

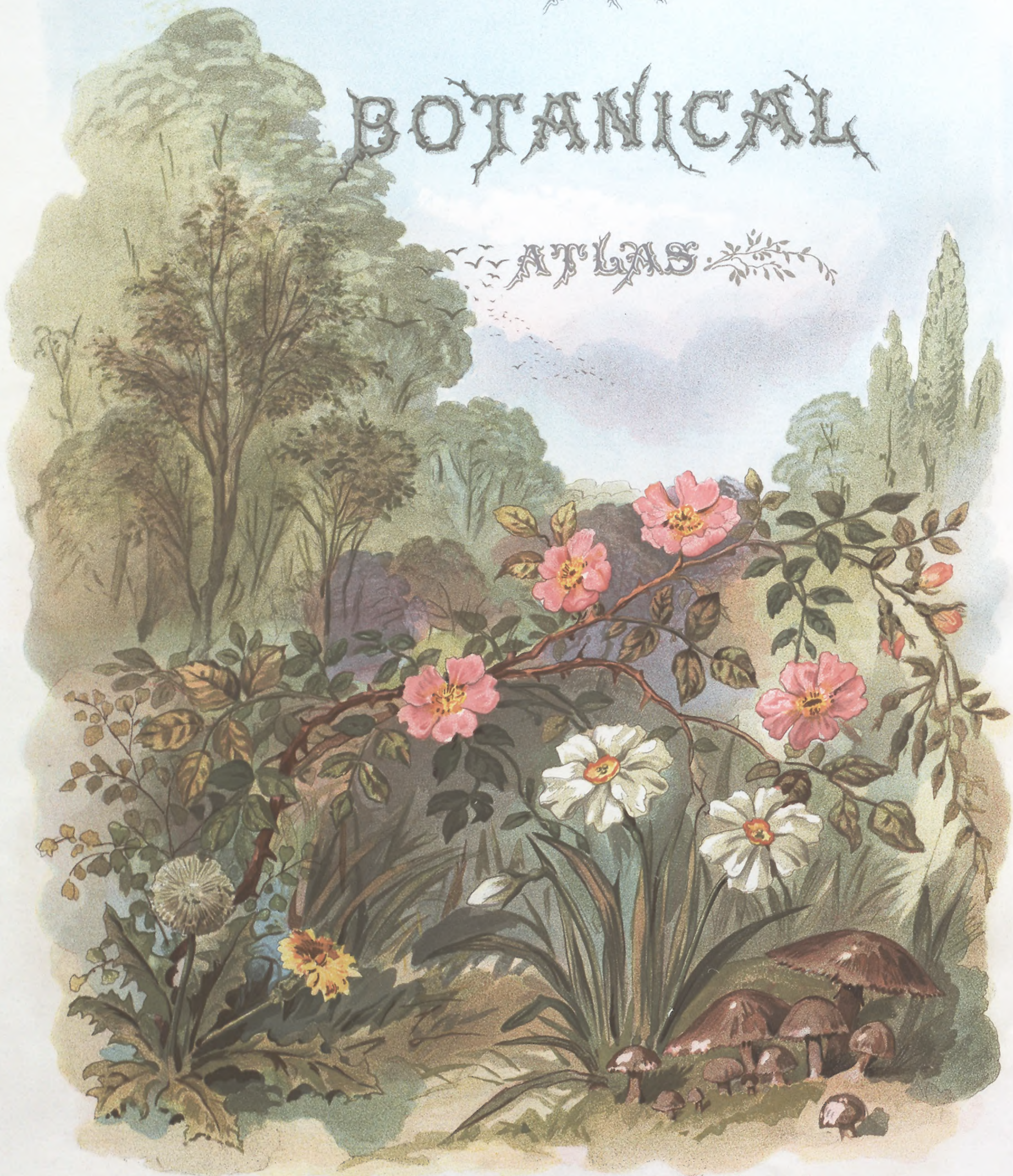


THE  
BOTANICAL  
ATLAS

PHANEROGAMS.



THE  
BOTANICAL  
ATLAS



THE CENTURY COMPANY, NEW YORK.



THE  
BOTANICAL ATLAS  
A GUIDE TO  
THE PRACTICAL STUDY OF PLANTS

CONTAINING

REPRESENTATIVES OF THE LEADING FORMS OF PLANT LIFE

WITH EXPLANATORY LETTERPRESS



BY

D. M'ALPINE, F.C.S.

[*Phanerogams*]

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THE CENTURY CO., NEW YORK

1883



TO

**The Right Honourable the Earl of Rosebery**

LL.D., F.R.S.E., Etc.

LORD RECTOR OF EDINBURGH UNIVERSITY.

THIS WORK IS, BY SPECIAL PERMISSION, RESPECTFULLY DEDICATED BY YOUR LORDSHIP'S

MOST OBEDIENT HUMBLE SERVANT

THE AUTHOR



## PREFACE.

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THE "BOTANICAL ATLAS" is carried out on the same plan as the "BIOLOGICAL" and "ZOOLOGICAL" ATLASES, which have been so favourably received. There are several improvements, however, introduced, which it is hoped the student will appreciate. The colour, for instance, is natural, so that every plant, or part of a plant, wears its appropriate garb. The Life Histories of organisms, too, have received full recognition, and the student of Animal Life will thus see that there is much in common between the two kingdoms.

The CRYPTOGAMS range from the simplest organisms which cause Disease or produce Alcohol, through Mushroom, Seaweed, Lichen, Moss, Fern, Horse-Tail, and Club-Moss, ending with those which foreshadow the higher Seed-bearing Plants. The microscope is here necessarily the principal instrument of research; and in delineating minute objects requiring the highest powers for their proper determination, I have been largely indebted to the labours of others. My thanks are specially due to Professor Dodel-Port, who allowed me free and full use of the beautiful Figures in his "Anatomical and Physiological Atlas of Botany," and even favoured me with other drawings to choose from, if necessary.

The PHANEROGAMS are represented in all their leading divisions, and the various reproductive processes are fully illustrated. Typical members are chosen from the principal Natural Orders, and the mode of examination pointed out. The Flower and its various parts passing into Fruit and Seed are mainly considered, and this forms the best introduction to a course of Practical Botany, since the eye and hand, trained to dissect and distinguish these comparatively conspicuous structures, can then more easily pass to the study of the minute structure of Root, Shoot, and Leaf, and their various modifications.

As the specimens chosen are of the commonest kind—from the road-side, the sea-shore, the ponds, the meadows, and the woods—and as full directions are given along with the drawing for their proper examination, this Atlas appeals to every one who takes an interest in the various forms of Plant Life; and as they are taken up in order, commencing with the simplest and most uniform, and ending with the most complex, that general view of the whole field is given which is the best preparation for dipping deeper into any department of it.

D. M'ALPINE.

*April, 1883.*



PHANEROGAMS



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much reduced



Fig. 2 Young Carpellary Leaf  
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Fig.3 Mature Carpellary Leaf of *C. revoluta*  
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Fig.4 Mature Ovule  
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Fig.8 Female Cone of *Zamia muricata*



Fig. 6 Male Flower of *Cerato-zamia Mexicana*

a. Longitudinal section of part of Cone  
b. Transverse section seen from under surface

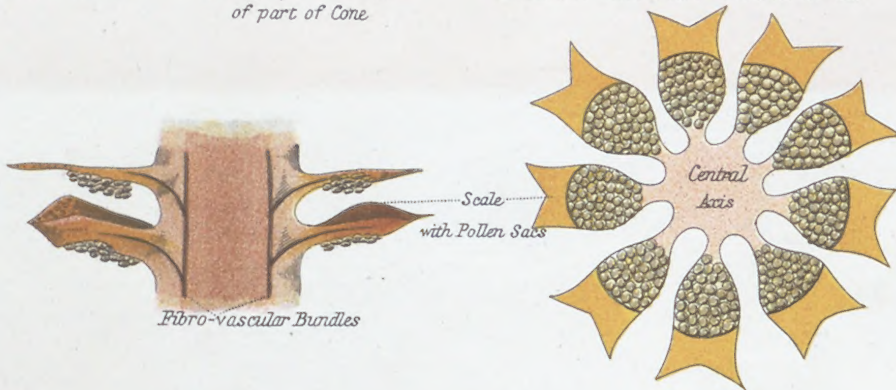


Fig.5 Male Cone of *Zamia muricata*



Fig.7 Stamen of *Zamia muricata*



Fig.11 Seed in Vertical section

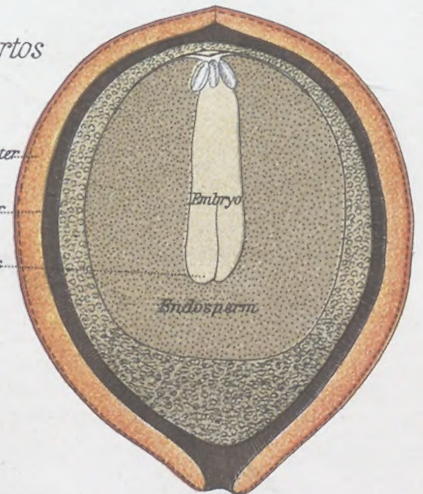


Fig.10 Unfertilized Seed of *Encephalartos*

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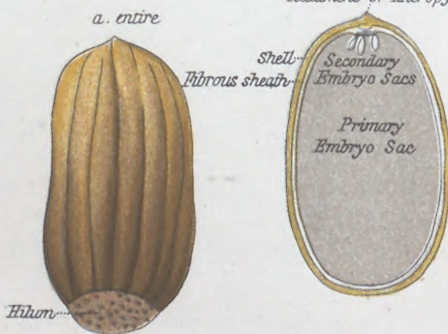


Fig.9 Carpel of same bearing 2 Ovules





## PLATE I.—CYCADEÆ.

(*Cycas and Zamia*, from Dodel-Port and Luerissen.)

Cycads belong to the warmer parts of the world, their chief centres being Tropical America, South Africa, Eastern Asia, and Australia. Although there are no living representatives in this country, still as they form the base of the lowest class of Phanerogams, or seed-bearing plants, they naturally come in first for consideration.

They show the nakedness of the seeds, or Gymnospermy, and the leafy nature of the ovule-bearing organs so clearly, that they are referred to in the most elementary text-books of Botany, and this also must be taken as some sort of justification for introducing them here.

The practical examination of the Coniferæ, with which they are closely allied, will enable the student to understand the various drawings, where he cannot hope to obtain specimens. Cycads may be seen growing in the "Palm-houses" of our Botanic Gardens, where their resemblance to Tree-ferns, or Palms, is strikingly manifest.

The genus *Cycas* shows, in a very elementary form, the essential characteristic of the Phanerogams, *viz.* the structure of a Flower producing Seed. The terminal *bud* of the stem becomes a *flower* of the simplest kind—a number of modified leaves arranged spirally on an axis, and these modified or *carpellary leaves* assume the simplest form—their lobes being converted into naked *ovules*. The central bud of the flower again grows out and produces ordinary leaves, thus showing the flower to be a *modified bud*, and the carpels or ovule-bearing organs to be *modified leaves*.

Fossil forms are found in this country, particularly in the Upper Oolite. In the Island of Portland there are the remains of an old land surface, known as the "Dirt Bed," and in it are embedded the roots and woody stumps of Cycads.

### GENERAL CHARACTERS—

- Fig. 1.** In *Cycas* the male and female flowers are produced by distinct individuals, but both plants have the same general aspect.  
Stem, woody, fifteen to twenty feet in height, surface covered with the scars of fallen leaves, and summit bearing a terminal crown of leaves, in the centre of which is the terminal bud.  
Leaves, of three kinds—scale-like leaves, foliage leaves, and carpellary leaves.  
Scale-leaves envelope the bud, while a new crown of foliage-leaves is being prepared, and thus alternate regularly with them.  
Foliage-leaves are pinnate, and form a palm-like crown.  
Carpellary leaves produced by the terminal bud, and bearing ovules.

### FLOWER—

- Figs. 2 and 3.** The leafy nature of the carpel shown.  
The Carpellary leaf in *Cycas* bears a general resemblance to the ordinary foliage-leaf, but is smaller, and may be either lobed (Fig. 2) or pinnate (Fig. 3). The lower portion of the leaf is fertile, bearing ovules instead of lobes or pinnæ.  
**Fig. 4.** Mature Ovule about the size of a plum and like it, with a soft outer and a hard inner portion.  
**Fig. 5.** Male Flower of *Zamia* a cone, consisting of an elongated axis, covered with a number of scales, bearing pollen-sacs.  
**Fig. 6.** Transverse and longitudinal section of flower of *Cerato-zamia*.  
Scales arranged radially on a central axis, and bearing pollen-sacs on their under surface.  
Fibro-vascular bundles pass out to each scale from the axis.  
**Fig. 7.** Stamen of *Zamia* shield-shaped.  
**Fig. 8.** Female flower of *Zamia* a cone, consisting of an elongated axis with scales closely packed, and their thickened ends hexagonal in shape.  
**Fig. 9.** Carpel in the form of a scale, bearing two ovules on the under surface.

### SEED—

- Fig. 10.** Mature Ovule, before pollination.  
(a.) Outer succulent coat removed. End of shell perforated where the fibro-vascular bundles passed through.  
(b.) Vertical section.  
Outer shell.  
Fibrous sheath representing remains of Nucellus.  
Primary Embryo-sac.  
Secondary Embryo-sacs.  
**Fig. 11.** Seed of *C. circinalis* in vertical section.  
Outer succulent layer.  
Inner hard layer.  
Endosperm.  
Embryo with two Cotyledons.  
In addition to the perfect Embryo there are several rudimentary Embryos.

### CLASSIFICATION.

*Sub-kingdom.*—Phanerogams, so-called because the reproductive organs are generally more conspicuous than in Cryptogams.  
Reproductive organs condensed into conspicuous structures known as Flowers.  
Seed produced from the flower, and containing an embryo *before* it is detached from the parent plant.

*Group.*—Gymnosperms.

Ovules not enclosed in an ovary.  
Embryo-sac with endosperm before fertilisation.  
Pollen-grain divided into two or more cells.

*Order.*—Cycadeæ.

Stem, seldom branched.  
Foliage-leaves, large and usually pinnate.  
Flowers, in the form of cones, or as a rosette of leaves.  
Male and Female Flowers produced on different individuals.  
Ovules on the margins of carpellary leaves or scales.





Fig. 1 Male Flower of *Pinus Laricio*

Fig. 2 Male Flower enlarged of *P. Laricio*



Fig. 6. Transverse section of Male Flower of Yew

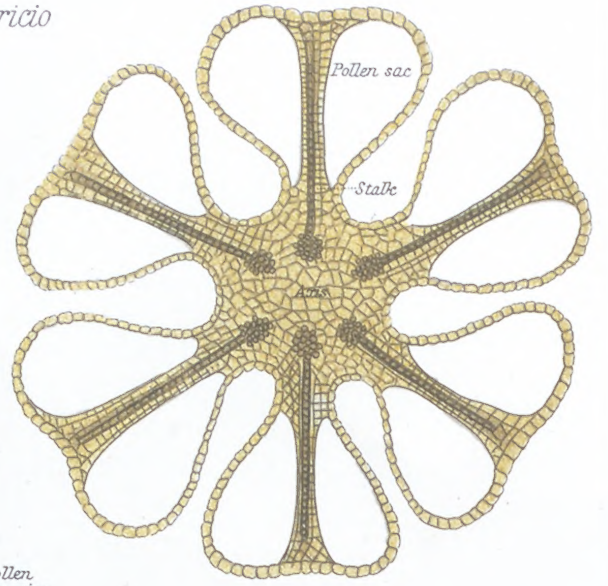


Fig. 3. Longitudinal section of Male Flower

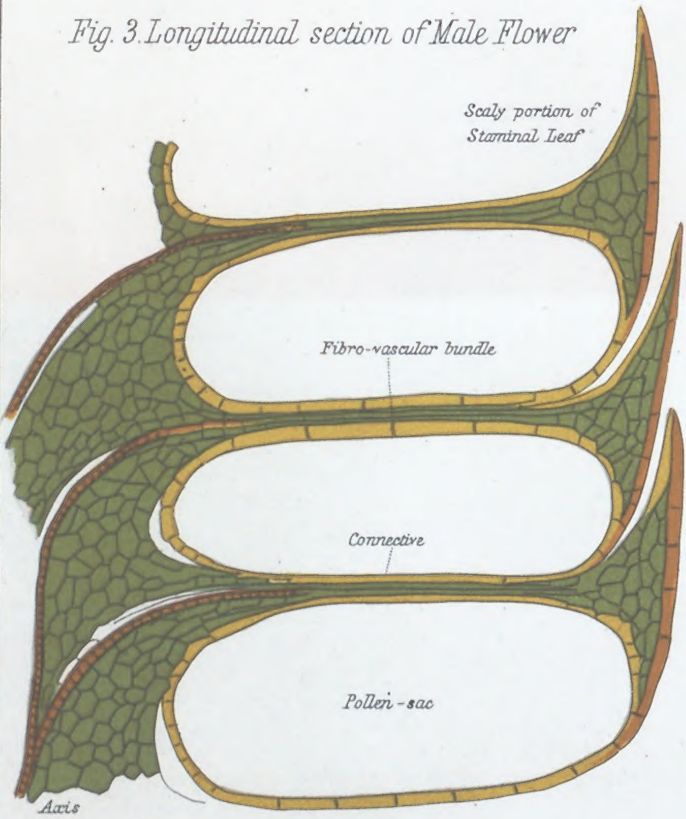


Fig. 5 Male flower of *Taxus baccata* (\*10)



Fig. 7 Stamen of Yew



Fig. 4. Staminal scale of *P. sylvestris*  
lower or outer surface viewed obliquely



Fig. 8 Stamen from below opened



Fig. 9 Pollen grain of Scotch Fir (\*725)

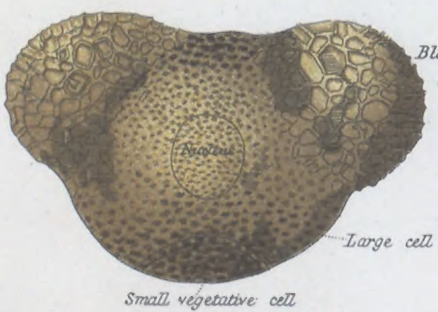


Fig. 10 Ripe Pollen grain of *P. Laricio*  
in optical section (\*500)

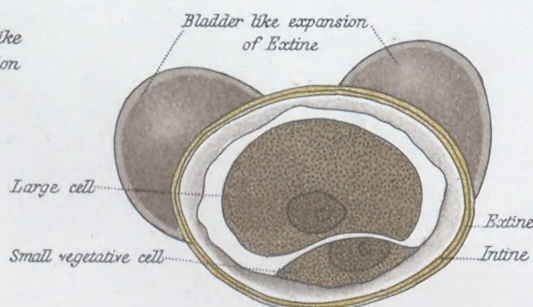
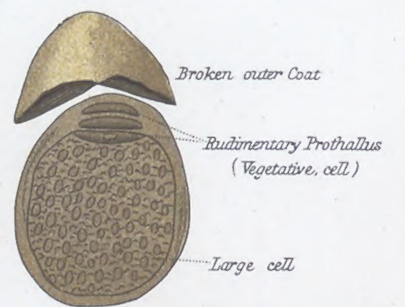


Fig. 11 Pollen grain of Larch





## PLATE II.—CONIFERÆ—Male Organs.

(Figs. 2 and 10 after Dodel-Port; Fig. 9 after Luerissen.)

The Coniferæ are usually trees, with needle-shaped leaves, and fructification in the form of a cone, hence the name cone-bearers. This structure has been already met with in the higher Cryptogams. The cone of a Lycopod or Selaginella has an upright axis, clothed with modified leaves or bracts, bearing sporangia in their axils.

The Stem of Pines and Larches, for instance, bears merely brown scales to represent leaves, and in their axils arise a tuft or a pair of the green foliage-leaves. These pairs or tufts of green leaves are really branches with their axis undeveloped; indeed, if a young Larch is examined, some of the tufts will be met with elongated and developed into branches.

The Flower and Fruit will only be considered now—the Male Flower in this Plate and the Female Flower and Fruit in the next. The male flowers are much simpler in their construction than the female flowers. They are little cones developed in the axils of scales. They discharge their pollen about May, and in such enormous quantities as to give rise to the so-called showers of sulphur—the pollen being powdery and of a sulphur-yellow colour.

Fossil forms occur in the Carboniferous formation, the wood exhibiting the bordered pits characteristic of the wood-cells of Conifers.

**Fig. 1.** Shoot, bearing Inflorescence of nine Male Flowers.

Primary shoot with leaves reduced to mere brown scales.

Rudimentary shoots arising from the axils of the brown scales, each with needle-shaped leaves in pairs.

Terminal bud which develops into new shoot.

Male Flowers arranged at the base of the young shoot.

**Fig. 2.** Single Male Flower.

Each male flower is situated—like an ordinary bud—in the axil of a bract. It is a modified shoot, the lateral appendages of which become Stamens.

**Fig. 3.** Embed Male Flower in paraffin, and make longitudinal section. Examine first under low power to make out general arrangement, then under high power to make out details of structure.

Axis of cone with fibro-vascular bundles running through it, branching to each stamen.

Pollen-sacs borne on the under surface of modified leaves, one on each side of midrib, which here forms a Connective between the two. When the inner cells of a leaf give rise to pollen-grains, such a leaf is called a Staminal leaf, or simply a stamen; and the particular part of the leaf where this formation of pollen takes place is called an Anther. The Male cone is therefore a single flower, because it consists of a single axis bearing Stamens, which are here arranged spirally.

**Fig. 4.** Detached Stamen with two pollen-sacs upon its under surface, and provided with a very short stalk or filament.

The pollen-sacs open by a longitudinal slit on the under surface.

**Fig. 5.** Male Flower of Yew, consisting of an axis bearing a number of shield-shaped bodies. These are the Stamens.

**Fig. 6.** Embed Male Flower in paraffin, and make transverse section (compare with transverse section of cone of *Equisetum*).

Central axis giving off fibro-vascular bundle to each Stamen.

**Fig. 7.** Detached Stamen—the pollen-sacs are developed radially, and not bi-laterally, as in Fig. 4.

**Fig. 8.** Pollen-sacs opening on their under surface.

**Figs. 9 and 10.** Examine pollen-grains, first under low power, then under high power. Stain with iodine to bring out the division between the two cells.

Pollen-grain with a double coat.

Outer coat or Extine is yellowish, and sculptured all over. It comes off in water, being ruptured by the swelling of the inner. It expands into two wing-like swellings.

Inner coat or Intine is colourless and expansible.

Contents divided into two cells—a small *Vegetative* cell, representing the last rudiment of a prothallus, and a larger *Antheridial* cell, so-called, because it forms the pollen-tube, which corresponds to an antheridium not developing antherozoids.

**Fig. 11.** Treat some pollen of Larch with caustic potash, and crush, to rupture outer coat, which is somewhat opaque. Examine under high power.

The small vegetative cell is seen to be divided into several cells.



Fig. 1 Female Cone of *Pinus* at different stages of development

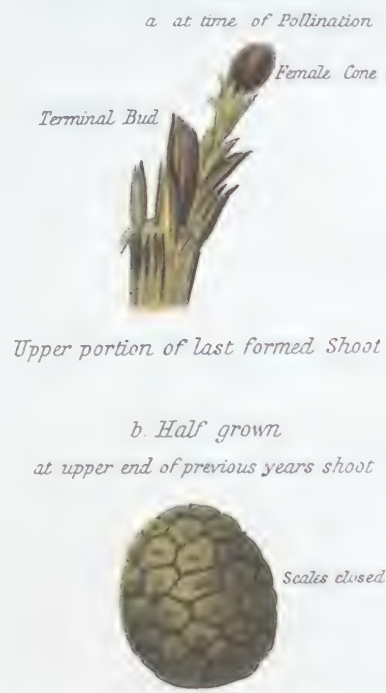


DIAGRAM I Longitudinal section of portion of Female cone of *Pinus*



Fig. 5 Seed-bearing Scale



Fig. 4 Ripe Fruit cone of *P. sylvestris*



Fig. 2 Female Cone at time of Pollination enlarged



DIAGRAM II Longitudinal section of portion of Female cone of *Cupressus*



Fig. 6 Vertical section of Seed of *P. sylvestris*



Fig. 3 Longitudinal section through Flower of Yew



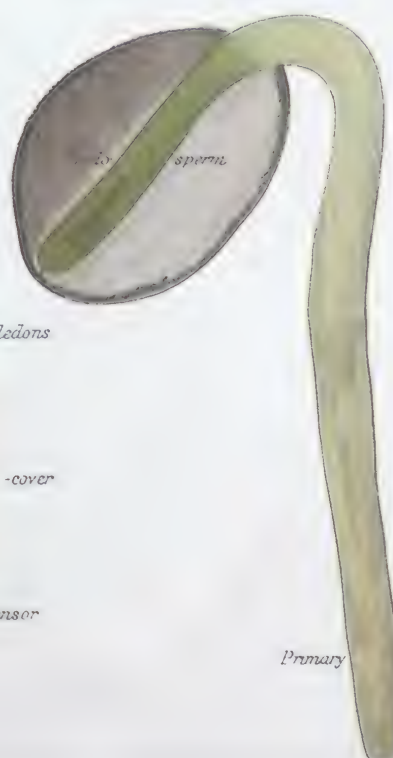
Fig. 9 Young Plant of Yew



Fig. 7 Ripe Fruit of Yew



Fig. 8 Germination of Yew section of Seed with testa removed





### PLATE III.—CONIFERÆ—Female Organs.

(Figs. 2, 8, and 9 from Dodel-Port.)

The Female Organs are the well-known Fir-cones. Fertilisation takes place by the pollen being carried by the wind to a naked ovule; and to assist in this action various expedients are resorted to. The pollen is produced in large quantities, thus allowing for a deal of waste, each pollen-grain has two wing-like expansions to expose a greater surface to the wind, and the needle-shaped foliage-leaves permit ready access of the pollen to the cones. The opening of the micropyle is also filled with a fluid secretion which holds the pollen-grain alighting on it, and as this dries up the pollen-grain gradually slips down, till it reaches the spot where the work of fertilisation begins.

The ripening of the cone in *Pinus* is slow. During the first summer the pollen-tube has grown but a short distance into the nucellus. The scales of the cone close together, as in Fig. 1, *b*, and, there is no further progress, till next summer, when the pollen-tube reaches the embryo-sac and fertilises the central cells of the archegonia. Then, at the beginning of the third summer, the dry woody scales separate, as in Fig. 5, and the winged seeds are ready to be scattered, to build up in future the same structures as those from which they were derived.

#### FLOWER—

- Fig. 1.** (*a*.) Young Female Cone, as in May, upright and situated in the axil of a bract like one of the rudimentary branches.  
(*b*.) Previous year's cone hanging, with scales firmly closed to protect the ovules.  
Ripe cone in Fig. 5.

**Fig. 2.** Young Female Cone enlarged, showing the beaked, open scales.

**Diagram I.**—The Ovule-bearing scale in *Pinus* is situated in the axil of a Bract (too small to be seen in Fig. 2), and the arrangement of the fibro-vascular bundles in each shows that the two have their corresponding faces turned towards each other.

Ovule consisting of a central Nucellus enclosed in a Coat which leaves a small opening called the Micropyle leading into the Nucellus.

The Female Cone is variously regarded as equivalent to a single flower—like the male cone—or to an aggregation of flowers forming an Inflorescence. Taking a Flower in its simplest expression to be a modified axis bearing modified lateral appendages for reproductive purposes, then if the bract be regarded as a Carpellary leaf (as is sometimes done), and the scale as the placenta to which the ovules are attached, the whole cone will constitute a *Flower*; but, if on the other hand, as many suppose, the ovule-bearing scale represents a reduced branch, then the primary axis of the cone bears secondary axes, and such an assemblage must be considered as an *Inflorescence*. So instead of the violent supposition of one leaf in the axil of another, there is a single leaf representing a reduced branch, and the first leaf of the branch is, as it should be, opposite to the bract from which it arises.

**Diagram II.**—The Ovule-bearing scale and Bract are united in *Cupressus*, as shown by the double fibro-vascular bundle, and the inner portions of each bundle being contiguous, shows that the two corresponding faces are opposite to each other. The Ovule is thus borne upon the dorsal surface of the leaf, *i.e.*, the surface originally turned away from the axis bearing it.

Ovules may occur singly, as in Yew and Araucaria; in pairs, as in Pines and Firs, Larches and Spruces; or in groups, as in Cypress.

**Fig. 3.** Embed Female Flower of Yew in paraffin, and make longitudinal section.

Integument, single.

Arillus, supposed to represent outer Integument.

Nucellus, a mass of cellular tissue, at first without any integument.

Embryo-sac, at first a single cell (May), then cellular tissue formed in it by free cell-formation, and from that

Endosperm the Secondary Embryo-sacs are gradually derived (June).

The Yew bears male and female flowers on different trees, and the male plants are apparently the more numerous, thus ensuring an abundant supply of pollen.

The growing point of the primary axis is thrust aside, and the flower is apparently terminal. The flower is of the simplest possible description, consisting merely of a naked Ovule.

