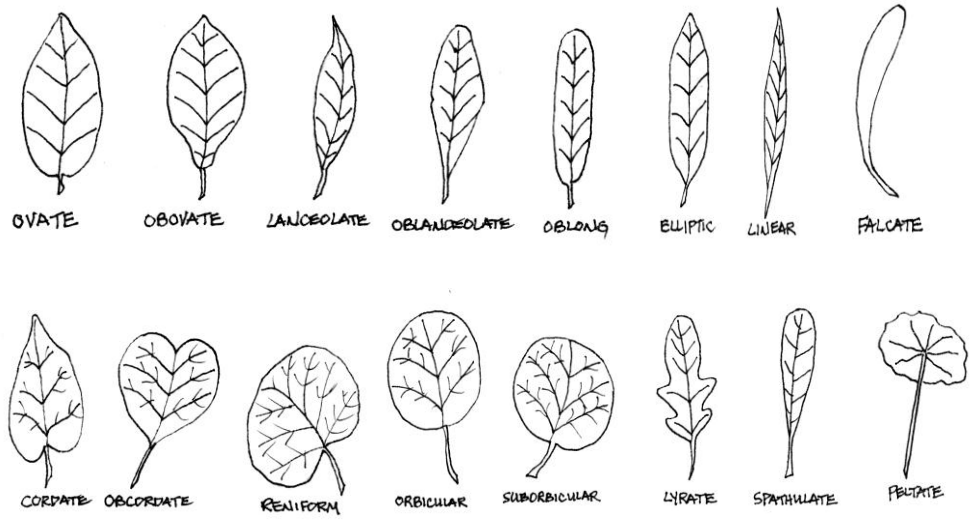


Fig. 8. Leaf Shapes

If the apical end is wider than the basal end, it is called **oblanceolate** (Fig. 8). Obviously, ovate and lanceolate are sometimes difficult to distinguish. Some leaves are widest towards the middle; if the leaf sides in this condition are parallel, the leaf is referred to as **oblong** (Fig. 8); if the sides curve from both ends to the middle, the leaf is referred to as **elliptic** (Fig. 8). The use of the prefix **sub-** on a leaf shape term means that the leaf is just a little less than this condition, as in subsessile noted earlier. If the leaf is much longer than wide, it is referred to as **linear** (Fig. 8). If it is heart-shaped, it is **cordate** (Fig. 8). If the heart-shaped leaf is widest towards the tip, it is **obcordate** (Fig. 8), an unusual condition. Similar to obcordate is kidney-shaped, **reniform** (Fig. 8), an equally uncommon condition. If the leaf is round, it is **orbicular** (Fig. 8); if nearly round, **suborbicular** (Fig. 8). Other uncommon shapes include **lyrate** (shaped like a lyre, a banjo-like musical instrument) (Fig. 8), **spathulate** (spoon-shaped) (Fig. 8), **subulate** (awl-shaped), **rhombic** (kite-shaped), and **falcate** (curved-linear) (Fig. 8). In most leaves, the petiole is attached to the base of the blade. In a relatively few, however, the petiole is attached to the lower surface of the blade away from the margin, a condition referred to as **peltate** (Fig. 8).

Glossary for Leaf Shape

Cordate—Heart-shaped, said of leaves or their bases. (Fig. 8)

Elliptic—Shaped like an ellipse, i.e., with rounded ends and a curved sides. An ellipsoid is a 3-dimensional figure shaped in outline like an ellipse, said of some fruits. Compare oblong. (Fig. 8)

Falcate—Sickle-shaped. (Fig. 8)

Lanceolate—Lance-shaped in outline, several times (2.5x or more) longer than wide, with the widest portion towards the base of the leaf. Compare oblanceolate. (Fig. 8)

Linear—Long and narrow, with the sides almost parallel. (Fig. 8)

Lyrate—Pinnately lobed with a large terminal lobe and smaller lateral ones, said of some leaves. (Fig. 8)

Ob- —A prefix added to a term describing a leaf shape to indicate that the blade is widest towards the tip rather than the normal condition of being widest towards the base.
Obcordate—Reverse heart-shaped with the wider end towards the tip, said of leaves, petals, etc. (Fig. 8)
Oblanceolate—Lanceolate, but with the widest part towards the tip. Compare lanceolate. (Fig. 8)
Oblong—Longer than broad, with the sides nearly parallel to each other. (Fig. 8)
Obovate—Ovate or egg-shaped, with the widest part towards the tip. Compare ovate. (Fig. 8)
Orbicular—Round in outline. Compare suborbicular. (Fig. 8)
Ovate—Oval in outline, with the widest part towards the base. Compare obovate. (Fig. 8)
Peltate—Referring to a leaf with the petiole joined to the blade away from the margin. (Fig. 8)
Rhombic—Kite-shaped in outline, like a square with one corner attached to the petiole.
Reniform—Kidney-shaped in outline. (Fig. 8)
Spathulate—Spoon-shaped. (Fig. 8)
Sub- —Prefix meaning less than or not quite. See the entries below.
Suborbicular—Nearly round in outline. Compare orbicular. (Fig. 8)
Subulate—Awl-shaped.

9. LEAF BASES AND TIPS

The shape of the base and tip of a leaf is often useful in identifying plants. Some descriptive terms for these apply only to one or the other, not both, since the two are structurally different—the apical end is always free, while the basal end is almost always attached to a petiole.

Most leaves are sharp-tipped, which is referred to **acute** (Fig. 9), and many leaf bases are the same. If the tip or base gradually tapers concavely into to a sharp point, it is referred to as **acuminate** (Fig. 9). If the tapering tip is long and slender, it is referred to **attenuate** (Fig. 9). Many tips and bases are rounded, a condition called **obtuse** (Fig. 9) or sometimes more simply, **rounded**. If the leaf or base appears to be cut off perpendicular to the midrib, it is referred to as **truncate** (Fig. 9). If the tip is rounded or obtuse but with an extended tail-like tip, it is referred to as **caudate** (Fig. 9). **Cuspidate** (Fig. 9) is somewhat intermediate between caudate and acuminate, but is a term only infrequently used. Some leaves have a tiny apical projection called a **mucro**, and such leaves are referred to as **mucronate** (Fig. 9), which is virtually the same thing as **apiculate** (Fig. 9). Other leaves have a notch at the tip. If the notch is deep and forms two equal lobes, the tip is referred to as **bifid** (Fig. 9). If shallower, it is either **emarginate** (Fig. 9) or **retuse** (Fig. 9), both of which mean about the same thing. The gap between the lobes of a leaf or corolla is called the **sinus**. Uncommonly, the ends of the lobes or petals of a corolla are cut into narrow segments, a condition referred to as **laciniate**.

Some terms refer only to the base. If the base gradually tapers to the petiole, it is referred to as **cuneate** (wedge-shaped) (Fig. 10). It the base is like the base of an arrowhead, it is referred to as **sagittate** (Fig. 10). If the lobes of the arrowhead-shaped base are divergent, it is **hastate** (Fig. 10). If the lobes are ear-shaped, the base is **auriculate** (Fig. 10). If the petiole has wings on either side, it is **winged** (like stems mentioned earlier). This is very similar to **decurrent** (Fig. 10), when the blade becomes gradually narrowed and extends all or most of the length of the petiole. If the base is like the top half of a heart, it is **cordate** (Fig. 10). If it is unequally sided, usually with one side rounded and the other acute, it is referred to as **oblique** (Fig. 10). One more condition should be mentioned. In some palms, the basal lobes of the pinnately compound leaves are long and pendent; these hanging lobes are referred to as **reins**.

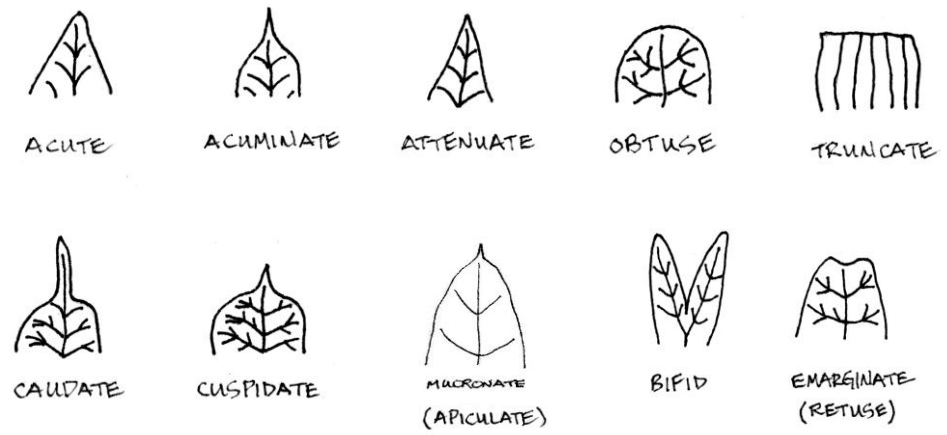


Fig. 9. Leaf Tips.

Glossary for Leaf Bases and Tips

Acuminate—Referring to an acute tip that tapers to a long, drawn-out point, usually with somewhat concave sides. (Fig. 9)
Acute—Tapering to a sharp, but not drawn-out point. Compare attenuate. (Fig. 9)
Apiculate—Referring to a tip with a small, short, sharp, flexible point. (Fig. 9)
Attenuate—Tapering gradually to form a long, straight-sided tip. Compare acute. (Figs. 9, 10)
Auriculate—Bearing an ear-like lobe (i.e., an auricle). (Fig. 10)
Bifid—Split at the tip into two lobes. (Fig. 9)
Caudate—Having a long, narrow, tail-like tip. (Fig. 9)
Cordate—Heart-shaped, said of leaves or their bases. (Fig. 10)
Cuneate—Wedge-shaped or triangular, referring to leaf bases. (Fig. 10)
Cuspidate—A leaf tip with a long, sharp-pointed tip with concave sides. (Fig. 9)
Decurrent—Referring to a leaf blade base that tapers down to a narrow wing that extends to the stem. (Fig. 10)
Emarginate—Referring to a leaf with a notch at the tip. (Fig. 9)
Hastate—Arrowhead-shaped with the basal lobes divergent. (Fig. 10)
Laciniate—Divided into narrow, pointed lobes.
Mucro—A sharp, tooth-like tip of some leaves, bracts, petals, or other parts.
Mucronate—Said of leaves that bear a short awn at the tip (mucro). The same thing as apiculate. (Fig. 9)
Oblique—Unequally-sided, as in the bases of some leaves. (Fig. 10)
Obtuse (rounded)—Blunt, rounded. (Fig. 9)
Reins—Long, hanging leaflets found at the base of some palm fronds.
Retuse—Notched at the tip. (Fig. 9)
Rounded—With a semi-circular tip or base.
Sagittate—Shaped like an arrowhead. (Fig. 10)
Sinus—Space between two lobes or divisions of a leaf or corolla.
Truncate—Appearing cut-off or squared at the end, as of a leaf tip. (Fig. 9)
Winged—Having ridges (wings) or longitudinal ridges running down the stem or petiole.

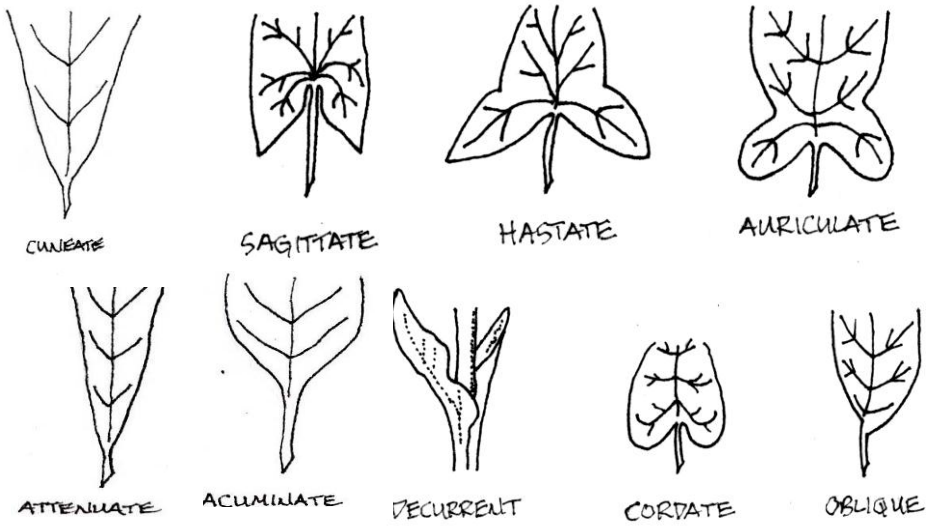


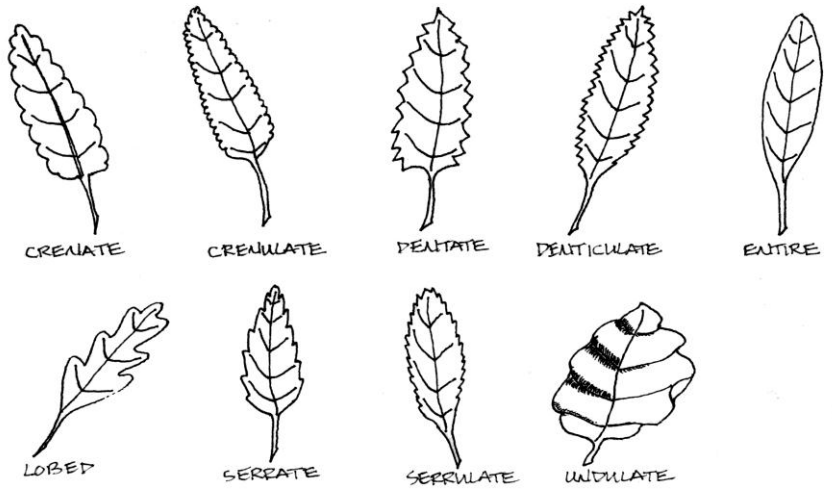
Fig. 10. Leaf Bases

10. LEAF MARGINS

Another leaf part sometimes useful in identification is the leaf margin. Most leaves have **entire** margins (Fig. 11), which means the edges are straight rather than toothed or wavy. Others characteristically have **toothed** margins that bear small teeth. The three main types of toothed margins are **dentate** (with triangular, equally sided teeth) (Fig. 11), **serrate** (with one side of the tooth longer than the other) (Fig. 11), and **crenate** (with rounded teeth) (Fig. 11). If the teeth are small, these three terms become **denticulate** (Fig. 11), **serrulate** (Fig. 11), and **crenulate** (Fig. 11). If the tips of the teeth are sharp and spiny, they are referred to as **spinulose**. If the tooth is topped by a bristle or seta, it is called **setose**. If the teeth are large and extend a considerable way to the midrib, the margin is then referred to as **lobed** (Fig. 11), which is half way to being compound. Between entire and toothed are margins that are wavy, a condition called **undulate** (Fig. 11). If it is only slightly so, it is **subundulate**. Most leaf surfaces are flat, but on some the edge curls under, a condition known as **revolute**. The reverse condition, **involute**, is not common in leaves, but is occasional of some flower parts.

