



Cooperative Extension Service
Institute of Food and Agricultural Sciences

Botany Handbook for Florida, Revised Edition¹

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FOREWORD

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Table 1. Examples of common name, scientific name and meaning of scientific name.

Common Name	Scientific name	
Grape Ivy	<i>Cissus</i>	<i>rhombifolia</i>
	ivy	diamond-shaped leaves
Red Maple	<i>Acer</i>	<i>rubrum</i>
	maple	red
Sweet Gum	<i>Liquidambar</i>	<i>styraciflua</i>
	liquid amber	flowing with gum
Pink Pinxter Azalea	<i>Rhododendron</i>	<i>canescens</i>
	rose tree	off-white hairs
Spider Plant	<i>Chlorophytum</i>	<i>comosum</i>
	green plant	tufted

INTRODUCTION

Ivy, maple, gum, azalea, spider plant — these names are as familiar to us as old friends, yet very few people bother to learn their scientific names. This is unfortunate because the two-word names (binomials) given to plants are very colorful and usually very descriptive. The genus and species names of plants have been compared to the first and last names of people —there may be many Janes, but they are divided into Jane Smith, Jane Jones, Jane Johnson, and so on. Similarly, there are many species of *Quercus* (oaks), but only one *Quercus hemisphaerica* (laurel oak). The species name is a very specific adjective or noun which narrows down an entire genus to just one plant. Consider the examples given in Table 1.

As you can see, learning the scientific names of plants can be a lot of fun. After working with these names a while, you will begin to recognize certain prefixes, suffixes, and word roots and be able to identify plants by physical characteristics which match their names.

Plants which are very similar are often in the same family. Therefore, knowing the family characteristics can sometimes significantly narrow the identification process. What is the first step for identification when you have the actual plant in front of you? This very important first step is to examine characteristics of things like stems, leaves, flowers, fruits and seeds.

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This handbook will assist you in learning the terms used to describe these characteristics with clear, concise definitions and examples. I am sure it will prove to be an invaluable tool for the beginning botanist.

CHAPTER 1: THE PLANT WORLD

The plant world is extremely diverse, ranging from the one-celled algae to the huge oaks and sequoias. It contains plants like the mushroom which have no green coloring. We find in our gardens and woods lichens and mosses, which are green plants but have no true roots and leaves and no flowers. Many of us grow ferns of various kinds in our gardens. They are green plants with true leaves and roots but no flowers; instead, they reproduce by means of spores on the backs of the leaves or on separate stems. And finally there are the flowering or seed-bearing plants, which make up the vast majority of the plant kingdom. It is with this group of plants that this hand-out is concerned.

Spermopsida or Spermatophyta

Seed Plants

The seed plants are those which produce true seeds, each containing an embryo (a minute, inactive plant) that germinates (begins to grow) under favorable conditions. Seed-bearing plants have true leaves, stems, roots, and vascular tissue. These plants constitute the greater part of the vegetation of the earth. They consist of two classes, the **Gymnospermae** and the **Angiospermae**.

Gymnospermae

Gymnosperm means "naked-seeded." All gymnosperms are woody, perennial, and with few exceptions, evergreen plants. The reproductive organs are borne in structures called catkins or in cones with the seeds usually uncovered. Their leaves may be fern-like, scale-like, strap-shaped, or needle-shaped. This group is represented today principally by the cone-bearing trees (conifers) and palm-like plants (cycads). Examples of plant families which are gymnosperms include:

- **Cupressaceae** - Cypress family - *Juniperus* spp. (junipers); *Taxodium* spp. (cypresses)
- **Cycadaceae** - Cycad family - *Cycas* spp. (cycads)
- **Ginkgoaceae** - Ginkgo family - *Ginkgo biloba* (maidenhair tree)

- **Pinaceae** - Pine family - *Pinus* spp. (pines); *Cedrus* spp. (true cedars)
- **Podocarpaceae** - Podocarpus family - *Podocarpus* spp. (podocarpus)
- **Taxaceae** - *Taxus floridana* (Florida yew); *Torreya taxifolia* (Florida torrey)
- **Zamiaceae** - *Zamia* spp. (zamia)

Angiospermae

The **angiosperms** include those species which have flowers and seeds always protected by a fruit. They form a large, complex group of flowering plants under two main divisions: the **Monocotyledoneae** (monocots) and the **Dicotyledoneae** (dicots). These divisions are based upon the number of cotyledons, or "seed leaves" found in the seed.

The **Monocotyledoneae** (Mon o-kot-i-le don-e-e) have one cotyledon (embryonic leaf) in the seed. Generally they have parallel-veined leaves and flower parts in 3's or 6's (or in multiples of 3's, but never 4's or 5's). Their stems are made up of fibrovascular bundles without pith or bark. A few of the monocots such as bamboos and palms are tree-like. The majority, however, are herbaceous plants such as grasses, cattails, lilies, irises, orchids, bananas, and bromeliads.

Dicotyledoneae (Di kot-i-le don-e-e) have two cotyledons in the seed. They can be recognized by their net-veined leaves and by their flower parts (sepals, petals, stamens, and pistils), which are generally in 4's or 5's or multiples of 4's or 5's. Some dicots have many small flowers, without petals or sepals, in catkins, as in willows and poplars. Others have flowers of separate petals and sepals, as in *Rosa* spp. (rose) and *Magnolia grandiflora* (southern magnolia). Still others have flowers in which the petals or sepals or both are fused to form a trumpet-shaped flower, as in *Lonicera* spp. (honeysuckle) and *Allamanda cathartica* (allamanda).