#### FRUIT AND SEED—

**Fig. 4.** Ripe fruit cone, with dry woody scales, opened to allow the escape of the seed.

**Fig. 5.** The seed-bearing scale of *Pinus* has apparently no bract. In the ripe cone, owing to the excessive crowding of the parts, the bract has become welded to the scale, forming a dense woody mass; whereas in the Larch, the compression of the membranous scales is not so great, and the bracts remain distinct.

**Fig. 6.** Detach a seed from the wing, make a vertical section, and examine under low power in glycerine.

Seed-cover or Testa.

Endosperm.

Embryo with several cotyledons arranged spirally.

Suspensor embedded in endosperm.

**Fig. 7.** The ripe Fruit of the Yew has a crimson cup known as the Arillus. It is fleshy and sweet to the taste, and grows from the base of the seed, surrounding it and finally rising above it. The hard-shelled Seed is attached to the bottom of the cup and is poisonous.

#### GERMINATION—

**Fig. 8.** Germinating Yew with two Cotyledons, which are *green*.

**Fig. 9.** Young plant showing the two green Cotyledons opposite and persistent, and succeeding leaves arranged spirally.

The leaves of the Yew are seen at first to have a regular spiral arrangement; but as branches are formed, which spread out more or less horizontally, the leaves get twisted upon their stalks and come to lie in one plane, as if arranged in two rows. In that way the original radial symmetry has become bi-lateral.

#### CLASSIFICATION.

*Sub-kingdom.*—Phanerogams.

*Group.*—Gymnosperms.

*Order.*—Coniferæ.

Trees or shrubs, extensively branched.

Leaves, small, and often needle-shaped.

Flowers, usually produced in the form of cones.

Male Flowers, in the form of small cones, or reduced scales bearing pollen-sacs.

Female Flowers, in the form of cones, or a single Ovule.

Fruit, woody or scaly cones, or succulent like a berry.



CONIFERÆ.—Female Organs—*Continued.*

*Family or Sub-Order.*—Taxineæ, represented by Yew.  
Abietineæ, represented by Scotch Fir.  
Cupressineæ, represented by Cypress.

*Genus.*—*Pinus* with woody cone.

*Species.*—*P. sylvestris*, or Scotch Fir, with leaves in pairs, and winged seeds.

*Advance in Organization.*—Instead of being herbaceous, like *Selaginella*, they are usually trees, and this heavier growth is met by the growing point consisting of a *group of cells*, and not of a single apical cell.

Stem increases in circumference, and the vascular bundles possess the power of continuous growth, and are not closed.

Pollen-grain, representing Microspore, no longer produces antherozoids, but only a pollen-tube. The Antheridial cell producing a tube instead of antherozoids is a beautiful adaptation to changed conditions. Antherozoids require moisture to move about in, and are adapted for plants living in moist situations; but with the Coniferæ, inhabiting dry mountain slopes, such an arrangement would be evidently unsuitable, and only a single drop of moisture is provided at the entrance gate of the ovule.

Embryo-sac, representing Macrospore, develops Endosperm while connected with the parent plant.



Fig.1 General Characters of Poa



ANNUAL MEADOW GRASS

Fig.2 Spikelet detached (\*10)



Fig.3 Floret detached (\*10)

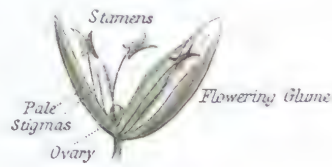


Fig.5 Ovary & Stigmas magnified



DIAGRAM II Theoretical Flower of Grass



DIAGRAM I Plan of Flower



Fig.4 Parts laid out



Fig.8 Wheat germinating



Fig.6 Grain of Wheat



Fig.7 Longitudinal section along the groove

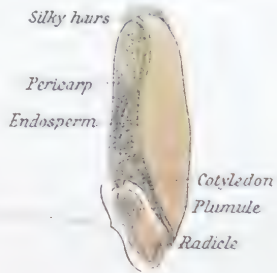


Fig.9 Root-hairs highly magnified



SAND CAREX

Fig.10 Triangular & Solid Stem



Fig.11 Panicle

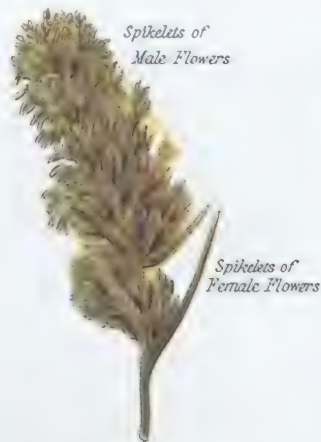


Fig.12 Male Flower



Fig.13 Female Flower



Fig.14 Fruit



DIAGRAM III Plan of Male Flower



DIAGRAM IV Plan of Female Flower

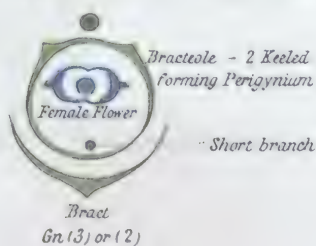


DIAGRAM V Arrangement of parts

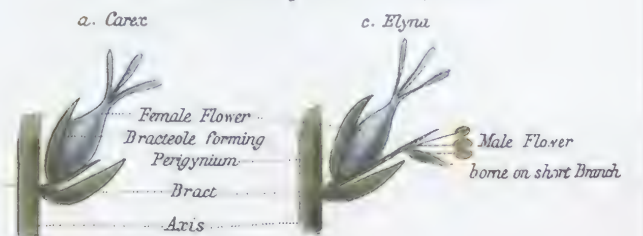




PLATE IV.—ANNUAL MEADOW GRASS (*Poa annua*) and SAND CAREX (*Carex arenaria*).

Grass.

The Grass chosen is common everywhere by the road-side, and may be had in flower at almost any season of the year. The flower is exceedingly small, and when the season permits the flower of Wheat might be examined instead.

Grasses are usually wind-fertilised—the pollen is wafted from flower to flower, and thus there is an interchange of pollen. In accordance with this arrangement, the flower is inconspicuous and without gaudy colours, the anthers hang out on long filaments and turn about with every breath of wind, and the stigma is a branching tree, in miniature, to entangle the pollen as it passes.

Some, however, are self-fertilised—and the Annual Meadow Grass is an example.

**Fig. 1.** General characters.

Root, fibrous.

Stem, hollow and jointed. In the quickly growing stem, the outer parts grow faster than the inner, so that the interior is ruptured and a hollow produced. The fibro-vascular bundles form a horizontal partition at the nodes, and thus strengthen the stem.

Leaves, linear and alternate, with pointed membranous Ligule at junction of sheath and blade.

Inflorescence consisting of an axis with branches bearing stalked flowers.

Spikelet composed of several flowers.

**Fig. 2.** Spikelet detached.

There are two bracts at the base, imbricating with each other, and the axis of the spikelet bears the flowers.

**Fig. 3.** Floret detached.

The Stigma in the centre is seen to be branched and hairy in order to intercept and retain the pollen.

The Anthers are placed on slender filaments.

The Flowering glume and Pale are simply bracts overlapping each other.

**Fig. 4.** Under the dissecting microscope detach the different parts of the flower, by steadying it with needle in left hand and removing parts with cutting needle in right. Remove the flowering glume and two little scales will be seen side by side, embracing ovary opposite to pale, and one stamen coming out between them. Great care and steadiness of hand is required in removing these entire, so that they may be laid out and examined.

The Flower is extremely simple, consisting of two little scales, three Stamens, and two Carpels, as indicated by the two Stigmas—

Little scales or Lodicules probably representing a Perianth.

Stamens three, alternating with lodicules. The anthers hang down because the filaments are weak.

Carpels consisting of swollen Ovary, crowned by two diverging feathery Stigmas.

*Diagram I.*—Plan of flower, showing the parts at one level and in their proper relations.

Perianth of two free segments.

Andrœcium of three Stamens.

Gynœcium of two united Carpels.

*Diagram II.*—By comparing a number of flowers it is possible to construct a theoretical diagram, showing the flower of which grass may be a reduced form. In the Rice flower, for instance, there are two rows of stamens of three each. This diagram will be seen to agree with that of the Lily in the following Plate.

**Fig. 5.** Ovary with spreading Stigmas.

**Figs. 6 and 7.** Grains of Wheat soaked in water and sections made.

Embryo is at base of seed, and the rest filled up with mealy Endosperm.

**Fig. 8.** Place a few grains of wheat in flannel, keep moist and at a moderate temperature, and germination will soon begin.

**Fig. 9.** Root-hairs.

On young roots, the cells of the epidermis are drawn out into delicate root-hairs. These root-hairs being so thin are extremely permeable to fluids, and it is through them the root withdraws from the soil the necessary plant-food.

Sedge (*from Luerssen*).

Sedges may be contrasted in their general structure with Grasses. The Stem is solid and usually triangular. The Leaves are arranged in three rows on the stem and the sheath is not split. The Flowers are developed in scale-like bracts called glumes, as in grasses, but are usually male and female, and not bi-sexual like the flower of Grass.

Sedges are mostly found in damp places.

**Fig. 10.** Triangular Stem.

**Fig. 11.** Spike bearing Female spikelets at bottom, female and male spikelets about middle, and entirely Male spikelets at top.

**Fig. 12.** and *Diagram III.*—Male Flower consisting simply of three Stamens enclosed by a bract.

**Fig. 13.** and *Diagram IV.*—Female Flower consisting of two united Carpels, and the bracteole has grown completely round, enclosing it as in a bottle.

**Fig. 14.** Fruit is of a chestnut colour, and invested by the enlarged bracteole.

*Diagram V.*—In *Carex* the flower is seen to be really borne on an aborted axis, which arises in the axil of the outer bract.

In *Elyna* this axis is seen to develop further, producing not only a Female but also a Male Flower.

The apparently single flower in the case of *Carex* would thus seem to be a reduced Inflorescence.

CLASSIFICATION.

*Group*—Angiosperms.

Ovules enclosed in an Ovary.

Endosperm, not formed in Embryo-sac before fertilisation.

*Class.*—Monocotyledon.

Leaves with parallel veins.

Parts of Flower in threes.

Embryo with one Seed-leaf or Cotyledon.



ANNUAL MEADOW GRASS—*continued.*

*Order.*—Graminaceæ.

Stem, hollow.

Leaves, alternate, with split sheaths, and ligules at junction of blade and sheath

Flowers, in scaly bracts.

Stamens, three, and anthers versatile.

Stigmas, two, and feathery..

Fruit, dry, and one-seeded.

Seed with Endosperm.

*Order.*—Cyperaceæ.

Stem, solid and triangular.

Leaves, with unsplit sheaths and no ligule

Flowers, in scaly bracts.

Stamens, one to three.

Stigmas, two or three.

Fruit, dry, and one-seeded.

Seed with Endosperm.



Fig. 1 Fully developed Lily

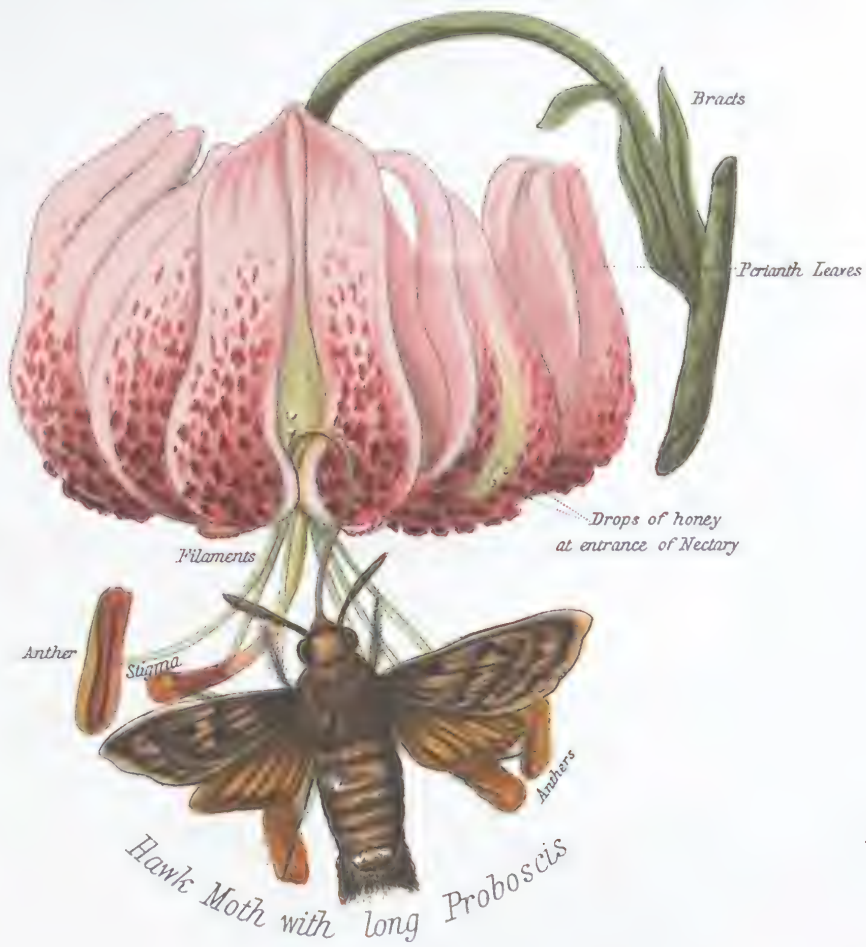


Fig. 2 Flower of Fritillaria-Longitudinal section

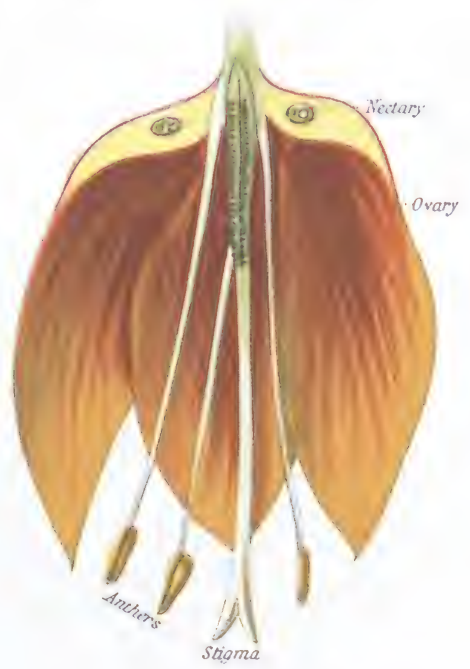


Fig. 3 Transverse section to show Nectaries



DIAGRAM 1 Plan of Flower

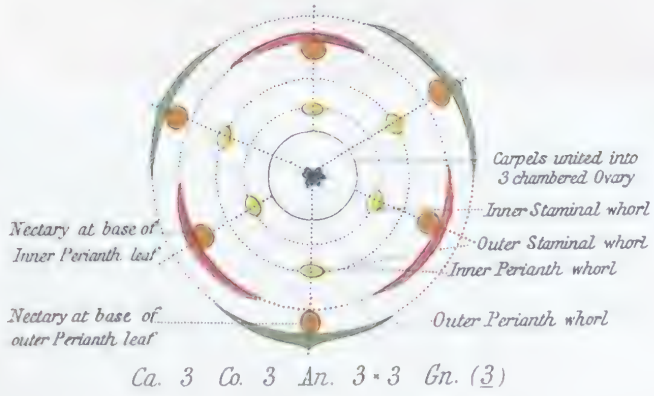


Fig. 4 Foliage Leaves



Fig. 5 Bract



Fig. 6 Stamen



Fig. 7 Transverse section of Anther of Fritillaria

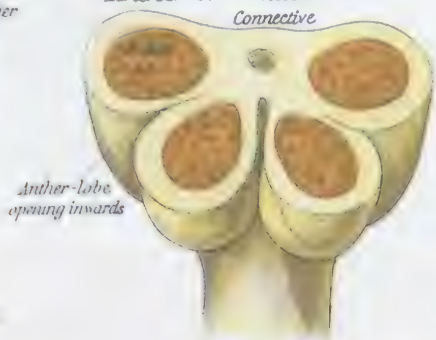
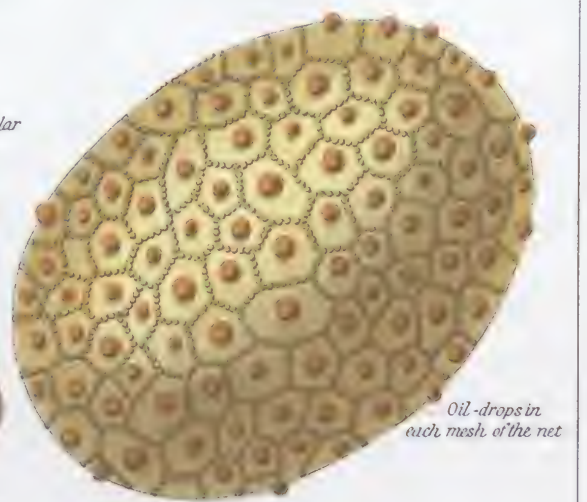


Fig. 8 Transverse section and Longitudinal view of opening Anther



Fig. 9 Pollen-grain of Lily ( $\times 1000$ )







**PLATE V.—MARTAGON LILY (*Lilium Martagon*) and CROWN IMPERIAL (*Fritillaria imperialis*).**

(Figs. 1, 8, and 9, after Dodel-Port).

The flowers hitherto considered have all been rather sombre in their tints. In the case of the Coniferae there were no brilliant or gaudy colours, but the flowers were hidden, as it were, out of sight with a covering of scales. The Grasses and Sedges, too, had their minute flowers of a greenish or brownish tint, and everything betokened business, but no attempt at decoration.

But when we come to Lilies and such like, the beauty of their flowers form the most striking feature, often with further attractions in the shape of perfume and honey. This change from grave to gay, to sweetness and scent, has probably reference to the visits of insects; and now, instead of the pollen being scattered by the wind with extravagant wastefulness, a more economical method has been found in the agency of insects. Insects are attracted first of all by the colour and scent, then honey is provided, so that in obtaining it they may carry the pollen of one flower to the stigma of another, and thus unconsciously, while pursuing their own selfish ends, effect cross-fertilisation, which enables the plant to produce a stronger and healthier progeny than otherwise.

The Nectary consists of a tissue, formed of small, thin-walled cells, from which sweet juices exude and keep it constantly moist. They are generally placed in the recesses of the flower, and in the present instance occupy the base of the perianth-leaves.

The Martagon Lily is an instance of a *regular* Monocotyledon flower adapted for cross-fertilisation by insects, although in the absence of insects it may be self-fertilised.

**Fig. 1.** Flower of Martagon Lily fully developed.

The flower in the bud condition has its various parts arranged, as in *Fritillaria* (Fig. 2). The coloured leaves are directed downwards, enclosing the straight stamens and style; but as the flower expands these different parts diverge, until finally the coloured leaves curl upwards and meet around the stalk; the stamens spread out like a fan, and the style curves in the direction of most light. The nectaries, at the base of the coloured leaves, secrete drops of honey, and the anthers open to discharge their pollen. If, now, an insect visits the flower, alighting on the spread-out stamens, as a convenient resting-place, while sipping the honey with its long proboscis, it will carry away pollen on various parts of its body, and likely leave some of it on the stigma of the next flower it visits.

**Figs. 2 and 3.** *Fritillaria* has been halved lengthwise in its natural pendent position, and the six nectaries are seen at the base of the perianth-leaves in Fig. 3.

*Diagram I.*—Plan of Flower, representing typical Monocotyledon.

Calyx or outer whorl of three free Sepals.

Corolla or inner whorl of three free Petals, alternating with the Sepals.

When the parts of the Calyx and Corolla are similar in size, shape, and colour, it is usual to call them collectively the Perianth.

The Nectaries are at the base of each perianth-leaf.

Andrœcium of two whorls of three Stamens each.

Gynœcium of three united Carpels.

**Figs. 4 and 5.** The Foliage-leaves get smaller on ascending the stem, till you pass by regular gradations into the bracts at the base of the flower-stalks.

**Fig. 6.** Stamen.

The Anther appears at first to be quite in line with the Filament, but as the stamen curves outwards, the anther comes to swing on the very top of the filament, so as readily to discharge its contents (as in Fig. 1).

**Figs. 7 and 8.** Each Anther-lobe consists of two pollen-sacs, and opens by a longitudinal slit down the side.

**Fig. 9.** The Pollen-grain of Martagon Lily is a striking example of beauty and utility combined. It is beautifully netted on the outer surface, and each mesh of the net usually contains a globule of oil. This oil is to keep it moist until it reaches the stigma with its secretion, and the netted arrangement distributes the oil more evenly and generally over the surface.



Fig. 4 Longitudinal section of portion of pollinated Stigma of Lily

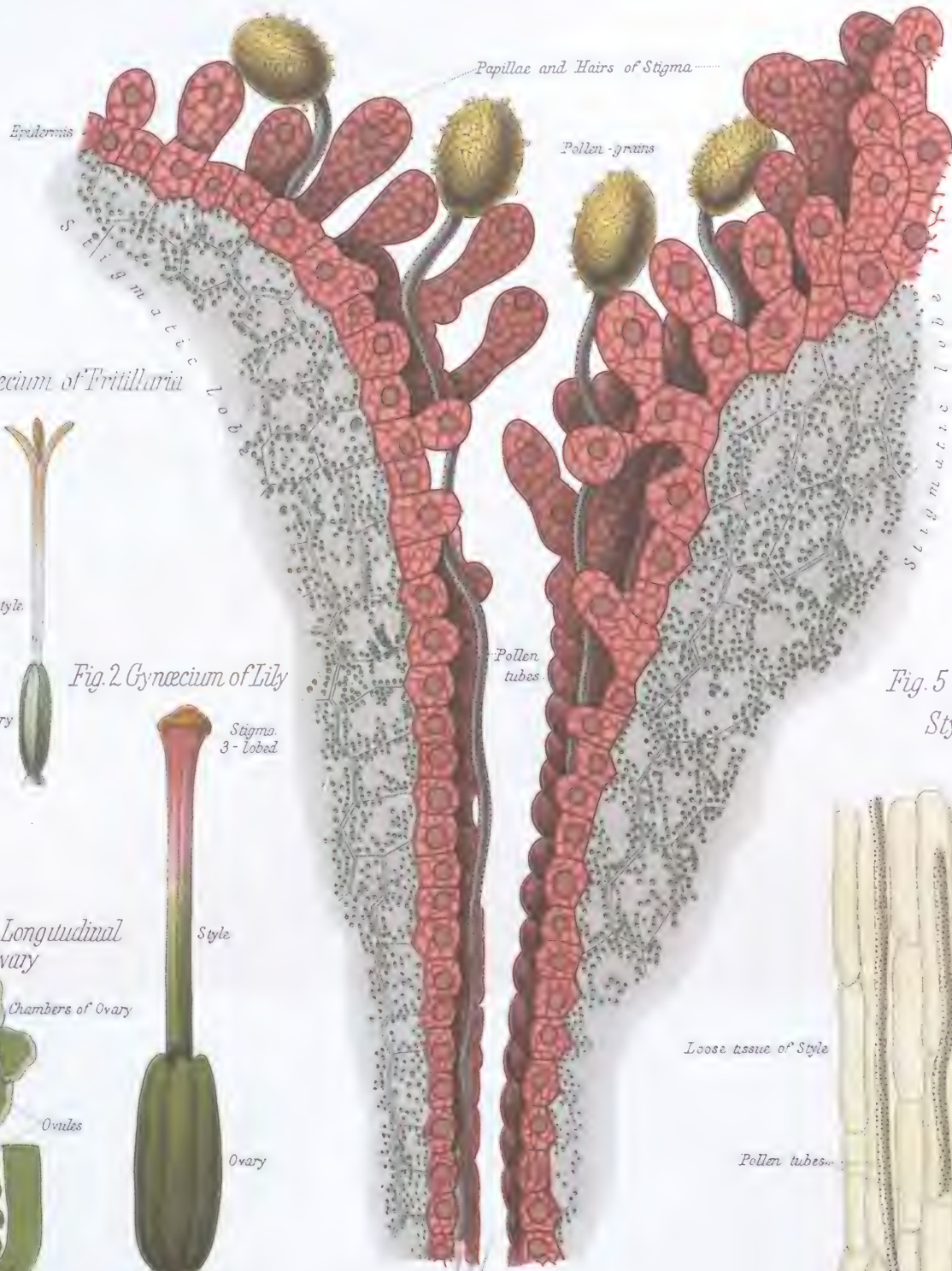


Fig. 1 Gynæcium of Fritillaria



Fig. 2 Gynæcium of Lily

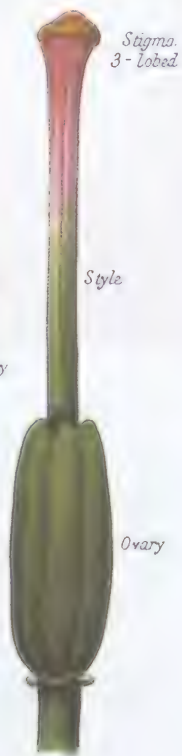


Fig. 5 Longitudinal section of Style of Fritillaria

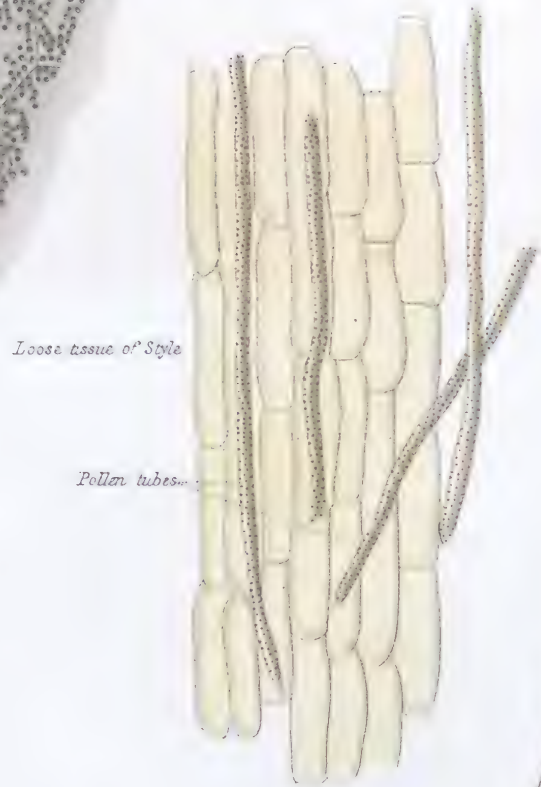


Fig. 3 Transverse & Longitudinal section of Ovary



Canal of Style expanding above into Stigmatic cleft

Fig. 6 Fruit of Lily—a Capsule



Fig. 7 Transverse section & Longitudinal view of Fruit



Fig. 8 Seed

a. natural size

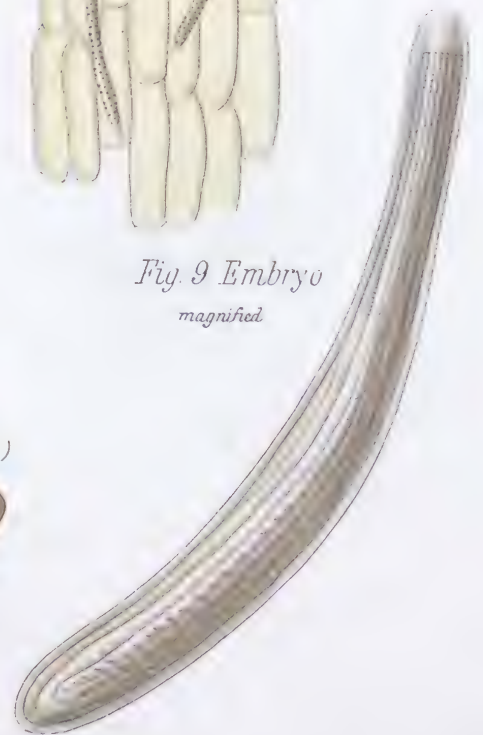


b. Section (x 10)



Fig. 9 Embryo

magnified





## PLATE VI.—CROWN IMPERIAL and MARTAGON LILY.

(Figs. 3 and 4 after Dolet-Port.)

### FLOWER—*contd.*

**Fig. 1.** Gynœcium of Crown Imperial.

Ovary is elongated.  
Style with three grooves.  
Stigmas, three, distinct.

**Fig. 2.** Gynœcium of Martagon Lily.

Ovary with six grooves.  
Style, smooth.  
Stigma, indistinctly lobed, three narrow clefts marking off lobes.

**Fig. 3.** Transverse section about the middle of Ovary, and Longitudinal section through its lower portion.

Three Carpels evidently united together, forming a three-chambered Ovary.  
Ovules in two vertical rows in each chamber of ovary.

Placentation is axile, because the ovules arise from a central axis which is attached to walls of ovary.

**Fig. 4.** Longitudinal section of Stigma with pollen, showing two stigmatic lobes—highly magnified.

The *Stigmatic surface* is seen to consist of an epidermis, the cells of which have either grown out into papillæ or hairs. Such a surface evidently entangles pollen-grains falling upon it, and the *secretion of the stigma* not only retains the pollen, owing to its viscid nature, but supplies nourishment for the growth of the pollen-tube.

The Pollen-tube is seen to grow down the *canal* of the style, the walls of which are furrowed, so as to guide the pollen-tube to the ovules.