Glossary for Leaf Margins

Crenate—Round-toothed or scalloped, as of leaf margins. (Fig. 11)
Crenulate—Said of margins with fine, rounded teeth. Compare crenate. (Fig. 11)
Dentate—With sharp teeth perpendicular to the margin (of a leaf). (Fig. 11)
Denticulate—Finely dentate. (Fig. 11)
Entire—Having a continuous margin lacking teeth or lobes, as on the edge of a leaf. (Fig. 11)
Involute—A surface, as of a leaf, rolled inward or towards the upper side. Compare its opposite, revolute.
Lobed—Bearing segments up to halfway or more to the base or center. (Fig. 11)



Revolute—A surface having margins rolled towards the lower surface, as of leaves. Compare involute.
Serrate—Having a saw-toothed margin, as of some leaves. (Fig. 11)
Serrulate—Finely serrate. (Fig. 11)
Setose—Bearing a stiff bristle (seta).
Spinulose—Bearing small spines.
Subundulate—Nearly undulate or wavy, said of leaf margins.
Toothed—Bearing teeth or indentations along the margin, said of leaf margins. This includes serrate, dentate, and crenate.
Undulate—Wavy rather than smooth, said of some leaf margins. (Fig. 11)

11. LEAF SURFACES

The surface of a leaf can have distinguishing characteristics, especially in the amount and type of hairs present. Many leaves are **glabrous**, i.e., they lack hairs, particularly the upper surface. The opposite of glabrous is **pubescent**, i.e., bearing hairs (**pubescence**). Bearing very fine pubescence is referred to as **puberulent**. Some leaves start out pubescent, but then lose their pubescence at maturity, a condition referred to as **glabrescent**. Many types of pubescence are recognized, but some of the terms are used more often than others, and some are hard to distinguish from each other. Some of the more common types of pubescence are **canescent** (densely covered with gray hairs growing nearly flat on the surface), **hirsute** (bearing long, coarse hairs), **pilose** (bearing soft, relatively short hairs), **sericeous** (silky-pubescent), **tomentose** (densely wooly with tangled, matted hairs), and **villous** (shaggy with long, soft hairs). Some hair types are more easily distinguished. Leaf surfaces rough to the touch because of short, stiff hairs or scales are referred to as **scabrous**. Surfaces covered with short stiff hairs are referred to as **hispid**. If finely so, then **hispidulous**. Most leaves are darker on the upper surface than on the lower, but those that are basically the same color on both surfaces are referred to as **concolorous**.

Two other kinds of pubescence are unique and useful for identification. **Stellate** hairs are star-shaped with a cluster of them radiating out from one point. Only a few families have stellate pubescence, notably the Mallow Family Malvaceae. The other unusual type, which comprises tiny round scales mounted flat to the surface, is called **lepidote** (comparable to the scales of butterflies and moths, which belong to a group called Lepidoptera). Surfaces and edges bearing long thin, scattered hairs are referred to as **ciliate**.

Leaf surfaces have other diagnostic characteristics besides hairs. Some are covered with a powdery wax, a condition referred to as **glaucous**. Others are covered with glands (**glandular pubescent**) that produce a sticky substance, or with translucent glands embedded in the surface (**glandular punctate**). The Citrus Family Rutaceae can sometimes be recognized by the tiny translucent glands, filled with fragrant oil, that are imbedded in the leaf surface. Some leaves have a wrinkled rather than a flat surface, a condition referred to as **rugose**. If the wrinkles are fine, the condition is referred to as **rugulose**. Small bumps on a plant surface are called **papilla**. The stiffness or thickness of the leaf is also sometimes used as a diagnostic characteristic. Leaves that are leathery to the touch are referred to as **coriaceous**. Others, referred to as **chartaceous**, are like parchment paper, and can make a sound when the ends are quickly pulled on. Most leaves are between these two extremes; but this intermediate condition is not usually given a name. Some hairs have a swollen base called a **tubercle**, but most come directly out of the leaf surface. (This is often referred to as a "tubercle-based hair.") Most hairs stand erect, but others lie nearly flat on the surface, a condition referred to as **appressed**. Structures (usually parts of flowers rather than leaf surfaces) with a tuft of hairs on them are referred to as being **bearded**.

One other feature of some leaf surfaces should be mentioned, **domatia** (singular: domatium). These are small pits or chambers found in the axils of the secondary veins of some plant species, and are characteristic of some plant families (e.g., the Madder Family Rubiaceae). They come in a variety of shapes and sizes, and may serve as a shelter for insects, mites, fungi, bacteria, or blue-green algae.

Glossary for Leaf Surfaces

Appressed—Lying flat against a surface, as appressed hairs.
Bearded—Bearing a tuft of hairs, as in some grass florets.
Canescent—Gray pubescent or hoary, said of some leaf surfaces.
Chartaceous—Papery in texture, said of leaves. Compare coriaceous.
Ciliate—With a fringe of hairs on a margin (e.g., leaf margin).
Concolorous—Similarly colored on both sides, as of lower and upper leaf surfaces.
Coriaceous—Leathery in texture, said of leaves. Compare chartaceous.
Domatia—Pit-like structures found in the axils of secondary veins on the lower side of the leaves of some plant species. The singular is domatium.
Glabrescent—Nearly or becoming glabrous with age.
Glabrous—Said of a surface lacking pubescence; hairless.
Glandular pubescent—With hairs and glands mixed together on the surface, or with hairs topped with pinhead-like glands.
Glandular punctate—Having translucent glands (such as oil glands) embedded on the surface.
Glaucous—Covered with a white, waxy bloom, or a white substance that rubs off.
Hirsute—Bearing long, coarse hairs.
Hispid—Bearing stiff, short hairs or bristles.
Hispidulous—Finely hispid.
Lepidote—Covered with tiny scurfy (easily shed) scales, like a butterfly wing.
Papilla—Small pimple-like projections. Surfaces with these are referred to as papillate.
Pilose—Bearing soft, relatively long hairs.

Puberulent—Covered with a very fine pubescence.
Pubescent—Bearing hairs (pubescence). The opposite is glabrous.
Rugose—Having a wrinkled surface, said of some leaves.
Rugulose—Having a finely wrinkled surface.
Scabrous—Feeling rough, usually because of short, stiff hairs or scales.
Sericeous—Silky pubescent.
Stellate—Star-shaped, said of some hairs.
Tomentose—Densely woolly with tangled, matted hairs.
Tubercle—A rounded protruding body, as the base of some hairs. Tuberculate means covered with tubercles.
Villous—Shaggy with long, soft hairs.

Reproductive Parts

The term flower refers to the reproductive structure that is unique to the group called Angiospermae (angiosperms), or simply "flowering plants". Gymnosperms, which once dominated the forests the world, but which now dominate only in cold to temperate areas, lack flowers. The flower evolved from cone-like reproductive structures that are characteristic of the Gymnospermae (gymnosperms, the best know of which are conifers, like pines). The evolution from cones to flowers involved the differentiation of the reproductive parts into whorls that are usually different in structure and function. The outer **whorl** of the flower is called the **calyx**, the whorl inside of this is called the **corolla**. The inner two whorls (one or the other is missing from unisexual flowers) are the **androecium** (male part) and the **gynoecium** (female part of the flower). This differentiation and elaboration of the flower parts gave the angiosperms a selective advantage over gymnosperms, and has enabled the latter to dominate the world.

The main difference between gymnosperms and angiosperms is explained in their names; gymnosperm in Greek means "naked seed," angiosperm means "enclosed seed." In gymnosperms the seeds and their precursors, the ovules lie exposed on the edges of the spirally arranged scales that comprise the cone. In nearly all living angiosperms, the scale is now an enclosed compartment where the ovules and the resulting seeds have more protection from hungry insects and other herbivores. The scales evolved over millions of years either by folding over and fusing their edges, or by fusing several of the scales together to accomplish the same thing. At the same time, there was a change in the prevalent type of pollination in the world. Pollination is necessary for sexual reproduction, which makes species more adapted to their world. Gymnosperms are mostly wind pollinated, but most angiosperms are pollinated by insects. The latter method is more effective, as less pollen is needed for the task. But it comes at a cost, and angiosperms had to develop structures and means of attracting the insects to the flower. This was accomplished by the differentiation of the scales that made up the gymnosperm reproductive parts to the colorful petals and the production of fragrant nectar so prevalent today. Reproductive parts are much more variable than vegetative parts, which creates the need for a larger, specialized terminology.

Following the descriptions of flowers in general, the flower parts are discussed in four separate whorls, starting from the outside: **calyx**, **corolla**, **stamens** (**androecium**), and **pistil** (**gynoecium**). The outer two whorls are collectively called the **perianth** (Greek: "around the flower") (Fig. 13).

12. FLOWERS

The opening of a flower is called **anthesis**. There are only a few characteristics associated with this. One is the order of events during flowering. To ensure that a flower does not

pollinate itself ("self-pollinate"), some flowers have the male and female parts maturing at different times. Flowers that are **protandrous** have the stamens maturing first. By the time the ovary is receptive for pollination, the pollen grains from the anthers of the same flower are no longer functional, ensuring it will pollinated only by another flower (and ideally from another individual). Other flowers may be **protogynous**, in which the ovary is receptive first, followed by the stamens after the ovary is no longer receptive.

Flowers vary in their sexuality. Most have both male and female parts, and are referred to as **bisexual**. Another term for this is **perfect**, i.e., perfect flowers have both male parts (stamens) and female parts (pistil). Many flowers, however, have only one or the other, and are termed **unisexual** or **imperfect**. There are two variations of unisexual flowers. If the male and female flowers occur on the same plant, the condition is referred to as **monoecious** (Greek: "one house"). If the two sexes occur on different individuals, the condition is referred to as **dioecious** (Greek: "two houses"). **Dioecious** plants are always pollinated by pollen from a different individual (referred to as "out-crossing"), since the male and female plants are separate, but this is not necessarily the case with monoecious species. Two other terms apply to the presence or absence of parts from a flower. **Complete flowers** have all four **whorls**, i.e., calyx, corolla, stamens, and pistil. **Incomplete flowers** lack one or more of these whorls.

Glossary for Flowering

Anthesis—The flowering period, or when the flower opens.
Bisexual—Having functional male and female organs in the same flower.

Complete flower—A flower that has all the whorls, i.e., sepals, petals, stamens, and pistil. Compare incomplete flower.
Dioecious—Condition of plants with unisexual flowers in which the male and female flowers are on separate plants. Compare monoecious.
Imperfect flower—A flower lacking either stamens or pistil. Compare perfect flower.
Incomplete flower—A flower lacking one or more of the four whorls. Compare complete flower.
Monoecious—Condition of a plant with unisexual flowers when male and female flowers are on the same plant. Compare dioecious.
Perfect flower—A flower that has both male and female parts. Compare imperfect flower.
Protandrous—Referring to a flower with the anthers maturing before the stigma is receptive.
Protogynous—Referring to a flower with the stigma receptive before the anthers are mature.
Unisexual—Said of flowers lacking either stamens or an ovary.
Whorls—The four parts of a flower, i.e., sepals, petals, stamens, and pistil, that evolved in rings (whorls).

13. CALYX

The outer whorl of a flower is called the **calyx** (Fig. 13). It serves mainly for protection of the reproductive parts inside, securing them from direct access by potentially harmful insects. The calyx has some diagnostic characteristics, but many fewer in comparison to the usefulness of the other whorls in the identification of plant species. The earliest flowering plants had a calyx comprising separate units called **sepals** (Fig. 13). Many flowers have retained this primitive condition of free sepals and are referred to as **aposepalous**, which is usually simplified as "sepals free." In evolution, the sepals of many plant groups fused together, resulting in a condition referred to as **synsepalous**, or more simply, "sepals fused."

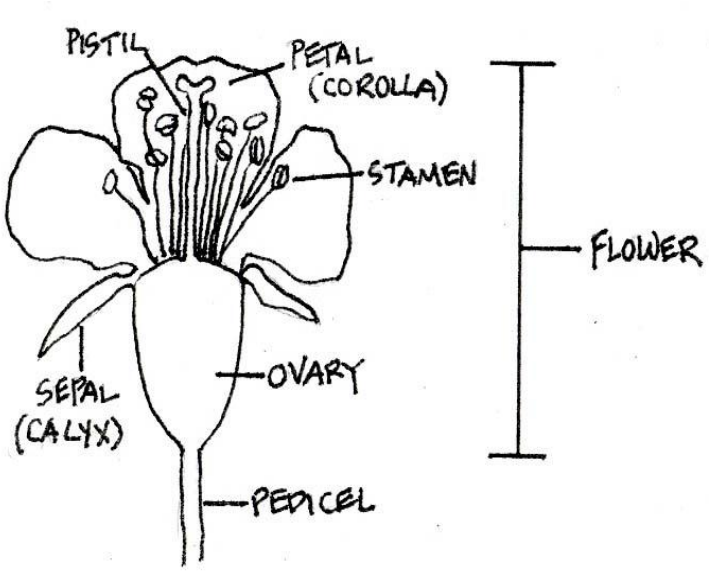


Fig. 13. Flower Parts

The calyx is usually borne on a stalk called the **pedicel** (Fig. 13) or flower stalk. Where the two meet is sometimes referred to as the **receptacle**, especially when it is enlarged. In some flowers, the calyx has become petal-like (**petaloid**) and indistinguishable from the corolla, and in such cases the segments of the two whorls are called **tepals**. This is typical in monocots with showy flowers, such as lilies.

Some species bear other structures associated with flowers. The most common one is a **bract**, which is a modified leaf found below the calyx or on the stalk bearing the flowers (inflorescence). Bracts may be green and nondescript, but in some families, particularly in the Acanthus Family Acanthaceae, they may be large and showy. In some species, particularly in the Mallow Family Malvaceae, several bracts may be fused together into a calyx-like structure called the **epicalyx**, which is below the real calyx. A structure that forms at the base of another structure, like an epicalyx does to a calyx, is said to **subtend** the other structure. In some families, small bracts fused to make a structure called an **involucre** that is similar to an epicalyx. These are sometimes overlapping like shingles on a roof, a condition called **imbricate**. Smaller bracts occur on the branches of inflorescences, and are referred to as **bracteoles**. Some flowers have a layer of tissue formed from the receptacle or fused staminodes and nectaries that surround the ovary, and when conspicuous, this is a **disc**.

Glossary for the Calyx

Aposepalous—Have free sepals. This condition is usually called "sepals free."

Bract—A scale, formed from a leaf that has been reduced during evolution, that is borne on a flower. Compare bracteole.

Bracteole—A scale borne on an inflorescence; a secondary bract. Compare bract.

Calyx—The outer, usually green whorl of the flower enclosing the flower bud. It is composed of free or fused sepals. The plural is calyces. (Fig. 13)

Disc—A distinct layer of tissue formed from a protrusion of the receptacle or from fused staminodes or nectaries of some flowers.

Epicalyx—A whorl of fused bracts forming a calyx-like structure at the base of the flower of some species, particularly in members of the Mallow Family Malvaceae.

Imbricate—Overlapping like shingles on a roof, said of flower parts such as bracts.
Involucre—A whorl of scales borne beneath the flowers of some species, particularly members of the Spurge Family Euphorbiaceae.
Pedicel—The stalk of a flower. Pedicellate means borne on a pedicel. (Fig. 13)
Perianth—Collective term for the petals and sepals (corolla and calyx).
Petaloid—Petal-like in texture or color, said of the calyx of some flowers. Compare apetalous.
Receptacle—The base of the flower or inflorescence, especially when it is enlarged.
Sepal—A division of the calyx. (Fig. 13)
Subtend—To be attached below something.
Synsepalous—Fused sepals. Often written "sepals fused."
Tepals—The collective term for petals and sepals when they are similar to each other.

14. COROLLA

The whorl inside the calyx is called the **corolla** (Fig. 13). The individual segments are called **petals** (Fig. 13). In flowering plants, the corolla is usually bright and colorful in order to attract insects or birds necessary for pollination. Flowers that are wind pollinated usually have a green corolla, or more often, none at all. Flowers lacking a corolla are referred to as **apetalous**. Flowers having only one outer whorl of the perianth (i.e., the corolla plus calyx) are believed to have lost the corolla rather than the calyx. However, in some flowers that have lost the colorful petals, the calyx has evolved to look like a corolla, a condition known as **petaloid** (see the preceding section).

The petals of flowering plants evolved from leaf-like structures that were originally free of each other. This condition is termed **apopetalous** (Fig. 14). However, the petals of some groups of flowering plants (usually families) have fused in evolution into what is called a **sympetalous** corolla. The fusion is partial in some families, complete in others. Fused petals or other structures fused to each other are referred to as **connate**. The degree, if any, of the fusion of the petals is an important diagnostic characteristic in plant identification, because most families have either one or the other (sympetalous or apopetalous) but not both.