CHAPTER 2: ROOT SYSTEMS

The functions of roots are: to act as support for the stem; to absorb and conduct water and nutrients from the soil; and to store food. Root systems consist of a main or primary root, rootlets or secondary roots, and root hairs.

The **primary root** arises from the embryo. Branches of the primary (tap) root are often fibrous and are called **secondary roots**. The primary root system of many plants is short-lived and is replaced by a secondary root system. These secondary root systems become the permanent roots of many monocotyledons such as the grasses. Roots coming from bulbs, corms, rhizomes, or tubers (see Chapter 4) are adventitious roots, as are roots developed from aerial stems (stolons and runners) and cuttings from stems or leaves. *Rhizophora mangle* (red mangrove), *Pandanus* spp. (screw-pine), and *Ficus* spp. (banyan) send down adventitious roots which become supports for heavy, horizontal branches.

Root hairs are specialized cell extensions which penetrate into the openings between soil particles. The outside wall of the cell becomes distended to form a tubular outgrowth which makes contact with the soil and absorbs water and dissolved minerals from it. Water and soluble nutrients enter the root hairs, pass into the rootlets, and travel through the main root into the stems and leaves. Root hairs are formed in great numbers near the tips of roots. In most plants they are short-lived. If a plant is transplanted carelessly, it is the loss of many of these small root hairs with their water-absorbing cells that will cause the plant to wilt.

Tap roots are prominent primary roots from which all other lateral rootlets or secondary roots grow. They may divide, become fleshy, and often penetrate deeply into the soil.

Fibrous roots are adventitious, have no distinguishable primary root and are composed of a number of fine, thread-like roots of the same kind and size originating at the base of the stem. Fibrous roots often spread out near the surface of the soil, rather than penetrating straight down or deep.

Fleshy roots become food reservoirs which retain surplus food during the winter or adverse periods to be used by the plant when it is able to renew its growth. *Daucus carota* (carrots), *Brassica rapa* (turnips), and *Beta vulgaris* (beets) have main or tap roots containing food. *Ipomoea batatas* (sweet potatoes) and *Dahlia* spp. (dahlia) have secondary roots transformed into tuberous roots packed with food.

Aerial roots form freely on many land and water plants in a favorable, moist atmosphere. These roots enable climbers such as *Philodendron* spp. (philodendrons) to attach themselves to a host. The aerial roots of air plants or epiphytes such as some

orchids not only attach the plant to its host but also absorb water from the air. Many aerial roots are fleshy or semi-fleshy, functioning as reservoirs for water storage.

Knees (pneumatophores) are developed by *Taxodium distichum* (bald cypress), when grown in swampy ground. As the water or ground cuts off the air from the roots, these trees develop woody-knees which protrude above the surface to enable the plant to obtain air.

CHAPTER 3: STEMS

A **stem** may be defined as that structure which develops from a bud to bear leaves — either full-sized or rudimentary — and buds. Stems have swellings at certain points called **nodes**. A node is the point on a stem where a leaf is or was attached. The area between nodes is termed the **internode**. Stems usually grow upward to the light, but may be subterranean.

The functions of stems are: to support and display leaves, fruit, and flowers; to carry water and nutrients from the roots to the leaves; and to carry food produced by the green parts back to the roots. In plants which lack leaves, such as cacti, all food is produced in the green stem. Stems may be annual, biennial, or perennial, although some plants with perennial roots have annual stems.

Stems may be adapted for food storage, such as tubers, corms, bulbs, or rhizomes. They may also be specialized as runners, tendrils, or thorns. The tendrils of *Vitis* spp. (grapes) and *Parthenocissus quinquefolia* (Virginia creeper) are modified stems. (Keep in mind that, in some species, tendrils may be modified leaves.)

- **Crowns** - short and inconspicuous stems. Such plants are said to be stemless or acaulescent, such as *Gerbera* spp. (gerbera daisy). Crown is also the name for the base of the stems where roots arise.
- **Simple** - stems without branches (side growths), such as in *Carica papaya* (papaya) and *Zea mays* (corn).
- **Branched** - stems with more than one terminal bud; with side growths or branches.
- **Climbing** - stems too weak to support themselves, which lean or twist about other plants or posts for support, such as in *Bougainvillea* spp. (bougainvillea) and *Pyrostegia venusta* (flame vine).

- **Creeping** - stems which rest on the surface of the ground, sending down roots at the nodes or joints, such as in the weed *Complaya trilobata* (wedelia) and *Lantana montevidensis* (trailing lantana).
- **Rhizomes** - prostrate, usually thickened, subterranean stems, with leaves coming from one side and roots from the other, such as *Canna x generalis* (canna) and some of the *Begonia* spp.
- **Stolons** - slender, modified stems growing along the surface of the ground and rooting at the nodes, as in *Fragaria x ananassa* (strawberry) and *Stenotaphrum secundatum* (St. Augustinegrass).

CHAPTER 4: FOOD RESERVOIRS

Many plants accumulate food — sugars, starches, and other products — especially in fruits and seeds and in modified roots and stems.