In order to see Pollen-tubes distinctly, take a drop of the secretion from the stigma on a slide, by simply bringing it into contact with the moist stigma, then apply this to the tip of the mature anther, and a few pollen-grains will stick. In a short time (about half-an-hour) the pollen-grains will begin to put forth their tubes, if the secretion is kept moist, and the tubes with their contents appear beautifully transparent.

**Fig. 5.** Embed Style of Crown Imperial in paraffin, and make longitudinal section to show pollen-tubes passing down to fertilise the ovules.

The Style consists of loose tissue, through which the pollen-tubes make their way. The secretion of the stigma will give the pollen-tube a start, then it passes down the centre of the style, where the cells are largest and loosest, and thus follows the line where the ovules are attached.

The growth of the pollen-tube is thus seen to be different in the two cases. In the Lily, the pollen-tube depends entirely on its own resources and the secretion of the stigma, whereas in the Crown Imperial, it bores into the tissue of the style, just like the hypha of a fungus, absorbing it, and dying off in its hinder parts as it proceeds.

### FRUIT AND SEED—

**Fig. 6.** Fruit of Lily consisting of a Capsule, which splits lengthways along the middle of each carpel to allow the seed to escape.

**Figs. 7 and 8a.** The Seeds are flattened out and lie one above another in two rows in each chamber.

There is a margin to each, and the Embryo is seen embedded in the endosperm.

**Figs. 8b and 9.** Take the flattened seed between finger and thumb and cut it in two, parallel with its flattened surface.

Embryo occupies the axis of the seed, and is slightly curved.

### CLASSIFICATION.

*Class.*—Monocotyledon.

*Oder.*—Liliaceæ.

Perianth, inferior, petaloid, usually in two whorls of three leaves each

Stamens, in two whorls of three each.

Gynœcium, superior, of three united carpels.

Ovules, numerous, and Placentation axile.

Fruit, a capsule usually.

Seeds, with endosperm.

*Genera.*—Fritillaria, flowers surmounted by a crown of leaves.

Lilium.



Fig.1 *Narcissus pseudo-narcissus*



DIAGRAM I *Plan of Flower*



Ca. 3 Co. 3 An. 3+3 Gn. (3)

DIAGRAM II *Imbricate Arrangement of Perianth leaves in Bud*



Fig. 2 *Polyanthus Narcissus* Inflorescence-an Umbel



Fig.3 *Vertical section of Flower of Polyanthus Narcissus*

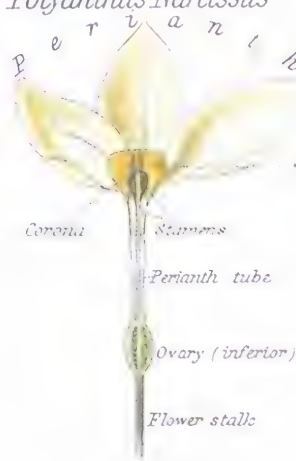


Fig.4 *Perianth tube spread out*



Fig.7 *Anatropous Ovule in section*

*F u n i c l e*

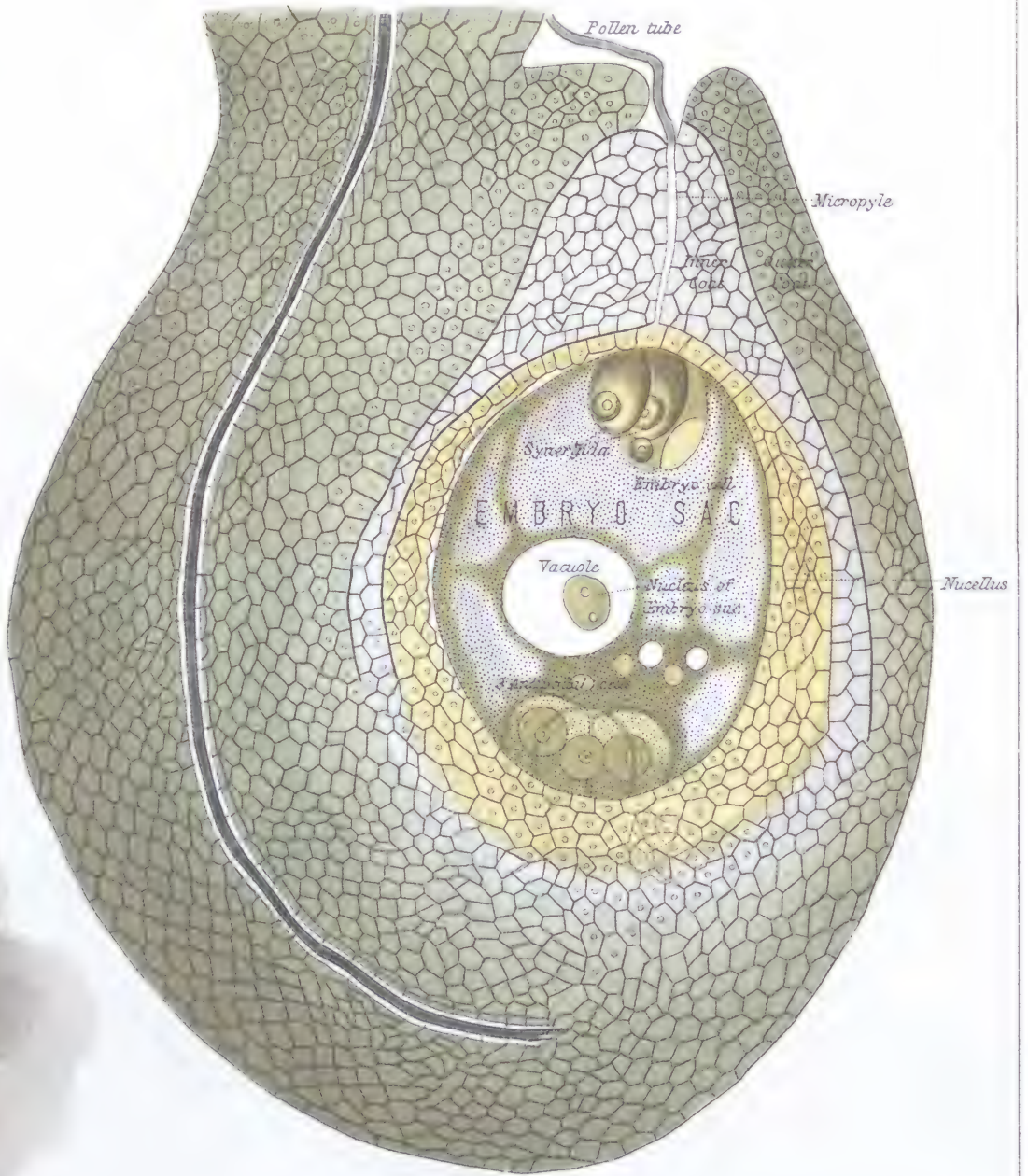


Fig.5 *Stamen with versatile Anther*

a. lower Stamen unopened. b upper Stamen opened.

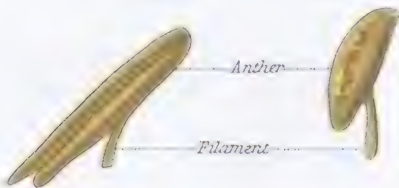


Fig.6 *Transverse section of Ovary*





## PLATE VII.—NARCISSUS.

The Daffodil is a favourite garden-flower appearing in the early spring. It occurs in woods, in moist and shady situations, sometimes in great profusion. The flower is solitary, on a long stalk; but in the *Polyanthus Narcissus* there are a number of flowers forming an umbel.

In the Daffodil the most striking part of the flower is the Corona, which forms the central tube. In *Polyanthus Narcissus* it is simply like a little cup; and in the Snowdrop, belonging to the same Natural Order, it disappears altogether. This structure is merely an appendage of the perianth, resembling the ligule of grasses, and the processes we shall meet with in Pinks, at the throat of the corolla.

**Fig. 1.** Daffodil.

Bract, membranous.

Perianth of six spreading segments with a large tubular Corona. The corona or crown is an outgrowth from the perianth-leaves, and is to be regarded as composed of ligules, which have united by their edges so as to form a tube.

Stamens, concealed by the corona.

Ovary, inferior.

**Fig. 2.** The umbellate arrangement of the flowers in *Polyanthus Narcissus* is here shown, and the single bract at their base.

**Figs. 3 and 4.** Vertical section of *Polyanthus Narcissus*.

Perianth with long tube.

Corona, short, relative to perianth-segments.

Stamens, six, inserted in the tube.

Ovary with slender style and blunt stigma.

*Diagram I.*—Calyx of three Sepals.

Corolla of three Petals alternating with the Sepals. } Perianth.

Andrœcium, of six Stamens, in two alternating whorls.

Gynœcium of three united Carpels.

*Diagram II.*—Showing imbricate arrangement of perianth-leaves in bud.

**Fig. 5.** Anther capable of turning on short filament, and opening inwards.

**Fig. 6.** Ovary three-angled, and three-chambered.

Ovules, in two vertical rows in each chamber of Ovary.

Placentation, axile.

**Fig. 7.** Ovule of *Narcissus poeticus* in section.

Make horizontal sections of Ovary and you also get sections of Ovules.

In the previous Plate the pollen-grain was traced from the stigmatic surface, where it formed a tube through the style, till it reached the place where the ovules are attached. Here the pollen-tube will be traced into the ovule, and the ovule itself considered.

The ovule may be perfectly erect, as in the Yew, or it may be curved, but in the vast majority of cases it is inverted. The opening of the ovule is thus turned towards its attachment, and the line of attachment is the course followed by the pollen-tube, so that, as the pollen-tubes go on growing, they can hardly help making their way into this entrance, and coming in contact with the surface of the nucellus. Then they pass through and reach the embryo-sac when the process of Fertilisation takes place.

(a.) Three principal parts of Ovule.

Stalk or Funicle, attaching it to ovary-wall.

Outer and Inner Coat, leaving a narrow passage for the entrance of pollen-tube.

Nucellus or central mass of tissue.

(b.) Embryo-sac in detail—

Embryo-sac, originally a single cell of the Nucellus, growing fast and enlarging.

Embryo-cell with two other cells called Synergidæ or Co-operative cells. These three cells are without a cell-wall.

Three Antipodal cells, each with a cellulose-wall.

Nucleus of Embryo-sac, surrounded by a vacuole.

### CLASSIFICATION.

*Class.*—Monocotyledon.

*Order.*—Amaryllidæ.

Perianth, superior and petaloid.

Stamens, six, with anthers opening inwards.

Gynœcium, inferior, of three united carpels.

Ovules, numerous, and Placentation, axile.

Fruit, a capsule.

Seeds, endospermous.

*Genera.*—*Narcissus* with a corona.

*Galanthus* (Snowdrop) without corona, and outer perianth-segments largest.

*Leucojum* (Snow-flake) without corona, and perianth-segments equal.



Fig. 1 Flower with Projecting Stigma



Fig. 2 Flower with projecting Anthers



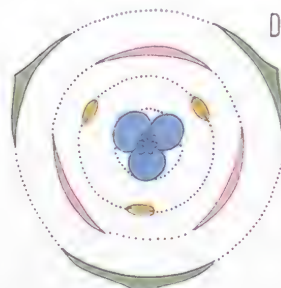
Fig. 6 Foliage Leaf & Section



Fig. 3 Side view of 6 Perianth Leaves



DIAGRAM I Plan of Flower



Ca. 3 Co. 3 An. 3 Gn. (3)

DIAGRAM II Arrangement of Perianth Leaves in Bud



Bract

Fig. 4 Longitudinal section of Flower

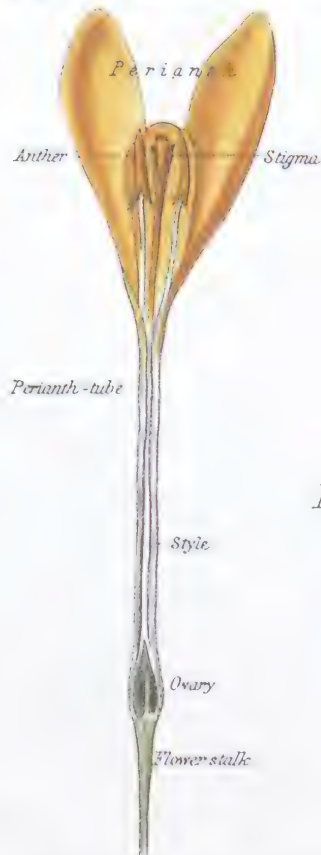


Fig. 8 Stigmatic Surface

a. oblique top view

b. side view

c. expanded



Fig. 5 Underground Stem



Fig. 7 Stamen



Fig. 9 Fruit

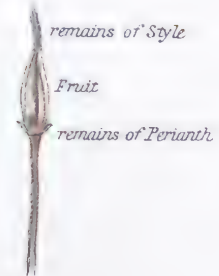


Fig. 10 Seed





## PLATE VIII.—CROCUS.

The Crocus, the Gladiolus, and the Iris are well-known members of a family, prized for their large and showy flowers, which vie with the rainbow in their hues. Yellow, blue, purple, and crimson are the prevailing colours.

The Crocus comes to us as the harbinger of spring, and forms a very good introduction to that wealth of floral display which is continued onwards almost to the close of the year. But it has not merely beauty to recommend it, for the Saffron or *Crocus sativus*, which has been cultivated for centuries, yields that beautiful yellow colouring matter which is used for dyeing, for flavouring soups, and also in medicine. It is from the stigmas, which are of a deep orange-red colour passing into yellow, that the dye is obtained.

This order is characterised by having three stamens, the anthers of which open outwards, and the stigmas usually petaloid.

**Figs. 1 and 2.** Two different flowers are represented to show the relative position of Stigma and Anther in each case.

Fig. 1 shows the expanded stigmas projecting above the Anthers, while Fig. 2 shows the mature Anthers at the mouth of the perianth-tube, the stigmas being lower down.

**Fig. 3.** Perianth of six Segments, uniting below to form a long slender tube.

**Fig. 4.** Detach flower from underground stem, and slit it up from below.

Flower-stalk, relatively short.

Perianth-tube, expanding into the showy Segments. The Segments are usually equal, but in this particular instance they were as indicated.

Ovary, underground, and Ovules arranged around a central axis. The Ovary is *apparently* inferior and the Perianth superior, but as the ovary ripens the Perianth-tube is clearly seen to arise from the base of the ovary, as in Fig. 9.

The ovules are fertilised while still underground, but the flower-stalk afterwards lengthens, thus raising the Ovary above ground where the ripening of the seeds is completed.

Style, long and filamentous, usually projecting from the tube and ending in the three-lobed Stigma.

*Diagrams I. and II.*—Examine young Crocus, and make out spiral arrangement of Perianth-leaves as in Diag. II.

### PLAN OF FLOWER—

Calyx of three coloured Sepals, }  
Corolla of three coloured Petals, } united at base to form a tube.

Androecium of three Stamens inserted at the base of the three outer segments of the Perianth.

Gynoecium of three united Carpels.

**Fig. 5.** The underground Stem is distinguished as a Corm (Lat. *cormus*, a solid bulb), because the swollen portion is chiefly composed of stem, whereas in the Bulb it is composed largely of the swollen bases of leaves as well.

**Fig. 6.** Foliage-leaves, long, narrow and pointed, with a *furrow* running along the middle, and a corresponding *ridge* on the opposite side.

This is well seen in a transverse section of the leaf.

**Fig. 7.** Stamen—the Filament is flattened, and the Anther is arrow-shaped.

**Fig. 8.** The Stigmatic surface is a lobed expansion, and when fully expanded, as in *c*, there are three distinct stigmas.

**Fig. 9.** Fruit, a Capsule which opens by three valves, and has an elongated slender stalk. Each carpel splits along the middle of its length, so that each valve of the fruit is composed of the halves of two adjacent carpels.

**Fig. 10.** Seed, somewhat globular, and containing Endosperm in addition to the Embryo.

### CLASSIFICATION.

*Class.*—Monocotyledon.

*Order.*—Iridaceæ.

Leaves, long and narrow.

Perianth, petaloid, of six segments.

Stamens, three, with anthers opening outwards.

Carpels, three, united.

Ovules, numerous; Placentation, axile.

Fruit, capsular, opening by valves.

Seed with endosperm.



Fig. 1 Tuberous Rhizomes

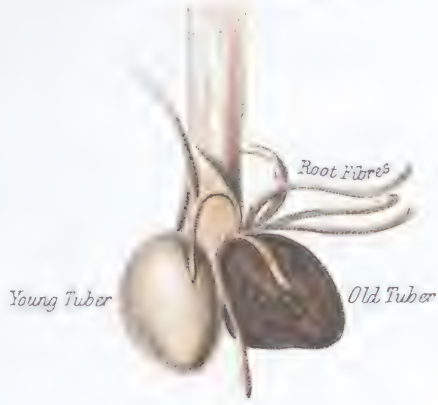


Fig. 2 Vertical Section of Tuber

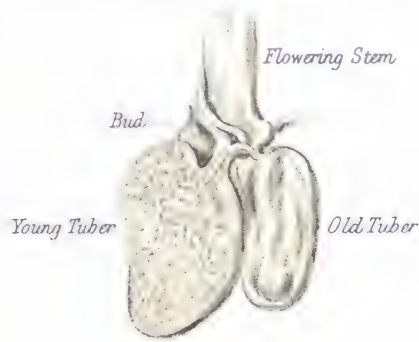


Fig. 3 Front view of Flower (\*10)

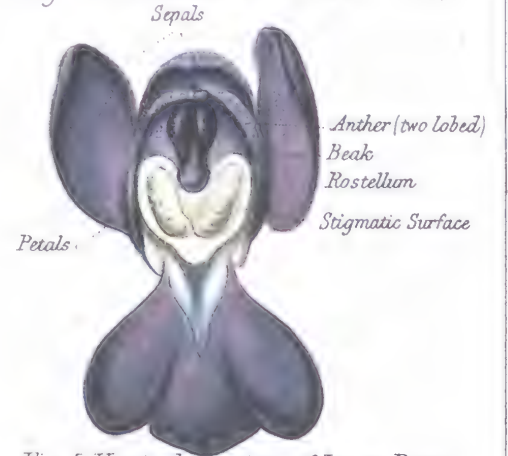


Fig. 6 Foliage Leaf



Fig. 7 Bract Spread out



Fig. 8 Sepal



Fig. 9 Pollinium



Fig. 4 Central Portion of Flower

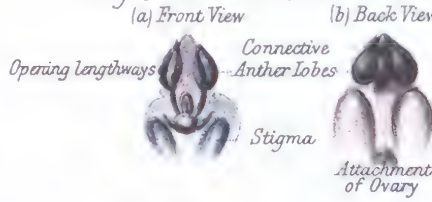


Fig. 5 Vertical Section of Inner Parts



DIAGRAM Plan of Flowers

Fig. 10 Twisted Ovary



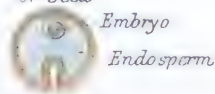
(a) Orchid

(b) Lady's Slipper



Fig. 15 Germination of Date

(a) Transverse Section of Seed



b Seed germinating



c. Section of Germinating Seed



(d) Germination further advanced



Fig. 12 Transverse Section of Ovary of Lady's Slipper

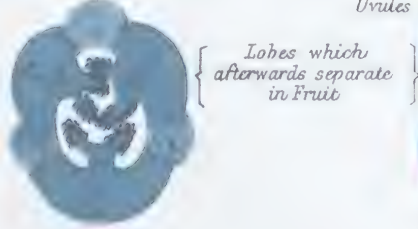


Fig. 11 Transverse Section of Ovary



Fig. 13 Fruit. A Capsule



Fig. 14 Seed





## PLATE IX.—COMMON ORCHIS (*Orchis mascula*).

Orchids are remarkable, in many respects, for the curious shapes of the flowers, the peculiar structure of their parts, and the numerous and beautiful contrivances for cross-fertilisation. The common or purple Orchis occurs in shady situations, and flowers early in April. The underground stem is in the form of a Tuber, which in this species is ovoid, or it may be divided at the base into finger-like processes. There are two Tubers, a young one storing up material for next year, while the old one is providing for the present. The young Tuber arises as a lateral bud, growing in size as the old one decays, and thus the plant is carried on from year to year. The flower and its arrangement will be noticed in connection with the Figures.

As the Orchid ends the Monocotyledons, space has been found to show the germination of the Date. The Date belongs to the Palm family, but is here introduced to show the well-developed primary or tap-root, a structure with which Monocotyledons are not usually credited.

### ROOT AND STEM—

**Fig. 1.** Dig up Tubers at various seasons, before, during, and after flowering, and examine.

The old Tuber is shrivelled, and dark in colour, while the young one is firmer and paler. The relative sizes will vary according to the time at which they are dug up.

Root-fibres arise from the base of the flowering stem, and are thus adventitious.

**Fig. 2.** Vertical section of Tuber preserved in spirit.

The old Tuber lies beneath flowering stem, and has been pretty largely drained of its substance to afford nourishment to it, as well as to give rise to the young Tuber.

The young Tuber is now plump and in good condition, and bears a bud at its summit, which is a preparation for the flowering stem of next year. The young Tuber, at least in its early stages, exhibits indications of its first root at the base, but the future rapid growth of the tuber causes this primary root to disappear.

### FLOWER—

**Fig. 3.** Flower in front view.

Sepals, three, one median and two lateral.

Petals, three, the lower one forming a platform on which insects may alight.

Stamen, one, and Anther two-lobed.

Stigmas, three, two lateral and one median, modified into the Rostellum (Lat. *a little beak*).

Ovary, beneath and not seen in this view.

**Fig. 4.** Remove sepals and two of the petals, so as to expose central portion of flower; *a* and *b* show the essential organs and their relative positions.

Anther-lobes open lengthways, exposing the pollen-masses, and there is a Connective between, which arches over at the top.

**Fig. 5.** Make a vertical section of the flower used in Fig. 4.

The relative position and structure of the parts have evidently reference to the visits of insects. The entrance to the spur is guarded by the Rostellum, in which, as in a cup, lies the sticky base of each pollen-mass. The stigmatic surfaces project immediately beneath and by the side of rostellum, so that the upright pollen-mass, when it becomes horizontal on the insect's head, will strike against it.

### DIAGRAM OF THE UNOPENED FLOWER—

(*a.*) Orchid—Calyx of three coloured Sepals.

Corolla of three coloured Petals, alternating with sepals.

Andrœcium of one Stamen, the so-called Auriculæ on each side of it representing Staminodes.

Gynœcium of three united Carpels.

(*b.*) Lady's Slipper or Cypripedium is distinguished by having two Anthers, not, however, corresponding to any of those in Orchis, but from their position forming two of an inner whorl of stamens.

A comparison of Lady's Slipper with other Orchids, and a consideration of monstrous flowers, has led to the view that the original type of Orchid flower was one in which there were six Perianth-segments and six Stamens in two whorls, as represented by the formula Ca. 3, Co. 3, An. 3+3, Gn. (3).

### FOLIAGE AND FLORAL-LEAVES—

**Fig. 6.** Foliage-leaf, with parallel veins, and shining surface spotted with dark purple.

**Fig. 7.** Bract coloured, with central nerve, broad base, and pointed tip.

**Fig. 8.** Sepal, blunt at tip.

**Fig. 9.** In a ripe flower insert the point of a pencil for instance, so as to rupture rostellum, and on withdrawing the pencil, one or two pollinia will be found adhering to it.

Pollinium, consisting of a club-shaped pollen-mass borne on a stalk, with a sticky gland at the base.

**Fig. 10.** In a young unopened flower it is interesting to note that the Ovary is untwisted, and that the *lip* is *uppermost* (as shown in Diagram). In expanding, however, the twisting of the ovary turns the parts of the flower right round, and the lip comes to occupy its inferior position.

The stalk-like ovary shows the flower to be sessile, and the Inflorescence is therefore a spike.

**Figs. 11 and 12.** Transverse sections of Ovaries.

The ovary is one-chambered, containing numerous ovules arranged along the walls in three principal rows.

### FRUIT AND SEED—

**Fig. 13.** The Fruit has the remains of perianth adherent to it, and opens by three valves or lobes, leaving the ribs still standing between.

**Fig. 14.** Detach one of the Seeds from wall of fruit, and examine under microscope.

The Seed consists of a Cover, which is irregularly netted, and an Embryo, which is a roundish undifferentiated mass of tissue.

### CLASSIFICATION.

*Class.*—Monocotyledon.

*Division.*—Petaloidæ.

*Order.*—Orchidacæ.

Perianth, irregular, superior.

Andrœcium and Gynœcium, united.

Pollen-grains in club-shaped masses.

Ovary, inferior, one-chambered.

Ovules, numerous; placentation, parietal.

Fruit, capsular.

Seed, without endosperm.



**Germination of Date.**

**Fig. 15.** The Seed, or so-called Stone of the Date, was planted in a small pot and kept in a hot-house. In about two months some of the seeds planted germinated, as shown in *b* and *d*.

(*a.*) Stone taken from Date.

There is a little hollow on surface of seed, showing position of Embryo. Cut through at that spot.

SEED. { Cover, a thin skin.  
Embryo, small.  
Endosperm, large and horny.

(*b, c.*) Germinating seed—*c*, in its natural position and in vertical section.

One end of the single Cotyledon remains in the seed, absorbing the endosperm, while the other end lengthens and carries with it the other parts of the embryo out of the seed. The primary root is developed with its root-cap, and leaves are formed within the sheath of the cotyledon.

(*d.*) The young leaves have burst through the sheath of the cotyledon, and the Primary root has become largely developed, giving rise to numerous Rootlets. The primary root has a coil at the base, because it had reached the bottom of the flower-pot.



Fig. 1 Male & Female Inflorescence of Birch



Fig. 2 Scale detached (a) outer (b) inner view



BIRCH

Fig. 3 Male Flower Fig. 4 Stamen with forked Filament



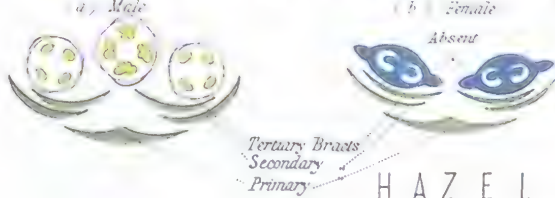
Fig. 5 Female Flowers



DIAGRAM I Plan of Flowers of Birch



DIAGRAM II Plan of Flowers of Alder



HAZEL

Fig. 8 Male & Female Inflorescence of Hazel



Fig. 9 Scale detached inner view



Fig. 10 Inner view of Scale magnified

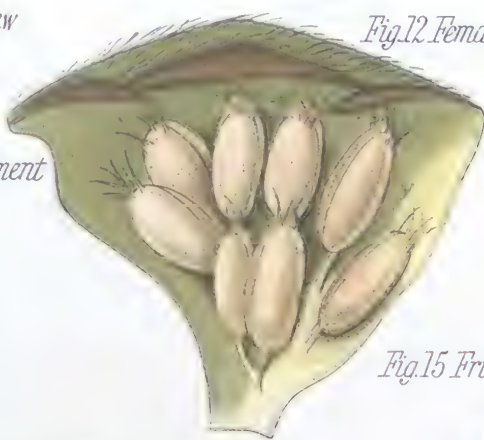


Fig. 12 Female Inflorescence enlarged



Fig. 14 Female Flower

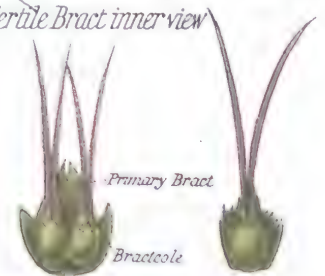


Fig. 11 Stamen with forked Filament



Fig. 13 Fertile Bract inner view

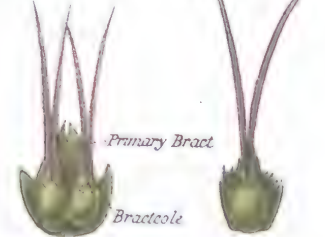


Fig. 17 Male & Female Inflorescence of Oak



DIAGRAM III Plan of Flower

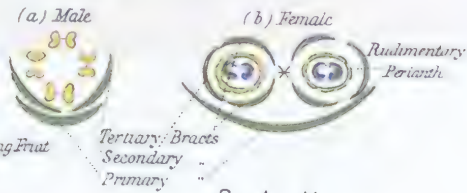


Fig. 15 Fruit with shell cut through



Fig. 16 Seed Vertical Section

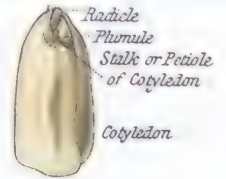
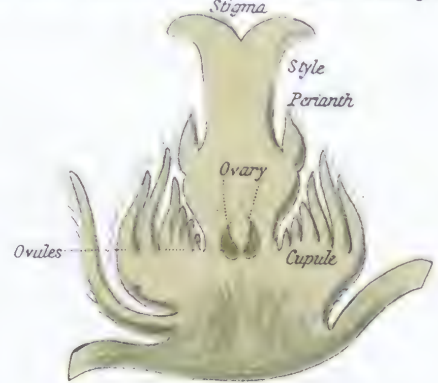


Fig. 20 Vertical Section of same enlarged



WILLOW

Fig. 23 Male Inflorescence of Willow



Fig. 25 Female Inflorescence



24 Male Flower



Fig. 26 Female Flower

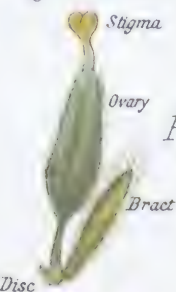


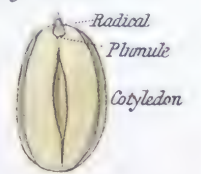
Fig. 27 Fruit enlarged



Fig. 21 Fruit of Oak Remains of Stigma



Fig. 22 Seed





**PLATE X.—BIRCH (*Betula*), HAZEL (*Corylus*), OAK (*Quercus*), and WILLOW (*Salix*).**

These four well-known Trees, chosen to illustrate the simpler forms of flowers among Dicotyledons, have this in common, that the flowers are small and simple, male and female being separate and arranged in different spikes which fall away after flowering: hence commonly called Catkins. The Male Flower consists of Stamens, and the Female of Carpels, to which may be added a Perianth more or less obvious. There are also frequently a number of investing Bracts connected with the flowers which have an interest in the detailed comparative study of plants, but for our present purpose are mere accessories—not essentials.

