EXPLANATIONS SUPPLEMENTARY TO THE DIAGRAMS

Note: Terms used but not explained in these pages can be found in the glossary.

Leaves

A complete leaf consists of **blade**, **petiole**, and **stipules**. If the petiole is absent, the blade is **sessile**. Stipules are present in some species and absent in others; if present, they may abscise early in the season. Stipules may be leaflike or bractlike, or they may be spines or glands.

The portion of a stem at which a leaf (or leaves) is attached is called a **node**. Leaves are **alternate**, **opposite**, or **whorled**. If a line is drawn from the lowest leaf-base through the base of each of the successively higher alternate leaves on a twig, it is evident that the line is a spiral. Suppose that on this spiral one leaf is designated as the first, the next above as the second, etc. If the third leaf-base is on a vertical line above the first, the fourth above the second, and so on, the leaves are 2-ranked (in two vertical rows on the stem). If the fourth is above the first and the fifth above the second, the leaves are 3-ranked. Several other less obvious types of ranking occur.

If the blade of a leaf is in one continuous piece, the leaf is **simple**. The common types of shapes, tips, bases, and margins of simple leaf-blades (and of bladelets) are illustrated on the first two pages of diagrams. Various combinations of shapes, tips, bases, and margins occur; for example, an ovate blade may have an acute tip, a rounded base, and an entire margin, or it may have an acuminate tip, a cordate base, and a serrate margin. The four general types of **venation** (arrangement of the principal veins in a leaf-blade) are illustrated on the second page of diagrams.

The blade of a **compound** leaf is divided into wholly separate segments called **leaflets**. Compound leaves are **pinnately** compound or **palmately** compound. Leaflets may be sessile or stalked. A stalked leaflet consists of **bladelet** (expanded portion) and **petiolule** (stalk). If the leaflets of a compound leaf are compounded one or more times, the leaf is **decompound**. Ultimate leaflets of a twice compound leaf may be called secondary leaflets; of a thrice compound leaf, tertiary leaflets. Use of the term ultimate leaflet (or bladelet) is convenient, especially when the degree of compounding is not the same in all parts of a compound leaf.

Other types of foliage leaves include needle leaves, scale leaves, and leaves which consist of blade and sheath. Many plants have one or more kinds of leaves in addition to ordinary foliage leaves. Among them are bud-scales, spines, scale leaves on rhizomes and at base or dwarf branches of pine, and bracts that subtend flowers and flower-clusters. These are usually smaller than foliage leaves and are often different in shape.

Flowers

In a complete flower of angiosperms there are four sets of parts arranged in concentric cycles or in spirals. These parts, in order, beginning at the base, are: **sepals, petals, stamens,** and **carpels.** In the hypogynous flower, these parts are attached to a somewhat enlarged stem-tip, the **receptacle.** Sepals taken together make up the **calyx;** petals taken together make up the **corolla. Perianth** consists of calyx and corolla together, or of either calyx or corolla if only one of them is present. Stamens collectively make up the **androecium**. A stamen usually consists of **filament** and **anther.** If the filament is missing, the anther is sessile. Sometimes one or more filaments are present without anthers.

The **gynoecium** of a flower consists of a single carpel or of two to many separate or united carpels. A carpel usually has three parts: **stigma,** at the apex; **style;** and **ovary**, the widened basal portion containing one or more **ovules.** If the style is absent, the stigma is sessile. The ripened gynoecium, together, sometimes, with other structures that ripen with it, is the **fruit.** If the ovules mature, they become **seeds.** Often it is only the ovary of the carpel or carpels that persists until maturity; the style and stigma usually wither before the fruit is ripe. Pistil, a term widely used, has been omitted here because **gynoecium** and **carpel** more simply convey the intended meaning.

The degree of union of carpels varies all the way from slight to complete. If carpels are only partly united, they are usually united at base and separate above; but rarely the stigmas, or the styles, or both are united and the ovaries are

separate. A **compound** ovary consists of the united ovaries of two or more carpels. In like manner, a style or a stigma may be compound.