Fruits of various types (see Chapter 9) serve as food reservoirs. Examples are *Malus* spp. (apples), *Prunus* spp. (cherries), *Mangifera indica* (mangos), and *Cucurbita* spp. (squashes), as well as the one-seeded dry fruits of the grains, such as *Triticum aestivum* (wheat) and *Zea mays* (corn).

Seeds of such plants as *Pisum sativum* (English pea) serve as food reservoirs.

Roots accumulate food, such as the taproot of *Daucus carota* (carrots), *Pastinaca sativa* (parsnips), and *Beta vulgaris* (beets), and the tuberous roots of *Ipomoea batatas* (sweet potatoes) and *Manihot esculenta* (cassavas). These root tubers do not have buds or "eyes", but may produce adventitious ones which become stems.

Stems may be adapted as food reservoirs, as in the following examples:

- **Stem Tubers** usually grow underground but have buds or "eyes" from which spring new stems, such as in *Solanum tuberosum* (Irish potato) or *Caladium bicolor* (caladium), see *Caladium hortulanum*.
- **Corms** are solid masses of stem tissue. They are actually a condensed stem with a bud on top from which the new stem grows. *Gladiolus* spp. (*gladiolus*) is an example of a corm.

Cormels are small corms which form around the base of a larger corm.

- **Bulbs** are compressed stems containing a growing point (bud) or flower bud enclosed by thick, fleshy scale leaves. Some bulbs such as *Hippeastrum* spp. (amaryllis) and *Allium cepa* (onion) are called **tunicate** bulbs because they are protected from drying and mechanical injury by dry and membranous outer scales called a tunic.

Other bulbs such as *Lilium longiflorum* (Easter lily) are called **non-tunicate** or **scaly** because their outer scales are succulent and separate.

- **Bulblets** are small bulbs growing from the main bulb, such as in *Hippeastrum* spp. (amaryllis).
- **Bulbils** grow on the stem in the axils of leaves or bracts. They may be small bulbs, as in some lilies, or leafy appendages, as in *Alpinia purpurata* (red ginger), *Dietes iridioides* (African iris), and *Hemerocallis* spp. (daylilies). Bulbils may be used for propagation.
- **Rhizomes** may also become a food reservoir and also an easy means of propagation by division into separate parts. Examples are *Heliconia* spp. (heliconia), *Arundinaria gigantea* (switch cane), and *Pleopeltis polypodioides* (Resurrection fern).

CHAPTER 5: LEAVES

Evergreen plants have foliage that remains functional through more than one growing season, whereas **deciduous** plants shed all or nearly all their foliage each year. A typical **leaf** consists of two principal parts: the expanded **leaf blade** or **lamina**, and the slender **leaf stalk** or **petiole**. Frequently there are scaly or leaf-like outgrowths at the base of the petiole known as **stipules**, which may be leaf-like, spines, or glands. In dicots and some gymnosperms, the lamina is a thin sheet of green tissue strengthened by the midrib and lateral veins. There are three main types of venation in leaves:

1. In **parallel-veined** leaves, the veins run parallel to each other. This condition is characteristic of the monocotyledoneae. Parallel veins may run lengthwise on the leaf, as in *Eucharis grandiflora* (Amazon lily), or they may be parallel, but directed outward from the midrib to the margin (penniparallel).

2. **Pinnately-veined** leaves have a single primary vein or midrib, from which smaller veins branch off, like the divisions of a feather. Examples are *Eriobotrya japonica* (loquat) and *Camellia japonica* (camellia).
3. **Palmately-veined** leaves have several principal veins radiating from the base of the leaf blade, as in *Acer rubrum* (red maple) and *Carica papaya* (papaya).

Leaf Forms

Linear - narrow, several times longer than wide, and essentially of the same width throughout.

Lanceolate - much longer than wide and tapering towards the apex from a broader base.

Ob lanceolate - much longer than wide, tapering towards the base instead of the apex (the opposite of lanceolate).

Oblong - nearly twice as long as broad, with the sides nearly or parallel most of their length.

Elliptic - oblong, broadest in the middle with the two ends narrowing.

Ovate - egg-shaped, with the broadest part near the base.

Obovate - opposite of ovate, with the narrower part near the base.

Cuneate - wedge-shaped, broad at the tip and tapering by nearly straight lines to an acute angle at the base.

Spatulate - oblong but tapering to a narrow base; spoon-shaped.

Sagittate - arrow-shaped; lobes at base acute and pointing downward, while the main body tapers upward to a point.

Leaf Bases

Cordate - heart-shaped.

Reniform - kidney-shaped; like cordate but rounder and broader than long.

Auriculate - a small pair of projections, or ears, usually at the base.

Hastate - halberd-shaped; lobes at base pointed and narrow and nearly at right angles to petiole.

Oblique - slanting, unequal-sided.

Leaf Tips

Acuminate - prolonged into a narrowed or tapering point.

Acute - ending in an acute angle, but not a prolonged point.

Obtuse - blunt or rounded apex.

Truncate - square end that looks cut off.

Emarginate - indented or notched.

Obcordate - inversely heart-shaped; an obovate leaf which is much more deeply notched at the tip.

Cuspidate - tipped with an elongated sharp or rigid point.

Mucronate - abruptly tipped with a small, short point; like a mere projection of the midrib.

Leaf Edges/Margins

Entire - even line, without teeth, notches, or lobes.

Serrate - cut into sharp, saw-like teeth pointing forward.

Dentate - toothed, teeth point outward instead of forward and are large.

Crenate - teeth are short and rounded; also called scalloped.