The Birch and Alder, Oak and Hazel, are wind-fertilised, and the pollen is therefore dry and powdery, falling from the male catkins like showers of fine dust, and the male and female flowers are on the same tree. But in the Willow, which is insect-fertilised, the golden-yellow pollen is not dry and powdery, and the two kinds of flowers are on separate trees.

**Common Birch (*Betula alba*), flowers in spring.**

**Fig. 1.** Male and Female Catkins on the same tree, the female being smallest.

**Fig. 2.** Detach a scale from male catkin and examine.

There are two small scales overlapped by a larger one, and each of the three bears its own stamens.

**Fig. 3.** Detach a small scale with its accompanying stamens from inside of large scale.

There are two Stamens with branching filaments.

**Fig. 4.** Stamen detached, showing Filament branching.

**Fig. 5.** Detach one of the scales from female catkin.

Three scaly bracts are united at time of flowering, each with a female flower in its axil.

*Diagram I.*—There are three flowers in a group, with three overlapping scales, the largest in the middle.

(a.) Male Flower—each consists of two Stamens, the filaments of which fork, and so give rise to the appearance of four Stamens.

(b.) Female Flower—each consists of two Carpels united.

*Diagram II.*—Alder (*Alnus*).

(a.) Male Flower—each consists of four unbranched Stamens and a Perianth of four Segments.

(b.) In the Female group the middle flower is absent.

**Fig. 6.** Winged Fruit—in the ripe catkin the scaly bracts are united and bear three winged fruits.

**Fig. 7.** Make a vertical section of the fruit parallel to the wings.

Only one of the two Ovules has ripened into Seed, the other becoming aborted.

**Common Hazel (*Corylus Avellana*), flowers in early spring.**

**Fig. 8.** Male and Female Inflorescence on same tree, the female being small and bud-like with the crimson stigmas projecting.

**Fig. 9.** Detach scale from Male Inflorescence—outer view (not inner as on Plate).

Wedge-shaped and hairy, with two smaller scales appearing on each side.

**Fig. 10.** Examine inner side of scale.

Male flower consisting of four Stamens with forked filaments, so that there are apparently eight stamens.

**Fig. 11.** Stamen detached and magnified.

Filament forked, and Anthers hairy at the tip.

**Fig. 12.** Female Inflorescence enlarged.

**Fig. 13.** Remove some of the outer scales and observe that they are barren, while the inner are fertile.

**Fig. 14.** Single flower detached from scale.

Female flower consisting of two united Carpels, as indicated by the two long, separate Styles. There are indications of minute teeth surrounding upper part of Ovary, and these may be regarded as a very rudimentary Perianth.

*Diagram III.*—(a.) Male Flower consisting of four branched Stamens.

There are three scaly Bracts, but only a single flower appears to be developed.

(b.) Female Flower consisting of two united Carpels, with a rudimentary Perianth.

There are three small Bracts surrounding the flower, united towards their base and deeply cut at their margins, forming the "husk" of the fruit.

**Fig. 15.** Fruit—a Nut. A Filbert, for instance, may easily be procured and examined.

Split the nut-shell in two lengthways, as shown, without injuring the seed.

Shell hard and woody with scar *at bottom*, to which fruit-stalk was attached, and mark left *at top* by the styles.

Seed usually single, attached to bottom of shell by a brown, fibrous cord stretching from top of seed. This cord originally formed the axis between the two chambers of the Ovary, but by the excessive development of one seed at the expense of all the rest, this has been displaced to one side.

**Fig. 16** Soak seed for a little in boiling water with a little washing-soda added, then the two coats of the seed may be removed—an outer brown and an inner white—and the two cotyledons parted from one another.

Two fleshy Cotyledons.

Short Radicle at top.

Plumule continuous with radicle, and forming a terminal bud.

**Oak (*Quercus Robur*), flowers in spring.**

**Fig. 17.** Male and Female Inflorescence on same tree—the male slender and pendulous with numerous flowers, the female stouter and upright.

**Fig. 18.** Male flower with lobed Perianth and ten Stamens, the filaments of which are not forked.

**Figs. 19 and 20.** Female flower entire and in section.

Investment or cupule of numerous bracteoles.

Perianth, toothed.

Ovary, Style, and three-lobed Stigma



**Willow (*Salix Caprea*), flowers in spring—the earliest of all British Willows.**

- Fig. 21.** The Fruit of the Oak is the well-known Acorn.  
The woody cup or cupule consists of numerous overlapping scales, and the acorn is simply a Nut.  
In the Birch and Hazel there were two Ovules, only one of which usually forms a perfect Seed; but in the Oak there are six Ovules, and yet only one seed finally survives.
- Fig. 22.** Seed with usually two Cotyledons, but sometimes, as in this case, with three.
- Fig. 23.** Male Inflorescence, a bushy, soft mass of golden-yellow Stamens.
- Fig. 24.** Detach a single Flower with its accompanying Bract.  
Two Stamens constitute the flower, with a small Disc at the base.
- Fig. 25.** Female Inflorescence, elongated and of a silver-grey colour.
- Fig. 26.** Detach a single Flower from the central axis.  
Two united Carpels constitute the flower.
- Fig. 27.** The capsular Fruit splits along the midrib of each carpel, and the two valves curl over at the top, exposing the hairy Seeds.
- Fig. 28.** Each Seed is enveloped by a pencil of silky hairs springing from the base.

CLASSIFICATION.

*Class.*—Dicotyledon.

Leaves, net-veined.  
Embryo with two cotyledons.

*Orders.*—Betulaceæ (Birch and Alder).

Male and Female flowers on same tree.  
Female flowers without perianth.  
Ovary, two-chambered, with one Ovule in each chamber.  
Fruit, a flattened nut, usually winged and without investment

Corylaceæ (Hazel).

Male and Female flowers on same tree.  
Female flowers with rudimentary perianth.  
Ovary, two-chambered, with one Ovule in each.  
Fruit, a nut, with leafy investment.

Cupuliferæ (Oak).

Male and Female flowers on same tree.  
Male and Female flowers with perianth.  
Ovary, three-chambered, with two Ovules in each.  
Fruit, a nut, with cupule.

Salicaceæ (Willow).

Male and Female flowers on different trees.  
Disc, representing Perianth.  
Ovary, one-chambered, with numerous Ovules.  
Fruit, capsular, splitting into two valves.  
Seeds, numerous, with silky hairs.



Fig 1. Flower-bud of White Water Lily



Fig 2. Vertical Section of partially opened Bud

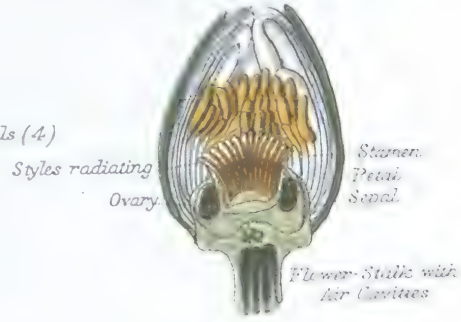
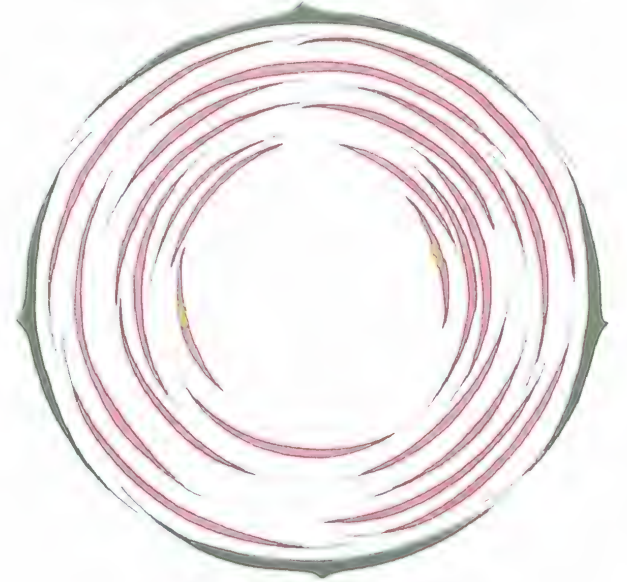


DIAGRAM I Plan of Flower in Bud



Ca 4 Co ∞ An. ∞ Gn. ∞

Fig 3. Flower-bud of Yellow Water Lily



Fig 4. Vertical Section of Bud



DIAGRAM II Plan of Flower in Bud



Ca 5 Co 13. (Variable) An ∞ Gn. ∞

Fig 6. Floral Leaves of Nymphaea



Fig 7. Stamens



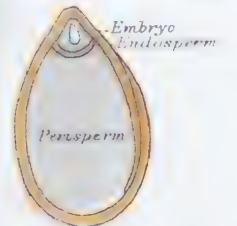
Fig 5. Foliage Leaf of Nymphaea



Fig 8. Fruit of White Water Lily



Fig 9. Seed -vertical section





**PLATE XI.—WHITE WATER-LILY (*Nymphaea alba*) and YELLOW WATER-LILY (*Nuphar luteum*).**

These are water-plants, growing in lakes or ponds, with floating leaves and large solitary flowers. The leaves and flowers are borne on long stalks, so as to reach the surface of the water, and the stalks are permeated by large air-cavities.

The White Water-lily is specially interesting, as showing a gradual passage from Sepal to Petal and from Petal to Stamen.

The Yellow Water-lily has an alcoholic odour like brandy, hence it sometimes gets the name of brandy-bottle.

**FLOWER—**

**Fig. 1.** Flower-bud, showing four Sepals, green on the outside.

**Fig. 2.** Partially opened Bud, halved from below upwards.

Flower-stalk with air-cavities.

Sepals, less green than in unopened bud.

Petals and Stamens apparently inserted on Ovaries, but really attached to Receptacle, which is developed around, and adherent to the carpels.

Carpels with ovaries, partly above and partly below insertion of stamens.

*Diagram I.*—Calyx, of four Sepals.

Corolla, of numerous Petals, gradually getting smaller as they approach the Stamens.

Andrœcium, of numerous Stamens.

Gynœcium, of numerous Carpels.

**Fig. 3.** Flower-bud of Yellow Water-lily showing five greenish-yellow Sepals.

**Fig. 4.** Bud halved lengthways showing superior Ovary.

*Diagram II.*—Calyx of five Sepals.

Corolla, of a variable number of Petals, often thirteen.

Andrœcium, of numerous Stamens.

Gynœcium, of numerous superior Carpels.

**FOLIAGE- AND FLORAL- LEAVES—**

**Fig. 5.** Foliage-leaf, large and heart-shaped.

**Fig. 6.** Floral leaves of White Water-lily, showing transition from Sepal to Petal.

(a.) Sepal, quite green.

(b.) Petal, white, but otherwise resembling sepal.

(c.) Regular Petal

**Fig. 7.** Stamens, showing transition from petals to Stamens,

(a.) Stamen, which is essentially a petal-bearing anther.

(b.) Regular stamen.

**FRUIT AND SEED—**

**Fig. 8.** The Fruit consists of the numerous carpels, surrounded by a fleshy Receptacle upon which the petals and stamens were spirally arranged.

It ripens under water and afterwards splits up irregularly to allow the escape of the seeds.

**Fig. 9.** Vertical section of Seed.

The Seed contains a small Embryo with large Endosperm. This endosperm is not only developed as usual in the Embryo-sac, but Nucellus outside the embryo-sac also becomes loaded with nutritious matter, and this is sometimes called Perisperm.

**CLASSIFICATION.**

*Class.*—Dicotyledon.

*Division.*—Polypetalæ.

*Sub-division.*—Thalamifloræ.

*Order.*—Nymphæaceæ.

Water-plants.

Leaves, usually large and floating.

Flowers, regular.

Petals and Stamens, indefinite.

Carpels, indefinite.

Fruit, berry-like.



Fig 1. Vertical Section of Flower (x 10)

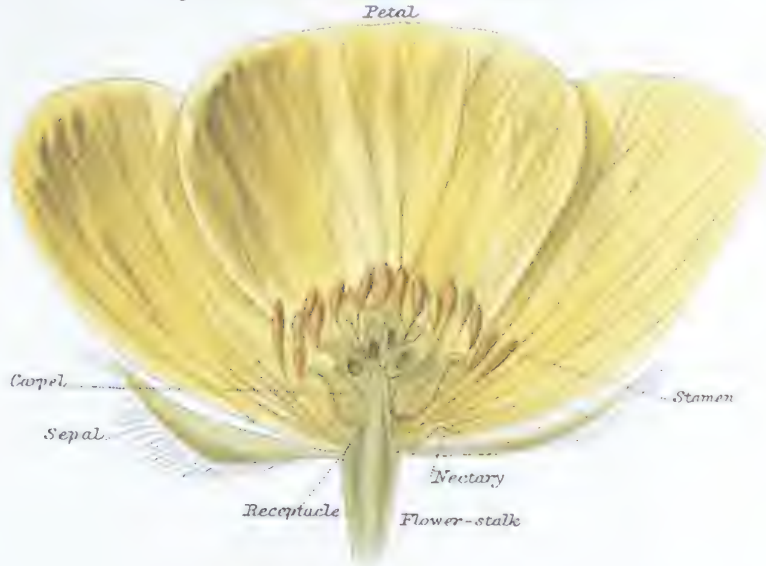
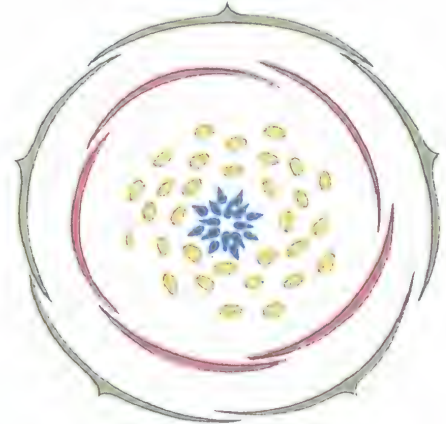


DIAGRAM I Plan of Flower in Bud



Ca 5 Co 5 An ∞ Gn ∞

Fig 2 Foliage Leaves becoming simplified as they approach the Flower



Fig 3 Floral Leaves



Fig 4 Stamen (x 10)



Fig 5 Carpel



Fig 11 Raceme of Actæa Spicata (Baneberry)



Fig 12 Fruit - A Berry



Fig 6 Side Wall of Ovary removed



Fig 7 Fruit-Achene

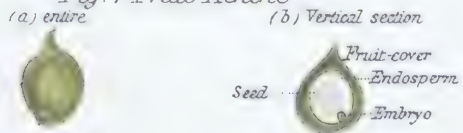


Fig 13 Seed detached



Fig 8 Columbine

Vertical Section of Flower



DIAGRAM II Plan of Flower

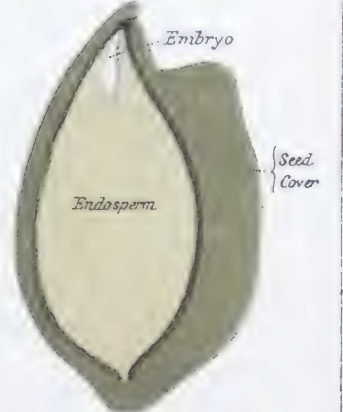


Ca 5 Co 5 An 50 Gn 5

Fig 9 Fruit-Follicles



(a) entire





## PLATE XII.—BUTTERCUP (*Ranunculus*) and COLUMBINE (*Aquilegia*).

(*Columbine after Baillon*).

Buttercups are very common, but they are not on that account to be lightly passed over. The Flower shows the four sets of organs very distinctly, and the parts in each are separate. The Leaves are also very instructive as showing how the much-divided compound leaf gradually gets simpler and simpler as the flower is approached, until there is no difficulty in passing from them to the sepals. In the White Water-lily the passage of one *floral-leaf* into another was shown, but no attempt was made to connect the ordinary *foliage-leaves* with them; in fact there is often a difficulty in doing so, especially where the leaves are compound, for you invariably find the leaves of the flower to be simple. The Buttercup shows the process of simplification very beautifully, and it may also be observed in the white-flowered garden *Peony*, belonging to the same Order as the Buttercup.

The simple flower of the Buttercup has many contrivances worth noticing. It is of a golden colour to attract insects; it has a nectary at the base of each petal to entice them into the recesses of the flower; the outer stamens shed their pollen before the inner, and before the carpels are ready to receive it, in order that insects may carry the pollen from younger flowers, to those more advanced, in which the carpels are mature; and, finally, the whole flower is beautifully spread out to sun and sky, enabling it, with the help of its minutely divided leaves, to get the full benefit of its surroundings.

### Buttercup.

#### FLOWER—

**Fig. 1.** Halve the expanded flower by cutting from below upwards.

Flower-stalk expanding into Receptacle which is conical, and to which the various parts of the flower are attached.

Sepals inserted on receptacle below carpels, soon falling off.

Petals inserted on receptacle, with little scale at base protecting nectar from excessive evaporation.

Stamens inserted on receptacle, and spirally arranged.

Carpels inserted at top of conical receptacle, each with one Ovule, and spirally arranged.

**Diagram I.**—Make transverse section of Bud, just above the base, in order to cut through the various parts. Gently separate the parts with dissecting needle and make out their relative position.

Calyx of five free Sepals, imbricate.

Corolla of five free Petals, imbricate.

Andrœcium of numerous free Stamens.

Gynœcium of numerous free Carpels.

#### FOLIAGE- AND FLORAL- LEAVES—

**Fig. 2.** Foliage-leaves gradually passing into floral-leaves.

This gradation of leaves may not all occur on one plant, so several plants should be examined.

**Fig. 3.** Floral-leaves.

Green Sepal, hairy outside.

Coloured Petals, notched and unnotched.

**Fig. 4.** Filament of Stamen continued along the back or outer face of stamen.

**Fig. 5.** Carpel with small point of attachment, and consisting of swollen Ovary, short Style and hooked Stigma.

**Fig. 6.** Side wall of Ovary removed, showing single Ovule in the cavity.

#### FRUIT AND SEED—

**Fig. 7.** Fruit entire and in vertical section.

Fruit-cover or Pericarp enclosing Seed.

Seed consisting of—Membranous coat.

Endosperm, white and solid.

Embryo or rudimentary plant towards base.

### Columbine.

The scientific name *Aquilegia* (Lat. *aquila*, an eagle), and the common name, *Columbine* (Lat. *columba*, a dove), have both reference to the form of the petals, since one of the petals with a sepal on each side resembles a bird.

**Fig. 8.** Section of Flower as in Fig. 1.

Flower-stalk expanded at top.

Sepals, sometimes greenish, but usually coloured, hence called petaloid.

Petals with spur projecting below.

Stamens in several whorls above one another.

Carpels inserted on top of receptacle, each with numerous Ovules.

**Diagram II.**—Plan of Flower.

Calyx of five free petaloid Sepals.

Corolla of five free spurred Petals, alternating with the Sepals.

Andrœcium of ten whorls of Stamens of five each, arranged in ten radiating rows. The innermost and uppermost ten Stamens are reduced to flattened scales, and being barren are called Staminodes.

Gynœcium of five free Carpels, opposite the Petals.

**Fig. 9.** Fruit.

Each Carpel opens along its inner face to discharge the seeds.

A dry fruit, consisting of a single carpel, containing a number of seeds, and opening lengthways along its inner or ventral face is called a *Follicle*.

**Fig. 10.** *a, b.* Seed consisting of—Cover, which forms a projecting ridge on one side, ending in a *scar* or place of attachment.

Endosperm, large and fleshy.

Embryo towards apex, with two Cotyledons and Radicle pointing to Micropyle.

### Bane-berry.

**Fig. 11.** Inflorescence—a Raceme.

**Fig. 12.** Fruit—a Berry, containing a number of Seeds.

**Fig. 13.** Single Seed with its covering or Testa.

It may be remarked that in Baneberry, where the Carpels are reduced to their lowest number, viz., one, the fruit becomes an attractive Berry, which is eaten by animals, and so the Seeds are deposited under the most favourable conditions.



BUTTERCUP—*continued.*

CLASSIFICATION.

*Class.*—Dicotyledon.

*Division.*—Polypetalæ.

*Sub-division.*—Thalamifloræ.

*Order.*—Ranunculaceæ.

Flowers with free sepals and petals.

Stamens, indefinite.

Carpels, separate and superior.

Fruit, achenes or follicles usually.

Seed with endosperm, and Embryo minute.



BARBERRY

DIAGRAM I

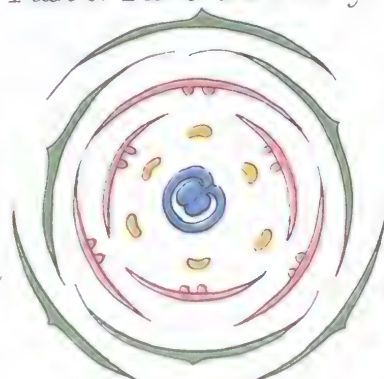
Fig. 1. Inflorescence  
*A pendulous Raceme laid out*



Fig. 2. Flower seen from above  
(x10)



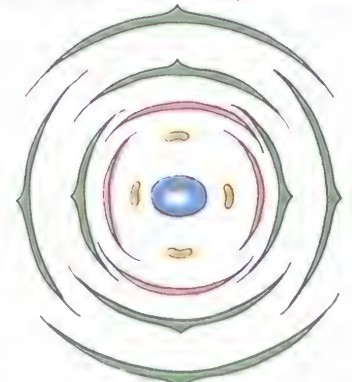
Plan of Flower of Barberry



Ca 3+3 Co 3+3 An 3+3 Gn 1

DIAGRAM II

Plan of Flower of Epimedium



Ca 2+2 Co 2+2 An 2+2 Gn 1  
*repeated*

Fig. 4. Fruit - a Berry

Fig. 5. Seed vertical section

Fig. 3. Stamens (x10)



POPPY

Fig. 2. Vertical Section  
of Flower

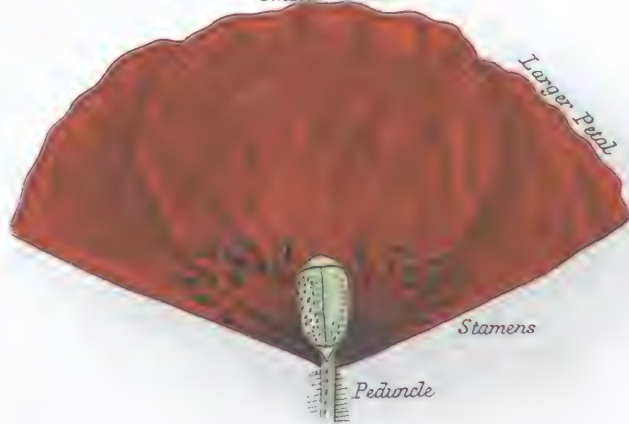
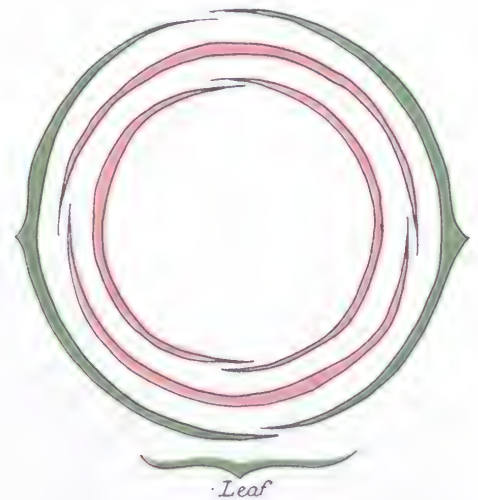


DIAGRAM III  
Plan of Flower



Ca. 2 Co 2+2 An. ∞ Gn. ∞

Fig. 1. Flower-bud

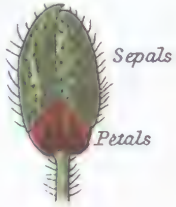


Fig. 4. Floral Leaves - inner view

(b) Outer Petal

(c) Inner Petal



Fig. 3. Foliage Leaf



Fig. 8. Seed of Opium Poppy (magnified vertical section)

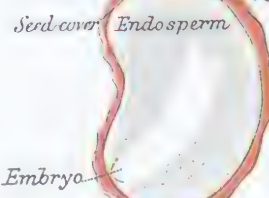


Fig. 10. Fruit of Chelidonium dehiscent

DIAGRAM IV Transverse Section of Poppy Fruit



Fig. 5. Stamens (x10)



Fig. 6. Fruit - a Capsule



Fig. 9. Embryo detached



Fig. 7. Seeds (x10)



DIAGRAM V Transverse Section of Chelidonium Fruit





## PLATE XIII.—BARBERRY (*Berberis vulgaris*) and POPPY (*Papaver Rhœas*).

### Barberry.

The common Barberry is remarkable for its leaf-spines and its irritable stamens.

The Leaf-spines (see Cryptogams; Pl. XVI.) are hard woody pointed structures, bearing in their axils the branches reduced to tufts of leaves.

The Stamens stand out from the Carpel and lie in the hollow of the petals. If a stamen is touched at the base, with a pin for instance, it curves forward towards the centre of the flower; and it is evident that when an insect visits the honey-glands, situated at the base of the petals, it will irritate the stamens, get dusted with the pollen, and possibly be hurried off in alarm to the next flower.

The connection of the Barberry with Rust of Wheat is shown in treating of that Fungus.

**Fig. 1.** Inflorescence—a Raceme, as in Baneberry.

**Fig. 2.** Flower showing twelve honey-glands—in pairs—at base of each petal, and the Stamens close to the petals.

*Diagram I.*—Barberry—Parts of the flower in three's; Gynœcium being single.

*Diagram II.*—Epimedium—Parts of the flower in two's; Gynœcium being single.

**Fig. 3.** Stamen with Anther opening by Valves.

The irritability of the stamens can easily be tested in species of Barberry or Mahonia, common in shrubberies.

**Fig. 4.** Fruit—a Berry, as in Baneberry.

**Fig. 5.** Seed in vertical section.

Seed cover.

Endosperm.

Embryo occupying the axis of the seed.

### Poppy.

The Field Poppy, so common in fields and waste places, has a conspicuous scarlet flower. If the flower is examined while still wrapped up in the two sepals, it will be found that the anthers fit exactly between the stigmatic rays; and as the *inner* stamens open *first* by lateral slits, the pollen is necessarily dusted over the rays of the stigma which stand up like so many ribs in the centre of the flower. The Stigma is not quite mature, and the pollen is just so much dainty food, spread out on a table as it were, and arranged along radiating lines. When the sepals fall away and the flower expands the stamens have diverged, as in Fig. 2. An insect attracted by the scarlet naturally alights on the solid centre, and finds the pollen it is in quest of. It is arranged along certain lines, and just as the lines and bands of many flowers are supposed to be honey-guides, so these stigmatic rays may be of the nature of pollen-guides. There is abundance of pollen produced by the numerous stamens; and the insects, no doubt while feasting themselves, will carry pollen on their bodies from one flower to another.

#### FLOWER—

**Fig. 1.** Flower-bud showing the two Sepals which fall off as the flower expands, and the crumpled Petals beneath.

**Fig. 2.** Take an expanded flower, and make a section through it.

Peduncle, hairy.

Petals, larger and smaller, inserted beneath ovary.

Stamens, inserted beneath ovary.

Carpels, united.

*Diagram III.*—Calyx of two free hairy Sepals.

Corolla of four free Petals, in two whorls of two each.

Andrœcium of numerous Stamens in alternating whorls.

Gynœcium of numerous united Carpels, as indicated by the partial partitions of the ovary.

#### FOLIAGE- AND FLORAL- LEAVES—

**Fig. 3.** Foliage-leaf with ascending lobes and bristle at the tip of each,

**Fig. 4.** Floral-leaves—inner side.

(a.) Sepal, concave.

(b, c.) Outer and inner Petals, the outer pair largest.

**Fig. 5.** Stamens with anthers opening laterally.

#### FRUIT AND SEED—

**Fig. 6.** Fruit—a Capsule which opens by pores.

**Fig. 7.** Seeds with netted markings.

**Figs. 8 and 9.** Section of seed showing Embryo and Endosperm.

Embryo turned out with the fine hairs of a small brush.