It may help the student to understand the relationship between carpel and compound ovary if, with diagrams and, if possible, an actual carpel at hand, he carefully thinks through the following explanation. If a young fruit of a plant such as pea (a single carpel) is split along the groove at the placenta and the sides are spread apart, ovules are seen to be attached to the two edges of the carpel. If the two edges are brought together (that is, if the carpel is closed as it was before it was split), the ovary is 1-loculed and the ovules within it are attached to a parietal (marginal) **placenta.**

Imagine that the two walls of a carpel meet at the placenta at an angle of 120 degrees, and that three of these carpels are joined in such way that in cross section the whole has the appearance of a pie cut in three pieces, each piece a carpel. The compound ovary so formed has as many locules as carpels, and the **placentation** is **central (axile).** Imagine again that the edges of each of the three carpels are separated as in the split pea-fruit, and that the carpels are joined to one another in a circle with each edge of a carpel meeting an edge of an adjoining carpel. The compound ovary so formed has one **locule;** the placentae are **parietal** (where the edges of the carpels meet) and are equal in number to the carpels. Within a 1-loculed compound ovary the ovules are sometimes attached to a postlike structure in the center. Such placentation is called **free central.** Ovules may also be attached basally in the ovary or suspended from the top.

Variations from the situations described above may occur. A carpel may contain no ovules. In some species some of the ovules regularly fail to develop into seeds. Partitions may be present in the lower part of an ovary but absent in the upper part; then the ovary in cross section appears to have one locule above and more than one locule below. A septum may form within a carpel resulting in twice as many locules as carpels.

Because it is sometimes difficult or impossible for the student to decide how many carpels make up a gynoecium of a single carpel or of united carpels, the keys have been constructed in this edition in such way that this decision never has to be made. However, the number of carpels can usually be inferred from one or more of the following: number of styles or style-branches; number of stigmas or stigma-lobes; number of locules; and number of placentae.

Except in those plants that have multiple fruits, the term **fruit,** as used here, means the ripened gynoecium of a flower, plus, sometimes, other structures such as receptacle or hypanthium that ripen with it. If the gynoecium consists of a single carpel, the fruit is one of several types including achene, follicle, drupe, and others. If the gynoecium consists of separate carpels, two or more of which ripen, the fruit is an **aggregate** of achenes, follicles, drupes, etc., (whatever the individual carpels become). If the gynoecium consists of united carpels, the fruit may be any one of a number of types, among which are capsule, achene, grain, berry, and pome. Some fruits fit none of the named types and are referred to by such terms as berrylike, nutlike, etc. A **multiple fruit** is a ripened flower-cluster.

A flower is said to be **incomplete** if it lacks one or more of the four sets of flower-parts. A flower is **bisporangiate (perfect)** if it has both stamens and carpel or carpels, regardless of whether a perianth is present. A **monosporangiate** flower has either stamens or carpels but not both; however, vestigial stamens may be present in a carpellate flower and vestigial carpels may be present in a staminate flower. A species is **dioecious** if its flowers are monosporangiate and the two kinds are on different plants. A species is **monoecious** if its flowers are monosporangiate and the two kinds are on the same plant. Note that the adjectives monoecious and dioecious can not correctly be used to describe flowers. Sometimes both bisporangiate and monosporangiate flowers are found on the same plant.

Flowers can be classified as **hypogynous, perigynous,** or **epigynous.** In a hypogynous flower the parts of the perianth are attached to the receptacle below the gynoecium; the ovary is said to be **superior.** The stamens may be borne on the receptacle below the gynoecium or they may be adnate to the corolla. In a perigynous flower there is a cuplike, saucerlike, or tubular structure attached to the receptacle below the gynoecium. In this manual, this structure is called **hypanthium** (see hypanthium in glossary). Attached to the hypanthium, usually at its rim, are perianth and stamens. The ovary is superior in a perigynous flower; that is, the hypanthium is attached below the ovary. In an epigynous flower the other flower-parts are borne at the summit of, or somewhere along the side of, the gynoecium. The ovary is said to be wholly or partly **inferior.** An epigynous hypanthium may be present, attached to the summit of the ovary and extending upward, bearing upon its edge the other flower-parts. The stamens may be free from or adnate to the corolla. To decide whether a flower is hypogynous, perigynous, or epigynous, cut the flower lengthwise through the center and look at a cut surface.