When viewed from the top, flowers have **symmetry**, which is the relationship between two halves of an organ that are separated by an imaginary line. If numerous lines can be drawn through a flower viewed thusly, the condition is called **radial symmetry** (Fig. 14). If only one line can be drawn to divide the flowers into two equal halves, the condition is called **bilateral symmetry** (Fig. 14). Flowers thus constructed have a top and a bottom when viewed from above, as well as a right and left hand side. This can be compared to the animal world where humans, who are bilaterally symmetrical, have a top, a bottom, and two sides, while a starfish, which has radial symmetry, can be divided in numerous ways to make two equal halves. The symmetry of corollas is also an important diagnostic characteristic. Families that have changed the least from their ancestors have radial symmetry (the "primitive" condition); those that have changed the most have bilateral symmetry (the "advanced" condition).

Several parts of corollas can be recognized. In sympetalous flowers, the lower portion that is fused together is referred to as the **tube** (Fig. 14). The upper part comprising the free lobes is called the **limb** (Fig. 14). The inside of the tube is called the **throat** (Fig. 14). The petals, especially of sympetalous flowers, may have the lobes overlapping each other, a condition called **contorted**. If the petals are arranged edge to edge, the condition is called **valvate**. An unusual condition occurs in some flowers, especially in the Myrtle Family

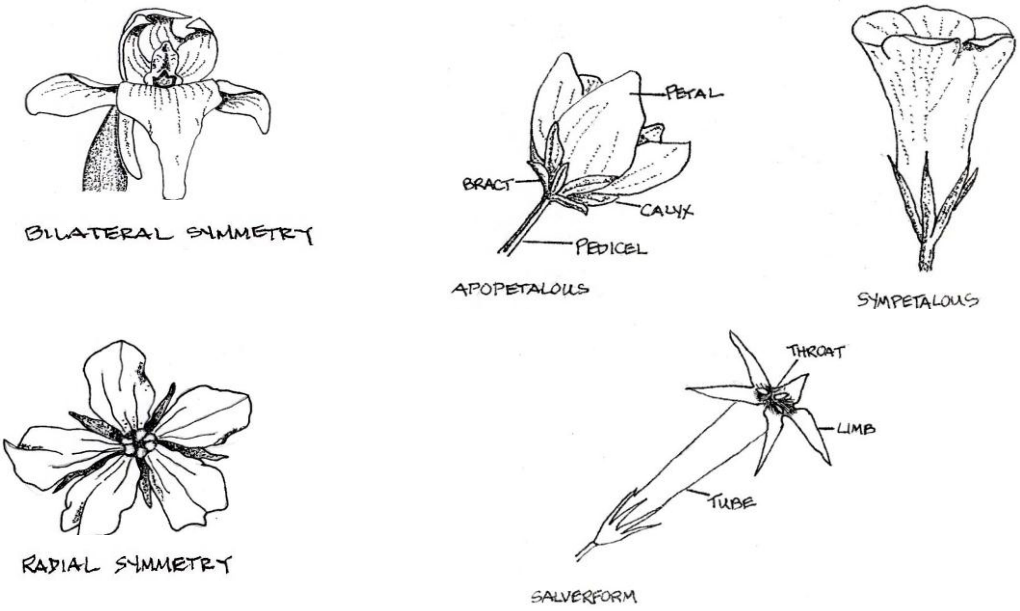


Fig. 14. Corolla Symmetry and Parts

Myrtaceae, where the petals are sometimes fused into a cap that falls off as a single structure, a condition known as **calyptrate** (the cap itself is called the **calyptra**). In some flowers, the corolla stays on the flower long after pollination, a condition referred to as **persistent**. In others, they fall off immediately after pollination (i.e., after they have served their purpose of attracting a pollinator), a condition referred to as **caducous**.

One of the most diagnostic characteristics of corollas is their color. Also important is the shape of the corolla, and there are a number of terms that are used to describe this. Three of the most common corolla shapes are **campanulate** (bell-shaped) (Fig. 15), **funnelform** (funnel-shaped) (Fig. 15), or **tubular** (tube shaped with no expanded limb. If the petals are flared out to make a tire-shaped corolla, it is referred to as **rotate** (Fig. 15). If the flower has a narrow tube with the limb jutting out at nearly right angles, it is referred to as **salverform** (Fig. 15). If the flower is urn-shaped, it is called **urceolate** (Fig. 15).

Bilaterally symmetrical flowers that have the lower part of the corolla (lower **lip**) (Fig. 15) different from the upper part (upper **lip**) (Fig. 15) are called **bilabiate** (Latin: "two-lipped") (Fig. 15). One of the most unusual types of flowers is called **papilionaceous** (Latin: "butterfly-like") (Fig. 15). These bilaterally symmetrical flowers usually have two lateral petals called the **wings** (Fig. 15), one large petal usually notched at the top called the **banner** (Fig. 15) or **standard**, and a fourth one at the bottom called the **keel** (Fig. 12), which is formed from two fused petals that enclose the inner flower parts. Papilionaceous flowers are characteristic of one subfamily of the Pea Family Fabaceae. Free petals that are stalk-like at the base are referred to as **clawed** (see cover), an unusual condition. Petals of flowers that spread out horizontally are referred to as **spreading**, and those that bend back abruptly are referred to as **reflexed**.

Glossary for the Corolla

Apetalous—Lacking petals, said of flowers having no corolla. In such cases, the sepals sometimes look like petals. Compare petaloid.

Apopetalous—Having free petals. This condition is usually called "petals free." (Fig. 14)

Banner—The uppermost petal of a papilionaceous flower (i.e., one from the Fabaceae subfamily Papilionoideae); also called the standard. Compare wing and keel. (Fig. 15)

Bilabiate—Two-lipped, said of a corolla or calyx with the parts fused into an upper and lower lip. Compare lip. (Fig. 15)

Bilateral symmetry—Two sided, said of flowers in which a line through only one plane divides the flowers into two equal halves. Compare radial symmetry. (Fig. 14)

Caducous—Falling off early, referring to sepals or petals.

Calyptra—Cap-like structure, e.g., the one formed by the fused petals in the genus *Syzygium*. The condition is called calyptrate.

Campanulate—Bell-shaped, said of a corolla or calyx. (Fig. 15)

Clawed—Having a long, stalk-like base, often said of petals with this base. (See cover).

Connate—United or joined, said of similar structures, such as petals of a flower.

Contorted—Twisted, used to refer to flowers in which the petals are twisted in the bud before anthesis. Compare to valvate.

Corolla—The flower whorl situated between the calyx and the gynoecium or androecium, and composed of the petals. (Fig. 13)

Funnelform—Funnel-shaped, said of corollas of flowers.

Keel—The front two united petals of a flower in the Fabaceae subfamily Papilionoideae. They are often folded to enclose the stamens and ovary. Compare banner and wing. (Fig. 15)

Limb—Expanded terminal portion of some corollas. Compare tube and throat. (Fig. 14)

Lip—The lower or upper part of a corolla or calyx when the petals or sepals are unequal. Compare bilabiate. (Fig. 15)

Papilionaceous—Butterfly-like, said of sweetpea-type flowers of species in the legume subfamily Papilionoideae. (Fig. 15)

Persistent—Not falling, remaining on the plant or flower part.

Petal—A division of a corolla. (Fig. 13)

Petaloid—Petal-like in texture or color, said of the calyx of some flowers. Compare apetalous.

Radial symmetry—Condition of a flower in which a line through any plane divides it into equal halves. See bilateral symmetry. (Fig. 14)

Reflexed—Abruptly bent downward or backward.

Rotate—Wheel-shaped, as in rotate corollas. (Fig. 15)

Salverform—Said of corollas with a slender tube and abruptly expanded limb; trumpet-shaped. (Fig. 14)

Spreading—Bending or growing outward or horizontally.

Standard—Another name for banner. (Fig. 15)

Symmetry—Correspondence between two sides of a structure on opposite sides of a dividing line. See radial symmetry and bilateral symmetry.

Sympetalous—Having the petals fused together to form the corolla. (Fig. 14)

Throat—The part of a sympetalous corolla where the limb joins the tube. Compare limb and tube. (Fig. 14)

Tube—Basal, cylindrical portion of a corolla having fused petals. Compare limb and throat. (Fig. 14)

Tubular—Tube-shaped. (Fig. 15)

Urceolate—Urn-shaped, usually referring to a corolla. (Fig. 15)

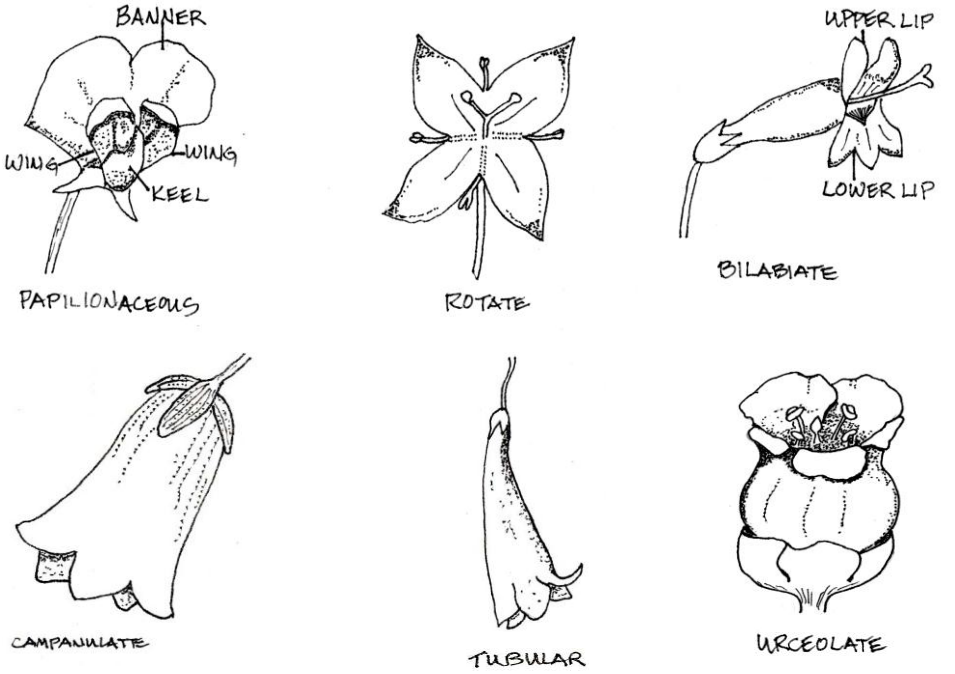


Fig. 15. Flower shapes

Valvate—Arrangement in an opening flower of petals that are set edge to edge. Compare contorted.

Wing—One of the two lateral petals of the flowers of species in the Fabaceae subfamily Papilionoideae. Compare banner and keel. (Fig. 15)

15. STAMENS

The functional male part of the flower is the **stamen** (Fig. 16). It comprises an **anther** (Fig. 16), which contains the pollen, and a stalk, called the **filament** (Fig 16), that attaches the anther to the rest of the flower. Collectively the stamens of a flower are referred to as the **androecium** (Greek: "home of the male"). Some stamens lack a filament, in which case the anther or stamen is referred to as being **sessile**. Most stamens have the filament attached to the base of the anther, but in some it is attached in the middle, allowing the anther to swing back and forth, a condition referred to as **versatile**.

The earliest flowering plants possessed many free stamens, a condition referred to as "primitive." The families least changed from this ancestral condition are referred to as "primitive families." During the course of evolution, the stamens of flowering plants decreased in number (sometimes to as low as a single stamen) and often became fused to each other in various ways. The most common number of stamens for dicots is five; the most common for monocots is three. In general, flowers with stamens in multiples of four or five are dicots; those with them in multiples of three are monocots. The number and presence or absence of fusion of stamens are very important characteristics in distinguishing flowers or groups of flowers. In some plant families, all species have the same number of stamens, a number which is characteristic of that family. For example, the Wood-Sorrel Family Oxalidaceae characteristically has ten stems in two whorls. In some families, the numerous

stamens are fused together by their filaments to make a structure called a **staminal tube** (Fig. 16). The presence of this characteristic, referred to as **monadelphous** (Fig. 16 and cover), is diagnostic of the Mallow Family Malvaceae. One subfamily of the Pea Family Fabaceae has ten stamens arranged into two groups, nine of them fused together into a sheath-like structure, and one free. This arrangement of stamens into two groups is referred to as **diadelphous** (Fig. 16).

The position of the stamens is another diagnostic characteristic. The normal condition is for them to be fused to the base of the flower. However, in most sympetalous flowers they are fused to the corolla, a condition referred to as **epipetalous** (Greek: "on the petals") (Fig. 16). Stamens borne in the throat may be deeply buried there, a condition known as **included** (Fig. 16), or the anthers may stick out of the top of the throat, a condition known as **exserted** (Fig. 16). The filaments of some anthers have a characteristic zigzag shape, a condition known as **geniculate** (having "knees"), which is characteristic of the Melastome Family Melastomaceae.

As noted earlier, flowers lacking either the male or female parts are referred to as being unisexual (these flowers are also incomplete and imperfect). Flowers with only functional male parts are referred to as **staminate**; those with only functional female parts are referred to as **pistillate** (see below). However, there is another way for a flower to be considered unisexual. It may have both male and female parts, but one or the other may not be functional. The stamen may not form pollen but still be present. If the stamen is sterile and reduced, it is often referred to as being **vestigial** or **obsolete**. Likewise, a male flower may have a non-functioning, vestigial ovary. These latter two types of unisexual flowers are sometimes referred to as being functionally unisexual (as opposed to structurally unisexual). The condition of being a male unisexual flower therefore runs from having normal-looking stamens that do not work to having no stamens at all. Stamens lacking anthers are called **staminodes**. Some flowers have a crown-like outgrowth from the stamens that is referred to as a **corona**. These are sometimes showy, as in the Passionfruit Family Passifloraceae.

Glossary for Stamens

Androecium—Collective term for the stamens.

Anther—The pollen sac attached to a stamen. Compare filament. (Fig. 16)

Corona—An outgrowth, typically in the form of a crown or whorl, that grows out of the base of a whorl of stamens between them and the petals. It is found only in a few flowering plant families, especially the Milkweed Family Asclepiadaceae.

Diadelphous—Bearing stamens in two bundles, especially in papilionaceous flowers that usually have a 9 plus 1 arrangement. Compare monadelphous. (Fig. 16)

Epipetalous—Borne on the corolla or petals, said of stamens. (Fig. 16)

Exserted—Sticking out, said of stamens when they protrude from the corolla. Compare included. (Fig. 16)

Filament—The stalk of a stamen, bearing the anther. Stamens lacking this are called sessile. (Fig. 16)

Geniculate—Bent like a knee, said of awns and filaments.

Included—Referring to stamens that do not protrude from the corolla. Compare exserted. (Fig. 16)

Monadelphous—Said of stamens united by the filaments into a bundle. Compare diadelphous. (Fig. 16 and cover)

Obsolete—No longer of use, referring to flower parts that are no longer functional.

Pistillate—Unisexual flowers having only functional female parts. Compare staminate.

Sessile—Lacking a stalk, said of leaves, flowers, etc.