**Fig. 10.** Fruit of Celandine (*Chelidonium*) opening by two valves.

*Diagram IV.*—The edges of the carpels are infolded, nearly meeting in the centre, and the ovules are attached to the surface (not to the edges) of the inturned carpels.

*Diagram V.*—Fruit of Celandine consisting of two carpels, and forming a siliquose fruit.

### CLASSIFICATION.

*Class.*—Dicotyledon.

*Division.*—Polypetalæ.

*Sub-division.*—Thalamifloræ.

*Order.*—Berberideæ.

Flower with Bract.

Stamens definite, and Anthers opening by valves.

Fruit, a Berry usually.

Seed with endosperm.

*Order.*—Papaveraceæ.

Flower, regular.

Petals, four.

Stamens, indefinite.

Fruit, a Capsule.

Seed with endosperm.



FUMITORY

Fig.1. Inflorescence - A Raceme



Fig.2. Side View of Flower



Fig.3. Vertical Section

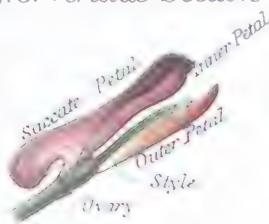


DIAGRAM I Plan of Flower



Ca. 2. Co. 2+2 An. 2<sup>3</sup> Gn. (2)

Fig.4. Foliage Leaf-Compound



Fig.5. Bract



Fig.6. Sepal



Fig.7. Petals (Inner View)



Fig.8. Stamens



Fig.9. Carpel



Fig.10. Fruit an Achene



Fig.11. Vertical Section of Fruit



DIAGRAM II Transverse Section of Fruit of Corydalis



WALLFLOWER

Fig.1. Inflorescence - a Raceme



Fig.2. Vertical Section of Flower



DIAGRAM III Plan of Flower in Bud



Ca. 2+2 Co. 4 An. 2+2<sup>2</sup> Gn. (2)

Fig.3. Foliage Leaves (No Bracts)



Fig.4. Sepals Saccate



Fig.5. Petals

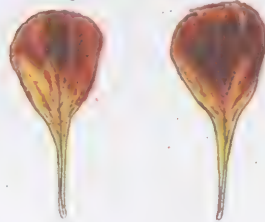


Fig.6. Stamens



Fig.7. Pistil

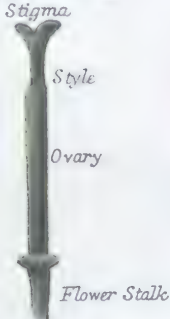


Fig.8. Fruit - A Siliqua



DIAGRAM IV Transverse Section of Fruit



Fig.9. Seed - Seed-cover Removed leaving Embryo



Fig.11. Transverse Section of Embryo





PLATE XIV.—FUMITORY (*Fumaria officinalis*), and WALL-FLOWER (*Cheiranthus Cheiri*).

Fumitory.

The common Fumitory may be readily obtained, generally from May onwards, in all sorts of waste places and corn and other fields. It is a weak straggling herb, with finely divided leaves, and a peculiar shaped irregular flower. The flower is of a pale rose-colour and inconspicuous, and said to be fertilised without the agency of insects. The form and arrangement of the different parts are evidently suggestive of some purpose.

FLOWERS—

**Fig. 1.** Inflorescence—a Raceme, and flowers with Bracts.

**Figs. 2. and 3.** Make a vertical section of the flower from the base, holding it between finger and thumb.

Bract, a modified leaf with a flower in its axil.

Pedice, short in flower, elongating in fruit.

Sepals, small and scale-like.

Petals, one of the outer bulging at the base.

Stamens and Carpels best seen separate.

*Diagram I.*—The part of the flower turned towards the axis may be conveniently termed *dorsal*, or *posterior*, and the opposite part towards the bract (when present) will be *ventral*, or *anterior*.

Calyx, two sepals become lateral by a twisting of the flower-stalk.

Corolla, two outer petals (anterior and posterior) large, two inner small.

Andrœcium, two stamens, each splitting into three anthers.

Gynœcium, two united carpels, as indicated by the lobed stigma.

FOLIAGE- AND FLORAL-LEAVES—

**Fig. 4.** Foliage-leaf much divided.

**Fig. 5.** Bract with broad base of attachment.

**Fig. 6.** Sepal with indented margin.

**Fig. 7.** Petals, detached—inner view.

(a.) Anterior petal flat.

(b.) Posterior petal saccate, having a dilated base.

(c.) Inner petals united at tip.

**Fig. 8.** Stamen with flattened out filament bearing three anthers.

**Fig. 9.** Carpel with stigma lobed.

FRUIT AND SEED—

**Fig. 10.** Fruit—an Achene.

**Fig. 11.** Hold the minute fruit between finger and thumb, and cut section lengthways.

Fruit-cover or Pericarp.

Seed consisting of minute embryo with endosperm.

*Diagram II.*—Fruit in *Corydalis*, a two-valved capsule, with numerous parietal seeds.

CLASSIFICATION OF FUMITORY.

*Class.*—Dicotyledon.

*Division.*—Polypetalæ.

*Sub-division.*—Thalamifloræ.

*Order.*—Fumariaceæ—

Flowers, irregular.

Stamens, two, each with three anthers.

Ovary, one-chambered.

Fruit, one-seeded Achene or many-seeded Capsule.

Seed, with endosperm.

*Genera.*—*Fumaria* and *Corydalis*, the two British genera.

Wall-flower.

Wall-flower is a universal favourite no less from its beautiful colours than from its sweet smell. It may be had for examination at almost any season of the year. The cross-like arrangement of the petals gives the name to the Order—Cruciferae—which includes, not only ornamental plants, such as Wall-flower and Stock, but many useful vegetables, such as Turnip and Cabbage, Cress and Cauliflower.

LEAVES AND FLOWERS—

**Fig. 1.** Inflorescence—a Raceme with generally a bract at the base, but individual flowers without bracts.  
Foliage-leaves alternate.

Opened flowers outer, unopened towards centre.

**Fig. 2.** Make a vertical section of fully opened flower, so as to pass through lateral sepals which bulge at the base.

Receptacle, the slightly expanded end of flower-stalk.

Sepals, inserted upon receptacle.

Petals, inserted upon receptacle.

Stamens—long and short—inserted upon receptacle.

*Diagram III.*—In a Flower-bud examine arrangement and relation of parts—

Calyx, in two whorls of two sepals each—the anterior and posterior overlapping the two lateral sepals.

Corolla, a whorl of four petals, alternating with sepals.

Andrœcium, in two whorls—outer whorl of two short stamens, opposite to lateral sepals, and inner whorl of four long stamens.

Gynœcium of two united carpels.

**Fig. 3.** Foliage-leaf, lance-shaped, entire.

FLORAL-LEAVES—

**Fig. 4.** Lateral sepals, bulging at the base to accommodate the bending of the two short stamens; this bending in turn being due to a little gland on their inner side.



WALL-FLOWER—*continued.*

**Fig. 5.** Petals, with long claw, and blade or limb bent at an angle to it.

**Fig. 6.** (*a, b, c.*) Stamens—  
Filament terminating at base of lance-shaped anther.  
Anther opening lengthways on inner face.

**Fig. 7.** Gynœcium with elongated Ovary, short Style and bi-lobed Stigma.

FRUIT AND SEED—

**Fig. 8.** Fruit—a Siliqua, opening by two valves from below upwards.

*Diagram IV.*—Seeds in two longitudinal rows.

The Septum is not formed by the united edges of the two carpels, but by the placentas meeting, and thus forming a spurious partition.

**Fig. 9.** Seed, with short wing.

**Fig. 10.** After the seed-cover is removed, nothing is left but the embryo, thus the seed is without endosperm.  
Embryo—the Radicle is lateral to the two Cotyledons.

CLASSIFICATION OF WALL-FLOWER.

*Class.*—Dicotyledon.

*Division.*—Polypetalæ.

*Sub-division.*—Thalamifloræ.

*Order.*—Cruciferae.

Leaves, alternate.

Flowers, regular and without bracts.

Petals, arranged cross-wise.

Stamens, four long and two lateral short.

Carpels, united and two chambers formed.

Fruit, a siliqua or silicula.

Seed, without endosperm.

*Genus.*—Cheiranthus.



Fig. 1 Inflorescence - a Dichotomous Cyme



Fig. 2 Cerastium - a Dichotomous Cyme

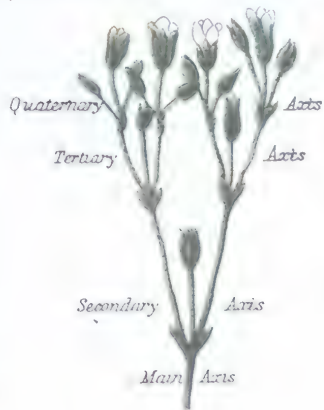


Fig. 3 Vertical section of Flower

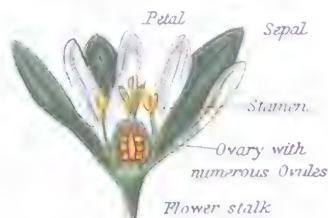
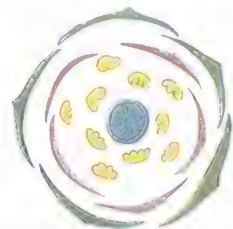


DIAGRAM Plan of Flower



Ca. 5 Co. 5 An. 10 to 5 or less Gn. (3)

Fig. 4 Foliage Leaves



Fig. 5 Floral Leaves  
a. Sepal inner view (\*10) b. Petal (\*10)



Fig. 6 Stamen



Fig. 7 Gynæcium (\*10)



Fig. 8 Transverse section of Ovary



Fig. 9 Fruit - a Capsule (\*10)



Fig. 10 Seed in Optical section



Fig. 11 Section of Seed

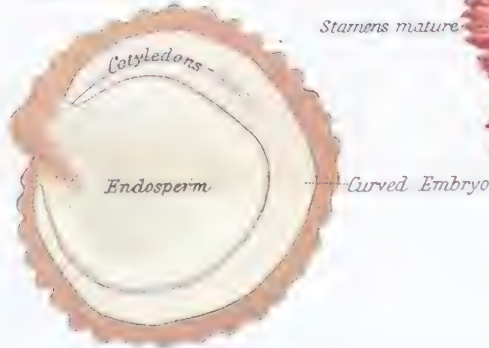


Fig. 12 Pink-Dianthus in first condition



Fig. 13 Pink in second condition



Fig. 14 Campion (Lychnis) Male flower



Fig. 15 Vertical section of same



Fig. 16 Campion - Female flower





**PLATE XV.—CHICKWEED (*Stellaria media*), MAIDEN PINK (*Dianthus deltoides*), and CAMPION (*Lychnis vespertina*).**

**Chickweed.**

The common name of Chickweed is applied to two different genera of the same order—the one being *Stellaria*, which is easily known by the line of hairs on stem and branches, and the other *Cerastium*, distinguished as Mouse-ear Chickweed. *Stellaria* has been chosen for representation, which is common on roadsides and waste places at almost any season of the year, and though small it forms a very good example of a large and varied class of plants. The flowers are not very conspicuous, the petals being overtopped by the sepals, and the pollen is ripe before the stigmas are ready to receive it. The inner stamens are often absent, and even the outer are sometimes reduced to three.

STEM AND LEAVES—

- Fig. 1.** Stem, swollen at the nodes, with a line of hairs on alternate sides.  
Leaves, opposite, and successive pairs forming right angles with each other.  
Branches, formed in the axil of each leaf, hence two spring from a node.

FLOWERS—

- Figs. 1 and 2.** Inflorescence—the main axis terminates in a flower, and two lateral axes below that are similarly terminated by a flower, and so on. Generally when an axis produces a flower at its apex its growth is closed; hence such an Inflorescence is called *Definite*.

When a definite inflorescence produces *two* lateral axes of equal value in this way, it is called a Cyme of two branches, or a *Dichotomous Cyme*.

- Fig. 3.** Sepals, longer than petals.  
Petals, bifid.  
Stamens, with slender filament arising from receptacle beneath ovary.  
Carpels, united; Styles, free.

*Diagram.*—Calyx, of five free sepals.

Corolla, of five free petals.

Andrœcium, of five long stamens alternating with petals, and five short alternating with five long.

Gynœcium, of three united carpels.

FOLIAGE- AND FLORAL-LEAVES—

- Fig. 4.** Lower Foliage-leaves with stalk; upper, sessile.  
**Fig. 5.** (a) Free Sepal, with broad base of attachment.  
(b) Petal, deeply cleft.  
**Fig. 6.** Stamen, with glandular swelling at base of filament.  
**Fig. 7.** Gynœcium, with globular Ovary, and three distinct Styles.  
**Fig. 8.** Placentation, free-central, because ovules are attached to a central axis *free* from wall of ovary

FRUIT AND SEED—

- Fig. 9.** Fruit, a dry, dehiscent Capsule, opening by six valves, and containing numerous seeds.  
**Figs. 10 and 11.** Seed, with curved Embryo enveloping Endosperm.

**Maiden Pink.**

- Figs. 12 and 13.** Pink, in its first condition, with stamens mature and projecting; second condition, with stigmas mature, and occupying position of the shrivelled-up stamens.

**Campion.**

Campion, like the generality of flowers which expand by night, is *white*; since white is a colour which reflects even the faint light existing at night-time, thus rendering objects of that colour as conspicuous as possible. It also smells in the evening in order to guide and attract insects.

In Chickweed, the male and female organs exist, but there is a tendency to reduction in the stamens, and the pollen is shed before the stigmas of the flower are mature. In Pink, male and female organs also exist, but the pollen is shed while the stigmas are not only immature but concealed. In Campion, the separation of the male and female organs has gone further, since the male and female flowers are produced on separate plants.

- Figs. 14 and 15.** Male Flower, with ten Stamens—five long, alternating with sepals, and five short, alternating with petals.  
Corona, at junction of claw and blade of petal, scale-like—essentially a ligular appendage, occupying same position and at right angles to leaf as in Grasses.  
Axis of flower, developed between sepals and petals.

- Fig. 16.** Female Flower, with five curling stigmas, thus offering a large surface for the reception of pollen.

CLASSIFICATION

*Class.*—Dicotyledon.

*Division.*—Polypetalæ.

*Sub-division.*—Thalamifloræ.

*Order.*—Caryophyllaceæ, or Pinks.

Stem, with swollen nodes.

Leaves, opposite and entire.

Inflorescence, definite.

Flowers, regular.

Stamens, definite.

Ovules, many, and Placentation free-central.

Fruit, a capsule (usually).

Seed, with endosperm.

*Genera.*—*Stellaria*, *Cerastium*, *Dianthus*, *Lychnis*.



Fig. 2 Plant in Flower & Fruit



Fig. 3 Vertical section of Flower

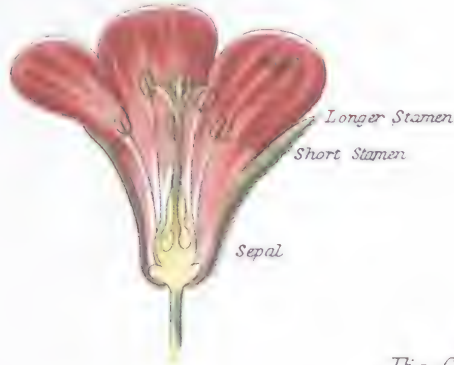


DIAGRAM 1 Plan of Flower

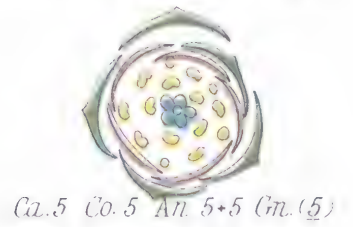


Fig. 7 Gynæcium



Fig. 6 Stamen



Fig. 5 Petal



Fig. 4 Sepal



Fig. 11 Section of Seed showing Folded Cotyledons

a. Longitudinal



b. Transverse

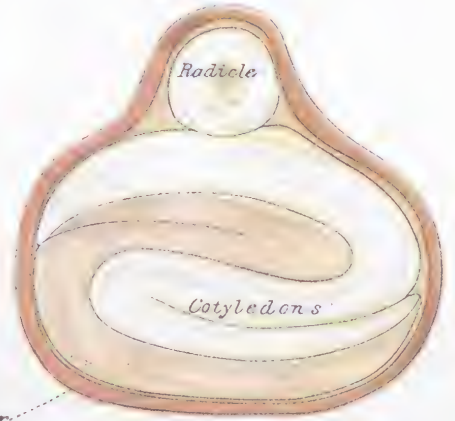


Fig. 8 Transverse section of Ovary ( $\times 10$ )  
Showing Axile Placentation

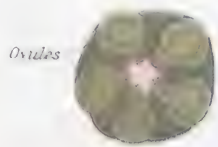


Fig. 10 Seed ( $\times 10$ )



Fig. 1 Compound Foliage-leaves  
becoming simplified as they approach the Flower

Fig. 9 Fruit dehiscing (Calyx removed)





## PLATE XVI.—HERB-ROBERT (*Geranium Robertianum*).

Herb-Robert is a very common member of the Crane's-bill family, so called from the form of the fruit. It appears in flower towards the end of April, and I have met with it on to the end of December. It attracts notice by its disagreeable smell, and the bright colour of the flower; and in the autumn, when its foliage assumes a tint to match the flower, the whole plant becomes a conspicuous object. The stem forks a deal, and is very brittle at the joints. The leaves are in pairs as well as the flowers, and are deeply segmented. Honey-glands are situated at the base of the petals, and insects entering for the sake of the honey will encounter the stigmas or the anthers at the entrance.

### STEM, LEAVES, AND FLOWERS—

**Fig. 1.** Compound leaf with five leaflets, which are again much divided. The leaf as it approaches the flower is seen to become not only smaller but simpler.

**Fig. 2.** Stem brittle at the joints.  
Leaves with long stalks and membranous stipules.  
Flower, bent—thus protecting the honey better from being acted on by rain.  
Fruit, the long and tapering style persisting as the beak.

**Fig. 3.** Cut a flower through from the base upwards—  
Sepals, hairy, arising from receptacle.  
Petals, arising from receptacle, pointed at base and expanded at top.  
Stamens, long and short, also arising from receptacle.  
Carpels, united.

*Diagram I.*—Calyx of five free sepals.

Corolla of five free petals, alternating with sepals.

Andrœcium of five outer, shorter stamens *opposite* to petals, and five longer, inner stamens.

Gynœcium of five carpels, as shown by the five stigmas, alternating with inner stamens.

Nectaries, in the form of five small glands, alternating with petals. If these nectaries be regarded as modified stamens, then the alternation of the different parts of the flower would be quite regular—sepals with petals; petals with nectaries or outermost row of modified stamens; outer with middle, short stamens; middle with inner, long stamens; and inner with carpels.

### FLORAL-LEAVES—

**Fig. 4.** Sepal with a long awn.

**Fig. 5.** Petal with a narrow claw and expanded blade.

**Fig. 6.** Stamen with flattened-out filaments.

**Fig. 7.** Gynœcium with Ovary, Style, and five distinct Stigmas. There are two Ovules superposed in each chamber of the ovary, one of which grows largely, while the other shrivels up.

**Fig. 8.** Cut across ovary to see Placentation.

Ovules attached to a central axis, with partitions between each ovule. This is called Axile Placentation.

### FRUIT AND SEED—

**Fig. 9.** The sepals persist at the base of the Fruit, as in Fig. 1, but spread out when fully ripe.

The carpels split from below upwards, and to prevent the jerk separating them entirely from the central axis, each ovary is fastened to the base of the stigma by two silky hairs. These hairs are sufficiently strong to keep the ovaries in place till the wind wafts them to new quarters, so by this beautiful and delicate contrivance the seeds are properly scattered.

**Fig. 10.** Seed, smooth.

**Fig. 11.** Take the seed between finger and thumb, and make a section lengthways and another cross-wise.  
Embryo occupies the whole of the seed, and has its cotyledons much folded.

### CLASSIFICATION.

*Class.*—Dicotyledon.

*Division.*—Polypetalæ.

*Sub-division.*—Thalamifloræ.

*Order.*—Geraniaceæ (*Gr. geranos*, a crane, from the beak-like prolongation of the carpels).

Leaves, stipulate.

Stamens, definite.

Placentation, axile.

Fruit, capsular.

Seed, without endosperm.

*Genus.*—*Geranium*.

*Species.*—*Robertianum*.



Fig. 1 Leaf stipulate



Fig. 2 Vertical section of Flower

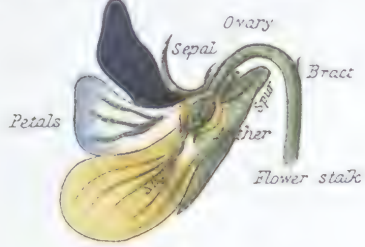


Fig. 3 Vertical section of Sweet Violet

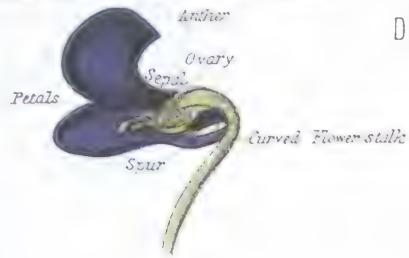
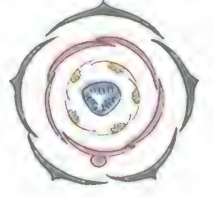


DIAGRAM Plan of Flower



Ca. 5 Co. 5 An. 5 Gn. (3)

Fig. 10 Longitudinal Section of Ovule highly magnified

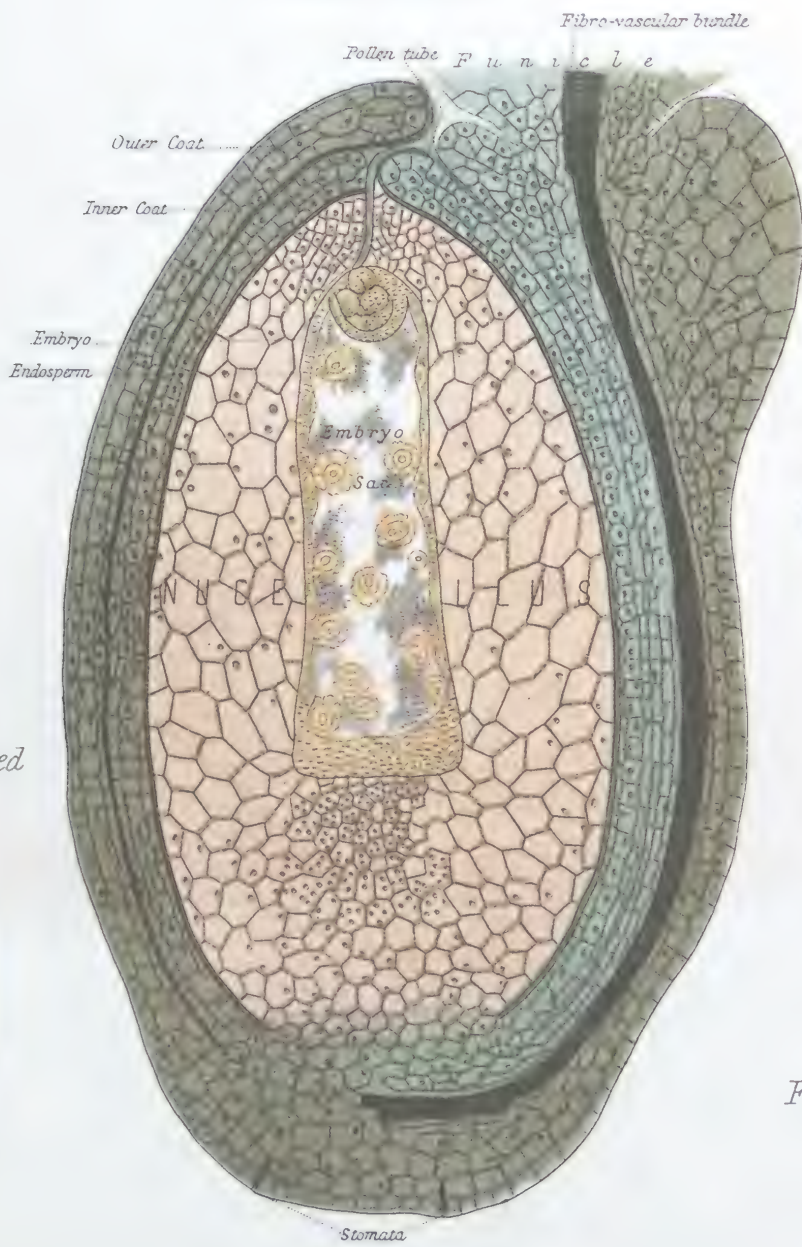


Fig. 7 Stamen-inner view highly magnified



Fig. 4 Bract (x 10)



Fig. 5 Sepal



Fig. 6 Lateral Petal enlarged



Fig. 8 Gynaecium (x 10)

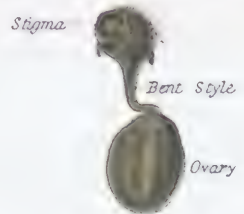


Fig. 9 Transverse section of Ovary



Fig. 13 Section of Albuminous Seed taken from unopened Fruit

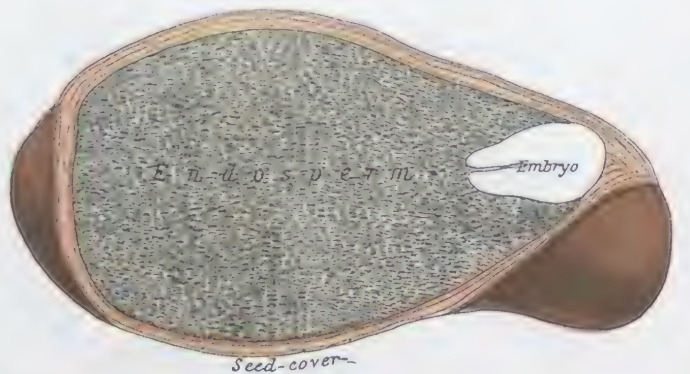


Fig. 11 Fruit a 3-valved Capsule



Fig. 12 Dehiscent Fruit





## PLATE XVII.—SWEET VIOLET (*Viola odorata*) and PANSY (*Viola Tricolor*).

The fragrant odour of the one and the brilliant colouration of the other have rendered these flowers universal favourites, but to the botanist they have an additional charm in the beautiful mechanical arrangement of parts for ensuring cross-fertilisation—that is, the transference of the pollen from one flower to the stigma of another.

As there are many other flowers with equally remarkable contrivances, it may prove interesting and instructive to ask ourselves and answer for ourselves some of those questions which this very flower—the Sweet Violet—suggested to the mind of Sprengel, who was one of the first during the last century, to perceive the relations between flowers and insects. After examining the flower in order to understand the position and arrangement of the different parts, he asked himself, What is the meaning of all this? and proceeded to write down questions and answers similar to the following:—

1. *Why does the flower bend over?*—To protect the honey from rain, and to place the stamens so that the pollen will fall into the space between the ovary and the free end of the stamens.
2. *Why has the corolla a spur?*—To make room for the appendages of the Anthers, and to hold the nectar they secrete.
3. *Why is the lower petal expanded?*—To serve as an alighting place for insects.
4. *Why have some of the anthers appendages?*—To secrete nectar.
5. *Why is the base of the style bent and thin?*—To enable the insect readily to bend it, as if straight it would be more difficult to bend.
6. *Why is the pollen more powdery than usual?*—To fall out of the anther more readily into the box formed by the membranous connectives.

The object of the whole contrivance is evidently to get an interchange of pollen through the agency of insects—the honey, the colour, and the smell all being so many inducements to attract them. The insect on alighting crawls between the style and the petal to reach the nectar. In so doing it comes in contact with the stigma and leaves there any pollen about its head brought from another flower. At the same time it bends the flexible style which moves the ovary, thus pressing back the anthers surrounding the ovary, and tapping the pollen-box, as it were. As the anthers slightly overlap, this motion is communicated all round, and the pollen collecting in the lower anthers will be jerked out by the necessary wagging of their appendages. The converging spoon-shaped connectives (Fig. 7) regulate the distribution of the pollen on the insect's head, so that when it visits the next flower, the bulk of the pollen will be left upon the open mouth of the stigma ready to receive it. The lower lip of the stigma will clearly prevent the insect, as it withdraws its head, from leaving any of the flower's own pollen, since the lip will close and none will stick.

The Sweet Violet may be found in shady woods as early as February, but it may be purchased much earlier.

**Fig. 1.** Leaf of Pansy—Stipules, large and leafy.

**Figs. 2 and 3.** Vertical section of Pansy and of Sweet Violet.

Bracts, minute, near bend of flower-stalk in Pansy, about middle of flower-stalk in Sweet Violet.

Sepals, attached to receptacle so as to leave posterior ends, free.

Petals, of different size and shape; the lowest the largest and prolonged into a spur.

Stamens, surrounding the ovary, with little membranous orange tips, and the two lower anthers with appendages projecting into the spur.

Carpels, consisting of swollen Ovary, bent Style, and hollow Stigma, with the opening directed downwards.

*Diagram.*—Calyx, of five free Sepals, unequal in size.

Corolla, of five free Petals, unequal in size.