Types of symmetry of flowers or of flower-parts **(regular, zygomorphic, isobilateral)** are illustrated on the third page of diagrams. If all the sets of flower-parts are regular, the flower can be said to be regular. In many flowers, however, the sets of flower-parts do not all have the same symmetry. If, for example, calyx and corolla are regular but stamens and carpels are not, then, in strict accuracy, only the perianth can be called regular.

A **peduncle** may end in a solitary flower or it may end in a cluster of flowers. The stalk of a flower in a cluster is a **pedicel**; if the pedicel is absent, the flower is sessile. The term **inflorescence,** as used here, is synonymous with **flower-cluster**. The common types of flower-clusters are illustrated on the fourth page of diagrams. A **spike** consists of a single more or less elongate axis bearing sessile or nearly sessile flowers. A **raceme** differs from a spike in that each flower is pediceled, the pedicels not greatly different in length. A **corymb** is like a raceme except that the pedicels are progressively shorter from base to tip of the cluster. Sequence of flowering in these three types is usually, but not always, from base to tip. A **panicle** is compound and somewhat elongate, usually made up of spikes, racemes, or corymbs, but sometimes of other types of clusters. The **cyme** which is diagrammed is a dichasium. A simple dichasium consists of three flowers; below the terminal (oldest) flower is a pair of opposite branches, each ending in a flower. In a compound dichasium there is, below each of the younger flowers of the three-flowered unit, a pair of opposite branches, each ending in a flower or a bud. Repeated compounding in this manner results in widening of the inflorescence. Other flower-clusters that are often called cymes have branching patterns different from that of the dichasium.

In an **umbel** the order of flowering may be from center to periphery or in the opposite direction. Umbels and corymbs may be compound; that is, each ray may bear, instead of a single flower, a secondary inflorescence. A **head** is similar to an umbel except that the pedicels are short or absent. **Spikelet** is used mostly to designate the small spikes of grasses and sedges. The **spadix**, usually with a subtending **spathe**, is characteristic of the Arum Family. The **cyathium** is the flower-clusters in *Euphorbia*. Because some flower-clusters do not fit any of the named types or are difficult to interpret, it is convenient to use the term racemiform (or umbelliform, etc.) to indicate that a cluster has the superficial appearance of, but not necessarily the strict character of, a raceme (or umbel, etc.).

Ferns

Pteridophytes differ from spermatophytes (seed plants) in that they have no seeds. Pteridophytes in the Ohio flora include horsetails, club-mosses, *Selaginella*, quillworts, and true ferns. In this manual, keys to the pteridophytes are based upon vegetative characters and upon features of sporangia.

Sporangia of true ferns are usually grouped in sori. These sori are on the lower sides of leaf-blades. They may be distributed over the lower blade-surface, or they may be in a continuous or a discontinuous band at blade-margin. A **sorus** may be naked (without an indusium) or it may have an **indusium** (a scalelike structure which covers the young sporangia). The indusium may be above (when the blade is lying with its lower side upward), or it may be at least partly beneath, the sporangia. As the sporangia enlarge, the indusium usually becomes withered and may eventually disappear, and sori that were originally separate sometimes become confluent. For a long time special terms have been applied to parts of fern plants. **Frond** means leaf; **stipe,** petiole; **pinna,** primary leaflet of a compound frond; and **pinnule,** division of a pinna.

Deciduous Woody Plants in Winter

Many of the characters used in keys to woody plants in winter are those of twigs, illustrated on the fifth page of diagrams. The term **twig,** as used here, means the stem-segment that grew during the most recent growing season. The scars of leaves, of veins, and of stipules are among the twig-features useful in identification. In this manual, length of a leaf-scar or of a stipule-scar is measured vertically on the twig; width is measured horizontally around the twig. Thus a wide, short leaf-scar extends far around the twig but only a short distance up and down the twig. This usage differs from that in many other manuals. In some species, at leaf-abscission, a portion of the lower part of the petiole is left on the stem. This petiole-base may remain all winter or may abscise during the winter. Stipule-scars are usually separate at sides of a leaf-scar, but sometimes they appear as a continuous ring around the twig. In some species stipules themselves persist in winter. Most twigs have **lenticels** (small cork-filled breaks in the epidermis); their number and character may occasionally be distinctive.