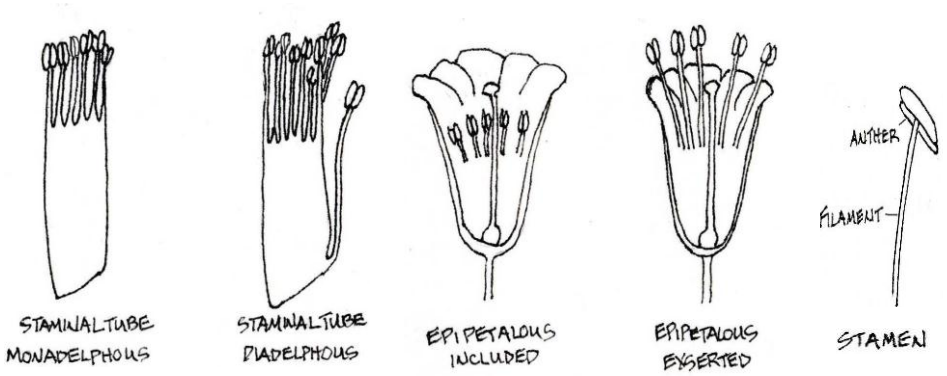


Fig. 16. Stamen Condition

Stamen—The male part of the flower, consisting of an anther and a filament. (Figs. 13, 16)
Staminal tube—A tube formed by the fusion of staminal filaments. (Fig. 16)
Staminate—Unisexual flower bearing stamens but no functioning female parts. Compare pistillate.
Staminode—A sterile stamen, lacking the anther.
Versatile—Said of anthers attached in the middle of the filament, and often moving freely.
Vestigial—Poorly developed and no longer functional, typically said of some flower parts.

16. PISTIL

The female part of a flower is called the **pistil** (Fig. 17). Most flowers have a single pistil, but when more than one is present, the collective term is **gynoecium** (Greek: "house of the female"). The pistil comprises two main parts: the **ovary** (Fig. 17), which is the compartment in which the unfertilized seeds (**ovules**) (Fig. 17) are enclosed, and the **stigma** (Fig. 17), which is the receptive surface to which the pollen grains adhere when they fertilize the flower. The stigma is usually borne on a stalk of varied length called the **style** (Fig. 17). The stigma may be distinct, often in the form of a round ball (referred to as **capitate**), it may be almost so (**subcapitate**), or it may be barely distinguishable from the style. Stigmas lacking a distinct style are referred to as **sessile**, a term used similarly for other plant structures lacking a stalk. When the ovules are fertilized, they develop into **seeds**, which serve to reproduce the plant. Unisexual flowers bearing only female parts are referred to as **pistillate**. However, some pistillate flowers have stamens, but these are reduced (**vestigial**), sometimes so much so that only the filaments are present (**staminodes**). There is great variation in female flower parts, and these are often very useful in distinguishing between different species or groups of species.

The ancient flowering plants had the ovules and their resulting seeds borne on the edges of leaves (like those in the living but ancient group of plants called cycads). The term **apocarpous** refers to plants that have more than one pistil, the "primitive condition." Because these exposed ovules could easily be found and devoured by insects, it is believed that very slowly the processes of evolution caused the ovule-bearing scale (**carpel**) to fold up and close, enclosing the ovules within its protective layer. The scientific name for flowering plants is **angiosperms**, which is derived from the Latin words for "enclosed seed." It is believed that in some groups of plants the leaves folded up individually to form a pistil from a single carpel, a condition referred to as **unicarpellate**. Other species or groups of species are believed to have had their pistil formed by the fusion of two or more carpels along their

edges, forming a compound structure referred to as **multicarpellate** or **syncarpous**. Another way some multicarpellate ovaries are thought to have been formed is by already closed carpels fusing together. The number of carpels that went into forming an ovary or pistil can often be determined in several ways: (1) by counting the number of seams on the fruit; (2), by counting the number of compartments in the ovary or fruit; or (3) counting the stigma lobes. These methods work most but not all of the time. Most flowering plants are multicarpellate, with most dicots having two or five cells (called **locules**) inside, while most monocots have three.

The way the carpels fused or closed is also reflected in the arrangement of the seeds in the ovary or fruit. This arrangement is referred to as **placentation** (Fig. 17), which is sometimes a useful diagnostic characteristic. (Their place of attachment is called the **placenta**: Fig. 17.) If the carpels of an ovary fused together on their edges, the seeds would be arranged in rows along the inner walls of the ovary. Two carpels fusing would produce two rows of seeds along the inner walls of the ovary. The number of rows usually indicates the number of carpels that fused to form the ovary. This type of placentation with the seeds on the inner wall is referred to as **parietal** (Fig. 17), a somewhat uncommon condition. If a carpel closed by itself to form a unicarpellate ovary, the ovules are typically in a single row on the side of the carpel opposite the midrib of the carpel. If that carpel then fused with one or more other ones, the seeds in the resulting multicarpellate ovary would be attached to a central column or axis formed at the point where the carpels fused. This placentation is referred to as **axile** (Fig. 17), the most common type in flowering plants. If the axil to which the seeds are attached becomes reduced and no longer makes contact with the top, the placentation is referred to as **free-central** (Fig. 17), a type restricted to only a few families of flowering plants. The partitions, called **septa** (plural: **septum**) (Fig. 17), that separate the locules may become reduced or disappear altogether, making an ovary that originally had more than one locule evolve to one that has only one.

The position of the ovary in relation to the perianth (calyx and corolla) is also an important characteristic. It is believed that the original ovary sat unprotected by itself within the flower. However, in some plants an evolutionary trend occurred in which the bases of the petals and sepals fused together and to the ovary to add layers of tissue for protection from chewing insects. An ovary having the original condition, with the bases of the petals and sepals attached to its base, is referred to as **superior** (Fig. 17). The adjective that refers to this condition is **hypogynous** (Greek: "under the ovary") (Fig. 17). An ovary with the more "advanced" condition is called an **inferior ovary** (Fig. 17), and the adjective is **epigynous** (Greek: "upon the ovary") (Fig. 17). Sometimes the fusion of the perianth parts and the ovary is not complete. This condition is known as **half-inferior** (Fig. 17), or by the adjective **perigynous** (Greek: "around the ovary") (Fig. 17). The structure formed by this incomplete fusion is called a **hypanthium** (Fig. 17), an uncommon structure in flowering plants. Most ovaries are sessile, but some are borne on a stalk, sometimes elongated, called a **stipe**.

Several other structures are found in some flowers. Some flowers (and other plant parts) have structures, called **nectaries**, that produce a sweet excretion (nectar) that serve to attract insects essential in pollination.

Glossary for the Pistil

Angiosperm—The technical name for flowering plant (Latin: "enclosed seed").

Apocarpous—Having a flower bearing separate carpels (ovaries) rather than a single ovary formed from the fused carpels.

Axile—A type of placentation in ovaries with two or more cells, and the seeds borne on a central axis. (Fig. 17)

Capitate—Head-like or bearing a head-like structure, such as a capitate stigma.

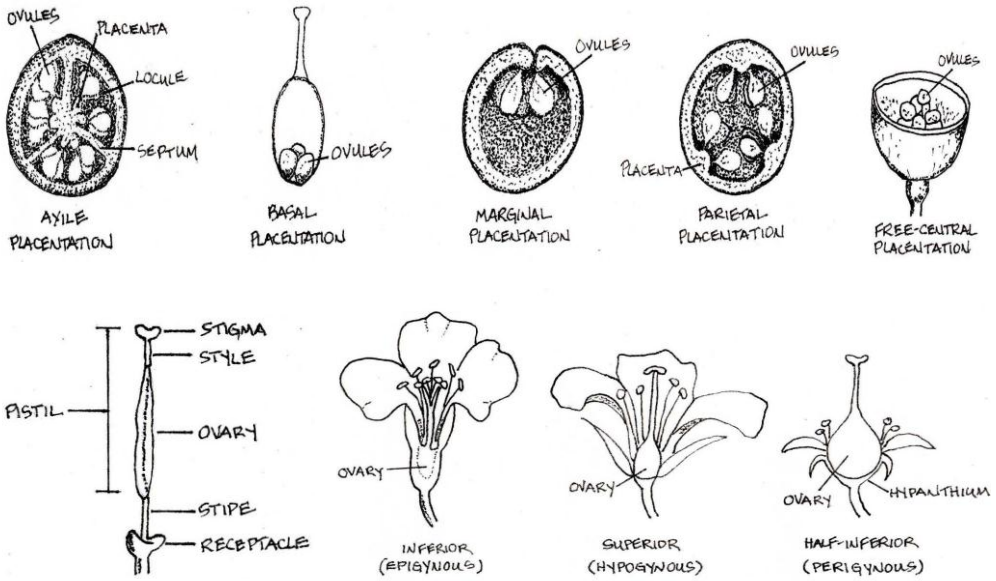


Fig. 17. Placentation and Ovary Position

Carpel—An ovule-bearing scale that in evolution formed a simple ovary by closing or a compound ovary by several of them fusing together.

Epigynous—A term referring to an inferior ovary. (Fig. 17)

Free-central—A type of placentation in a one-celled ovary in which the seeds are attached to a free-standing column or tissue from the base of the column-less ovary. (Fig. 17)

Gynoecium—The collective term for the female parts of the flowers, i.e., the pistil, ovary, style, and stigma.

Half-inferior—See perigynous. (Fig. 17)

Hypanthium—The cup-like receptacle of some flowers; it bears the sepals, petals, and stamens. (Fig. 17)

Hypogynous—A term referring to a superior ovary. (Fig. 17)

Inferior (epigynous)—Said of an ovary or fruit that has the sepals on top, i.e., the ovary is inferior to the attachment of the sepals. Compare superior. (Fig. 17)

Locule—A compartment or "cell" within an ovary. (Fig. 17)

Multicarpellate—An ovary formed from more than one carpel.

Nectary (pl: nectaries)—A structure that produces a sweet secretion (nectar) in some flowers (or other plant parts). It often is in the form of a scale, pit, or protuberance.

Ovary—The female part of the flower, containing the ovules or immature seeds. (Fig. 13)

Ovules—Unfertilized seeds inside the ovary. (Fig. 17)

Parietal—Type of placentation in a one-celled ovary in which the seeds are attached in rows on the inside walls. (Fig. 17)

Perigynous—Half inferior, said of an ovary in which the perianth parts are borne partway up the ovary wall. (Fig. 17)

Pistil—The ovary, along with the style and stigma. The female part of the flower. Compare gynoecium. (Fig. 13)

Pistillate—Having female parts, as in a female flower. Compare staminate.

Placenta—The place of attachment of ovules and seeds in an ovary. (Fig. 17)

Placentation—The arrangement of the seeds within the ovary. (Fig. 17)
Seed—The reproductive structure that forms a fertilized mature ovule.
Septum (pl: septa)—A partition in a multicarpellate ovary that separates the locules from each other. (Fig. 17)
Sessile—Lacking a stalk, said of leaves, flowers, etc.
Stigma—The sticky receptive tip of an ovary, with or without a style. (Fig. 17)
Stipe—The stalk of an ovary, found in a few plant families. (Fig. 17)
Style—The stalk between the ovary and stigma. (Fig. 17)
Subcapitate—Nearly capitate or globular.
Superior (hypogynous)—Said of an ovary or fruit with the sepals and petals on the bottom. Compare inferior. (Fig. 17)
Syncarpous—Referring to an ovary formed from several fused carpels.
Unicarpellate—Referring to an ovary formed from a single carpel, not from a fused carpel. Compare multicarpellate.
Vestigial—Poorly developed and no longer functional, typically said of flower parts.

17. INFLORESCENCES

The arrangement of flowers on a plant is referred to as an **inflorescence**. This may consist of a single flower (**solitary**) or a many-flowered structure. The parts comprising an inflorescence are the peduncle, the rachis, the pedicel, and the flowers themselves. The **peduncle** (Fig. 18) is the stalk of the inflorescence. The main axis is referred to as the **rachis** (Fig. 18). The **pedicel** (Fig. 18) is the stalk of the flower. Some inflorescences (e.g., umbels) have radiating branches called **rays**. Leaf like structures borne on the inflorescences are called **bracteoles**, of if they are directly under a flower, then **bracts**.

The position of the inflorescence is a useful diagnostic character. Those borne in the leaf axil (the angle between the stem and the upper leaf surface) are referred to as **axillary**. Those borne at the tips of the stems are referred to as **terminal**. So four main types of inflorescence can be solitary and axillary; solitary and terminal; many-flowered and axillary; and many-flowered and terminal. In some trees the inflorescence is borne on the trunk, a condition referred to as **cauliflorous**. The inflorescence is usually **stalked**, but some inflorescences have no peduncle and are referred to as **sessile**.

Probably the most diagnostic characteristic of inflorescences is the category or type to which it belongs. Several types of inflorescences are recognized. These are divided into two main types; **determinate** inflorescences, in which the first flower that opens is the terminal one, inhibiting further growth above that point; and **indeterminate** inflorescences, in which the first flowers to open are those on the bottom, while the distil end (tip) continues to grow. One of the most common indeterminate inflorescence types is the **raceme** (Fig. 18), which comprises a single axis called the **rachis** (Fig. 18) that bears stalked flowers. Very similar to this is a **spike** (Fig. 18 and cover), which has sessile flowers. Some inflorescences fall between these two, with subsessile flowers. Another very common type of determinate inflorescence is a **panicle** (Fig. 18), whose main axils bear branches that are further branched. One unique type of spike, in which the flowers are embedded in a fleshy axis called a **spadix** (Fig. 18 and cover). It is characteristic of the Aroid Family Araceae. The spadix is often enclosed within a sheath-like structure called a **spathe** (Fig. 18 and cover), which, in some aroids, is very showy (replacing the petals in attracting pollinators).

The most common type of indeterminate inflorescence is the **cyme** (Fig. 18), which is compound (with flower-bearing branches extending from the rachis) with its clusters of flowers bearing the oldest one (i.e., the one that opens first) in the center. A rather uncommon type of cyme in which the branches curl like a scorpion's tail is called a **scorpeoid cyme** (Fig. 18). It is characteristic of the Heliotrope Family Boraginaceae.

Inflorescences in which the pedicels of the flowers are of different lengths so as to form a flat-topped cyme are called **corymbs** (Fig. 18). Another common type of indeterminate inflorescence is the **umbel** (Fig. 18), in which the many flowers are borne in a starburst type of arrangement with all the flower pedicels more or less of similar length. Sometimes these are double, with each ray bearing its own branches (rays) that terminate in a flower. This is called a **compound umbel**. Umbels are characteristic of the Panax Family Araliaceae and the Carrot Family Apiaceae. A less common type of determinate inflorescence is a **thryse**, which is a compact, more or less compound cyme.

One of the most unique types of inflorescences is the **head** or **capitulum** (Fig. 19), which is similar to an umbel, but its flowers are sessile. This is characteristic of the Aster Family Asteraceae, which is one of the largest of all plant families. Virtually all members of the Aster Family have these flower-like heads. The heads sometimes comprise two types of **florets** (small flowers) (Fig. 19)—ray florets and disc florets. The **ray florets** (Fig. 19) are shaped like straps, and in **composite** heads (the name for this kind of inflorescence) they comprise the outside ring or zone of florets. The **disc florets** (Fig. 19) are tubular and are usually found in the center of the head. Some flowers have one or the other but not both types of florets. The Asteraceae was formerly named Compositae in recognition of inflorescences with both types of florets. Membranous **scales** called **chaffy bracts** are sometimes mixed with the florets on a composite or a ray-floret head. Another character unique to heads is the **pappus**, which has evolved from the calyx of the florets. It is sometimes modified to form a feather-like (described as **plumose**) or parachute-like structure that aids in the dispersal of the fruit of these species. The head often has a cup-like structure around it comprising numerous bracts called **phyllaries** (Fig. 19).

Several other types of inflorescences are notable. In some species, the stalked flowers are solitary, but are clustered together to form what is referred to as a **fascicle**. A **syconium**, which is unique to members of the Mulberry Family Moraceae (particularly to the fig genus *Ficus*), comprises a globose, berry-like structure that evolved from a large flat disc bearing sessile, solitary flowers enclosed within the structure. The edible fig is a syconium.