Andrœcium, of five free Stamens, with large curved anthers overlapping one another.

Gynœcium, of three united Carpels.

**Fig. 4.** Bract with indications of stipules.

**Fig. 5.** Sepal with auricles representing stipules.

**Fig. 6.** Petals—two lateral with a brush of hairs, and lower with double brush and spur.

**Fig. 7.** Stamen with very short Filament, anther-lobes opening inwards and connective forming a large scoop.

**Fig. 8.** Gynœcium with swollen Ovary, bent Style, and hollow Stigma.

**Fig. 9.** Ovary composed of three carpels, united by their in-turned edges, which bear the Ovules. Here there is a single chamber and the ovules are attached to the wall of the ovary, so that the placentation is said to be *parietal*.

**Fig. 10.** In *Narcissus* the Ovule was shown on the eve of fertilisation, here—in *Viola*—it is shown directly after fertilisation.

The pollen-tube has spread out on the Embryo-sac and, by virtue of some influence conveyed by the pollen-tube to the embryo-cell through the synergida, fertilisation has been effected and an *Embryo* formed.

The contents of the embryo-sac also break up into a number of *Endosperm* cells by a process of free-cell formation.

It may be noted that, whereas in *Narcissus* only a single layer of cells formed the apex of the Nucellus, here there are several layers.

**Figs. 11 and 12.** Fruit, a Capsule splitting up into three valves along what corresponds to the midrib of each carpellary leaf.

**Fig. 13.** Seed taken between finger and thumb may be readily halved.

Embryo, at the attached end of seed.

Endosperm, abundant.

### CLASSIFICATION.

*Class.*—Dicotyledon.

*Division.*—Polypetalæ.

*Sub-division.*—Thalamifloræ.

*Order.*—Violaceæ.

Leaves, stipulate.

Flowers, irregular.

Stamen with Connectives produced beyond Anthers.

Placentation, parietal.

Fruit, a three-valved capsule.

*Genus.*—Only one British genus, *Viola*.



Fig. 1 Compound Umbel



Fig. 2

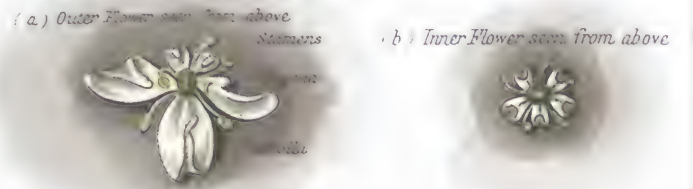


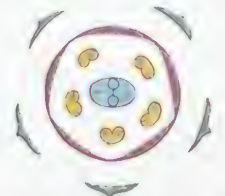
Fig. 3 Flower of Chervil



Fig. 4 Flower



DIAGRAM Plan of Flower



Ca 5 Co 5 An 5 Gn (2)

Fig. 5 Transverse section of Stem, grooved & hollow



Fig. 6 Foliage Leaf-compound pinnate



Fig. 7 Leaf reduced to sheath



Fig. 9 Stamen magnified

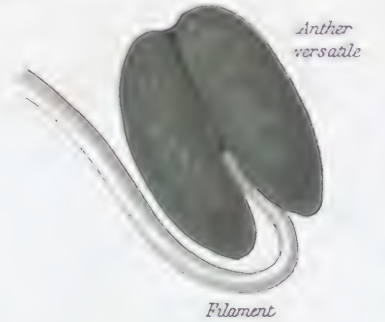


Fig. 8 Bract



Fig. 11 Fruit

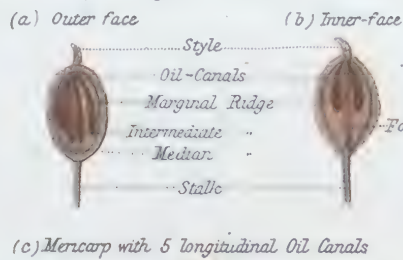


Fig. 12 Seed detached

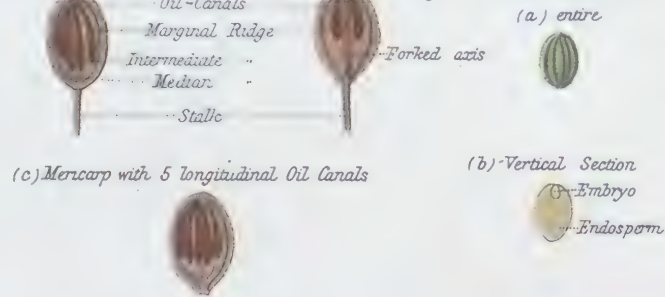


Fig. 13 Embryo detached

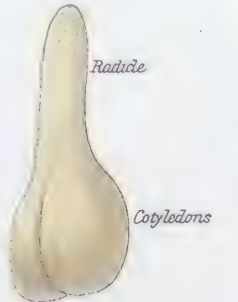
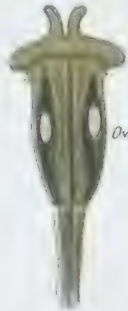
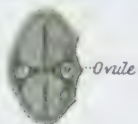


Fig. 10 Ovary

(a) Vertical Section (\*10)



(b) Transverse Section (\*10)





**PLATE XVIII.—COW-PARSNIP or HOGWEED (*Heracleum Sphondylium*).**

(Fig. 8 after Müller.)

Umbellifers are so named from the arrangement of their flowers, their stalks standing out from a central spot like the wires of an umbrella. The Order is a very extensive one—including useful forms, such as Carrots and Parsnips, Celery and Parsley, or poisonous forms, such as Hemlock and Fool's Parsley; and in keeping with this distribution the attractions and inducements held out to insects are neither few nor small. The flowers, though small individually, are associated together in such a way as collectively to present an imposing appearance. Further, the outer flowers of the umbel have their corollas larger and much more developed than those towards the centre; so the outer flowers, with plenty of room to expand, attract insects by their size and thus entice them to visit the less conspicuous flowers in the centre. Not only is there attraction, but there is inducement in the shape of honey. In the centre of each flower is a ring-like disc secreting nectar, which is thus not only central in position but also circular, to admit of free access to it from any and every part of the flower. As a further precaution against self-fertilisation the pollen is shed before the stigmas are ready to receive it.

The Fruit of Umbellifers is very characteristic, and important for purposes of classification, and even the smell of the plant may be of use in the same direction.

**Fig. 1.** Inflorescence—a compound Umbel with numerous rays. The primary umbel usually possesses a few Bracts at its base, and each of the secondary umbels a whorl of bracts.

**Fig. 2a.** Outer flower with the three outer Petals largely developed, and the two inner small.  
**b.** Inner flower with all the Petals equally small.

**Fig. 3.** Flower of Wild Chervil showing the first or Male condition, when the anthers are ripening and the stigmas still undeveloped; and the more advanced or Female condition, when the stamens are gone and the stigmas appear.

**Fig. 4.** Make vertical section of flower, between the two styles, to show insertion of parts.

Sepals, minute teeth arising from ovary.  
Petals, inserted upon ovary.  
Stamens, inserted upon ovary, at the base of disc (not seen in this section).  
Carpels with the flower-stalk prolonged between them.  
Disc, at top of ovary and attached to styles.

*Diagram.*—Calyx of five Sepals, represented by five small teeth.  
Corolla of five free Petals, alternating with the sepals.  
Androecium of five Stamens, alternating with petals.  
Gynoecium of two united Carpels.

**Fig. 5.** Stem—hairy, hollow except at the nodes, and grooved.

**Fig. 6 and 7.** The Foliage-leaves are large, and the leaf-stalk forms a sheath at its base. (Fig. 7 shows a leaf consisting wholly of sheath.)

**Fig. 8.** Bract, small and pointed.

**Fig. 9.** Stamen with curved Filament, attached to the back of the Anther by its tip.

**Fig. 10.** Take an Ovary well-developed, and make a vertical section, cutting through the two styles, and a transverse section in the region of the ovules.

One Ovule in each chamber suspended from the top.

**Fig. 11.** Fruit of two carpels, each containing a seed, and called a Cremocarp (Gr. *cremos*, I suspend). The forked axis in the middle separates and suspends each half of the fruit, which is called a Mericarp (Gr. *meros*, a part).

**a.** Outer face with five ridges and furrows between.

RIDGES— $\left\{ \begin{array}{l} \text{Two Marginal.} \\ \text{Two Intermediate.} \\ \text{One Median.} \end{array} \right.$

FURROWS—In the underlying tissue are the four oil-canals.

**b.** Inner face with two oil-canals.

**c.** Occasionally there are five oil-canals on the outer face, and the fifth furrow is made by the forking of the median ridge.

**Fig. 12.** If a Mericarp is soaked the cover can be easily removed, exposing the Seed. Then the seed can be cut in two, showing the small embryo and large endosperm.

**Fig. 13.** Minute embryo may be turned out of seed with a needle and examined.

**CLASSIFICATION.**

*Class.*—Dicotyledon.

*Division.*—Polypetalæ.

*Sub-division.*—Calycifloræ.

*Order.*—Umbelliferæ.

Stem, hollow except at nodes.

Leaves, sheathing.

Inflorescence, umbellate.

Petals, five, inserted at base of disc.

Stamens, five, incurved, inserted upon the ovary.

Ovary, two-chambered.

Ovules, pendent, one in each carpel

Fruit, dry, indehiscent, separating into two, by the splitting of the longitudinal axis.

Seed with endosperm.



Fig.1 Prickly Stem



Fig.3 Vertical section of Flower

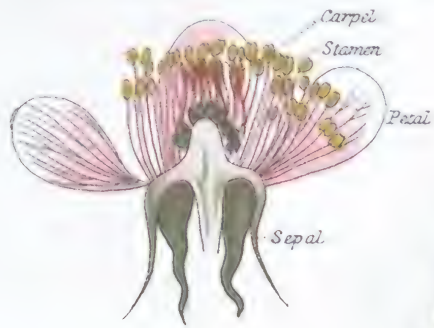


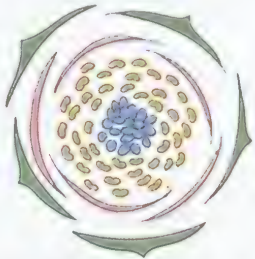
Fig.4 Calyx-lobe



Fig.5 Petal



DIAGRAM Plan of Flower in Bud



Ca 5 Co 5 An ∞ Gn ∞



Fig.2 Leaves becoming simplified as they approach the Flower

Fig.9 Embryo detached



Fig.6 Stamens

a. inner view

b. outer view



Fig.7 Fruit



Fig.8 Fruit-vertical section





**PLATE XIX.—BLACKBERRY or BRAMBLE (*Rubus fruticosus*).**

The Bramble is a straggling and prickly shrub of common occurrence in hedges and woods. It flowers in autumn and produces the well-known fruit. It is very variable in its characters, giving rise to quite a host of sub-species, some even treating these varieties as distinct species. The leaf is very variable and shows all the intermediate gradations from the *simple* leaf to the *compound* leaf of five leaflets. The simple leaf develops two leaflets, and becomes Fig. 2*c*; then the lower leaflets may become lobed, as in Fig. 2*b*, and the division may extend till it reaches the midrib, thus forming five leaflets as in Fig. 2*a*. This passage from the inferior leaves of the stem with five leaflets, through three leaflets, till nearer the flower the simple leaf appears, is very interesting as bearing on the simplicity of the floral leaves.

The Flower is much visited by insects, and the stamens ripen from the outside inwards, so that the stigmas will usually have received their pollen before the inner anthers have opened.

STEM—

**Fig. 1.** Stem with hooked prickles. These Prickles are superficial structures like hairs, but as they are not derived entirely from the epidermis, but from the underlying tissue as well, they are distinguished as Emergences.

LEAF—

**Fig. 2.** Compound Leaves becoming simpler as they approach the flower.

- (a.) Compound digitate leaf with five leaflets.  
Stipules adherent to base of stalk.
- (b.) Leaf with three leaflets, the lower two partly divided.
- (c.) Compound leaf with three leaflets.

FLOWER—

**Fig. 3.** Longitudinal median section of flower.

Receptacle, laterally expanded to support the sepals, petals, and stamens, and produced in the middle to bear the numerous carpels.

Sepals inserted on receptacle.

Petals with narrow base of attachment.

Stamens with minute anthers.

Carpels, seated on the elevated convex Receptacle.

*Diagram.*—In Flower-bud examine the arrangement of sepals and petals by gently separating them with needle, then make transverse section of bud to complete plan.

Calyx of five Sepals with imbricate arrangement.

Corolla of five Petals with imbricate arrangement, and alternating with sepals.

Androecium of numerous Stamens in alternating whorls.

Gynœcium of numerous distinct Carpels.

**Fig. 4.** Sepal continuous with the laterally expanded receptacle.

**Fig. 5.** Petal concave with short and narrow claw and expanded blade.

**Fig. 6.** Stamen with filament expanding into connective.

FRUIT AND SEED—

**Figs. 7 and 8.** Fruit entire and in vertical section.

The Receptacle has elongated and become conical, bearing the numerous fleshy *drupes*. Each little globular drupe has an outer skin or epicarp covering a juicy pulp or mesocarp, enclosing a little stone or endocarp.

Calyx and withered Stamens persist.

**Fig. 9.** Embryo.

CLASSIFICATION.

*Class.*—Dicotyledon.

*Division.*—Polypetalæ.

*Sub-division.*—Calycifloræ.

*Order.*—Rosaceæ.

Leaves, usually stipulate and alternate.

Flowers, regular.

Receptacle, laterally extended.

Petals free, on margin of receptacle.

Stamens free and indefinite usually, also inserted towards margin of receptacle.

Carpels free, one or more.

Seeds without endosperm.



Fig. 1 Sweetbriar ( $\times 10$ )



DIAGRAM of Roseæ



Ca 5 Co 5 An  $\infty$  Gn  $\infty$

Fig. 2 Fruit



Fig. 3 Fruit

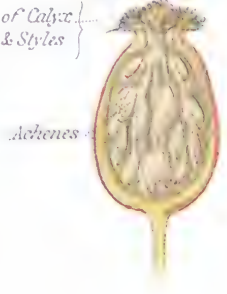


Fig. 4 Strawberry



Fig. 5 Base of Flower



DIAGRAM of Fragariæ



Ca 5. Co 5 An  $\infty$  Gn  $\infty$

Fig. 6 Fruit



Fig. 9 Fruit

(a) Transverse Section



Fig. 7 Spirea-Vertical Section

enlarged

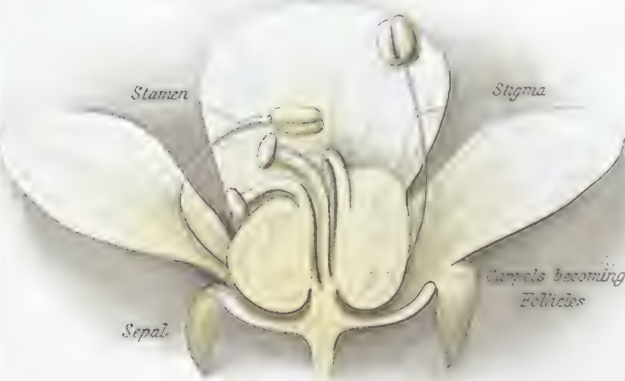


DIAGRAM of Spireæ



Ca 5 Co 5 An 20- $\infty$  Gn 5 or more

(b) Vertical Section

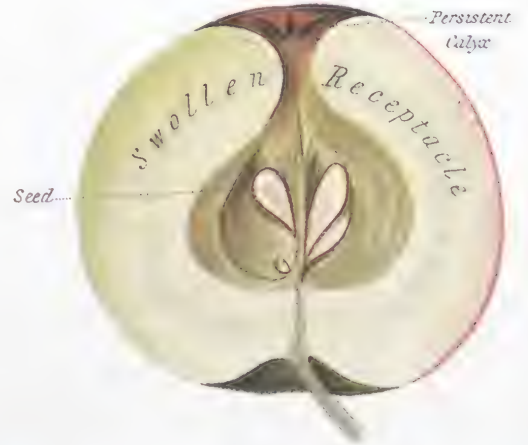


Fig. 8 Apple-Vertical Section



DIAGRAM of Pomeæ



Fig. 11 Fruit-A Drupe



Fig. 12 Fruit-Vertical Section



Fig. 10 Cherry



DIAGRAM of Prunææ



Ca 5. Co 5 An 15-20 Gn 5 or less

Fig. 14 Leaf of Apple-Simple



Fig. 15 Leaf of Rose-Compound



Fig. 16 Rose-bud

Sepals like Compound Leaf

Fig. 13 Lady's Mantle (enlarged)

(a) entire (a) Vertical Section



Ca 5 (or 4) Co 5 (to 0) An 5 more or less Gn 1-4 (Floral Formula of Sanguisorbæ)



PLATE XX.—ROSE, STRAWBERRY, SPIRÆA, APPLE, CHERRY, LADY'S MANTLE.

The large and important Natural Order of the Rosaceæ may be conveniently divided into five Series, based principally upon the number of the Carpels and the nature of the Fruit. There is a sixth Series which is exceptional and peculiar.

I. ROSEÆ.—Type, Dog Rose (*Rosa canina*) or Sweetbrier (*Rosa rubiginosa*).

**Fig. 1.** Sweetbrier Rose in vertical section.

Receptacle, *hollow*. The so-called Calyx-tube is simply the end of the Floral Axis hollowed out to protect the Ovaries, hence the sub-division Calycifloræ was founded on a misconception.  
Sepals, arising from margin of receptacular cup.  
Petals, arising from margin of receptacular cup.  
Stamens, arising from margin of receptacular cup.  
Carpels contained in hollow receptacle, the stigmas projecting beyond it.

*Diagram.*—Calyx of five Sepals.  
Corolla of five Petals.  
Andrœcium of numerous Stamens.  
Gynœcium of numerous Carpels.

**Figs. 2 and 3.** Fruit of Dog Rose entire and in section.

The receptacular cup has become fleshy, and the enclosed single-seeded fruits are Achenes enveloped in hairs.

II. FRAGARIÆ or DRYADEÆ.—Type, Bramble (*Rubus fruticosus*) or Strawberry (*Fragaria vesca*).

**Fig. 4.** Strawberry flower in vertical section.

Receptacle, *convex*.  
Sepals from lateral expansion of receptacle.  
Petals from lateral expansion of receptacle.  
Stamens from lateral expansion of receptacle.  
Carpels, studded over elevated receptacle.

**Fig. 5.** Base of Flower.

The Sepals have Stipules as well as the leaves, and these form an Epicalyx or Calyculus.

*Diagram.*—Calyx of five Sepals.  
Corolla of five Petals.  
Andrœcium of numerous Stamens.  
Gynœcium of numerous Carpels.

**Fig. 6.** Strawberry.

The receptacle has become swollen and succulent and the little Achenes are almost imbedded in it.  
In the Bramble (*Rubus*) the fruits which are little drupes, have become succulent, while the relatively small receptacle is dry.  
In the Silver-weed (*Potentilla*) both fruits and receptacle are dry.

III. SPIRÆACEÆ.—Type, Meadow-sweet (*Spiræa Ulmaria*).

**Fig. 7.** Spiræa in vertical section—with a few Stamens only shown.

Receptacle, a *flat expansion*, slightly raised in the centre.  
Sepals and Petals arising from margin of receptacle.  
Stamens arising from the flat receptacle.  
Carpels, attached to slightly raised central portion of receptacle  
Fruit of five Follicles.

*Diagram.*—Calyx of five Sepals, persistent in fruit.  
Corolla of five Petals.  
Andrœcium of numerous Stamens or reduced to twenty.  
Gynœcium of five Carpels usually, or more.

IV. POMEÆ.—Type, Apple (*Pyrus Malus*).

**Fig. 8.** Apple-flower in vertical section.

Receptacle, hollow and closed at the top.  
Sepals, Petals, and Stamens arising close together  
Carpels, adherent to hollow receptacle.

*Diagram.*—Calyx of five Sepals.  
Corolla of five Petals.  
Andrœcium from fifteen to twenty Stamens.  
Gynœcium, not more than five Carpels.

**Fig. 9.** Apple in transverse and vertical section.

The swollen succulent receptacle has enveloped the five carpels now ripened into fruit, and each has a cartilaginous lining.  
Seeds, two in each carpel, sometimes one aborts.  
Calyx, persistent at the top of receptacle.

V. AMYGDALÆÆ.—Type, Cherry (*Prunus Cerasus*).

**Fig. 10.** Cherry-flower in vertical section.

Receptacle, hollow.  
Sepals, Petals, and Stamens from margin of receptacle.  
Single Carpel in centre.

*Diagram.*—Calyx of five Sepals.  
Corolla of five Petals.  
Andrœcium from ten to twenty Stamens.  
Gynœcium of one Carpel.

**Figs. 11 and 12.** Cherry, a Drupe containing one Seed, enclosed within the innermost stony portion, surrounded by a succulent part, and covered by a skin.



VI. SANGUISORBEÆ.—Lady's Mantle (*Alchemilla vulgaris*).

**Fig. 13.** Lady's Mantle, entire and in section.

Receptacle, hollow.

Calyx of four Sepals with an Epicalyx.

Corolla, absent.

Stamens, four, arising from beneath disc.

Carpel, one.

The members in this Series are very variable, but generally the Carpels are not more than four, and the Stamens are sometimes indefinite.

**Fig. 14.** Simple leaf of Apple with Stipules at the base.

**Fig. 15.** Compound leaf of Rose with leaflets arranged pinnately.

**Fig. 16.** Rose-bud showing the Sepals compound like the leaf, but gradually becoming simpler as they pass inwards to the Petals.

*Summary.*—In the Rose the Carpels are indefinite and one-ovuled, and the receptacular cup becomes fleshy on ripening, forming the well-known Hip. The Anthers and Stigma are mature at the same time.

In the Strawberry the Carpels are still indefinite and one-ovuled, but instead of being in a cup are on an elevation, and the swollen elevated receptacle becomes excessively succulent. Stigma mature before Anthers, hence called Protogynous (Gr. *protos*, first; *gonos*, seed).

In Meadow-sweet the Carpels are reduced to five (sometimes more), and the slightly convex receptacle bears Follicles which contain *several* Seeds and *open* along one face.

In the Apple the Carpels are five (never more) and two-ovuled, enclosed in a receptacular cup which becomes much larger and more succulent than in the Rose. Stigma mature before Anthers.

In the Cherry the Carpels are reduced to their lowest—one, and the Fruit, in the form of a Drupe, has reached its highest perfection. The exquisitely coloured and delicately flavoured Peaches and Prunes, Plums and Cherries, are objects of attraction to various animals, and when eaten the seed protected by its stone is deposited under the most favourable conditions as to warmth, moisture, nutriment, etc. Stigma and Anthers mature at same time.



Fig. 1 Acacia flower magnified



DIAGRAM I Plan of Flower

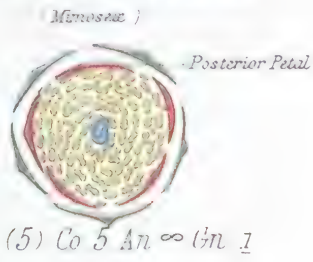


Fig. 2 Cassia flower



DIAGRAM II Plan of Flower

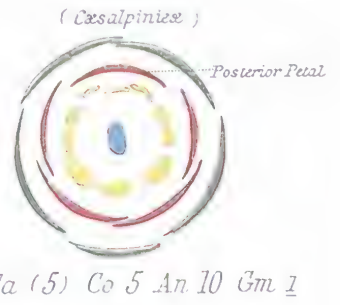


Fig. 3 Compound Leaf of Sweet Pea ending in Tendrils



Fig. 5 Vertical section of Flower

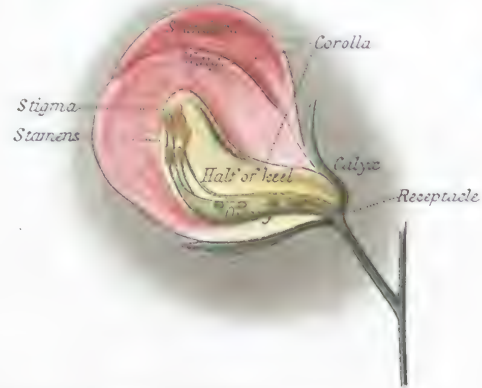


DIAGRAM III Plan of Flower

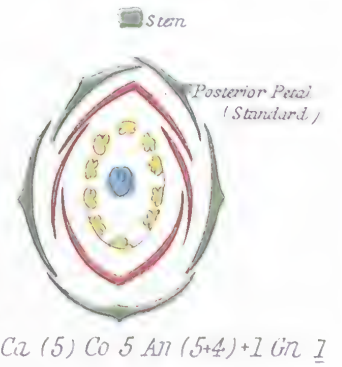


Fig. 4 Side view of Flower



Fig. 7 Stamens-diadelphous



Fig. 6 Petals



c. Keel split up & spread out

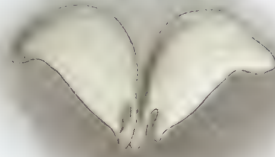


Fig. 11 Germination of Sweet Pea



Fig. 8 Fruit - a Legume



Fig. 9 Garden Pea

a with integument b. One Cotyledon seen from inside

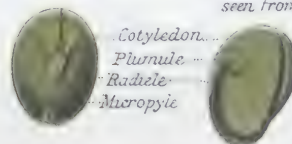


Fig. 10 Sweet Pea





**PLATE XXI.—LEGUMINOSÆ—SWEET PEA (*Lathyrus odorata*), principally.**

This large and important Order is only known to us in Britain as having irregular butterfly-shaped flowers, but in tropical regions the flower assumes a more or less regular form. The Order is thus capable of division into sections:—1. Mimoseæ—represented by Acacia, or Mimosa—the Sensitive Plant, having regular flowers; 2. Cæsalpinieæ—represented by Cassia—having irregular flowers but not butterflyed; and 3. Papilionaceæ—our British representatives—having flowers of the well-known Pea type, with a corolla fancifully resembling a butterfly, hence called *papilionaceous*.

The action of insects alighting on the Pea flower, for instance, may be imitated by pressing down the wings, and the keel goes along with them, thereby exposing the anthers and stigma.

MIMOSEÆ.—Flower, regular. Petals, valvate. Stamens, definite or indefinite.

**Fig. 1. and Diagram I.**—Calyx of five united Sepals.  
Corolla of five Petals.  
Andrœcium of numerous free Stamens.  
Gynœcium of one Carpel.

CÆSALPINIÆ.—Flower, irregular. Petals, imbricate. Stamens, definite.

**Fig. 2. and Diagram II.**—Calyx of five free Sepals.  
Corolla of five free Petals.  
Andrœcium of ten or less free Stamens.  
Gynœcium of one Carpel.

PAPILIONACEÆ.—Flower, irregular. Petals, imbricate.

**Fig. 3.** Compound leaf with Stipules which arise from the base of leaf-stalk and not from stem.  
There are two ordinary leaflets, then the next pair are modified into coiled *tendrils*, and the end of the leaf-stalk is prolonged into branching tendrils.  
Here the leaf or part of it is modified into an organ of support, enabling the weak stem to ascend.

**Fig. 4.** The Pea flower in its natural position, presents its standard to the breeze, so that it may act as a fluttering flag to attract insects, and as a shelter to the more delicate inner parts. But when an insect alights on the Wings which are of the nature of a platform, the wings and keel are depressed, and the anthers and stigma are exposed, but return again to their old position when the pressure is removed. The insect, while searching for pollen or nectar in the staminal tube, will undoubtedly carry away some pollen amongst its hairs and leave it on visiting other flowers.

**Fig. 5.** Cut the flower in two from the base upwards.  
Sepals, united about half-way down and inserted on receptacle.  
Petals—Standard is towards the main floral axis and therefore *dorsal* in position.  
Wings, one on each side, therefore *lateral* in position.  
Keel, of two partially united petals, is away from the main floral axis and therefore *ventral* in position.  
Stamens, one free, rest united into a tube.  
Carpel in the middle, arising from receptacle.

**Diagram III.**—Calyx of five united Sepals.  
Corolla of five Petals. Dorsal petal or Standard overlaps the rest in bud.  
Andrœcium of ten Stamens—dorsal stamen free, other nine united.  
Gynœcium of one Carpel, and the Ovules are out-growths from its margins.

**Fig. 6.** Petals of unequal size and shape.  
(a.) Standard laterally expanded, and tightly clasping rest of flower at base.  
(b.) Wing with interlocking processes at base for keel.  
(c.) Keel in natural position enclosing Stamens and Carpel, and forming a tight fit with keel.

**Fig. 7.** Stamens.  
Filaments united for the greater part of their length into a Staminal tube.  
Dorsal filament free to about base.

**Fig. 8.** Fruit—a Pod or Legume, from which the Order derives its name.  
The Calyx still persists, also the slender Style and even the withered Stamens.

**Figs. 9 and 10.** Steep some peas for a night in water, when they may be conveniently examined.  
On the outer surface of Sweet Pea observe elongated *scar* in the centre indicating its point of attachment inside the fruit, a small opening below, through which moisture can be squeezed, indicating the *micropyle*.  
In section of Garden Pea observe that when the skin is removed nothing is left but the Embryo consisting of  
Stem-bud or Plumule.  
Primary root or Radicle pointing towards micropyle.  
Seed-leaves or Cotyledons.