Every **bud** contains a stem-tip. In a **reproductive** bud, young flower-parts are on the stem-tip or on each of several stem-tips if the young stem in the bud is branched; in a **vegetative** bud, young leaves are on the stem-tip; and in a **mixed** bud, both young leaves and young flower-parts are on the stem-tip. Many buds remain dormant; of those that grow, only a flower or a flower-cluster emerges from a reproductive bud; only a leaf-bearing stem, from a vegetative bud; and a stem with both leaves and a flower or flowers, from a mixed bud. Lateral buds usually are located in the axils of leaves; therefore on winter-twigs they are usually just above leaf-scars. If the leaf-scar is U-shaped or ring-shaped, it may encircle or almost encircle the bud. Buds may be solitary at a leaf-scar, or **collateral** (side by side), or **superposed** (one above another). Sometimes they are located under the surfaces of leaf-scars or are covered by persistent petiole-bases. Unless otherwise stated, sizes of buds given in the keys are those of the larger ones on the twigs, often the terminal buds. Buds may be without scales (naked) or covered with a single scale or with two or more scales. Bud-scales may be **valvate** (with edges meeting) or imbricate (with edges overlapping). When a stem emerges from a bud, the bud-scales, if present, eventually abscise leaving scars. Consequently, at the base of each twig of a woody plant with scaly buds, there is a ring of **bud-scale scars.** These scars remain for a few years and eventually disappear as the bark roughens.

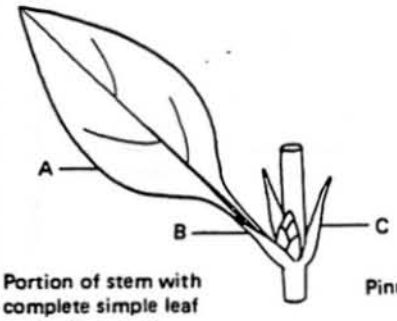
In some woody species each terminal bud regularly abscises before winter leaving a **bud-scar** (stem-scar). If leaves are opposite, the twig then ends in the two buds at the last node. If leaves are alternate, the last lateral bud usually has the appearance of a terminal bud. It can be distinguished from a true terminal bud by: 1) the presence of a leaf-scar under it; and 2) the presence of the scar of the terminal bud some distance around the twig from the leaf-scar. It is wise to look at several twigs before deciding that the terminal bud has abscised, because a scar of a terminal flower or flower-cluster on some of the twigs may be mistaken for a terminal bud-scar.

Thorns, spines, and prickles are sharp-pointed structures sometimes found on twigs and older stems. A **prickle** is superficial; it can be separated from the stem by pushing it from the side. In this manual, thorn and spine are applied to different structures. A **thorn** is a sharp-pointed stem; a **spine** is a leaf or some part of a leaf such as a stipule or a marginal tooth. If the spine is a leaf, it is located on the stem in the position of a leaf and it subtends a bud or a branch.

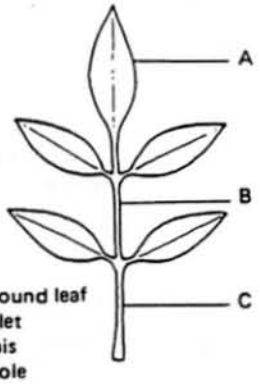
Pith of twigs or of somewhat older stems is sometimes distinctive. Pith is usually **continuous** but it sometimes has **cavities.** Horizontal **diaphragms** may be present, sometimes only at nodes; the space between the diaphragms may be filled with pith or it may be hollow. In cross section pith usually appears **circular**, but in some species it is **triangular** or **star-shaped** (5-pointed or 5-angled). It is usually white but it may be some other distinctive color.