Undulate - margin of the leaf forms a wavy line, bending slightly inward and outward in succession.

Sinuate - like undulate, margin is very wavy (sinuous).

Incised - cut into sharp, deep, and irregular teeth or incisions.

Lobed - incisions do not extend deeper than halfway between the margin and the center of the blade and are rounded.

Cleft - incisions extend more than halfway between the margin and the center of the blade, and are sharper.

Deeply Lobed - incisions are even deeper, but not quite to the midrib or base of the blade.

Leaf Divisions

Simple - blade is of one piece, as in *Camellia japonica*. It may still be simple and be lobed or cleft, as in *Hibiscus rosa-sinensis* (hibiscus), *Quercus shumardii* (Shumard oak), and *Acer rubrum* (red maple).

Compound - blade is made up of a number of separate leaflets. The two principal types of compound leaves are pinnate and palmate:

1. **Pinnate** - leaflets or pinnae are arranged on the sides of the main leaf stalk. Examples are *Nephrolepis exaltata* 'Bostoniensis' (Boston sword fern), *Roystonea regia* (Cuban royal palm), and *Zamia floridana* (coontie).

Odd Pinnate - pinnate with an odd number of leaflets; has an end leaflet. Examples are *Schinus terebinthifolius* (Brazilian pepper), *Wisteria sinensis* (wisteria), *Tecomaria capensis* (Cape honeysuckle), and *Koelreuteria elegans* (golden-rain tree).

Even Pinnate - pinnate with an even number of leaflets; no end leaflet. Examples are *Senna alata* (candle bush) and *Tamarindus indica* (tamarind).

Bi-pinnate - leaflets are twice pinnate (the primary pinnae or leaflets are again divided into secondary leaflets), such as in *Albizzia julibrissin* (mimosa), *Delonix regia* (royal poinciana), *Melia azedarach* (chinaberry), and *Jacaranda* spp. (jacaranda).

2. **Palmate** - the leaflets are attached directly to the end of the petiole and extend outward much like fingers in a palm. Examples are *Schefflera actinophylla* (Australian umbrella tree) and *Parthenocissus quinquefolia* (Virginia creeper).

Leaf Arrangements on Stem

Alternate - one leaf at each node, as in *Hibiscus rosa-sinensis* (hibiscus), *Brunfelsia australis* (yesterday-today-and-tomorrow), and *Citrus* spp. (citrus).

Opposite - two leaves at each node, always on opposite sides of the stem. Examples are *Catharanthus roseus* (periwinkle), *Ixora coccinea* (ixora), and *Viburnum odoratissimum* (sweet viburnum).

Whorled - more than two leaves at a node spaced around the stem, as in *Nerium oleander* (oleander) and *Macadamia* spp. (macadamia).

Leaf Attachments

Petiolate - petiole (leaf stalk) is present, examples are *Hibiscus rosa-sinensis* (hibiscus) and *Quercus* spp. (oaks).

Sessile - attached directly to the main stem or branch without a petiole, as in *Podocarpus macrophyllus* (Japanese yew) and *Gloriosa superba* 'Rothschildiana' (gloriosa lily).

Peltate - petiole attached to the lower surface of the leaf instead of at the base or margin, as in *Tropaeolum majus* (garden nasturtium).

Clasping - leaf partially encircles the stem, as in *Calendula officinalis* (calendula).

Sheathing - base of the leaf is wrapped around the stem like a grass leaf, as in *Zea mays* (corn) and *Zingiber* spp. (ginger).

Decurrent - leaf base extends downward to form a wing or ridge along the stem, as in *Psidium guajava* (guava).

Winged petiole - petiole has a leaf-like or membrane-like extension along its length, as in *Citrus x paradisi* (grapefruit).

Winged rachis - compound leaf stem with a membrane-like extension on both sides of the rachis, as in *Rhus copallinum* (winged sumac).

Stipule Types

Simple - stipules located on the sides of the petiole, as in *Hibiscus rosa-sinensis* (hibiscus).

Adnate - stipules which adhere to the sides of the petiole, as in *Trifolium* spp. (clover) and *Rosa* spp. (rose).

Leafy - green, leaf-like stipules which serve as foliage, as in *Pisum sativum* (pea) and *Delonix regia* (royal poinciana).

Other Leaf Types

Needle-shaped leaves - such as those in *Pinus* spp. (pines).

Needle-like leaves - margin of the leaf is so strongly rolled backward that the leaf appears tubular, such as in *Ceratiola ericoides* (Florida rosemary).

Awl-shaped and scale-like leaves - very reduced leaves, as in *Platycladus orientalis* (arbor vitae), *Taxodium ascendens* (pond cypress), and adult *Juniperus silicicola* (red cedar).

Leaf Textures

Succulent - juicy, fleshy, soft, and thickened in texture.

Scabrous - rough to the touch; texture of sandpaper.

Coriaceous - leather-like, tough.

Smooth (glabrous) - surface is **not** hairy, rough, pubescent, or scabrous.

Downy - covered with very short, weak, and soft hairs.

Pubescent - hairy.

Canescent - covered with gray or white soft hairs as in *Leucophyllum frutescens* (Texas sage).

Tomentose - covered with matted, woolly hairs.

Hirsute - pubescent with coarse, stiff hairs.

Hispid - rough with bristles, stiff hairs, or minute spines.