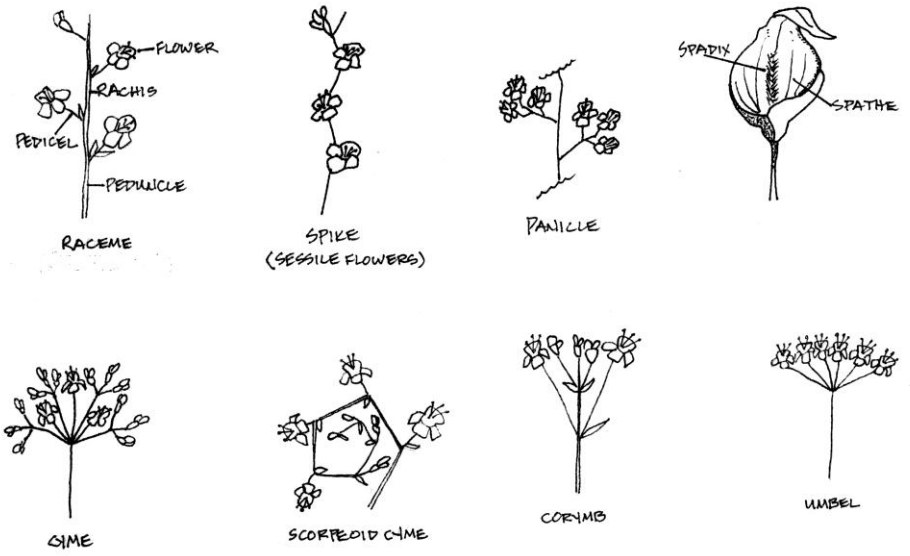


Fig. 18. Parts of an inflorescence.

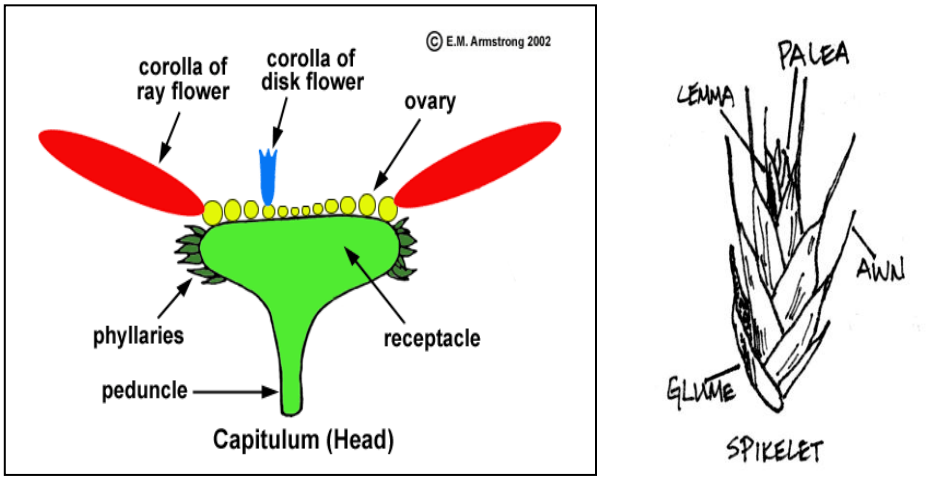


Fig. 19. Specialized f Infloresce

Three other types of inflorescences should be mentioned. A **scapose** inflorescence found in some herbaceous plants has the flowers clustered together at the top of a long stalk (the **scape**). A **cyathium**, which is restricted to some members of the Spurge Family Euphorbiaceae (especially the genus *Euphorbia*), comprises unisexual flowers enclosed within a bract-like envelope called an **involucre**. Perhaps the most unique inflorescence is called a **spikelet** (Fig. 19), which is characteristic of grasses (Grass Family Poaceae) and sedges (Sedge Family Cyperaceae). A spikelet is comprised of one to several florets which, instead of a calyx and corolla around them, have several series of dry scales called **glumes** (Fig. 19) on the outside and **paleae** (singular: **palea**) (Fig. 19) and **lemmas** (Fig. 19) on the inside. These are sometimes tipped by a filamentous extension called an **awn** (Fig. 19).

Glossary for Inflorescences

Awn—A slender, bristle-like appendage usually at the tip of a structure, especially on grass spikelets. (Fig. 19)

Axillary—Borne in the leaf axil, the angle between the stem and the upper leaf surface.

Bract—A scale, formed from a leaf that has been reduced during evolution, that is borne on or directly under a flower. Compare bracteole.

Bracteole—A scale borne on an inflorescence; a secondary bract. Compare bract.

Capitulum—Another name for a head inflorescence. (Fig. 19)

Cauliflorous—Bearing flowers on the trunk rather than at the ends of the stems.

Chaffy—Bearing thin, membranous scales in the inflorescence, as in the heads of some members of the sunflower family.

Composite—Composed of two types of florets, said of the flowers of the sunflower family, Asteraceae (Compositae). See disc and ray floret. (Fig. 19)

Compound umbel—An umbel that is doubly divided, with rays from the axis and bearing umbels. Corymb—A flat-topped, short, broad inflorescence with the center flower the youngest. The adjective form of the word is corymbose. (Fig. 18)

Cyathium—Type of inflorescence in the spurge genera (*Euphorbia* and *Chamaesyce*) in which the unisexual flowers are clustered together within a bract-like envelope. The plural is cyathia.

Cyme—A cluster of flowers with the oldest ones at the end or center. Cymose is the adjective form. Small or few-flowered cymes are cymules. Compare panicle. (Fig. 18)

Determinate—Referring to an inflorescence with the terminal flowers opening first, which determines the length of the inflorescence, e.g., a cyme. Compare indeterminate.

Disc floret—A central, tubular flower of a "composite" inflorescence of the sunflower family (Asteraceae or Compositae). Compare ray floret. (Fig. 19)

Fascicle—A condensed cluster, said of leaves or flowers.

Floret—A small flower of members of the sunflower family (Asteraceae or Compositae). Compare disc and ray florets. (Fig. 19)

Glume—One of two small, sterile bracts that form the outer series of a grass spikelet, but which is sometimes reduced or absent. (Fig. 19)

Head—An inflorescence with all the flowers sessile and attached at one point. Characteristic of the Aster Family Asteraceae. Compare composite. (Figs. 19)

Indeterminate—Referring to an inflorescence that flowers starting from the bottom and upwards, or from the edge inwards. E.g., a raceme. Compare determinate.

Inflorescence—A flower cluster or the arrangement of flowers on a plant.

Involucre—A whorl of scales borne beneath the flowers of some species, particularly members of the Spurge Family Euphorbiaceae.

Lemma—One of two pairs of membranous bracts surrounding a floret of a grass inflorescence (Grass Family Poaceae). (Fig. 19)

Palea—The membranous bract within the glumes of grass florets that, along with the lemma, encloses the flower. Palaea is the plural. (Fig. 19)

Panicle—A compound inflorescence with a main axis and racemose branches, with the youngest flowers towards the tip. Paniculate is the adjective form. Compare cyme. (Fig. 18)

Pappus—A floral structure on the ovary of composite (Asteraceae or Compositae) florets, often modified into a plume, scale, or bristle.

Pedicel—The stalk of a flower. Pedicellate means borne on a pedicel. (Fig. 18)

Peduncle—The stalk of a flower cluster or inflorescence. (Fig. 18)

Phyllary—The bract of an involucre, as in inflorescences of members of the Aster Family Asteraceae. (Fig. 19)

Plumose—Feather-like, said of some kinds of pappus of composite (Asteraceae or Compositae) flowers.

Raceme—Simple, elongated inflorescence with stalked flowers on a single main axis (rachis), the youngest ones at the top. Racemose is the adjective form. (Fig. 18)

Rachis—The axis of a compound leaf or inflorescence. Rachises is the plural. (Fig. 18)

Ray—A spreading branch of an inflorescence, e.g. of an umbel.

Ray floret—A strap-shaped flower of a composite inflorescence, usually in members of the sunflower family (Asteraceae or Compositae). Compare disc floret. (Fig. 19)

Scale—Dry leaf or bract.

Scape—An inflorescence having a long stalk. The adjective is scapose.

Scorpeoid cyme—A cyme coiled like the tail of a scorpion, common in the Heliotrope Family Boraginaceae. (Fig. 18)

Sessile—Lacking a stalk, said of leaves, flowers, etc.

Solitary—Single, as in an inflorescence consisting of only one flower.

Spadix—A spike with a thickened fleshy axis, as in members of the Aroid Family Araceae. (Fig. 18)

Spathe—An often showy leaf or bract subtending another structure, especially a spadix. (Fig. 18)

Spike—An unbranched inflorescence bearing sessile flowers, the youngest ones at the tip. (Fig. 18 and cover)

Spikelet—A grass or sedge inflorescence consisting of florets and membranous scales. (Fig. 19)

Stalked—Said of a leaf or flower with a stalk. Compare sessile.

Syconium—Kind of flower or fruit of the genus *Ficus* in which the receptacle forms a globose structure with the flowers inside.

Terminal—Situated at the end of a branch or rachis.

Thryse—A compact and more or less compound panicle.

Umbel—A flat- or round-topped inflorescence with the stalks of the flowers all arising from one point, the oldest flowers at the center. Umbellate is the adjective form of the word. (Fig. 18)

18. FRUITS

Botanically, a fruit is defined as the mature ovary of a flowering plant. This does not correspond exactly to the common (non-botanical) usage of the word. In everyday language, a tomato is considered a vegetable and breadfruit a starch, but botanically both of them are fruits. Fruits serve flowering plants in protecting the maturing seeds and often aid in dispersal, especially colorful fruits that are attractive to birds. Birds eat the fruits, but often cannot digest the seeds, which are subsequently excreted by the birds in a sometimes-distant place where the new seedling may thrive. In some plants, the fruit may be green in maturity, but it opens to expose the seeds that have a colorful edible tissue surrounding them, called the **aril**, that is attractive to birds. A good example of an aril is found in the two native nutmeg species (*Myristica* spp.) that have a large seed surrounded by a red or orange, net-like covering. (In the commercial species of nutmeg, the powdered aril produces the spice called mace).

The fruit itself comprises the seeds and the outer layers that make up the ovary wall, which are collectively called the **pericarp** (Greek: "around the fruit") (Fig. 20). The pericarp is divided into the skin on the outside (**exocarp**) (Fig. 20), the often juicy center layer (**mesocarp**) (Fig. 20), and the inner layer next to the seed or seeds (**endocarp**) (Fig. 20). Fruits that have the remains of the perianth on top have developed from an inferior ovary; those with these parts on the bottom next to the stalk have developed from a superior ovary (see the above section on the pistil).

Fruits contain many characteristics that are very useful for diagnostic purposes (i.e., for the identification of plant species). The main one is probably color, as most flowering plants use bright colors to attract birds or bats that eat the fruit and disperse the seeds. The most common fruit color is red, which is a color easily seen by birds. Fruits that are green at maturity are usually not bird-dispersed. Purple and black are also common colors, but not blue.

The two main division of types of fruits is based on whether the fruit is dry or fleshy at maturity. **Dry fruits** are further divided into those that split open (**dehiscent**) and those that do not (**indehiscent**). The most common type of dehiscent dry fruit is the **capsule** (Fig. 20). This type is almost always green at maturity, has at least two **locules** (compartments in the ovary) (Fig. 17), and opens by splitting to release the seeds from the locules. The sections of the capsule are called **valves** (Fig. 20). Some capsules split open along seams (**septicidal**) (Fig. 20), others along weaknesses in the middle of the locule (**loculicidal**), and still others (few) by means of pores (**poricidal**). In some capsules, particularly in a few families such as the Purslane Family Portulacaceae, the whole top splits off (it has free-central placentation), a capsule type known as **circumscissile**. Another type of capsule is called a **schizocarp** (Fig. 20), which, instead of the capsule splitting open, the schizocarp actually splits apart into free sections called **mericarps** (Fig. 20).

Another, less common dry dehiscent fruit is the **follicle** (Fig. 20), which comprises a single locule that splits open along a single seam. More common is the **legume** (Fig. 20), which is characteristic of the very large Pea Family Fabaceae. It comes from a fruit with two locules, and splits open along two seams.

There are several types of indehiscent dry fruits, but except for the first one, these are not nearly as common as the splitting fruit. An **achene** (Fig. 20) is a dry, indehiscent fruit comprising a single seed fused to the ovary wall. Members of the Grass Family Poaceae and the Aster Family Asteraceae have achene fruits; a sunflower seed is one, so is a rice or wheat grain. The grass achene is somewhat different and is called a **caryopsis**. The seed-like structures on strawberries are also achenes. A **nut** is a one-seeded fruit with a hard bony pericarp. This only sometimes corresponds to the term nut in everyday English; a peanut is not a nut (it is a legume), nor is a cashew a nut (it is a seed). Related to this is a **nutlet** (Fig. 20), which is similar, but is part of large fruit that is deeply lobed (similar to a mericarp, but not necessarily splitting apart). Much less common is an **utricle**, which is a bladder-like, 1-seeded fruit restricted mostly to the Amaranth Family Amaranthaceae, and an **anthocarp**,

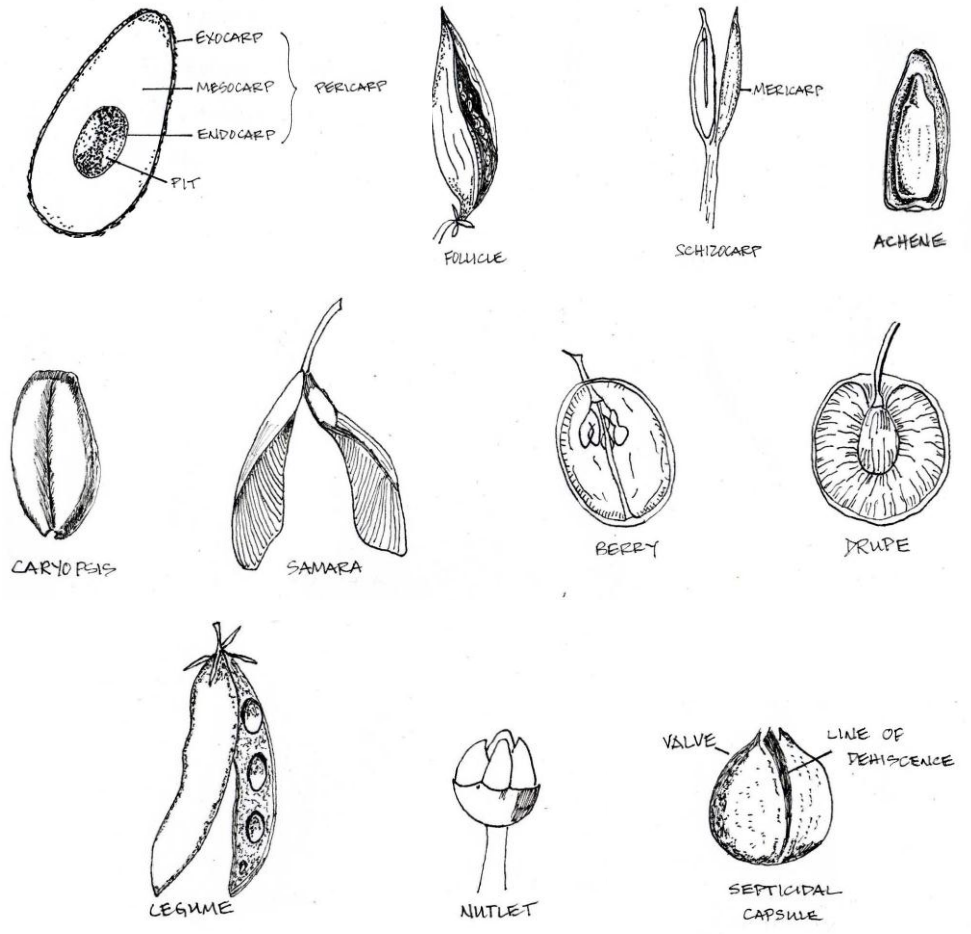


Fig. 20. Types of Fruits

which is a dry fruit formed from the ovary fused to, or surrounded by, the perianth tube; it is typical of the Four O'clock Family Nyctaginaceae. A fruit bearing wings, like a maple fruit, is called a **samara** (Fig. 20).