Many features other than those of twigs are useful in identification of woody plants in winter. Among the important ones are: growth habit, whether the plant is a tree, a shrub, or a vine; type of branching; characters of bark, such as color, exfoliation, whether smooth or fissured and, if fissured, the pattern of the fissures; persistence of dead leaves; and persistence of fruits.

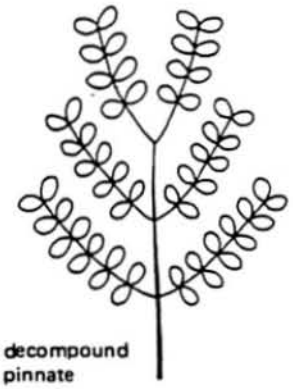
LEAVES



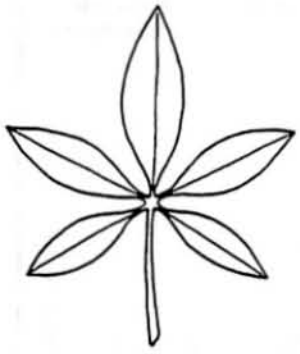
Portion of stem with complete simple leaf and axillary bud.
A, blade; B, petiole; C, stipule



Pinnately compound leaf
A, leaflet
B, rachis
C, petiole



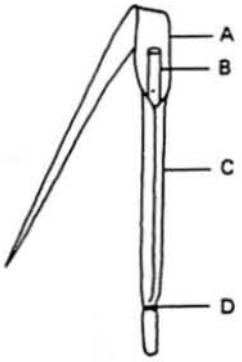
Pinnately decompound leaf, even pinnate

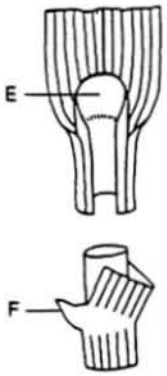


Palmately compound leaf

Dwarf branch with 2 needle leaves

Stem with scale leaves



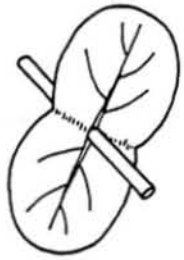


Leaf and part of stem of a grass; junction of blade and sheath enlarged. A, blade; B, stem; C, sheath; D, node; E, ligule; F, auricle