CHAPTER 6: FLOWER BRANCHES, CLUSTERS, AND INFLORESCENCES

Single Flower - one flower borne at the end of an elongated stalk or branch of the main axis of the plant, as in tulip and *Magnolia grandiflora* (southern magnolia). [The **peduncle** is the stalk which bears the single flower at the top (and is also the main stem or axis of a flower cluster). The **pedicel** is the stalk of an individual flower in a cluster.]

Cluster - three or more flowers gathered closely together in simple or branched groups to increase their conspicuousness, such as in *Pentas* spp. (pentas), *Ligustrum japonicum* (ligustrum), *Pyracantha coccinea* (firethorn), *Mangifera indica* (mango), and *Dianthus barbatus* (sweet William).

Inflorescence - general term for the arrangement of flowers or groups of flowers on a plant. There is great diversity in this arrangement among different types of plants, but they generally remain characteristic for a particular type and may be useful in identifying species. There are two main types of inflorescences, each of which is further subdivided; they are the **racemose** type and the **cymose** type.

- **Racemose Inflorescences** - the axis of the inflorescence continues to grow (it is an indeterminate inflorescence) and the flowers are borne in the axes of the reduced leaves or bracts, with the oldest flowers at the base and the newest flowers near the growing tip.

Raceme - flowers on short pedicels of about equal length along the main axis, as in *Antirrhinum majus* (snapdragon) and *Allamanda cathartica* (allamanda).

Panicle - compound raceme (the branches have branches), with individual flowers replaced by simple racemes, as in *Lagerstroemia indica* (crape myrtle) and *Murraya paniculata* (orange jessamine).

Spike - like a raceme, but flowers lack pedicels and are sessile or almost sessile. Examples are *Acalypha wilkesiana* (copperleaf) and *Callistemon* spp. (bottlebrush).

Spadix - type of spike; a fleshy axis bearing the sessile, generally fleshy flowers close together, commonly surrounded and partially enclosed by a **spathe**. Examples are *Zantedeschia aethiopica* (calla) and *Anthurium* spp. (anthurium).

Catkin - spike which normally produces only staminate or pistillate flowers (see next chapter), and at maturity falls away as a unit. Examples are *Betula nigra* (river birch) and *Quercus* spp. (oaks).

Corymb - pedicels of older flowers longer than those of younger flowers, which brings all of them to nearly the same level. Pedicels come from different points on the main peduncle, giving the

inflorescence a rather flat-topped or convex look with the outside flowers opening first. Examples are *Iberis* spp. (candytuft) and *Ixora coccinea* (ixora).

Umbel - short axis which causes pedicels to appear to arise from a common point (umbrella-shaped). This gives the inflorescence a knob-like look. The outer flowers open first. Examples are *Anethum graveolens* (dill) and *Crinum* spp. (crinum lily).

Head - similar to umbels, but sessile flowers are very close together. Heads may be globular or almost spherical as in *Cephalanthus occidentalis* (buttonbush) and *Trifolium hybridum* (alsike clover). What popularly passes for a "flower" in the Compositae (Asteraceae) is really an inflorescence with many small, true flowers, such as in *Helianthus annuus* (sunflower). **Ray** flowers form a fringe of radiating irregular, asymmetrical flowers (see chapter 8) on the edge of the head. **Disk** flowers cover the remainder of the head and are regular, symmetrical, and usually less showy. Heads may also have flowers which are all irregular with no differentiation into rays and disks.

Involucre - cluster or whorl of bracts or leaves directly under a flower or a cluster of flowers which is often conspicuous. They are often found under umbels and heads. Examples are *Helianthus annuus* (sunflower) and the cups of acorns in *Quercus* spp. (oaks).

- **Cymose Inflorescences** - Upward growth of the floral axis is stopped early by the development of a terminal flower. The first flower to open (the oldest) is at the tip; with younger flowers appearing lower down on the axis. The floral axis ceases to elongate after the first flower opens, and is therefore a determinate inflorescence.

Cyme - one terminal flower and two or more side flowers coming from the end of the axis. Examples are *Plumeria* spp. (frangipani) and *Solanum seaforthianum* (Brazilian nightshade).

Scorpioid cyme - floral axis curves over, carrying the flowers along the top of the curve, as in *Heliotropium* spp. (heliotrope).

Fascicle - flowers are very closely crowded on almost the same plane (in a tight bundle or group), as in *Dianthus barbatus* (sweet William).

Flower Positions

Terminal - flowers or clusters of flowers are carried on the ends of the axis or branches, as in *Magnolia grandiflora* (southern magnolia) and *Nerium oleander* (oleander).

Axillary - flowers or clusters of flowers arise at the junction of the stem or axis and the leaf, as in *Catharanthus roseus* (periwinkle), *Callicarpa americana* (beautyberry), and *Hibiscus rosa-sinensis* (hibiscus).

Some plants, such as *Ixora coccinea* (ixora), have both terminal and axillary flowers.

CHAPTER 7: FLOWER PARTS

A flower is a highly differentiated and specialized branch of the stem bearing modified leaves or flower parts. It is the site of sexual reproduction in these plants and is their most distinctive structure. The great variety of forms acts as a guide in separating flowering plants into the major groups. Before we look at the different classifications of flowers, we must first learn the terms for the individual structures in the flower.

Accessory Organs

The following are known as accessory organs because they are not directly involved in pollination.

Perianth - the outer floral parts, composed of the calyx and the corolla.