Fleshy fruits are more common than dry fruits, and a number of different types are recognized. The main two divisions of fleshy fruits are simple and compound. **Simple fruits** are fleshy fruits derived from a single ovary. The most common of the latter, and perhaps the most common type in flowering plants, is a **berry** (Fig. 20), which is a many-seeded fleshy fruit. It does not always correspond to the word berry in everyday English, because fruits like strawberries and raspberries are not botanically berries. Very similar to berries are **drupes** (Fig. 20), which differ in having a single seed (sometimes more) enclosed within a bony endocarp. These are also called stone fruits, because of the hard seed coating, and include peaches, cherries, and mangoes. Some drupes contain more than one of these hard bony seeds, in which case, the seeds are referred to as **pyrenes**. **Multiple fruits** are fruits that are derived from more than one ovary or flowers, or from parts other than the fleshy ovary. Examples of this include breadfruit and ***nonu*** (Indian mulberry). Another name for this is **syncarp** (Fig. 20). **Aggregate fruits** are formed from two or more pistils in an ovary (a condition known as apocarpous described earlier). An example of this is a raspberry.

Fruit shape is another important diagnostic characteristic. The shapes sometimes correspond to leaf shapes, except that they are three dimensional rather than two. Some of the more common shapes are **globose** (round), **subglobose** (nearly round), **ovoid** (egg-shaped), **obovoid** (egg-shaped with the largest diameter towards the top of the fruit), **fusiform** (spindle-shaped), **clavate** (club-shaped), **discoid** (disc-shaped), **turbinate** (top-shaped), **cylindrical** (self-explanatory), and **linear** (long and narrow). Some fruits may be basically round in cross section, but others may be flattened in this plane, a condition known as **laterally compressed** (think of a rubber egg with one side pressed on). Other fruits, such as those of the tropical almond tree (***talie***), have **wings**, which, when thin and pronounced, may allow the wind to carry the fruit away from the mother plant.

Glossary for Fruits

Achene—A small, dry, non-splitting, 1-seeded fruit with the seed fused to the ovary wall, as in the grass family. (Fig. 20)

Aggregate fruit—A fruit derived from two or more pistils of a single flower. Compare compound fruit.

Anthocarp—A fruit formed of the ovary fused to or surrounded by the perianth tube.

Aril—A fleshy outer covering of a seed, as in the net-like covering on a nutmeg seed (from which the spice mace is made).

Berry—A fleshy, pulpy fruit containing two or more seeds, such as a grape, passion fruit, or guava. (Fig. 20)

Capsule—A dry, splitting fruit with several cells, opening by sections called valves. (Fig. 20)

Caryopsis—Dry seed-like fruit produced by the cereal grasses. (Fig. 20)

Circumscissile—Describing a fruit whose top splits off along a seam.

Clavate—Club-shaped, referring to fruits or other structures.

Cylindrical—Shaped like a cylinder, said of some fruits.

Dehiscent—Referring to a dry fruit that splits open at maturity to release the seeds.

Discoid—Disk-shaped.

Drupe—A fleshy fruit with a single seed enclosed in a hard shell, such as a mango or peach; stone fruit. See endocarp. (Fig. 20)

Dry fruit—A fruit with a dry pericarp when ripe. Compare to fleshy fruit.

Endocarp—The inner layer of a fruit wall sometimes forming a hard surface. Compare drupe. (Fig. 20)

Exocarp—The outer layer, the skin, of a fruit. (Fig. 20)
Fleshy fruit—A fruit with a wet or fleshy pericarp. Compare dry fruit.
Follicle—A dry splitting fruit opening only along one side. (Fig. 20)
Fusiform—Spindle-shaped, narrow at the ends and thick in the middle, said of fruits or seeds.
Globose—Spherical in shape.
Indehiscent—Not splitting open, said of dry non-splitting fruits.
Laterally compressed—Compressed from side to side, rather than from top to bottom.
Legume—A simple fruit splitting along two seams, as is characteristic of the Pea Family Fabaceae. (Fig. 20)
Linear—Long and narrow, with the sides almost parallel.
Locules—Compartments or cells in a multicarpellate ovary. (Fig. 17)
Loculicidal—Referring to a capsule that splits open in the middle of the locules.
Mericarp—A section of a schizocarp (a splitting fruit). (Fig. 20)
Mesocarp—The middle layer of the fruit, enclosed within the endocarp and exocarp. (Fig. 20)
Multiple fruit—Fruit formed from several flowers fused together rather than separate. (Fig. 18)
Nut—A hard, non-splitting, one-seeded fruit with a hard bony pericarp. (Fig. 20)
Nutlet—A small, 1-seeded, non-splitting lobe of a divided fruit. (Fig. 20)
Obovoid—Ovoid, but with the wider end towards the tip.
Ovoid—Said of fruits, etc., that are oval in outline.
Pericarp—The outside layer of the ovary or fruit. (Fig. 20)
Pit—The hard-shelled endocarp of a drupe, as found in peaches and mangoes. (Fig. 20)
Poricidal—A capsule whose locules open by means of pores to release the seeds.
Pyrene—A nutlet in a drupe, typically with a hard seed coat.
Samara—A winged often one-seeded indehiscent fruit, such as those of ash or maple. (Fig. 20)
Schizocarp—A dry fruit splitting apart at maturity into 1-seeded segments called mericarps. (Fig. 20)
Septicidal—A capsule that splits open along the seams between the locules. (Fig. 20)
Simple—Said of a leaf, fruit, or other structure that is not divided into parts. Compare compound.
Subglobose—Nearly spherical in shape.
Syncarp—A fruit formed from the fused ovaries of more than one flower.
Turbinate—Top-shaped, referring to a fruit or seed.
Utricle—A bladder-like, 1-seeded fruit of some plants, as in the Amaranth Family Amaranthaceae.
Valve—A section or piece into which a capsular fruit splits. (Fig. 20)

Miscellaneous

Several other terms that refer mostly to position should be explained. The part of a structure that is attached at one end is referred to as the **proximal** end. The free end is referred to as being **distil**. Another term, **apical**, is similar, but is more specific to a structure with a distinct tip. **Longitudinal** refers to a lengthwise section. **Transverse** refers to something at right angles to the axis of a structure. **Medial** refers to the middle part of a structure. **Dorsal** refers to the backside of a structure, such as lower surface of a leaf. **Dimorphic** means occurring in two different shapes, e.g., opposite leaves that do not match each other.

Vocabulary for Miscellaneous

Apical—Towards the tip of a structure.
Dimorphic—Having or occurring in two forms.
Distal—At the far end of a structure, i.e., the end away from where it connects to the plant. Compare proximal.
Dorsal—The back or outer side of an organ.
Longitudinal—In a lengthwise direction, e.g., parallel to the length of a stem. Compare transverse.
Medial—Along the middle or midline of a structure.
Proximal—Located at the base or origin of a structure. Compare distal.
Transverse—At right angles to the axis of a structure. Compare longitudinal.

Glossary of Botanical Terms

Abaxial surface—The side of the organ away from the axis, e.g., the lower leaf surface.
Achene—A small, dry, non-splitting, 1-seeded fruit with the seed fused to the ovary wall, as in the grass family. (Fig. 20)
Acuminate—Referring to an acute tip that tapers to a long, drawn-out point, usually with somewhat concave sides. (Figs. 9, 10)
Acute—Tapering to a sharp, but not drawn-out point. Compare attenuate. (Fig. 9)
Adventitious roots—Roots appearing on the plant in places other than the stem base. (Fig. 1)
Aggregate fruit—A fruit derived from two or more pistils of a single flower. Compare compound fruit.
Alate—Winged, said of stems.
Alternate—Said of leaves arranged one per node. Compare opposite. (Fig. 7)
Androecium—Collective term for the stamens.
Angiosperm—The technical name for flowering plant (Latin: "enclosed seed").
Annual—A plant having a life span of a single year or season. Compare perennial.
Anther—The pollen sac attached to a stamen. Compare filament. (Fig. 16)
Anthesis—The flowering period, or when the flower opens.
Anthocarp—A fruit formed of the ovary fused to or surrounded by the perianth tube.
Apetalous—Lacking petals, said of flowers having no corolla. In such cases, the sepals sometimes look like petals. Compare petaloid.
Apex—The tip (e.g., of a leaf). (Fig. 3)
Apical—Towards the tip of a structure.
Apiculate—Referring to a tip with a small, short, sharp, flexible point. (Fig. 9)
Apocarpous—Having a flower bearing separate carpels (ovaries) rather than a single ovary formed from the fused carpels.
Apopetalous—Having free petals. This condition is usually called "petals free." (Fig. 14)
Aposepalous—Have free sepals. This condition is usually called "sepals free."
Appressed—Lying flat against a surface, as appressed hairs.
Aqueous veins—Veins that appear to be translucent on the leaf surface rather than opaque.
Aril—A fleshy outer covering of a seed, as in the net-like covering on a nutmeg seed (from which the spice mace is made).
Attenuate—Tapering gradually to form a long, straight-sided tip. Compare acute. (Figs. 9, 10)
Auriculate—Bearing an ear-like lobe (i.e., an auricle). (Fig. 10)
Awn—A slender, bristle-like appendage usually at the tip of a structure, especially on grass spikelets. (Fig. 19)
Axial surface—The upper leaf surface.

Axil—The upper angle between a leaf petiole and stem. Flowers situated in the axil are referred to as being axillary. (Fig. 3)
Axile—A type of placentation in ovaries with two or more cells, and the seeds borne on a central axis. (Fig. 17)
Axillary—Borne in the leaf axil, the angle between the stem and the upper leaf surface. (Fig. 3)
Axillary bud—The bud in a leaf axil that can develop into a branch or inflorescence. (Fig. 3)

Banner—The uppermost petal of a papilionaceous flower (i.e., one from the Fabaceae subfamily Papilionoideae); also called the standard. Compare wing and keel. (Fig. 15)
Basal rosette—The dense, circular cluster of leaves found at the base of some herbs. (Fig. 7)
Bearded—Bearing a tuft of hairs, as in some grass florets.
Berry—A fleshy, pulpy fruit containing two or more seeds, such as a grape, passion fruit, or guava. (Fig. 20)
Biennial—A plant that lives two years or seasons, using the first growing season to produce stored food, and the second to produce flowers and fruits.
Bifid—Split at the tip into two lobes. (Fig. 9)
Bilabiate—Two-lipped, said of a corolla or calyx with the parts fused into an upper and lower lip. Compare lip. (Fig. 15)
Bilateral symmetry—Two sided, said of flowers in which a line through only one plane divides the flowers into two equal halves. Compare radial symmetry. (Fig. 14)
Bipinnately compound—Twice pinnate, the first divisions being further divided into leaflets. (Fig. 6)
Bipinnately lobed—Doubly lobed in feather-like fashion, said of compound leaves with the first division lobed.
Bipinnatifid—Bipinnate compound with the leaflets lobed.
Bisexual—Having functional male and female organs in the same flower.
Blade—The expanded photosynthetic portion of the leaf. (Figs. 3, 4)
Bract—A scale, formed from a leaf that has been reduced during evolution, that is borne on or directly under a flower. Compare bracteole. (Fig. 10)
Bracteole—A scale borne on an inflorescence; a secondary bract. Compare bract.
Bulb—Structure formed when swollen leaves surround an underground stem and serve for food storage. Compare corm and tuber.

Caducous—Falling off early, referring to sepals or petals.
Calyptra—Cap-like structure, e.g., the one formed by the fused petals in the genus *Syzygium*. The condition is called calyptrate.
Calyx—The outer, usually green whorl of the flower enclosing the flower bud. It is composed of free or fused sepals. The plural is calyces. (Fig. 13)
Campanulate—Bell-shaped, said of a corolla or calyx. (Fig. 15)
Canaliculate—Having a small channel or groove, as on the upper side of some petioles.
Canescent—Gray pubescent or hoary, said of some leaf surfaces.
Canopy tree—A large tree whose crown occurs in a more or less discrete layer (the canopy) made by the foliage of tall trees in the forest.
Capitate—Head-like or bearing a head-like structure, such as a capitate stigma.
Capitulum—Another name for a head inflorescence. (Fig. 19)
Capsule—A dry, splitting fruit with several cells, opening by sections called valves. (Fig. 20)
Carpel—An ovule-bearing scale that in evolution formed a simple ovary by closing or a compound ovary by several of them fusing together.
Caryopsis—Dry seed-like fruit produced by the cereal grasses. (Fig. 20)
Caudate—Having a long, narrow, tail-like tip. (Fig. 9)

Cauliflorous—Bearing flowers on the trunk rather than at the ends of the stems.
Chaffy—Bearing thin, membranous scales in the inflorescence, as in the heads of some members of the sunflower family.
Chartaceous—Papery in texture, said of leaves. Compare coriaceous.
Ciliate—With a fringe of hairs on a margin (e.g., leaf margin).
Circumscissile—Describing a fruit whose top splits off along a seam.
Clavate—Club-shaped, referring to fruits or other structures.
Clawed—Having a long, stalk-like base, often said of petals with this base. (See cover).
Complete flower—A flower that has all the whorls, i.e., sepals, petals, stamens, and pistil. Compare incomplete flower.
Composite—Composed of two types of florets, said of the flowers of the sunflower family, Asteraceae (Compositae). See disc and ray floret. (Fig. 19)
Compound—Said of leaves with the blade further divided into leaflets or pinnae. Compare simple. (Fig. 6)
Compound umbel—An umber that is doubly divided, with rays from the axis and bearing umbels.
Concolorous—Similarly colored on both sides, as of lower and upper leaf surfaces.
Connate—United or joined, said of similar structures, such as petals of a flower.
Contorted—Twisted, used to refer to flowers in which the petals are twisted in the bud before anthesis. Compare to valvate.
Cordate—Heart-shaped, said of leaves or their bases. (Figs. 8, 9, 10)
Coriaceous—Leathery in texture, said of leaves. Compare chartaceous.
Corm—A swollen underground stem covered with dry scales and serving for food storage. Compare tuber and bulb.
Corolla—The flower whorl situated between the calyx and the gynoecium or androecium, and composed of the petals. (Fig. 13)
Corona—An outgrowth, typically in the form of a crown or whorl, that grows out of the base of a whorl of stamens between them and the petals. It is found only in a few flowering plant families, especially the Milkweed Family Asclepiadaceae.
Corymb—A flat-topped, short, broad inflorescence with the center flower the youngest. The adjective form of the word is corymbose. (Fig. 18)
Crenate—Round-toothed or scalloped, as of leaf margins. (Fig. 11)
Crenulate—Said of margins with fine, rounded teeth. Compare crenate. (Fig. 11)
Culm—The stem of a grass or sedge. (Fig. 4)
Cuneate—Wedge-shaped or triangular, referring to leaf bases. (Fig. 10)
Cuspidate—A leaf tip with a long, sharp-pointed tip with concave sides. (Fig. 10)
Cyathium—Type of inflorescence in the spurge genera (*Euphorbia* and *Chamaesyce*) in which the unisexual flowers are clustered together within a bract-like envelope. The plural is cyathia.
Cylindrical—Shaped like a cylinder, said of some fruits.
Cyme—A cluster of flowers with the oldest ones at the end or center. Cymose is the adjective form. Small or few-flowered cymes are cymules. Compare panicle. (Fig. 18)

Deciduous—Said of a plant that sheds its leaves for part of the year.
Decurrent—Referring to a leaf blade base that tapers down to a narrow wing that extends to the stem. (Fig. 10)
Decussate—Said of opposite leaves that are at right angles to the pair above and below; such leaves appear in four rows at right angles to each other. Compare distichous. (Fig. 7)
Dehiscent—Referring to a dry fruit that splits open at maturity to release the seeds.
Dentate—With sharp teeth perpendicular to the margin (of a leaf). (Fig. 11)
Denticulate—Finely dentate. (Fig. 11)

Determinate—Referring to an inflorescence with the terminal flowers opening first, which determines the length of the inflorescence. E.g., a cyme. Compare indeterminate.