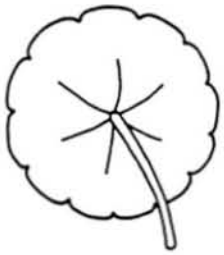
Sessile

Clasping

Perfoliate



Connate-perfoliate

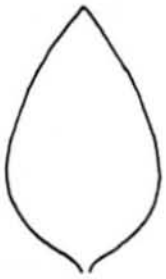


Peltate

Shapes of Blades

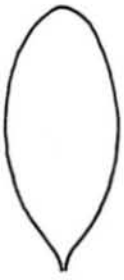
Linear

Lanceolate



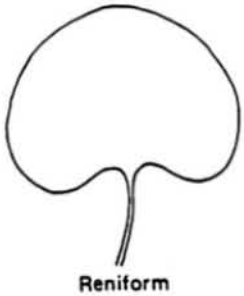
Ovate

Obovate



Elliptic

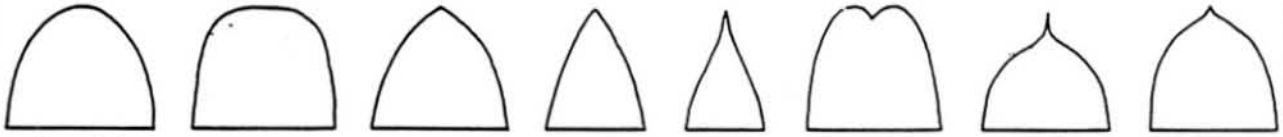
Oblong



Reniform

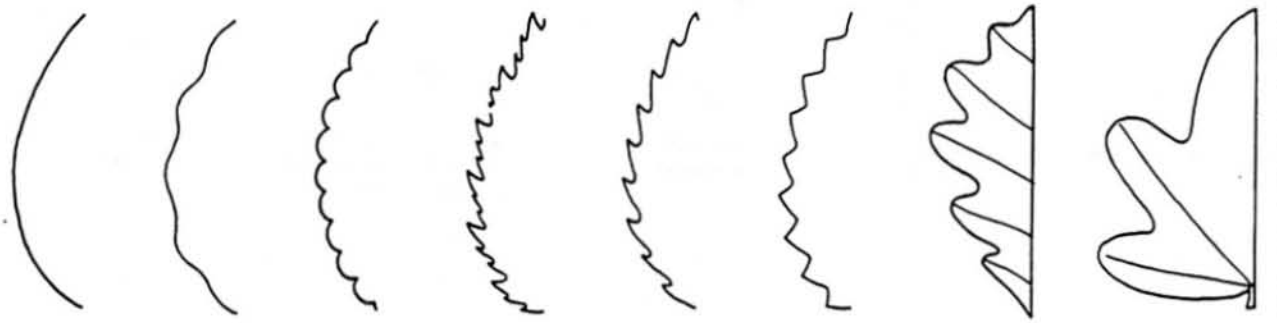
LEAVES

Tips of Blades

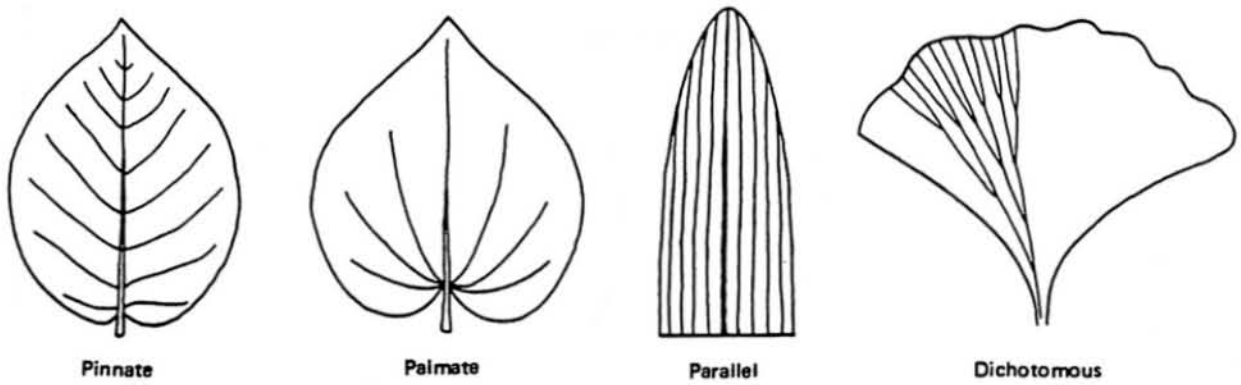


Bases of Blades

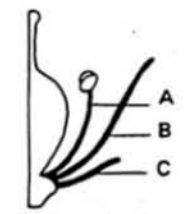
Margins of Blades



Venation



FLOWERS



Hypogynous. A, stamen; B, petal; C, sepal

Hypogynous, stamens adnate to petals

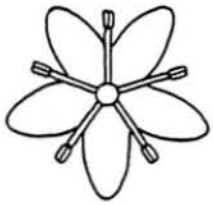
Perigynous. A, hypogynous hypanthium

Epigynous, ovary partly inferior

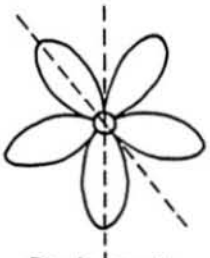
Epigynous, ovary wholly inferior

Epigynous with epigynous hypanthium