Tepal - used when calyx and corolla are very similar and not easily distinguished as in *Lilium catesbaei* (pine lily).

Calyx - the ring of **sepals** making up the outermost, leaflike part of the flower. Sepals are commonly green, but may be almost any color and serve primarily as protection for the other floral parts.

Corolla - the inner set of leaflike parts lying just within the calyx and composed of **petals**. Petals are generally white or brightly colored to attract pollinating insects to their nectar. They also serve as protection for the innermost organs.

Receptacle or torus - the apex of the pedicel upon which the organs of a flower are developed.

Floral Bracts - modified leaves which can simulate petals and add the conspicuous part to otherwise inconspicuous flowers. Examples are the red bracts surrounding the small *Euphorbia pulcherrima* (poinsettia) flowers; the purple, red, or white leaves enclosing the small white flowers of *Bougainvillea* spp. (bougainvillea); or the white leaves of *Cornus florida* (flowering dogwood). Many plants have floral bracts which are not colorful such as *Fittonia vershaffeltii* (silver nerve plant).

Reproductive Organs

Reproductive organs are directly involved in pollination and fertilization, hence their presence usually determines the survival of the species.

Stamens - male reproductive organs attached to the receptacle in some species inside the corolla or in other species to the corolla itself. Each stamen is composed of:

Filament - thin stalk which attaches the anther to the rest of the flower. Its attachment is called **basal** if it is at the lower end of the anther as in *Tulipa* spp. (tulip), and **versatile** if it is lateral, near the center of the anther as in *Crinum* spp. (crinum).

Anther - lobed, oblong, bag-like appendage at the top of the filament which produces the pollen grains which develop the male germ cells. Anthers are usually yellow and when young have from one to four cavities (cells) in which pollen grains arise. When mature, the anther usually contains two cavities from which the pollen grains are released by the formation of apical pores or longitudinal slits in the cavity wall.

Pollen Grains - usually appear as tiny specks barely visible to the unaided eye, but are produced in such quantity that they often form a layer of powder. Each grain is usually two-celled, spherical, ovoid, or disk-like in appearance, whose surface is marked with ridges, spines, and germ spores. Pollen grains, collectively known as pollen, are so characteristic of the different species that they are used for identification purposes.

In orchids and milkweeds pollen are in masses known as **pollinia**.

Stamens are called **opposite** when they are opposite to the petals as in *Vitis rotundifolia* (muscadine grape) or *Rhamnus caroliniana* (Carolina buckthorn) and **alternate** when they alternate with the petals as in *Viola odorata* (garden violet). The stamens are usually free or separate from each other, but in a few families they are united either by their filaments *Hibiscus rosa-sinensis* (hibiscus) and *Lycopersicon esculentum* (tomato) or by their anthers as in *Helianthus annuus* (sunflower).

Pistils - the female reproductive organs usually occur in the very center of the flower and are often surrounded by the stamens, petals, and sepals. Flowers may have just one simple pistil [as in *Lathyrus odoratus* (sweet pea)], or two, three, four, five, or more separate pistils as in *Consolida* spp. (larkspur). A **carpel** refers to either a simple pistil or one of the segments of a compound pistil. United carpels are found in *Dietes iridioides* (African iris) and *Antirrhinum majus* (snapdragon). Pistils are usually flask- or bottle-shaped. They are composed of three parts:

Style - the elongated stalk or neck connecting the ovary with the stigma.

Ovary - enlarged, bulbous, basal part of the pistil which bears the **ovules** (the egg-containing units which, after fertilization, become the seeds) attached either to its central axis or to its inner wall. The tissue to which the ovules are attached is called the **placenta**. Each ovule usually contains one **egg**, the female gamete or sex cell. The ovule normally develops into a seed when fertilized. Generally there are two or more ovules per carpel. In some plants, only one may mature into a seed. The ovary normally develops into a fruit containing seeds. An example is the pod of *Phaseolus lunatus* (lima bean).

Stigma - the tip of the pistil especially adapted to receive the pollen grains. The stigma may be expanded into a bulb or disk or divided into two or more slender parts. The stigma is often located atop a style.

A pistil is said to be **compound** when several or many carpels become united. Carpels are united so that a compound ovary often contains as many cavities as there are carpels. In some flowers, a compound ovary becomes "one-celled" by the disappearance of the partitions between the different carpels as in *Primula* spp. (primrose). Union of carpels may be so complete

that it includes the styles and stigmas as well as the ovaries.

We are now ready to list the different classifications of flowers according to the presence or absence of their parts:

- **Complete** flowers are made up of calyx, corolla, stamens, and a pistil or pistils (the four "regular parts").
- **Incomplete** flowers lack one or more of the four regular parts of a complete flower as in all of the Fagaceae (oak family), Betulaceae (birch family) and Juglandaceae (walnut family).
- **Perfect** flowers have both stamens and pistils, but not necessarily sepals or petals.
- **Imperfect** flowers lack either stamens or pistils, and may or may not have sepals or petals.
- **Naked** flowers are without petals (apetalous) or sepals (asepalous) as in *Zantedeschia* spp. (calla lily).
- **Apetalous** flowers lack petals as in *Elaeagnus pungens* (silverthorn), *Hydrangea* spp. and *Cornus florida* (flowering dogwood).
- **Staminate** (male) flowers have a stamen or stamens, but no functional pistils.
- **Pistillate** (female) flowers have a pistil or pistils, but no functional stamens.