Diadelphous—Bearing stamens in two bundles, especially in papilionaceous flowers that usually have a 9 plus 1 arrangement. Compare monadelphous. (Fig. 16)

Dicot—One of the two classes of flowering plants (angiosperms) that includes most flowering plant species. Dicot is short for the group Dicotyledonae, a word based on the characteristic two seed leafs (cotyledons) in the embryo. Compare monocot.

Diffuse roots—Roots that repeatedly divide rather than forming one main root, as in nearly all monocots. Compare taproot. (Fig. 1)

Digitate—Shaped or arranged like the palm of the hand, said of some plant structures.

Dimorphic—Having or occurring in two forms.

Dioecious—Condition of plants with unisexual flowers in which the male and female flowers are on separate plants. Compare monoecious.

Disc—A distinct layer of tissue formed from a protrusion of the receptacle or from fused staminodes or nectaries of some flowers.

Disc floret—A central, tubular flower of a "composite" inflorescence of the sunflower family (Asteraceae or Compositae). Compare ray floret. (Fig. 19)

Discoid—Disk-shaped.

Distal—At the far end of a structure, i.e., the end away from where it connects to the plant. Compare proximal.

Distichous—Referring to leaves that are all arranged in the same plane of a stem. They can be either alternate or opposite. Compare decussate. (Fig. 7)

Domatia—Pit-like structures found in the axils of secondary veins on the lower side of the leaves of some plant species. The singular is domatium.

Dorsal—The back or outer side of an organ.

Drupe—A fleshy fruit with a single seed enclosed in a hard shell, such as a mango or peach; stone fruit. See endocarp. (Fig. 20)

Dry fruit—A fruit with a dry pericarp when ripe. Compare to fleshy fruit.

Elliptic—Shaped like an ellipse, i.e., with rounded ends and a curved sides. An ellipsoid is a 3-dimensional figure shaped in outline like an ellipse, said of some fruits. Compare oblong. (Fig. 8)

Emarginate—Referring to a leaf with a notch at the tip. (Fig. 9)

Emergent tree—A very large tree scattered in the forest with its crown conspicuously emerging above the canopy.

Endocarp—The inner layer of a fruit wall sometimes forming a hard surface. Compare drupe. (Fig. 20)

Entire—Having a continuous margin lacking teeth or lobes, as on the edge of a leaf. (Fig. 11)

Epicalyx—A whorl of fused bracts forming a calyx-like structure at the base of the flower of some species, particularly in members of the Mallow Family Malvaceae.

Epigynous—A term referring to an inferior ovary. (Fig. 17)

Epipetalous—Borne on the corolla or petals, said of stamens. (Fig. 16)

Epiphyte—A plant, usually herbaceous, that grows on another plant. It uses the "host plant" as a place to live, does not harm it like parasites do.

Even-pinnately compound—Pinnate with an even number of leaflets, i.e., without a single unpaired leaflet at the tip. Compare odd-pinnately compound. (Fig. 6)

Exocarp—The outer layer, the skin, of a fruit. (Fig. 20)

Exserted—Sticking out, said of stamens when they protrude from the corolla. Compare included. (Fig. 16)

Falcate—Sickle-shaped. (Fig. 8)

Fascicle—A condensed cluster, said of leaves or flowers.
Filament—The stalk of a stamen, bearing the anther. Stamens lacking this are called sessile. (Fig. 16)
Fleshy fruit—A fruit with a wet or fleshy pericarp. Compare dry fruit.
Floret—A small flower of members of the sunflower family (Asteraceae or Compositae). Compare disc and ray florets. (Fig. 19)
Follicle—A dry splitting fruit opening only along one side. (Fig. 20)
Frond—The leaf of a palm or fern.
Free-central—A type of placentation in a one-celled ovary in which the seeds are attached to a free-standing column or tissue from the base of the column-less ovary. (Fig. 17)
Funnelform—Funnel-shaped, said of corollas of flowers.
Fusiform—Spindle-shaped, narrow at the ends and thick in the middle, said of fruits or seeds.

Geniculate—Bent like a knee, said of awns and filaments.
Glabrescent—Nearly or becoming glabrous with age.
Glabrous—Said of a surface lacking pubescence; hairless.
Glandular pubescent—With hairs and glands mixed together on the surface, or with hairs topped with pinhead-like glands.
Glandular punctate—Having translucent glands (such as oil glands) embedded on the surface.
Glaucous—Covered with a white, waxy bloom, or a white substance that rubs off.
Globose—Spherical in shape.
Glume—One of two small, sterile bracts that form the outer series of a grass spikelet, but which is sometimes reduced or absent. (Fig. 19)
Gynoecium—The collective term for the female parts of the flowers, i.e., the pistil, ovary, style, and stigma.

Habit—The gross physical form of a plant, i.e., whether it is an herb, vine, shrub, tree, etc.
Half-inferior—See perigynous. (Fig. 17)
Hastate—Arrowhead-shaped with the basal lobes divergent. (Fig. 10)
Head—An inflorescence with all the flowers sessile and attached at one point. Characteristic of the Aster Family Asteraceae. Compare composite and capitulum. (Fig. 19)
Herb—A non-woody plant, usually small. Compare shrub.
Herbaceous climbing vine—A weak-stemmed vine that climbs onto vegetation rather than growing prostrate on the ground.
Hirsute—Bearing long, coarse hairs.
Hispid—Bearing stiff, short hairs or bristles.
Hispidulous—Finely hispid.
Hypanthium—The cup-like receptacle of some flowers; it bears the sepals, petals, and stamens. (Fig. 17)
Hypogynous—A term referring to a superior ovary. (Fig. 17)

Imbricate—Overlapping like shingles on a roof, said of flower parts such as bracts.
Included—Referring to stamens that do not protrude from the corolla. Compare exserted. (Fig. 16)
Imperfect flower—A flower lacking either stamens or pistil. Compare perfect flower.
Incomplete flower—A flower lacking one of the four whorls. Compare complete flower.
Indehiscent—Not splitting open, said of dry, non-splitting fruits.
Indeterminate—Referring to an inflorescence that flowers starting from the bottom and upwards, or from the edge inwards. E.g., a raceme. Compare determinate.
Inferior—Said of an ovary or fruit that has the sepals on top, i.e., the ovary is inferior to the attachment of the sepals. Compare superior. (Fig. 17)

Inflorescence—A flower cluster or the arrangement of flowers on a plant.
Internode—The part of a stem between the nodes or points of attachment of leaves. (Fig. 3)
Interpetiolar stipule—The sheathing structure situated on a stem between two petioles of opposite leaves, almost exclusively restricted to all members of the Madder Family Rubiaceae. (Fig. 4)
Intramarginal collecting vein—A vein running parallel to and near the leaf margin, which is joined by or formed from the ends of the secondary veins. (Fig. 3)
Involucre—A whorl of scales borne beneath the flowers of some species, particularly members of the Spurge Family Euphorbiaceae.
Involute—A surface, as of a leaf, rolled inward or towards the upper side. Compare its opposite, revolute.

Keel—The front two united petals of a flower in the Fabaceae subfamily Papilionoideae. They are often folded to enclose the stamens and ovary. Compare banner and wing.

Laciniate—Divided into narrow, pointed lobes.
Lamina—Another name for blade of a leaf. (Fig. 3)
Lanceolate—Lance-shaped in outline, several times (2.5x or more) longer than wide, with the widest portion towards the base of the leaf. Compare oblanceolate. (Fig. 8)
Laterally compressed—Compressed from side to side, rather than from top to bottom.
Leaf—The expanded, photosynthetic organ of a plant. (Fig. 3)
Leaf arrangement—The way leaves are arranged on a stem, e.g., opposite or alternate.
Leafless—Said of plants that have through evolution lost their leaves.
Leaflet—A division of a compound leaf. (Fig. 6)
Legume—A simple fruit splitting along two seams, as is characteristic of the Pea Family Fabaceae. (Fig. 20)
Lemma—One of two pairs of membranous bracts surrounding a floret of a grass inflorescence (Grass Family Poaceae). (Fig. 19)
Lenticels—Tiny holes on a stem serving for aeration of the internal tissues. Stems marked by these conspicuous dots are referred to as lenticellate.
Lepidote—Covered with tiny scurfy (easily shed) scales, like a butterfly wing.
Liana—A woody vine that often climbs up into the canopy.
Ligule—Small appendage comprising a membrane or row of hairs found at the junction of the blade and sheath of members of the Grass Family Poaceae. (Fig. 4)
Limb—Expanded terminal portion of some corollas. Compare tube and throat. (Fig. 14)
Linear—Long and narrow, with the sides almost parallel. (Fig. 8)
Lip—The lower or upper part of a corolla or calyx when the petals or sepals are unequal. Compare bilabiate. (Fig. 15)
Lobed—Bearing segments up to halfway or more to the base or center. (Fig. 11)
Locule—A compartment or "cell" within an ovary. (Fig. 17)
Loculicidal—Referring to a capsule that splits open in the middle of the locules.
Longitudinal—In a lengthwise direction, e.g., parallel to the length of a stem. Compare transverse.
Lyrate—Pinnately lobed with a large terminal lobe and smaller lateral ones, said of some leaves. (Fig. 8)

Medial—Along the middle or midline of a structure.
Mericarp—A section of a schizocarp (a splitting fruit). (Fig. 20)
Mesocarp—The middle layer of the fruit, enclosed within the endocarp and exocarp. (Fig. 20)
Midrib (midvein)—The extension of the petiole that runs to the tip of the blade. (Fig. 4)

Milky sap—The presence of a milky latex in the phloem of some species in some families, like the Milkweed Family Asclepiadaceae.
Monadelphous—Said of stamens united by the filaments into a bundle. Compare diadelphous. (Fig. 16 and cover)
Monocot—One of the two classes of flowering plants (angiosperms) that includes grasses, sedges, palms, gingers, and many other groups. Monocot is short for Monocotyledonae, a word based on the characteristic single seed leaf (cotyledon) in the embryo. Compare Dicot.
Monoecious—Condition of a plant with unisexual flowers when male and female flowers are on the same plant. Compare dioecious.
Mucro—A sharp, tooth-like tip of some leaves, bracts, petals, or other parts.
Mucronate—Said of leaves that bear a short awn at the tip (mucro). (Fig. 9)
Multicarpellate—An ovary formed from more than one carpel.
Multiple fruit—Fruit formed from several flowers fused together rather than separate.

Nectary—A structure that produces a sweet secretion (nectar) in some flowers (or other plant parts). It often is in the form of a scale, pit, or protuberance.
Nerve—A distinct vein of a leaf.
Netted venation—A diffuse kind of leaf venation characteristic of dicots. See parallel venation. (Fig. 5)
Node—Point of attachment of a leaf on a stem. (Fig. 3)
Nut—A hard, non-splitting, one-seeded fruit with a hard bony pericarp.
Nutlet—A small, 1-seeded, non-splitting lobe of a divided fruit. (Fig. 20)

Ob- —A prefix added to a term describing a leaf shape to indicate that the blade is widest towards the tip rather than the normal condition of being widest towards the base.
Obcordate—Reverse heart-shaped with the wider end towards the tip, said of leaves, petals, etc. (Fig. 8)
Oblanceolate—Lanceolate, but with the widest part towards the tip. Compare lanceolate. (Fig. 8)
Oblique—Unequally-sided, as in the bases of some leaves. (Fig. 10)
Oblong—Longer than broad, with the sides nearly parallel to each other. (Fig. 8)
Obovate—Ovate or egg-shaped, with the widest part towards the tip. Compare ovate. (Fig. 8)
Obovoid—Ovoid, but with the wider end towards the tip.
Obsolete—No longer of use, referring to flower parts that are no longer functional.
Obtuse—Blunt, rounded. (Fig. 9)
Odd-pinnately compound—Pinnate with an odd number of leaflets, i.e., with an unpaired leaflet at the tip. Compare even-pinnately compound. (Fig. 6)
Opposite—Referring to leaves borne in pairs at the nodes. Compare alternate. (Fig. 7)
Orbicular—Round in outline. Compare suborbicular. (Fig. 8)
Ovary—The female part of the flower, containing the ovules or immature seeds. (Figs. 13, 17)
Ovate—Oval in outline, with the widest part towards the base. Compare obovate. (Fig. 8)
Ovoid—Said of fruits, etc., that are oval in outline.
Ovules—Unfertilized seeds inside the ovary. (Figs. 13, 17)

Palea—The membranous bract within the glumes of grass florets that, along with the lemma, encloses the flower. Palaea is the plural. (Fig. 19)
Palmate venation—Venation in which the main veins radiate out from one point, like the fingers on the palm of the hand. (Fig. 5)

Palmately compound—Divided in a hand-like fashion all the way to the petiole, usually in reference to leaf blades. (Fig. 6)

Palmately lobed—Lobed in a hand-like fashion, with the sinuses of the lobes not reaching the petiole. (Fig. 6)

Panicle—A compound inflorescence with a main axis and racemose branches, with the youngest flowers towards the tip. Paniculate is the adjective form. Compare cyme. (Fig. 18)

Papilionaceous—Butterfly-like, said of sweetpea-type flowers of species in the legume subfamily Papilionoideae. (Fig. 15)

Papilla—Small pimple-like projections. Surfaces with these are referred to as papillate.

Pappus—A floral structure on the ovary of composite (Asteraceae or Compositae) florets, often modified into a plume, scale, or bristle.

Parallel venation—Arrangement of veins in a leaf parallel to each other. Compare pinnate, netted, and reticulate venation. (Fig. 5)

Parietal—Type of placentation in a one-celled ovary in which the seeds are attached in rows on the inside walls. (Fig. 17)

Pedicel—The stalk of a flower. Pedicellate means borne on a pedicel. (Fig. 13)

Peduncle—The stalk of a flower cluster or inflorescence. (Fig. 18)

Peltate—Referring to a leaf with the petiole joined to the blade away from the margin.

Perennial—A plant living more than one season or year. Compare annual.

Perfect flower—A flowers that has both male and female parts. Compare imperfect flower.

Perianth—Collective term for the petals and sepals (corolla and calyx).

Pericarp—The outside layer of the ovary or fruit. (Fig. 20)

Perigynous—Half inferior, said of an ovary in which the perianth parts are borne partway up the ovary wall. (Fig. 17)

Persistent—Not falling, remaining on the plant or flower part.

Petal—A division of a corolla. (Fig. 13)

Petaloid—Petal-like in texture or color, said of the calyx of some flowers. Compare apetalous.

Petiole—The stalk of a leaf. Compare petiolule. (Fig. 3)

Petiolule—The stalk of a leaflet. Compare petiole. (Fig. 6)

Phyllary—The bract of an involucre, as in inflorescences of members of the Aster Family Asteraceae. (Fig. 19)

Pilose—Bearing soft, relatively long hairs.

Pinna—The first division of a compound leaf; the pinna is further divided into leaflets. Pinnae is the plural. (Fig. 6)

Pinnate venation—Venation that is divided in feather-like fashion. Compare palmate venation. (Fig. 3)

Pinnately compound—A leaf formed from several leaflets arranged in feather-like fashion. (Fig. 6)

Pinnately lobed—Lobed in feather-like fashion, as in simple leaves.

Pinnatifid—Deeply cut in pinnate (feather-like) fashion.

Pistil—The ovary, along with the style and stigma. The female part of the flower. Compare gynoecium. (Fig. 17)

Pistillate—Having female parts, as in a female flower. Compare staminate.

Pit—The hard-shelled endocarp of a drupe, as found in peaches and mangoes. (Fig. 20)

Placenta—The place of attachment of ovules and seeds in an ovary. (Fig. 17)

Placentation—The arrangement of the seeds within the ovary. (Fig. 17)

Plumose—Feather-like, said of some kinds of pappus of composite (Asteraceae or Compositae) flowers.