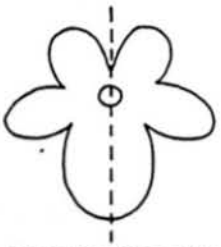
Stamens opposite petals



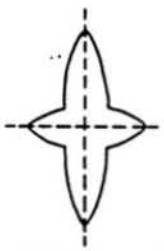
Stamens alternate with petals



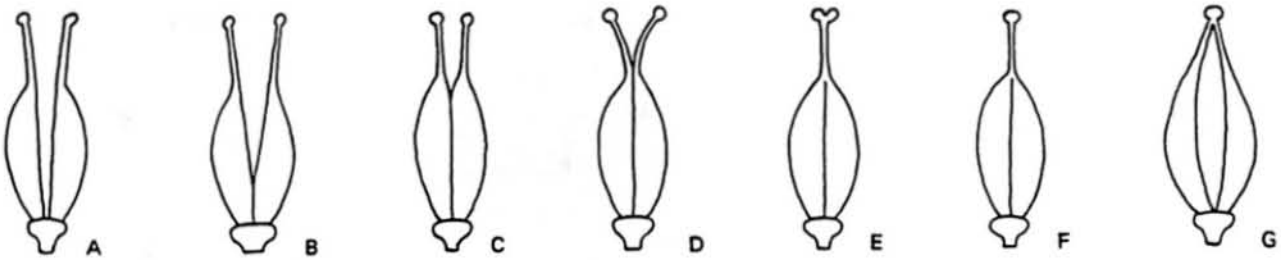
Regular corolla



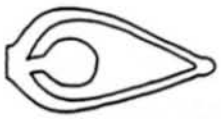
Zygomorphic corolla



Isobilateral corolla

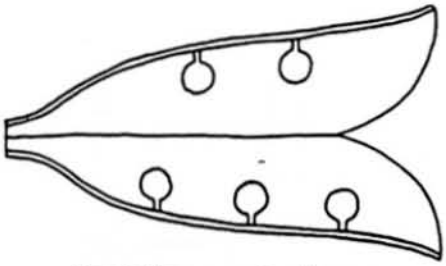


Gynecia of 2 carpels. A, carpels separate; B-F, carpels united (from united only at base to completely united); G, stigmas united, styles and ovaries separate

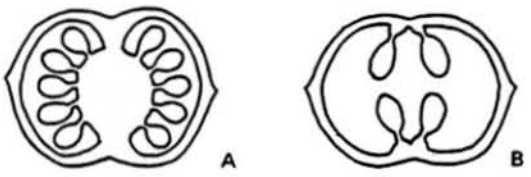


Cross section of ovary of one carpel

Cross sections of ovaries of 3 united carpels. A, placentation axile; B, placentation parietal; C, placentation free central

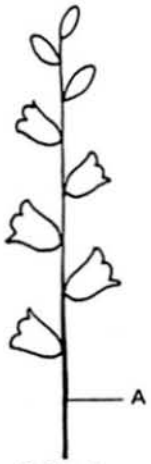


Ovary of one carpel, split open

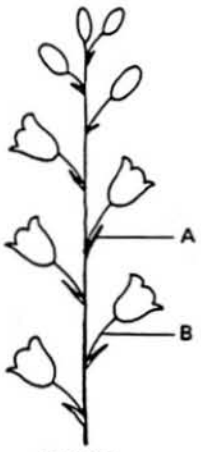


Cross sections of ovaries of 2 united carpels. A, placentae axile; B, placentae parietal