Three terms are applied to plants based on their flowering characteristics:

- **Monoecious** plants bear both staminate and pistillate flowers on the same plant as in *Quercus* spp. (oak) and *Zea mays* (corn).
- **Dioecious** plants bear staminate flowers on one plant and pistillate flowers on a different plant, hence the terms male and female plants. *Ilex* species (holly) and all cycads and many conifers are examples.
- **Polygamous** plants bear staminate, pistillate, and hermaphroditic (bisexual - both sexes present and functional in the same flower) flowers on the same plant. An example is *Acer rubrum* (red maple).

CHAPTER 8: FLOWER FORMS

Even a casual glance at the flowers in your garden will convince you of their diversity of form. This characteristic diversity in flower forms is a very important factor in plant identification. We have seen in Chapter 7 that flowers vary in the number of their floral parts, but they also vary in other ways relative to their parts:

1. Variations in the degree to which floral parts are united

Gamopetalous - petals united to form a tubular or rotate corolla with the united part known as the **tube** and the spreading or flat part known as the **limb**. These flowers take different forms as:

- **Funnel-form** - the tube gradually widens upward and flares into the limb without any particular point of demarcation. Examples include *Nerium oleander* (oleander) and *Ipomoea carnea* (bush morning-glory).
- **Rotate** - the tube is short and the limb is flat and circular. *Lycopersicon esculentum* (tomato), *Sambucus canadensis* (elderberry) and *Vinca minor* (creeping vinca) are examples.
- **Urn-shape (urceolate)** - broad tube and slightly recurved, short limb, as in *Vaccinium* spp. (blueberry).
- **Salver-form** - slender tube and an abruptly widened, flat limb. *Phlox drummondii* (annual phlox) and *Catharanthus roseus* (periwinkle) are examples.
- **Gamosepalous** - flower with united sepals. *Catharanthus roseus* (periwinkle) and *Hibiscus rosa-sinensis* (hibiscus) are examples.
- **Polypetalous** - petals of corolla composed of separate parts. *Magnolia grandiflora* (southern magnolia), *Camellia japonica* (camellia), and *Rosa* spp. (rose) are examples.
- **Polysepalous** - sepals of calyx composed of separate parts. *Magnolia grandiflora* (southern magnolia) and *Rosa* spp. (rose) are examples.

2. Variations in placement of floral parts on the receptacle

Hypogynous (*hi-poj'i-nus*) - sepals, petals, and stamens are attached to a convex or conical receptacle at the base of the ovary. Sepals are arranged in the outermost or lowest layer, followed by petals and stamens, with carpels or ovary innermost. The ovary is called **superior** and the perianth is **inferior** or hypogynous. *Lycopersicon esculentum* (tomato) is an example.

Perigynous (*pe-rij'i-nus*) - sepals, petals, and sometimes stamens borne on the edge or margin of the receptacle so that they appear to form a cup around the pistil. *Prunus persica* (peach) is an example.

Epigynous (*e-pij'i-nus*) - sepals, petals, and stamens appear to arise from the top of the ovary. The concave receptacle not only surrounds the ovary, but is fused with it. In this case, the ovary is called **inferior** and the perianth is called **superior** or epigynous. *Malus pumila* (apple) is an example.

3. Variations in the number of subdivisions of each of the four regular parts

The number of sepals and petals is three or multiples of three of each in the monocotyledonous plants, four or five of each in the dicotyledonous plants, and reduced to none in some plants.

There is a large and indefinite number of stamens in many flower types, but in some there is a definite number, often the same as or twice the number of petals, or even further reduced to one or two.

Some flowers have a large number of separate pistils, but in others they are more or less united to form a compound pistil, and in many there is just one simple pistil.

4. Variations in the symmetry of flower forms

Regular or Actinomorphic (*ak'ti-no-mor'fik*) - floral parts, especially the corolla, are arranged symmetrically so that when quartered all sections are equal. *Rosa* spp. (rose), *Camellia japonica* (camellia), and *Ipomoea carnea* (bush morning-glory) are examples.

Irregular or Zygomorphic (*zi'go-mor'fik*) - floral parts are not arranged symmetrically, and when divided horizontally the two parts are unequal and dissimilar. There are three types of irregular flowers:

- **Papilionaceous (Peas or beans)** - five petals of three distinct types. *Lathyrus odoratus* (sweet pea) and *Lupinus* spp. (lupine) are examples. The three types of petals are:
 - **Standard or Banner** - large petal in the uppermost part or back of the flower.
 - **Keel** - two usually narrow and elongated petals in front of and usually below the standard.
 - **Wings** - two petals placed to the right and left of the keel and more or less clasping the keel.
- **Labiata (Mints)** - tube of corolla usually deeply slit into two irregular lobes, the upper lobe erect and made up of two petals, and the lower lobe spreading or open and composed of three petals. **Bilabiate** means two-lipped or double-lipped corolla. *Salvia splendens* (scarlet sage), *Salvia coccinea* (tropical sage) and *Antirrhinum majus* (snapdragon) are examples.
- **Orchidaceous (Orchids)** - three sepals and three petals, with one petal, usually the lower one, modified to form the very different and variable lip. Stamens are reduced and united with the pistil to form the **column**. *Cattleya* spp. (cattleya orchid) and *Phalaenopsis* spp. (moth orchid) are examples.