**Fig. 11.** Germination.  
The Radicle has elongated, producing the primary root or Tap-root, with its Rootlets.  
The Plumule also grows upwards, producing at first the insignificant small leaves gradually growing larger as you ascend the stem.

CLASSIFICATION OF SWEET PEA.

*Class.*—Dicotyledon.  
*Division.*—Polypetalæ.  
*Sub-division.*—Calycifloræ.  
*Order.*—Leguminosæ.  
Leaves, usually compound and stipulate.  
Flower, irregular.  
Corolla, papilionaceous.  
Stamens, ten.  
Carpel, superior and solitary.  
Fruit, generally a Legume.  
Seed, without endosperm.



Fig.1 Inflorescence-a Sessile Umbel & Leaves-radical



Fig.4 Pollen-grains

(a) From Long styled Flower (b) From short styled Flower



Fig.5 Vertical section of Ovary



Fig.2 Long-styled form of Flower

(a.) Upper View

Fig.3 Short-styled form of Flower

(a.) Upper View

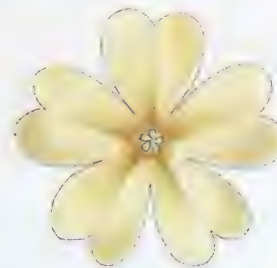
Fig.6 Fruit-a Capsule



Fig.8 Inflorescence a Raceme



(b) Vertical section



(b) Vertical section

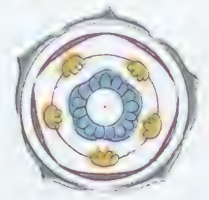
Fig.7 Seed-vertical section



Stigma  
Anthers  
Style  
Ovary



DIAGRAM I Plan of Flower



Ca (5) Co (5) An 0+5 Gn (5)

Fig.9 Flower



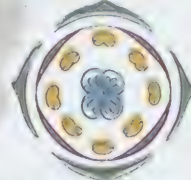
Fig.10 Vertical Section of Flower



Fig.11 Vertical Section of Rhododendron



DIAGRAM II Plan of Flower



Ca 4 Co (4) An 4+4 Gn (4)

Fig.12 Ovary transverse section



Fig.13 Fruit of Rhododendron





**PLATE XXII.—PRIMROSE (*Primula vulgaris*) and HEATH (*Erica*).**

**Primrose.**

The Primrose might be dismissed with the convenient expression, "too well known to need description;" but, although certainly known, it by no means follows that it is generally understood and appreciated, for in it there is to be seen a wonderful adaptation of means to ends, which Darwin was the first thoroughly to appreciate and to explain. If the flowers are examined on several different plants it will be found that they vary: those on one plant having the knob-headed stigma at the entrance to the corolla-tube, and those on another having the stamens in that position. These two different forms of flowers are respectively called Long-styled and Short-styled. A glance at Fig. 2 will show that an insect visiting the long-styled flower, and thrusting its proboscis down the tube, will carry away pollen so placed that, on visiting a short-styled flower, it will come in contact with the stigma, and thus ensure cross-fertilisation. Reversing the order of its visit, from short-styled to long-styled, the insect would still produce the same effect.

The Pollen-grains, too (Fig. 4), are adapted for their respective duties. In the long-styled flower they are smallest because they are intended to be transferred to the stigma of the short-styled flower, and so have to produce a shorter pollen-tube than the other.

The Primrose appears in early spring (*Primula*, from Lat. *primus*, first) at a time when insect life is still scarce; and yet so perfect is the adaptation of its various parts to secure cross-fertilisation—with the minimum of waste, so attractive is its flower and scent, and so well-chosen its situation on sloping bank or sheltered glade that it not only manages to thrive, but often overspreads the hedge-bank with its blossoms like so many golden stars.

**Fig. 1.** Form and Habit of the plant.

The wrinkled Leaves stand out from the base in radiating fashion, and the Flowers also radiate from a centre, having long flower-stalks. Here the Umbel is sessile, but in Cowslip it is stalked.

**Figs. 2 and 3.** Slit up a Long-styled and Short-styled form of flower from the base, and compare them.  
Stigma of one about the same height as the Anthers of another.

**Fig. 4.** Dust pollen on slides from the Anthers of the respective flowers, and observe different relative size in each case.

**Fig. 5.** Vertical section of Ovary, showing a free central column, to which the Ovules are attached.

**Fig. 6.** Fruit—met with in July.

Capsule of five valves opening by ten teeth, and containing numerous Seeds.

**Fig. 7.** Seed halved.

Seed-cover raised into little elevations.  
Embryo surrounded by Endosperm.

**CLASSIFICATION.**

*Class.*—Dicotyledon.

*Division.*—Gamopetalæ.

Calyx and Corolla present.  
Petals, united.

*Order.*—Primulaceæ.

Corolla, regular.  
Stamens, attached to corolla-tube, *opposite* petals.  
Ovary, superior, one-chambered.  
Ovules, numerous; Placentation, free-central.  
Fruit, capsular.  
Seed with endosperm.

**Heath.**

Heath is sufficiently common to give its name to large tracts of country where it protects the surface of otherwise barren wastes. It flowers during the summer months, when its modest bloom delights the eye and

"sheds beauty o'er the lonely moor."

Heather (*Calluna*) blooms in autumn, and the flower differs from that of Heath (*Erica*), principally in the Calyx being longer than the Corolla, and having four bracts at its base. Rhododendron is a well-known allied ornamental shrub, with large and showy flowers.

**Fig. 8.** Form and Habit of the plant.

The Stem is upright and much branched. The Leaves are in close-set whorls of four, and the Flowers are arranged in crowded racemes.

**Figs. 9 and 10.** Flower entire and in section.

Calyx of four sepals and coloured.  
Corolla is bell-shaped, with four broad lobes.  
Stamens, eight; anthers outside of corolla tube, and each opening by two pores.  
Carpels, four, united, with Style projecting beyond anthers.

**Fig. 11.** Flower of Rhododendron in section.

Calyx, represented only by minute teeth.  
Corolla of five lobes, deciduous and irregular.  
Stamens, ten.  
Carpels, five, united.

*Diagram II.*—Calyx of four Sepals.

Corolla of four united Petals.  
Andrœcium of eight Stamens, four opposite to sepals and four opposite to petals.  
Gynœcium of four united Carpels.

**Fig. 12.** Transverse section of Ovary.

The Ovary is divided into four chambers, with numerous Ovules in each, springing from the Axis.

**Fig. 13.** Fruit of Rhododendron—a Capsule.

The Carpels separate in the form of five Valves, the sides of which are formed by the split septa. In Heather the Capsule splits similarly, but is four-valved; while in Heath the splitting of the valves takes place along the *midrib* of each carpellary leaf.



CLASSIFICATION.

*Class.*—Dicotyledon

*Division.*—Gamopetalæ.

*Order.*—Ericaceæ.

Corolla, regular.

Stamens, free from corolla.

Ovary, superior, many-chambered.

Ovules, usually numerous; placentation, axile.

Fruit, capsular or berried.

Seed with endosperm.



Fig.1 Square Stem & opposite Leaves



DIAGRAM Plan of Flower



Ca.(5) Co.(5) An. 4 Gn.(2)

Fig.5 Gynœcium detached (\*10)



Fig.4 Stamen from unopened flower

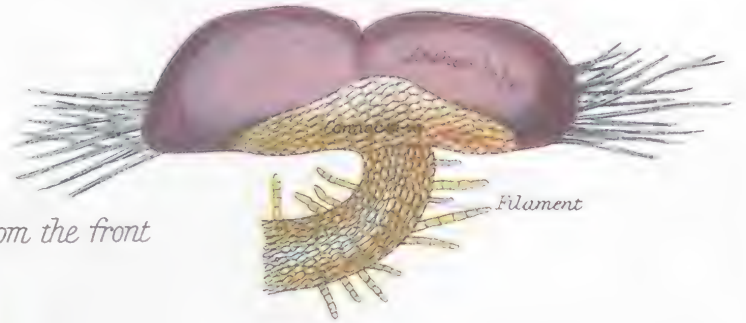


Fig.2 Vertical section of Flower



Fig.3 Flower opened up from the front

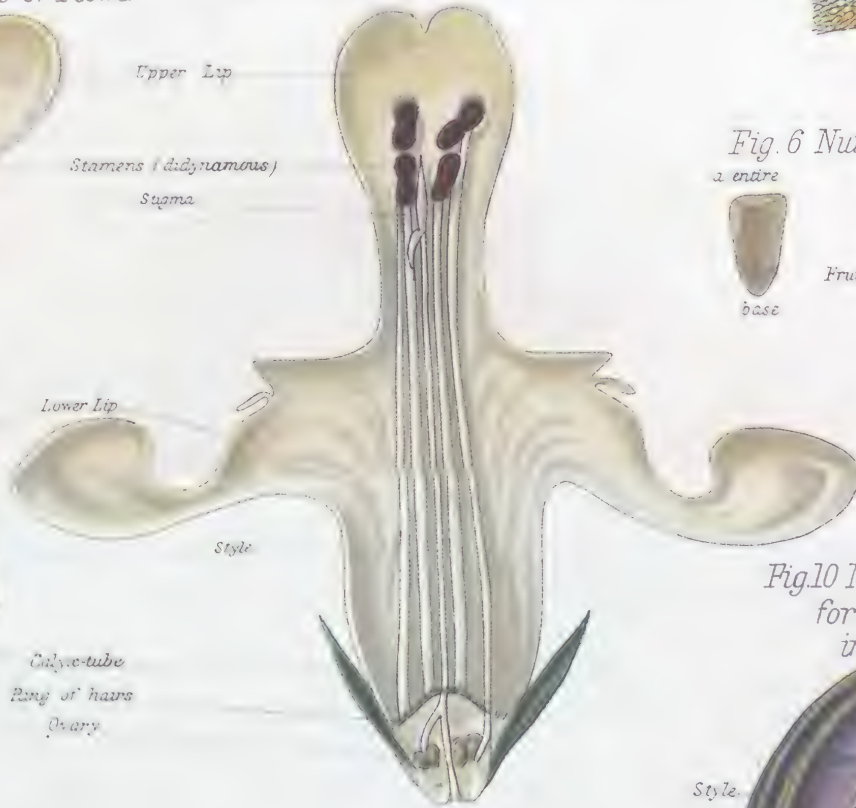


Fig.6 Nutlet

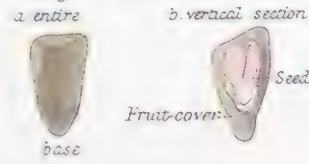


Fig.7 Embryo removed



Fig.10 Mechanical contrivances for cross fertilisation in S. sclarea

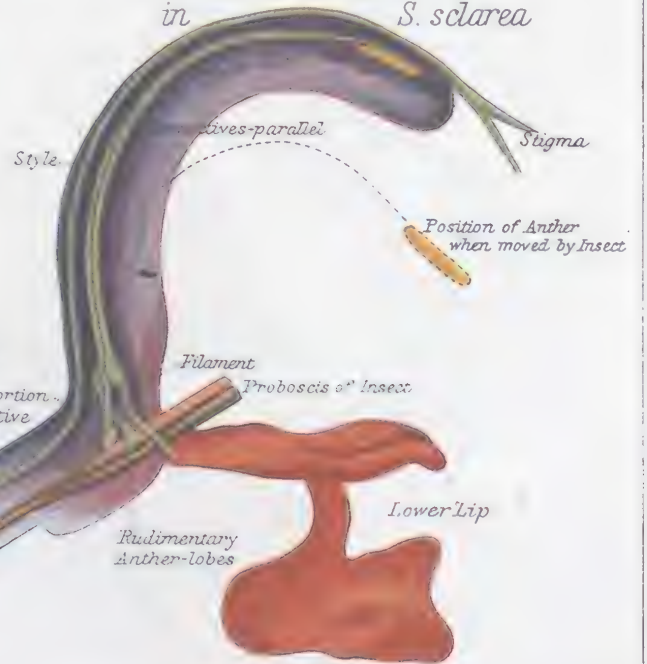
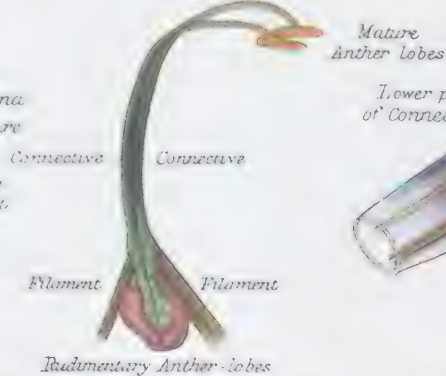


Fig.8 S. pratensis - side view



Fig.9 Stamens of S. pratensis oblique front view





## PLATE XXIII.—WHITE DEAD-NETTLE (*Lamium album*) and SAGE (*Salvia*).

(Figures of Sage from Dodel-Port, after H. Müller.)

### Dead-nettle.

The common white Dead-nettle owes, no doubt, much of its widespread character to the perfect adaptation of its structure to fertilisation by insects. The contrivances for ensuring cross-fertilisation will now be glanced at. The lower lip of the corolla is expanded, thus forming a platform for insects. The upper lip arches over the stamens like an umbrella, protecting them from rain, and preventing the pollen from being carried away, at the same time sheltering the tube of the corolla, at the base of which lies the honey. The ring of upwardly directed hairs near the bottom of the tube will exclude small insects from the honey. The stamens are arranged in parallel series of different lengths, and thus the pollen is not widely dusted over the insect's body, but confined to parts where it will most easily come in contact with the stigma. The stigma, too, hangs down beneath the anthers, and the stigmatic surface is turned outwards, so that any of the flower's own pollen falling down, will only fall upon the back of it, and produce no effect.

When an insect visits a flower of this construction, it alights upon the platform, attracted by the white flowers peeping out from the green foliage; and as it wedges its head into the tube for honey, the pollen on its back is sure to brush against the under surface of the stigma. As the stigma lies lower than the anthers, it will come against it first, and so leave the foreign pollen upon it. When backing out, the insect will receive a fresh coating of pollen from the stamens, and be ready to repeat the process over again on the next flower it visits.

#### STEM, LEAVES, AND FLOWERS—

**Fig. 1.** Stem, square.

Leaves, opposite, and alternately on opposite sides of the square stem.

**Figs. 2 and 3.** Flowers in the axils of leaves; the tufts in each axil being a dichotomous cyme condensed.

With a pair of scissors slit up the front face of the flower, that is, the ventral surface, and lay out the parts so as to display interior.

Sepals, separating from each other about half way into long, thin points.

Petals, upper lip notched; lower lip with central lobe, and a little tooth at each side.

Stamens, attached to throat of corolla, but their fibro-vascular cords may be traced to the base, and thus their relative position to the other parts of the flower fixed.

Carpels, with forked stigma; the stigmatic surface turned away from the Anthers.

#### Diagram.—Plan of Flower—

Calyx, bell-shaped, of five united Sepals—one dorsal, two lateral, and two ventral.

Corolla, two-lipped; upper lip of two united Petals, and lower lip of three (the upper lip is divided in the Ground Ivy, and the little teeth of the lower lip are known in some flowers to grow out into regular lobes; hence, from this and their alternating position, the two lips together are considered five united Petals).

Andrœcium, of four Stamens; two long and two a little shorter (in some instances a fifth rudimentary stamen is found).

Gynœcium, of two united Carpels.

#### FLORAL-LEAVES—

**Fig. 4.** Stamen, showing filament expanding into connective.

**Fig. 5.** Gynœcium.

The ovary is four-lobed, and this might be taken as indicating four Carpels without an explanation. There are really two carpels, as denoted by the bifid stigma, which meet by their edges in the middle, and each carpel bears two ovules, thus making four altogether. The midrib of each carpel grows out towards the centre, and becomes attached to it, thus making the double chamber into four. Then the dorsal side of each carpel, that is, the midrib portion, grows excessively, so that the style becomes sunk in the middle, and apparently rises from the *base* of the ovary.

#### FRUIT AND SEED—

**Fig. 6.** Fruit, consists of four little Nutlets.

Seed, entirely taken up with Embryo.

**Fig. 7.** Embryo, removed and enlarged.

### Sage.

**Figs. 8, 9, and 10.** In Sage, the *contrivances* for cross-fertilisation are carried to even a higher degree of perfection than in Dead-nettle, as the amount of fertilising material at command is less, there being only two stamens. The Figures will show the arrangement of the parts better than any description, and a brief explanation will suffice.

In Dead-nettle the two Anther-lobes were obliquely divided, but in Sage they are completely separated (Fig. 9). The Connective diverges to such an extent that this separation takes place, and the upper anther-lobe only bears pollen, while the lower is rudimentary and a mere pad. An insect visiting the flower (as in Fig. 9) strikes against this lower rudimentary lobe, and the upper anther-lobe swings round, dusting the insect's back with pollen. As an effectual preventative against self-fertilisation, the anthers are mature before the stigmas are ready, and on ripening the stigmas come to occupy the position formerly held by the anther-lobes, so that an insect carrying the pollen from one flower will leave it on the stigma of another. In the Dead-nettle, which even flowers in winter and early spring, when insects are either scarce or absent, the stamens may curve round and come in contact with the stigma, as has actually been observed. Here self-fertilisation does sometimes occur, but in the Sage that is impossible.

### CLASSIFICATION.

*Class.*—Dicotyledon.

*Division.*—Gamopetalæ.

*Order.*—Labiatae.

Stem, square.

Leaves, opposite.

Inflorescence, condensed cymes.

Corolla, two-lipped.

Stamens, two long and two short.

Carpels with four-lobed Ovary and bifid Style.

Ovules, one in each lobe.

Fruit, of four little Nutlets.

Seed, without endosperm.



Fig. 1 Inflorescence - A Raceme



Fig. 2 Longitudinal Section of Flower

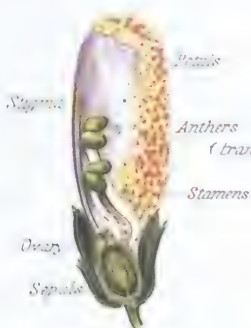


Fig. 3 Anthers opened



Fig. 4 Foliage Leaves



Fig. 5 Sepal



Fig. 6 Transverse Section of Ovary



DIAGRAM II Plan of Flower



Fig. 8 Fruit (a) Natural Size



(b) Longitudinal Section



Fig. 9 Fruit - A Capsule



Fig. 10 Fruit-transverse section



Fig. 11 Seed - Vertical Section



Fig. 12 Seed of Snapdragon





## PLATE XXIV.—FOX-GLOVE (*Digitalis purpurea*).

The purple Fox-glove is a well-known plant, coming into flower about June, and occurring usually on the rough and rugged slopes of the hill-sides. The shape of the flower has suggested both the common and the scientific name. Folk's-glove has reference to its resemblance to the finger of a glove, and *Digitalis* (Lat. *digitus*, a finger) implies the same. The leaves are used in medicine, and the flowers are adapted for insect-visitation. The Anthers ripen first, and in doing so change from a transverse to a longitudinal position, thus enabling the bee as it enters the bell to carry off the pollen, spread over a larger linear surface of its body.

There are several members of the same Order equally well-known and cultivated, such as Snapdragon, Musk, and Calceolaria, while the Speedwells, usually blue, are among the commonest of spring, summer, and even autumn flowers.

### LEAVES AND FLOWERS—

**Fig. 1.** Inflorescence—a Raceme, and each flower in the axil of a bract.

The unopened flowers towards the top are more or less of a whitish colour, and occasionally the mature flower remains white. It is no uncommon thing to find the axis, under cultivation, terminated by a flower which, under these circumstances, develops its lobes at the margin of the bell regularly, and not irregularly, as in the lateral flower.

**Fig. 2.** Take a flower with the lips still closed, and make a longitudinal section, cutting from the base upwards.

Sepals, inserted on receptacle.

Petals, inserted on receptacle.

Stamens, attached to corolla, but traceable to their attachment beneath ovary. The filaments are bent, and the unopened anthers lie transverse to the filaments.

Ovary, superior, with a long style lying close to the petals.

**Fig. 3.** Take a fully expanded flower and lay open Corolla.

Anthers are now open, and instead of being transverse they are longitudinal.

*Diagram I.*—Calyx of five Sepals, unequal in size and united at base.

Corolla of five united Petals, the upper lip being slightly notched in the middle, representing two petals, and the lower lip three-lobed, representing three petals.

Andrœcium of four Stamens, two long and two short. A rudimentary fifth stamen is found in the Snapdragon, sometimes developing into a complete one.

Gynœcium of two united Carpels, as indicated by the two-lobed stigma.

**Fig. 4.** Foliage Leaves, long-stalked towards the root, becoming sessile higher up. Bracts leafy.

**Fig. 5.** Sepal, or Calyx-lobe, broad base and pointed tip.

**Fig. 6.** Transverse section of Ovary (mounted in glycerine).

There are two chambers, and a central axis between, to which the numerous Ovules are attached.

The united edges of the two carpellary leaves form the swollen axis, so that the Placentation is axile.

**Fig. 7, and Diagram II.**—Speedwell, or Veronica, shows a reduction in the number of parts.

Calyx of four Sepals, the posterior one being suppressed.

Corolla of four Petals, united at the base, so as to form what is called a rotate corolla. The lower lip is three-lobed, and the upper lip undivided.

Stamens reduced to two.

Carpels, two united.

### FRUIT AND SEED—

**Fig. 8.** Fruit of Speedwell entire, and in vertical section.

Capsule is laterally compressed, the seeds are attached to a central axis and the two valves separate to allow seeds to escape.

**Figs. 9 and 10.** Fruit of Fox-glove entire, and in transverse section.

Capsule is pear-shaped, and the two valves separate by splitting from the top downwards.

**Fig. 11.** Seed in vertical section.

The embryo occupies the axis of the seed, and is surrounded by Endosperm.

**Fig. 12.** The Capsule of Snapdragon opens by pores, and the Seeds are curiously marked with depressions, surrounded by walls with jagged surfaces.

### CLASSIFICATION.

*Class.*—Dicotyledon

*Division.*—Gamopetalæ.

*Order.*—Scrophulariaceæ.

Corolla, irregular.

Stamens, four, two long and two short; sometimes two.

Ovary, superior, two-chambered.

Ovules, numerous; placentation, axile.

Fruit, capsular.

Seed with endosperm.



Daisy (Figs 1-5) Dandelion (Figs 6-14)

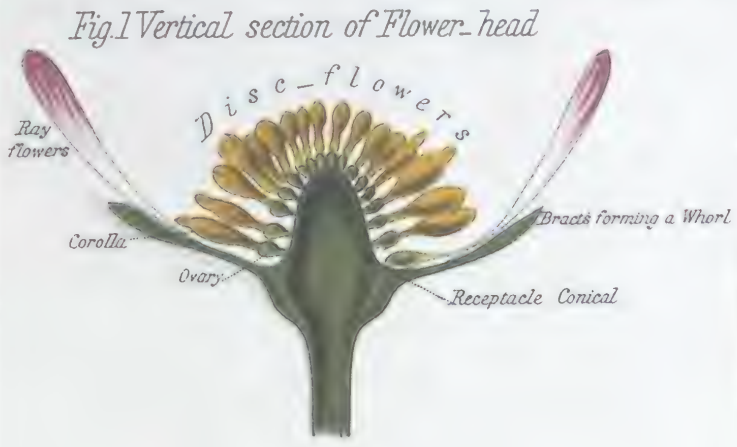


Fig. 1 Vertical section of Flower-head

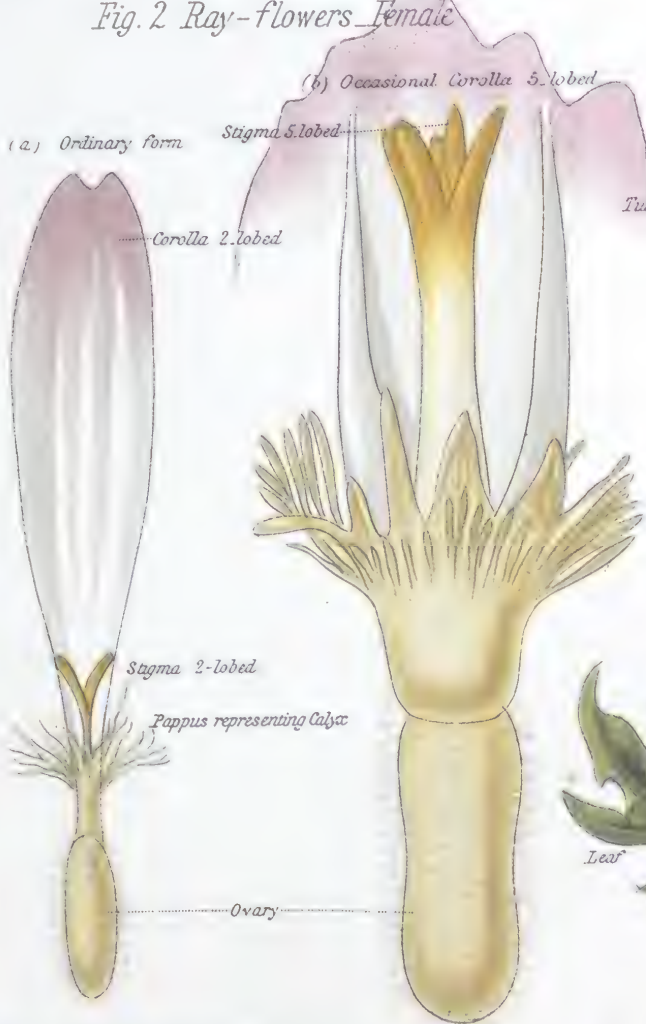


Fig. 2 Ray-flowers Female

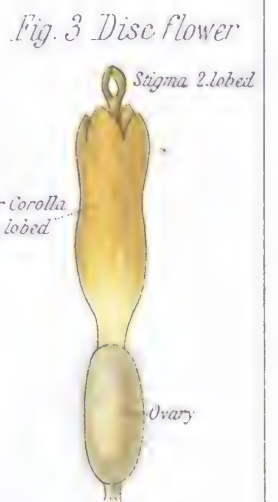


Fig. 3 Disc flower



Fig. 4 Disc flower opened up

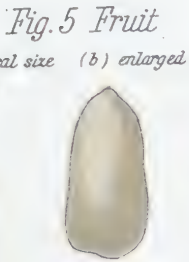


Fig. 5 Fruit

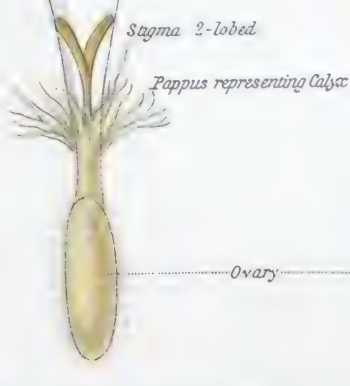


Fig. 6 Unopened Flower head



Fig. 7 Vertical section of Flower-head

Fig. 8 Flowers

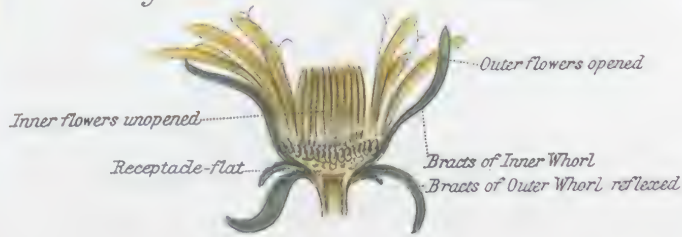


Fig. 9 Single Ovule detached

(b) Occasional on stalk



Fig. 10 Fruit

Fig. 11 Fruit (x10)



Fig. 12 Vertical Section of Fruit

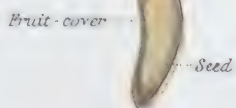


Fig. 13 Foliage Leaves

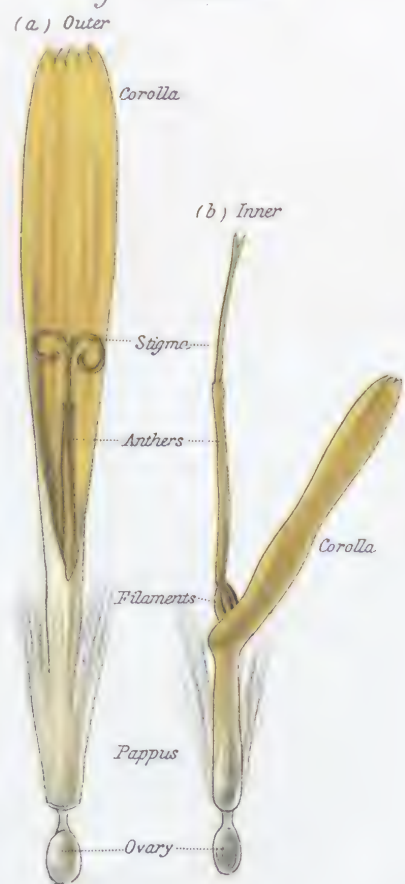


Fig. 14 Bracts

(a) Outer (b) Inner (c) Erect



**PLATE XXV.—DAISY (*Bellis perennis*) and DANDELION (*Taraxacum dens-leonis*).**

The Daisy and Dandelion are the commonest representatives of a Natural Order which is the largest known, and universal in its distribution. The flowers are arranged in great numbers side by side on the extremity of a stalk—flattened or conical—and from having such compound heads of flowers, they are reckoned composite plants or *Compositæ*. The large numbers and wide distribution of this Order are associated with a condensation of parts carried to its greatest possible extent. Not only are the flowers, as a whole, as closely packed as possible into a Head, but the individual flowers have their various parts bound together in closest union. This compactness gives a completeness to the whole for insect-fertilisation, inasmuch as a number of flowers are likely to be fertilised by one visit of the insect.