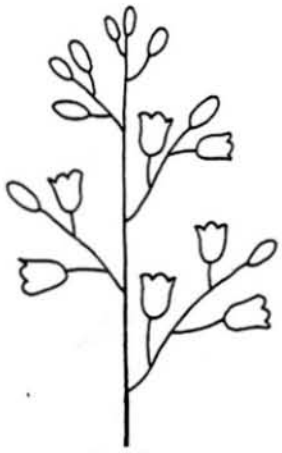
FLOWER CLUSTERS



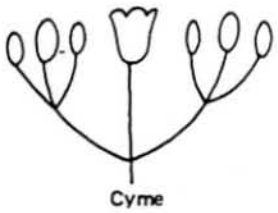
Spike. A, peduncle



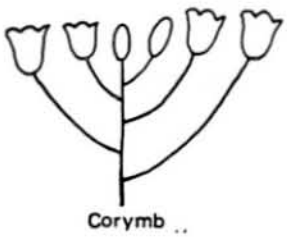
Raceme. A, bract; B, pedicel



Panicle



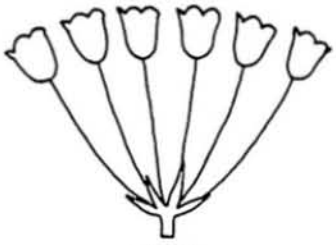
Cyme



Corymb

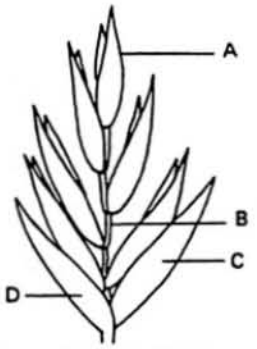
Head

Cyathium

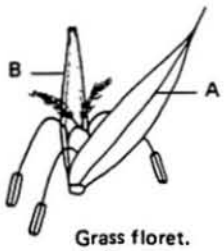


Umbel

Spadix with spathe



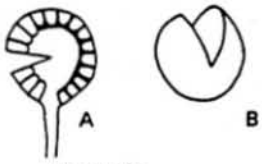
Grass spikelet. A, floret; B, rachilla; C, second glume; D, first glume



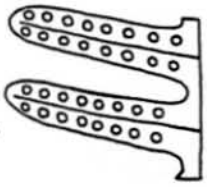
Grass floret. A, lemma; B, palea

FERNS

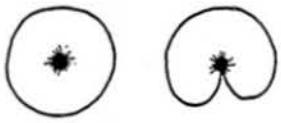
Leaf and rhizome



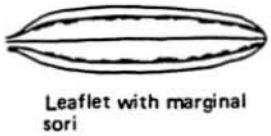
Sporangia. A, opening transversely; B, opening longitudinally



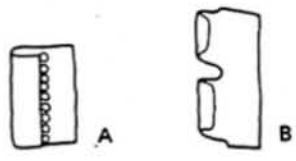
Portion of blade with sori



Five types of indusia

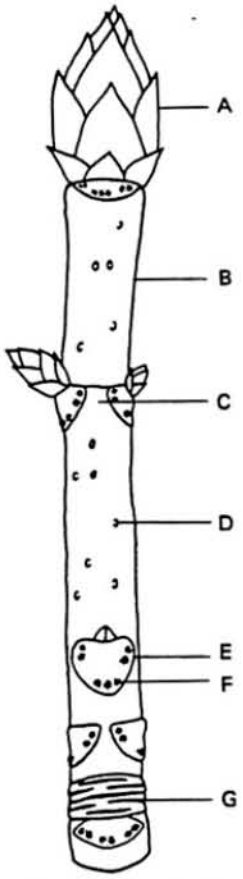


Leaflet with marginal sori

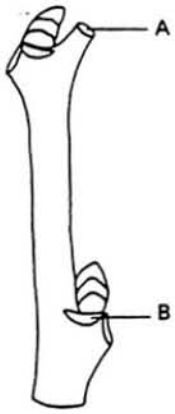


Marginal sori. A, continuous; B, discontinuous

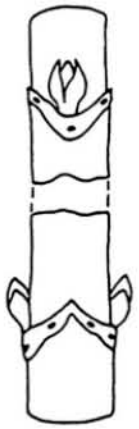
TWIGS IN WINTER CONDITION



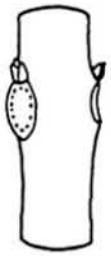
A, terminal bud, with imbricate scales; B, internode; C, node; D, lenticel; E, leaf-scar; F, vein-scar; G, bud-scale scars



Leaf-scars alternate, 2-ranked. A, scar of terminal bud; B, stipule-scar



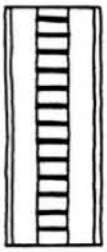
Leaf-scars opposite, meeting around twig



Leaf-scars whorled; vein-scars in an ellipse

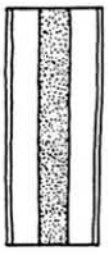
Stipule-rings

Pith 5-pointed



Pith diaphragmed, hollow

Pith diaphragmed, solid



Pith continuous

Vein-scar single

Buds superposed, bud-scales valvate

Buds collateral

Leaf-scar almost encircling bud

Bud appressed