CHAPTER 9: FRUITS AND SEEDS

Fruits are the ripened and seed-bearing ovaries of flowers. Fruits are nearly as varied in color, form, size, texture, and number as are flowers, making them valuable tools in plant identification.

Botanists use the term "fruit" in a much broader way than does the layperson. Fruits are divided into two large categories: **dry fruits** and **fleshy fruits**.

Dry fruits - generally grey, brown, or another dull color, with a very thin and dry ovary wall, so that the food is largely confined to the seeds. These may be further subdivided based on the number of seeds and whether the fruit remains closed at maturity (**indehiscent**) or opens naturally (**dehiscent**).

Achene - small, hard, indehiscent, one-cavities, one-seeded fruit with a thin, almost inseparable wall, as in *Helianthus annuus* (sunflower).

Samara - indehiscent, one or two-seeded winged fruit, as in *Acer rubrum* (red maple).

Nuts - hard-shelled, usually one-seeded, indehiscent fruits, such as *Juglans nigra* (black walnut) or *Carya illinoensis* (pecan).

Grain or Caryopsis - one-seeded, indehiscent fruit of most grasses, including the cereals. The enclosed seed is almost inseparable from the enveloping ovary wall. This fruit is little more than a seed for all practical purposes.

Capsule - dehiscent fruit composed of two or more carpels, generally with several or many seeds in each carpel, as in *Gossypium* spp. (cotton).

Silique - several-seeded fruit with two carpels which pull away from the central partition at maturity, as in *Iberis odorata* (candytuft) and *Brassica* spp. (mustard).

Silicle - a silique which is wider than long, such as in *Lepidium virginicum* (peppergrass).

Legume - pod formed from a simple pistil, dehiscent along both sides, as seen in *Pisum sativum* (pea) and *Senna alata* (candle bush).

Follicle - several-seeded fruit formed from a single carpel and splitting open along one side only. There may be two or more follicles produced by each flower, as in *Mandevilla splendens* (pink allamanda) and *Asclepias* spp. (milkweed).

Fleshy Fruits - are usually juicy and brightly colored, contrasting with their background to make them more noticeable to animals, who are responsible for their dispersal. All fleshy fruits are indehiscent and considerable fleshy tissue is developed as the ovary changes into the fruit.

Drupe - "stone fruit", a simple fruit produced from a single carpel, usually one-seeded, with an outer fleshy layer of tissue called the **pericarp** and an inner, heavy stony layer called the **endocarp**. Examples are *Prunus persica* (peach), *Cocos nucifera* (coconut), *Mangifera indica* (mango) and *Olea europaea* (olive).

Berry - one or more carpels developed within a thin covering, very fleshy within, with the seeds embedded in the common flesh of a single ovary, such as *Psidium guajava* (guava), *Lycopersicon esculentum* (tomato), and *Vaccinium* spp. (blueberry).

Pepo - berry-like fruit of large size, with a tough or very firm and hard outer wall (rind) which is developed from the receptacle, such as *Citrullus lanatus* (watermelon), *Cucumis sativus* (cucumber), and *Cucurbita* spp. (squash).

Hesperidium - berry-like fruit of *Citrus* spp. (citrus) with a thick rind with numerous oil glands, and an interior fleshy part composed of wedge-shaped compartments, with or without seeds.

Pome - fruit developed largely from the receptacle which surrounds the carpels or inedible core parts, as in *Malus* spp. (apple) and *Pyrus pyrifolia* (sand pear).

Aggregate - fleshy fruit developed from the ovaries of a single flower, which becomes enlarged and bears many simple, true fruits resembling achenes or drupes, as in *Fragaria x ananassa* (strawberry). Achenes are the fruit embedded in a fleshy receptacle.

Multiple - fruits derived from many closely clustered flowers, such as in *Morus* spp. (mulberry) and *Ananas comosus* (pineapple).

Gymnosperms - produce seeds but not true fruits since they have no ovary; such seeds are said to be naked and are borne on the inside of the scales or cones, but in plants such as *Juniperus* spp. (junipers) and *Podocarpus* spp. (podocarpus) they are embedded in a fleshy fruit-like organ, known as an **aril**.

Seeds - consist of an outer coat or wall, which is usually very tough, hard, or woody, within which are cotyledons and the embryo. Seeds normally have just one embryo, but sometimes have more than one, as *Citrus* spp.

(citrus) and *Mangifera indica* (mango), which results in two or more new plants growing from one seed. Seeds are developed as a result of the fertilization of the egg in the ovule of the ovary of a flower. Typically seeds are oval or globular and range in size from dust-like orchid seeds to the large seed of the *Persea americana* (avocado), with some plants bearing seeds of even greater size such as *Cocos nucifera* (coconut). Seeds vary greatly in color, texture, longevity, and methods of dispersal. Some of the modifications of seeds which aid in dispersal are coverings of spines, hooks, bristles, cotton, or plumes, or having wings and arils. They also vary in the types and abundance of food they contain.

Cotyledon - these "seed leaves" are the primary leaves in the seed. In monocotyledons, the seed contains only one seed leaf and in dicotyledons it has two. In monocots, such as grasses, the single cotyledon remains inside the seed and acts as a digestive organ for the embryo. Cotyledons of dicots are often pushed up out of the seed at germination and reach above ground where they develop green color and act as true leaves. In other dicots, such as *Pisum sativum* (English pea), the cotyledons remain below the surface and simply provide stored food for the young plant.