Poricidal—A capsule whose locules open by means of pores to release the seeds.

Prickle—A sharp-tipped outgrowth from a stem. A rose "thorn" is actually a prickle. Compare thorn and spine.
Prop root—A type of adventitious root that forms above ground and serves to support the plant, like those of screwpines. (Fig. 1)
Prostrate vine—A weak-stemmed plant that lacks the ability to climb and hence grows along the ground.
Protandrous—Referring to a flower with the anthers maturing before the stigma is receptive.
Protogynous—Referring to a flower with the stigma receptive before the anthers are mature.
Proximal—Located at the base or origin of a structure. Compare distal.
Puberulent—Finely pubescent.
Pubescent—Bearing hairs (pubescence). Compare glabrous.
Pulvinus—The enlarged base of some petioles, particularly in the Pea Family Fabaceae. (Fig. 3).
Pyrene—A nutlet in a drupe, typically with a hard seed coat.

Raceme—Simple, elongated inflorescence with stalked flowers on a single main axis (rachis), the youngest ones at the top. Racemose is the adjective form. (Fig. 18)
Rachis—The axis of a compound leaf or inflorescence. Rachises is the plural. (Fig. 6)
Radial symmetry—condition of a flower in which a line through any plane divides it into equal halves. See bilateral symmetry. (Fig. 14)
Ray—A spreading branch of an inflorescence, e.g. of an umbel.
Ray floret—A strap-shaped flower of a composite inflorescence, usually in members of the sunflower family (Asteraceae or Compositae). Compare disc floret. (Fig. 19)
Receptacle—The base of the flower or inflorescence, especially when it is enlarged. (Fig. 19)
Recurved—Bent backward, often said of prickles with a short terminal hook.
Reflexed—Abruptly bent downward or backward.
Reins—Long, hanging leaflets found at the base of some palm fronds.
Reniform—Kidney-shaped in outline. (Fig. 8)
Reticulate (netted) venation—Arrangement of veins in a net-like fashion. (Fig. 5)
Retuse—Notched at the tip. (Fig. 9)
Revolute—A surface having margins rolled towards the lower surface, as of leaves. Compare involute.
Rhizome—An underground stem, usually with nodes and buds. Rhizomatous means bearing rhizomes. (Fig. 2)
Rhombic—Kite-shaped in outline, like a square with one corner attached to the petiole.
Rotate—Wheel-shaped, as in rotate corollas. (Fig. 15)
Rounded—With a semi-circular tip or base.
Rugose—Having a wrinkled surface, said of some leaves.
Rugulose—Having a finely wrinkled surface.

Sagittate—Shaped like an arrowhead. (Fig. 10)
Salverform—Said of corollas with a slender tube and abruptly expanded limb; trumpet-shaped. (Fig. 14)
Samara—A winged often one-seeded indehiscent fruit, such as those of ash or maple. (Fig. 20)
Scabrous—Feeling rough, usually because of short, stiff hairs or scales.
Scale—Dry leaf or bract.
Scandent shrub—A shrub with weak stems that can ascend into trees. It is intermediate between a shrub and a vine.
Scape—An inflorescence having a long stalk. The adjective is scapose.

Schizocarp—A dry fruit splitting apart at maturity into 1-seeded segments called mericarps. (Fig. 20)
Scorpeoid cyme—A cyme coiled like the tail of a scorpion, common in the Heliotrope Family Boraginaceae. (Fig. 18)
Secondary vein—A vein that branches off from the midrib, and, in dicots in turn branches into tertiary veins. (Fig. 3)
Seed—The reproductive structures that from a fertilized mature ovule.
Sepal—A division of the calyx. (Fig. 13)
Septicidal—A capsule that splits open along the seams between the locules. (Fig. 20)
Septum (pl: septa)—A partition in a multicarpellate ovary that separates the locules from each other. (Fig. 17)
Sericeous—Silky pubescent.
Serrate—Having a saw-toothed margin, as of some leaves. (Fig. 11)
Serrulate—Finely serrate. (Fig. 11)
Sessile—Lacking a stalk, said of leaves, flowers, etc.
Setose—Bearing a stiff bristle (seta).
Sheath—Oblong tubular structure surrounding a plant part, such as a leaf sheath, which is the basal part of a grass leaf that surrounds the stem. (Fig. 4)
Shrub—A relatively short, woody plant with branches forming near to the ground.
Simple—Said of a leaf, fruit, or other structure that is not divided into parts. Compare compound.
Sinus—Space between two lobes or divisions of a leaf or corolla.
Solitary—Single, as in an inflorescence consisting of only one flower.
Spadix—A spike with a thickened fleshy axis, as in members of the Aroid Family Araceae. (Fig. 18)
Spathe—An often showy leaf or bract subtending another structure, especially a spadix. (Fig. 18)
Spathulate—Spoon-shaped. (Fig. 8)
Spike—An unbranched inflorescence bearing sessile flowers, the youngest ones at the tip. (Fig. 18 and cover)
Spikelet—A grass or sedge inflorescence consisting of florets and membranous scales. (Fig. 19)
Spine—A stiff, woody, sharp-tipped structure formed from a petiole or stipule. Compare prickle and thorn.
Spinulose—Bearing small spines.
Spreading—Bending or growing outward or horizontally.
Square stem—Stem that is square in cross section, as in the Mint Family Lamiaceae.
Stalked—Said of leaf, flower, or inflorescence borne on a stalk or petiole. Compare sessile.
Stamen—The male part of the flower, consisting of an anther and a filament. (Figs. 13, 16)
Staminal tube—A tube formed by the fusion of staminal filaments. (Fig. 16)
Staminate—Unisexual flower bearing stamens but no functioning female parts. Compare pistillate.
Staminode—A sterile stamen, lacking the anther.
Standard—Another name for banner. (Fig. 15)
Stellate—Star-shaped, said of some hairs.
Stigma—The sticky receptive tip of an ovary, with or without a style. (Fig. 17)
Stipe—The stalk of an ovary, found in a few plant families. (Fig. 17)
Stipels—Stipule of a leaflet, usually paired. Compare stipules. (Fig. 6)
Stipules—Paired basal appendages present on the petioles of some plants. Compare stipels. (Fig. 3)
Stolon—A horizontal stem rooting at the nodes or producing a new plant at its tip. (Fig. 2)

Striation—A fine groove, as on some stems. The adjective form is striate.
Style—The stalk between the ovary and stigma. (Fig. 17)
Sub- —Prefix meaning less than or not quite. See the entries below.
Subcanopy tree—A tree whose crown grows in a zone (the subcanopy) below that formed by the tallest trees (canopy trees).
Subcapitate—Nearly capitate or globular.
Subglobose—Nearly spherical in shape.
Suborbicular—Nearly round in outline. Compare orbicular. (Fig. 8)
Subsessile—Nearly stalkless or sessile.
Subshrub—A plant intermediate between a shrub and an herb.
Subtend—To be attached below something.
Subulate—Awl-shaped.
Subundulate—Nearly undulate or wavy, said of leaf margins.
Succulent—Fleshy, used to refer to the stems or leaves of some plants.
Superior (hypogynous)—Said of an ovary or fruit with the sepals and petals on the bottom. Compare inferior. (Fig. 17)
Syconium—Kind of flower or fruit of the genus *Ficus* in which the receptacle forms a globose structure with the flowers inside.
Symmetry—Correspondence between two sides of a structure on opposite sides of a dividing line. See radial symmetry and bilateral symmetry.
Sympetalous—Having the petals fused together to form the corolla. (Fig. 14)
Syncarp—A fruit formed from the fused ovaries of more than one flower.
Syncarpous—Referring to an ovary formed from several fused carpels.
Synsepalous—Fused sepals. Often written "sepals fused."

Taproot—A thickened, usually solitary root of some dicot plants, such as carrots. Compare diffuse root. (Fig. 1)
Tendril—A thread-like plant organ that by its rotating growth allows a plant to become attached to another plant for support. (Fig. 2)
Tepals—The collective term for petals and sepals when they are similar to each other.
Terete—Round in cross-section, said of stems.
Terminal—Situated at the end of a branch or rachis.
Terrestrial herb—Herbaceous plant that grows on the ground.
Tertiary veins—The small veins into which the secondary veins branch, often forming a netted pattern. (Fig. 3)
Thorn—A stiff, woody, sharp-pointed structure formed from a modified leaf. Rose "thorns" are actually prickles. Compare spine and prickle.
Throat—The part of a sympetalous corolla where the limb joins the tube. Compare limb and tube. (Fig. 14)
Thryse—A compact and more or less compound panicle.
Tomentose—Densely woolly with tangled, matted hairs.
Toothed—Bearing teeth or indentations along the margin, said of leaf margins.
Transverse—At right angles to the axis of a structure. Compare longitudinal.
Tree—A woody plant with a single trunk lacking branches near the base. Compare shrub.
Triangular stems—Stems that are 3-angled in cross-section, which is characteristic of members of the Sedge Family Cyperaceae. ("Sedges have edges" distinguishes them from members of the Grass Family Poaceae, which typically have round (terete) stems.
Trifoliate (trifoliolate)—Bearing leaves divided into three leaflets. Also called trifoliolate. (Fig. 6)
Tripinnately compound—Said of a leaf divided three times. Compare bipinnately compound. (Fig. 6)

Truncate—Appearing cut-off or squared at the end, as of a leaf tip. (Fig. 9)
Trunk—A thick woody stem, said of trees.
Trunk climber—A vine that climbs trees by means of adventitious roots that allow the plant to adhere to its host.
Tube—Basal, cylindrical portion of a corolla having fused petals. Compare limb and throat. (Fig. 14)
Tuber—An underground, swollen, root-like stem of some plants.
Tubercle—A rounded protruding body, as the base of some hairs. Tuberculate means covered with tubercles.
Tubular—Tube-shaped.
Tufted—Said of plants with the stems forming clumps, especially grasses.
Turbinate—Top-shaped, referring to a fruit or seed.

Umbel—A flat- or round-topped inflorescence with the stalks of the flowers all arising from one point, the oldest flowers at the center. Umbellate is the adjective form of the word. (Fig. 18)
Understory tree—A relatively small tree whose crown does not reach the forest canopy.
Undulate—Wavy rather than smooth, said of some leaf margins. (Fig. 11)
Unicarpellate—Referring to an ovary formed from a single carpel, not from a fused carpel. Compare multicarpellate.
Unisexual—Said of flowers lacking either stamens or an ovary.
Urceolate—Urn-shaped, usually referring to a corolla. (Fig. 15)
Utricle—A bladder-like, 1-seeded fruit of some plants, as in the Amaranth Family Amaranthaceae.

Valvate—Arrangement in an opening flower of petals that are set edge to edge. Compare contorted.
Valve—A section or piece into which a capsular fruit splits. Valvate refers to structures bearing valves. (Fig. 20)
Venation—The arrangement of the veins in a leaf.
Versatile—Said of anthers attached in the middle of the filament, and often moving freely.
Vestigial—Poorly developed and no longer functional, typically said of some flower parts.
Villous—Shaggy with long, soft hairs.

Vine—A woody or herbaceous plant with weak stems that either grows along the ground or has specialized structures or growth characteristics that allow it to climb onto taller plants.

Whorled—Said of leaf arrangements having more than two leaves per node. (Fig. 7)
Whorls—The four parts of a flower, i.e., sepals, petals, stamens, and pistil.
Wing—One of the two lateral petals of the flowers of species in the Fabaceae subfamily Papilionoideae. Compare banner and keel. Also see entry below. (Fig. 15)
Winged—Having ridges (wings) or longitudinal ridges running down the stem or petiole.
Winged stems—Stems with wings or longitudinal ridges running down it and/or the petiole.

REFERENCES FOR IDENTIFYING FIJIAN AND WESTERN POLYNESIAN PLANTS

Burkill, I.H. 1901. The flora of Vavau, one of the Tonga Islands. Jour. Linn. Soc. Bot. 35: 20–65.

Christensen, C. 1943. A revision of the Pteridophyta of Samoa. B. P. Bishop Mus. Bull. 177: 1–138.

Christophersen, E. 1935, 1938. Flowering plants of Samoa. B.P. Bishop Mus. Bull. 128: 1–221; II. B. P. Bishop Mus. Bull. 154: 1–77.

Cribb, P. and W.A. Whistler. 1996. The orchids of Samoa. Kew Gardens, London. 141 pp.

Hemsley, W.B. 1894. The flora of the Tonga or Friendly Islands, with descriptions of and notes on some new or remarkable plants... Jour. Linn. Soc. Bot. 30: 158–217.

Hotta, M. 1962. Flora of Tonga: a study of Tongan Plants. Unpublished ms. 268 pp.

Rechinger, K. 1907–1915. Botanische und Zoologische Ergebnisse einer wissenschaftlichen Forschungsreise nach den Samoa-Inseln... Denkschr. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl. 81: 197–317. 1907; 84: 385–562. 1908; 85: 175–432. 1910; 88:1–65. 1911; 89: 443–708. 1913; 91: 139–213. 1915.

Reinecke, F. 1896, 1898. Die Flora der Samoa-Inseln. Bot. Jahrb. Syst. 23: 237–368; 25: 578–708.

Seemann, B. 1865–1873. Flora Vitiensis: L. Reeve and Co., London. 453 pp.

Setchell, W.A. 1924. American Samoa. Part I. Vegetation of Tutuila Island. Publ. Carnegie Inst. Wash. 341: 1–175.

Smith, A.C. 1979, 1981, 1985, 1988, 1991, 1996. Flora vitiensis nova: a new flora of Fiji. Vol. 1: 1–495 (1979); II: 1–810 (1981): III: 1–758 (1985); IV: 1-377 (1988); V: 1–626 (1991). VI: 1–125 (1996). Nat. Trop. Bot. Gard., Lawai, Kauai.

St. John, H. 1977. The flora of Niuatoputapu Island, Tonga. Pacific Plant Studies 32. Phytologia 36 (4): 374–90.

Sykes, W.R. 1970. Contributions to the flora of Niue. New Zealand Dept. Sci. Industr. Res. Bull. 200: 1–321.

Sykes, W.R. 1977. The pteridophytes of 'Eua, Southern Tonga. Royal Soc. New Zealand Bull. 17: 119–52.

Whistler, W.A. 1992A. Polynesian herbal medicine. National Tropical Botanical Garden, Lawai, Kauai. 238 pp.

Whistler, W.A. 1992B. Tongan Herbal Medicine. Isle Botanica, Honolulu. 120 pp.

Whistler, W.A. 1992C. Flowers of the Pacific island seashore. Isle Botanica, Honolulu. 146 pp.

Whistler, W.A. 1992D. Palms of Samoa. Mooreana 2 (3): 24–29.

Whistler, W.A. 1995. Wayside Plants of the Islands. Isle Botanica, Honolulu. 202 pp.

Whistler, W.A. 1996. Samoan Herbal Medicine. Isle Botanica, Honolulu. 116 pp.

Whistler, W.A. 2000. Tropical ornamentals: a guide. Timber Press, Portland, OR. 542 pp.

Whistler, W.A. 2001. Plants in Samoan culture: the ethnobotany of Samoa. Isle Botanica, Honolulu. 234 pp.

Whistler, W.A. 2004. Rainforest trees of Samoa. Isle Botanica, Honolulu. 210 pp.

Whistler, W.A. & M. Thomas. 2008. Rare plants of Samoa. Website hosted by CIEER. http://www.cieer.org/efloras/samoa/index.php

Whistler, W.A. 2009A. Plants of the canoe People. National Tropical Botanical Garden, Lawai, Kauai. 241 pp.

Yuncker, T.G. 1943. The flora of Niue Island. B. P. Bishop Museum Bull. 178. 126 pp.

Yuncker, T.G. 1945. Plants of the Manua Islands. B. P. Bishop Mus. Bull. 184: 1–73.

Yuncker, T.G. 1959. Plants of Tonga. B. P. Bishop Mus. Bull. 220: 1–183.