The Daisy and Dandelion are types of the two great divisions of this Order—the Daisy having tubular flowers, except the outer row, and a watery juice; while the Dandelion has strap-shaped or ligulate flowers and a milky juice.

**Daisy.**

**Fig. 1.** Slit up a Flower-head from its base upwards.

Flowers, sessile, on a common Receptacle which is conical.

Bracts, forming a single whorl.

The outer Flowers are strap-shaped and constitute the Ray, while the inner are tubular and form the Disc.

The flowers open from the outside inwards, so that the youngest are towards the centre.

**Fig. 2.** Detach a single flower from the Ray, and magnify it.

(a.) Ordinary form, magnified.

(b.) Occasional form, more highly magnified.

Calyx may be represented by a short tuft of hairs called the Pappus.

Corolla, in one piece, tubular at the base, gradually flattening out, and ending in two small lobes. In some,

however, there are distinct indications of five small lobes, thus showing the five-fold nature of the corolla.

Stamens, absent.

Gynœcium of two united Carpels, as indicated by the bi-lobed stigma; but in the flower with five-lobed corolla, the stigma was also five-lobed. The Ovary is elongated.

The Ray-flower is thus seen to be Female, and consists of a probable remnant of a Calyx, a Corolla of five united Petals, and a Gynœcium of five united Carpels.

**Fig. 3.** Remove a flower from the Disc, and magnify it.

The Corolla is tubular and distinctly five-lobed, usually, and the Stigma is two-lobed; but there are no hairs crowning the Ovary.

**Fig. 4.** Open up tubular Corolla with dissecting needle, and spread it out as much as possible.

The flower is now seen to be bi-sexual.

The Stamens have short Filaments attached to corolla, and the Anthers are united so as to form a tube round the style.

**Fig. 5.** Look for specimens without Ray-flowers, with much enlarged common Receptacle studded over with small Fruits, or possibly lying in the cup-like whorl of bracts.

(a, b.) Fruit is an Achene, as on examination it will be found to be one-seeded, dry, and does not open.

**Dandelion.**

**Fig. 6.** Flower-head unopened, with portion of Stalk.

The stalk is usually leafless, but sometimes bears a reduced one.

There is an outer set of recurved bracts, and an inner upright set.

**Fig. 7.** Flower-head slit up.

Common Receptacle is a flat expansion of a hollow stalk.

Flowers are all strap-shaped, and the outer open first.

**Fig. 8.** Detach an outer mature flower and an inner less mature flower.

(a.) Calyx, represented by Pappus, well-developed.

Corolla with five distinct teeth.

Stamens with short Filaments, and long Anthers united to form a tube.

Gynœcium of two united Carpels, the lobes of the Stigma curling over and fertilising themselves, if insect should fail to do so.

(b.) At this stage the Stigma projects beyond the Corolla, and has mere indications of two lobes.

**Fig. 9.** Carefully remove the wall of the Ovary with needles, and expose single Ovule.

**Figs. 10 and 11.** The Fruit is very unlike that of the Daisy, in being conspicuous, and having a stalk bearing a tuft of hairs.

These hairs catch the faintest breath of wind, and so disperse the fruit.

**Fig. 12.** Cut the fruit in two, and expose seed.

There is one seed filling up the cavity, without endosperm.

**Fig. 13.** The ordinary Foliage-leaf is deeply segmented, the apex of the triangular segments pointing downwards.

The occasional Leaf on Stalk is much smaller, less segmented, and altogether simpler.

**Fig. 14.** The bracts may be traced through all gradations from a lobed leaf, as on stalk, till next the flower it becomes thoroughly simple, and even some of the petals are intermediate between bract and petal.

**CLASSIFICATION.**

*Class.*—Dicotyledon.

*Division.*—Gamopetalæ.

*Order.*—Compositæ.

Flowers, sessile, and in heads.

Corolla, in one piece, ligulate or tubular.

Stamens, epipetalous; anthers forming a tube.

Ovary, inferior, with one Ovule.

Fruit, an achene.

Seed without endosperm.



Fig. 5 Flowering Stem of Bladderwort



Fig. 6 Flower front view



Fig. 1 Roots of Mistletoe penetrating Branch of Fir



Fig. 2 Male Inflorescence (x10)



Fig. 9 Butterwort in flower



Fig. 3 Female Inflorescence (x10)



Fig. 13 Sundew in flower



Fig. 4 Fruit Vertical Section



Fig. 7 Young Leaf with Bladders



Fig. 11 Leaf detached



Fig. 10 Flower dorsal view



Fig. 8 Bladder in Vertical Section (x22)

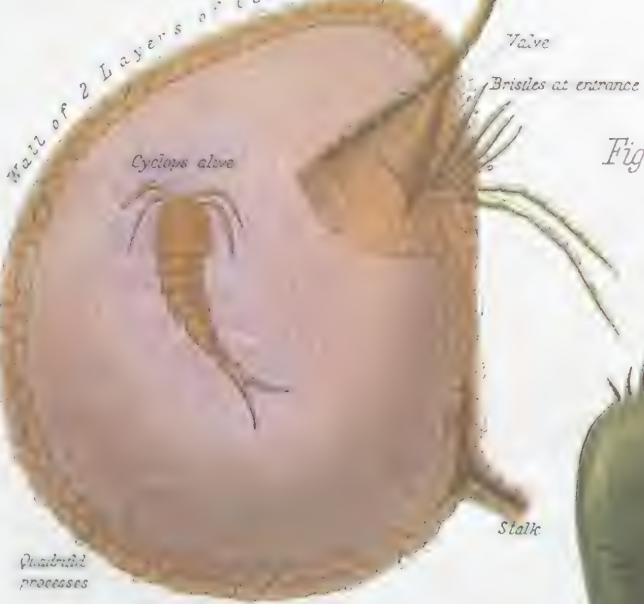


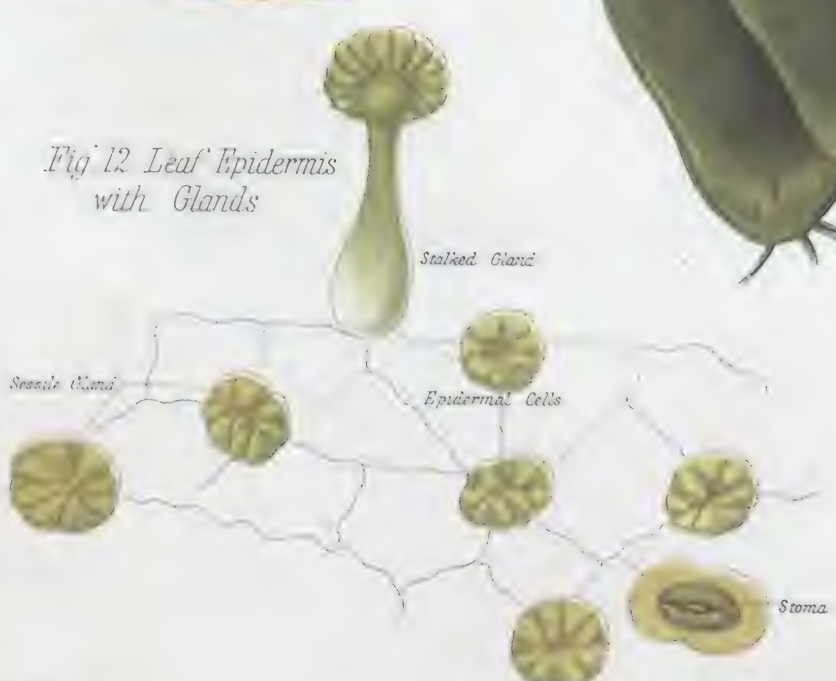
Fig. 15 Antenna of Insect caught by a Gland



Fig. 14 Leaf enlarged



Fig. 12 Leaf Epidermis with Glands





## PLATE XXVI.—PARASITES AND INSECTIVOROUS PLANTS.

In a work dealing with typical forms of plant-life it would be unpardonable entirely to overlook the subjects of the present Plate. They are not treated, however, with great fulness, because the object in view was rather to call attention to them, than to make a detailed study of them. I have endeavoured to represent them in such a way that they may be easily recognised when met with, and carefully examined.

In the case of Insectivorous Plants, students often either do not know them or overlook them from their relatively small size. They are accustomed to such magnified drawings and have such exalted notions of Traps, Tentacles, and Bladders, that the little Sundew of our moors, for instance, is hardly within their range of vision. To obviate this, each plant or a conspicuous portion of the plant is given in its natural size. The three British genera here figured were all obtained from around Edinburgh—Sundew from the neighbourhood of Balerno, and Butterwort and Bladderwort from Gullane—and the little that is given about them may tempt the student to seek further information in the late Mr Darwin's well-known work on "Insectivorous Plants."

The mode of Nutrition is the principal thing to be noted in each case, and it will be seen that not merely living and decayed vegetable matter may be absorbed by plants, but even *digestion* and absorption of living and decayed animal matter can be accomplished.

### Mistletoe (*Viscum album*).

The MISTLETOE with its berried Fruit is a familiar object at Christmas-time, but it is in summer that the Flower is met with. It is parasitic on trees, such as the Apple and Hawthorn, but rarely on the Oak. The berries are used for making bird-lime, hence the name of the plant *Viscum* (Lat. *viscus*, bird-lime). The seeds are often sown on the branches of trees by birds, which eat the fruit for the sake of its succulent and viscid cover, and afterwards cleaning their bill, leave the seed behind sticking to the tree. The seed begins to germinate generally after it has slipped round to the under surface of the branch, and puts forth rootlets which bore through the bark and pass towards the centre along the softest parts—the medullary rays. It thus becomes blended with the tissues of the plant on which it grows, and by means of this organic connection feeds upon it, frequently killing the branch on which it has settled. The Mistletoe is a parasite which does not live wholly at the expense of others, but does something for itself by means of its green leaves. The Dodder (*Cuscuta*), however, produces no leaves, not even seed-leaves, but twines round its host—such as the Clover—and sucks the substance out of it. There are plants even, such as the Bird's-nest Orchid (*Neottia*), which grovel in decay, and live upon decayed vegetable matter, such as decaying leaves and the like. Such are distinguished as *Saprophytes* (Gr. *sapros*, rotten; *phuton*, a plant).

**Fig. 1.** Branch of Fir-tree, in section, showing sucking roots running through it.

**Figs. 2 and 3.** Male and Female Plants distinct.

Male Inflorescence consists of three flowers, each flower having usually four Perianth-leaves, and the sessile Anthers inserted upon them.

Female Inflorescence also of three flowers, each with four Perianth-leaves and a relatively large inferior Ovary.

**Fig. 4.** Fruit, a berry, easily cut through.

The fruit-cover is pulpy and sticky, and the single seed frequently contains more than one embryo, usually two, embedded in the endosperm.

### Bladderwort (*Utricularia*—Lat. *Utriculus*, a little bottle).

(Fig. 8 after Cohn).

BLADDERWORT occurs in stagnant water and in ditches which are foul and therefore swarming with minute animal life. It flowers about July.

**Figs. 5 and 6.** The flowering stem rises above the surface of the water and bears a few yellow flowers. The flower has an upper and an under lip, with a well-marked prominence on the latter, and altogether has a general resemblance to the flower of Snapdragon.

**Fig. 7.** The Leaf is much divided and the divisions continually fork. The Bladders are borne on short stalks and vary in number.

**Fig. 8.** The Bladder consists of a transparent membrane, and the specimens examined were of a pale, purple tint. Small animals, such as Cyclops, Insect larvæ, etc., gain admission by following the bristles at the entrance, and thereby opening a folding door in the shape of the free edge of an elastic valve; this shuts after them so that they are entrapped. The Bladders do not secrete, but only *absorb*, the decayed matter by means of four-armed processes covering the interior.

### Butterwort (*Pinguicula vulgaris*—Lat. *pinguis*, fat).

BUTTERWORT grows in damp places, sometimes near to the stagnant waters containing *Utricularia*, but flowering earlier, usually in May.

**Figs. 9 and 10.** One or more stalks arise from the centre of the radical leaves, and each bears a terminal drooping, violet flower with a projecting spur.

**Fig. 11.** The leaves have usually incurved margins and are embedded in the boggy ground, so that they are on a level with the surface, and creeping things may readily get on to them. When plucked up by the root the leaves soon bend back and almost meet by their tips, and this folding is the same which keeps them flat when growing.

**Fig. 12.** Bend a leaf about the finger, and remove a thin portion of the surface with a sharp razor, and examine to see the glands on the surface.

There are two kinds of glands—those which stand out on a stalk and those which are sessile. These glands secrete a viscous fluid, and when small flies, etc., venture on the leaf, the margins arch over them, and the secretion acts upon them until they are dissolved. Here a process of digestion takes place.

### *Drosera rotundifolia* (Gr. *drosos*, dew).

The SUNDEW derives its name from the glistening appearance of the fluid drops at the tip of each of the tentacles of the leaves. It occurs on boggy ground and wet moors, and the moss serves as a sponge to keep up a supply of water. It flowers about July.

**Fig. 13.** The Leaves are arranged in the form of a rosette, and the scape bearing several flowers has a characteristic bend towards the top. The flowers are comparatively small, and the white petals are almost enclosed by the sepals, merely peeping forth a little at the top.

**Fig. 14.** The Leaf is beset with numerous Tentacles, each terminated by a gland, and surrounded by a colourless viscid secretion. An insect alighting on the centre of the leaf is speedily enveloped by the infolding tentacles, and the copious secretion poured forth by the glands not only weakens its struggles but shortly smothers it. Thus quietly resting on the leaf which forms a trough for its reception, the soft parts of the insect are gradually dissolved and absorbed by the Leaf, which again expands its tentacles to glitter in the sun and attract more prey.



PARASITES—*continued.*

**Fig. 15.** This is a case where the antenna was caught by a gland, and it would appear that the insect is bound hand and foot, as it were, by the inner, shorter tentacles and the outer, longer tentacles gradually fold over and seal its doom.

There are two ways in which a plant may feed, either by taking in *inorganic* substances and converting them into the organic material of which it is already composed, or by taking in *organic* materials and working them up into its own substance.

The first mode is that adopted by plants possessed of chlorophyll, or an allied colouring matter. This chlorophyll is commonly regarded as a carbonic-acid decomposing-apparatus; but quite recently it has been suggested that it is the living protoplasm underlying it which performs this work, while chlorophyll merely serves to mask it, and prevent too rapid action in the presence of sunlight. In this case chlorophyll would be an accompaniment, and not the cause, of decomposition.

The second mode is carried on by plants without chlorophyll, or an equivalent colouring matter; and, as already pointed out, *living* green plants or animals may be preyed upon, in which case the attacking plants are *Parasites*; or *dead* and decayed organic bodies may be used, when they are *Saprophytes*.

Starting with the ordinary Green Plants, every stage of Degradation may be traced.

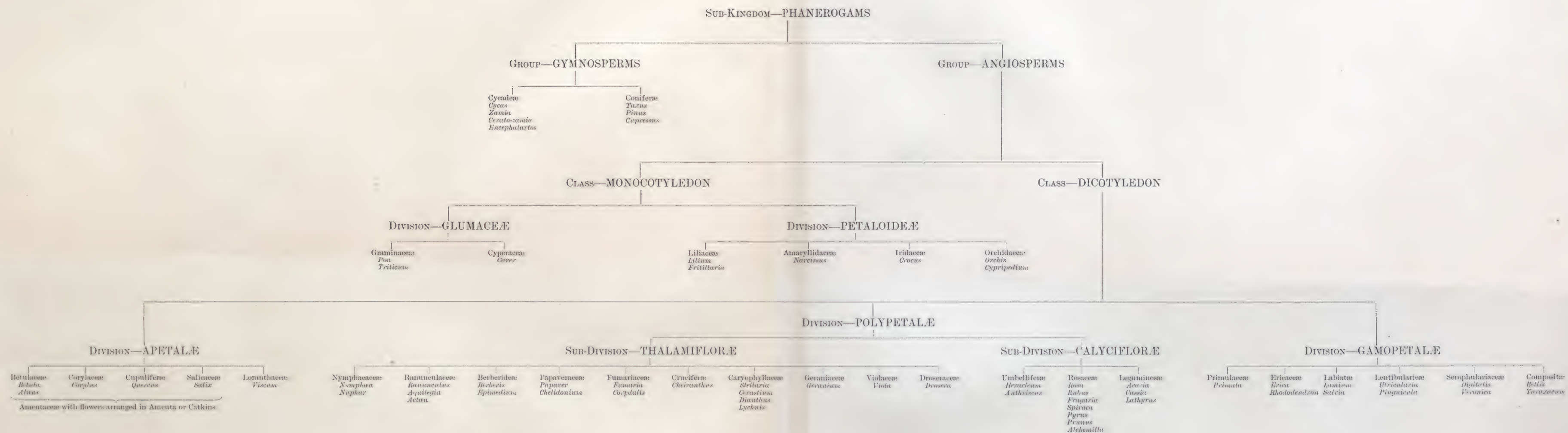
The *Mistletoe* is only partially parasitic, since it bears green leaves, but the *Dodder* is wholly parasitic. It forms little discs in contact with the stem of the plant it has attacked, from the centre of each of which a rootlet is emitted, and penetrates into the tissues of its host.

Then the next step is from living to decayed matter, as in the case of the brown Bird's-nest Orchid, which absorbs the liquified decaying leaves amongst which it lives. The Bladderwort, too, absorbs the decayed animal matter, putrifying in its bladders.

But a further stage is reached when the plant is able to bring its food-materials into a state of solution as well as to absorb them, and this is accomplished by the Butterwort and the Sundew, which have not only beautiful contrivances for catching their living prey but means for digesting it as well.



CLASSIFIED ARRANGEMENT  
OF THE  
VARIOUS ORDERS REPRESENTED, AND THE GENERA CHOSEN





# PHANEROGAMS

## INDEX TO ILLUSTRATIONS—FOR COMPARATIVE STUDY.

“D” INDICATES DIAGRAM.

	PLATES.	FIGS.		PLATES.	FIGS.
Anthers (opened) of Fox-glove	XXIV.	3	Flower of Columbine	XII.	8, D 2
Anther of Fritillaria	V.	7	Crocus	VIII.	1, 2, 4, D 1
Lilium Martagon	V.	8	Daisy, Ray	XXV.	2
Bladder of Bladderwort	XXVI.	8	Daisy, Disc	XXV.	3, 4
Bracts of Dandelion	XXV.	14	Dandelion	XXV.	8
Fumitory	XIV.	5	Epimedium	XIII.	D 2
Hazel	X.	13	Fox-glove	XXIV.	2, D 1
Hogweed	XVIII.	8	Fritillaria	V.	2
Lilium Martagon	V.	5	Fumitory	XIV.	2, 3, D 1
Orchis	IX.	7	Geranium	XVI.	2, 3, D 1
Pansy	XVII.	4	Grass	IV.	D 1, 2
Butterwort in Flower	XXVI.	9	Hazel, Male	X.	D 3
Calyx-lobe of Bramble	XIX.	4	Hazel, Female	X.	14, D 3
Carpel of Buttercup	XII.	5	Heath	XXII.	9, 10, D 2
Cycas circinalis	I.	2	Hogweed	XVIII.	2, 4, D 1
Cycas revoluta	I.	3	Lady's Mantle	XX.	13
Fumitory	XIV.	9	Lady's Slipper	IX.	D 1
Zamia muricata	I.	9	Lilium Martagon	V.	1, D 1
Cone, Female, of Cupressus	III.	D 2	Narcissus, pseudo-narcissus	VII.	1, D 1
Pinus Laricio	III.	1, 2, D 1	Nuphar	XI.	3, 4, D 2
Zamia muricata	I.	8	Nymphæa	XI.	1, 2, D 1
Cone, Male, of Zamia muricata	I.	5	Oak, Male	X.	18
Cycas circinalis, Female Plant	I.	1	Oak, Female	X.	19, 20
Embryo of Bramble	XIX.	9	Orchis	IX.	3, 4, 5, D 1
Hogweed	XVIII.	13	Pansy	XVII.	2, 3, D 1
Lilium Martagon	VI.	9	Pink	XV.	12, 13
Poppy	XIII.	9	Pinus Laricio, Male	II.	1, 2, 3
Wall-flower	XIV.	10, 11	Poa, laid out	IV.	4
White Dead-Nettle	XXIII.	7	Polyanthus Narcissus	VII.	3
Embryo Plant of Yew	III.	9	Poppy	XIII.	2, D 3
Floral Leaves of Buttercup (Sepals and Petals)	XII.	3	Poppy (Flower-bud)	XIII.	1
Chickweed do. do.	XV.	5	Primula, long-styled	XXII.	2
Nymphæa do. do.	XI.	6	Primula, "short-styled"	XXII.	3
Poppy do. do.	XIII.	4	Primula, plan	XXII.	D 1
Floret of Poa	IV.	3	Rhododendron	XXII.	11
Flower of Acacia	XXI.	1, D 1	Rose, in bud	XX.	16
Alder, Male	X.	D 2	Salvia pratensis	XXIII.	8
Alder, Female	X.	D 2	Salvia sclarea	XXIII.	10
Apple and Pomeæ	XX.	8, D	Speedwell	XXIV.	7, D 2
Barberry	XIII.	2, D 1	Spirea	XX.	7, D
Birch, Male	X.	3, D 1	Strawberry and Fragariæ	XX.	4, 5, D
Birch, Female	X.	5, D 1	Sweetbriar and Roseæ	XX.	1, D
Bladderwort	XXVI.	6	Sweet Pea	XXI.	4, 5, D 3
Bramble	XIX.	3, D 1	Wall-flower	XIV.	2, D 3
Buttercup	XII.	1, D 1	White Dead-Nettle	XXIII.	2, 3, D 1
Butterwort	XXVI.	10	Willow, Male	X.	24
Campion, Male	XV.	14, 15	Willow, Female	X.	26
Campion, Female	XV.	16	Yew, Male	II.	5, 6
Carex, Male	IV.	12, D 3	Yew, Female	III.	3
Carex, Female	IV.	13, D 4	Foliage-Leaves of Apple, compound	XX.	14
Carex and Elyna	IV.	D 5	Bladderwort	XXVI.	7
Cassia	XXI.	2, D 2	Bramble	XIX.	2
Cerato-zamia, Male	I.	6	Buttercup	XII.	2
Cherry and Pruneæ	XX.	10, D	Butterwort	XXVI.	11
Chervil	XVIII.	3	Chickweed	XV.	4
Chickweed	XV.	3, D 1	Crocus	VIII.	6



	PLATES.	FIGS.		PLATES.	FIGS.
Foliage-Leaves of Dandelion - - -	XXV.	13	Inflorescence of Birch, Male and Female -	X.	1
Fox-glove - - -	XXIV.	4	Bladderwort - - -	XXVI.	5
Fumitory - - -	XIV.	4	Carex - - -	IV.	11
Geranium - - -	XVI.	1	Cerastium - - -	XV.	2
Hogweed - - -	XVIII.	6, 7	Chickweed - - -	XV.	1
Lilium Martagon - - -	V.	4	Daisy - - -	XXV.	1
Nymphaea - - -	XI.	5	Dandelion - - -	XXV.	6, 7
Orchis - - -	IX.	6	Fox-glove - - -	XXIV.	1
Pansy - - -	XVII.	1	Fumitory - - -	XIV.	1
Poppy - - -	XIII.	3	Hazel, Male and Female -	X.	8, 12
Rose, compound - - -	XX.	15	Heath - - -	XXII.	8
Sundew - - -	XXVI.	14	Hogweed - - -	XVIII.	1
Sweet Pea - - -	XXI.	13	Mistletoe, Male - - -	XXVI.	2
Wall-flower - - -	XIV.	3	Mistletoe, Female - - -	XXVI.	3
Fruit of Apple - - -	XX.	9	Oak, Male and Female -	X.	17
Bane-berry - - -	XIII.	4	Polyanthus Narcissus -	VII.	2
Birch, a flat Nut - - -	X.	6, 7	Primrose - - -	XXII.	1
Bramble - - -	XIX.	7, 8	Wall-flower - - -	XIV.	1
Buttercup - - -	XII.	7	Willow, Male - - -	X.	23
Carex - - -	IV.	14	Willow, Female - - -	X.	25
Chelidonium - - -	XIII.	10, D 5	Mistletoe, roots penetrating Fir - - -	XXVI.	1
Cherry - - -	XX.	11, 12	Nectaries of Fritillaria Imperialis - - -	V.	3
Chickweed - - -	XV.	9	Ovary of Buttercup - - -	XII.	6
Columbine - - -	XII.	9	Chickweed - - -	XV.	8
Corydalis - - -	XIV.	D 2	Fox-glove - - -	XXIV.	6
Crocus - - -	VIII.	9	Geranium - - -	XVI.	8
Daisy - - -	XXV.	5	Heath - - -	XXII.	12
Dandelion - - -	XXV.	10, 11, 12	Hogweed - - -	XVIII.	10
Dog Rose - - -	XX.	2, 3	Lady's Slipper - - -	IX.	12
Fox-glove, a Capsule - - -	XXIV.	9, 10	Lilium Martagon - - -	VI.	3
Fumitory, an Achene - - -	XIV.	10, 11	Orchis - - -	IX.	10, 11
Geranium - - -	XVI.	9	Pansy - - -	XVII.	9
Hazel, a Nut - - -	X.	15	Poa - - -	IV.	5
Hogweed, a Cremocarp - - -	XVIII.	11	Polyanthus Narcissus - - -	VII.	6
Lilium Martagon, a Capsule - - -	VI.	6, 7	Primrose - - -	XXII.	5
Mistletoe - - -	XXVI.	4	Ovule of Cycas - - -	I.	4
Nymphaea - - -	XI.	8	Dandelion - - -	XXV.	9
Oak, an Acorn - - -	X.	21	Narcissus pseudo-narcissus - - -	VII.	7
Orchis, a Capsule - - -	IX.	13	Pansy - - -	XVII.	10
Pansy, a Capsule - - -	XVII.	11, 12	Perianth of Crocus - - -	VIII.	3, D 2
Pinus sylvestris, a Cone - - -	III.	4	Polyanthus Narcissus - - -	VII.	4, D 2
Poppy, a Capsule - - -	XIII.	6, D 4	Petals of Bramble - - -	XIX.	5
Primrose - - -	XXII.	6	Fumitory - - -	XIV.	7
Rhododendron - - -	XXII.	13	Geranium - - -	XVI.	5
Speedwell - - -	XXIV.	8	Pansy - - -	XVII.	6
Strawberry - - -	XX.	6	Sweet Pea - - -	XXI.	6
Sweet Pea, a Legume - - -	XXI.	8	Wall-flower - - -	XIV.	5
Wall-flower, a Siliqua - - -	XIV.	8, D 4	Poa, general characters of - - -	IV.	1
White Dead-Nettle, a Nutlet - - -	XXIII.	6	Pollen-grains of Larch - - -	II.	11
Willow - - -	X.	27	Lilium Martagon - - -	V.	9
Yew - - -	III.	7	Pinus Laricio - - -	II.	10
Germination of Date - - -	IX.	15	Pinus Sylvestris - - -	II.	9
Sweet Pea - - -	XXI.	11	Primrose - - -	XXII.	4
Wheat - - -	IV.	8	Rhizomes of Orchis - - -	IX.	12
Yew - - -	III.	8	Root-hairs of Wheat - - -	IV.	9
Glands of Butterwort on epidermis of leaf -	XXVI.	12	Scale from Inflorescence of Birch - - -	X.	2
Gland of Leaf of Drosera - - -	XXVI.	15	Hazel - - -	X.	9, 10
Grain of Wheat - - -	IV.	6, 7	Seed of Bane-berry - - -	XII.	13
Gynœcium of Chickweed - - -	XV.	7	Barberry - - -	XIII.	5
Fritillaria Imperialis - - -	VI.	1	Chickweed - - -	XV.	10, 11
Geranium - - -	XVI.	7	Columbine - - -	XII.	10
Lilium Martagon - - -	VI.	2	Crocus - - -	VIII.	10
Pansy - - -	XVII.	8	Cycas circinalis - - -	I.	11
Wall-flower - - -	XIV.	7	Encephalartos - - -	I.	10
White Dead-Nettle - - -	XXIII.	5	Fox-glove - - -	XXIV.	11
Inflorescence of Barberry - - -	XIII.	1	Garden Pea - - -	XXI.	9



	PLATES.	FIGS.
Seed of Geranium - - - - -	XVI.	10, 11
Hazel - - - - -	X.	16
Hogweed - - - - -	XVIII.	12
Lilium Martagon - - - - -	VI.	8
Nymphæa - - - - -	XI.	9
Oak - - - - -	X.	22
Orchis - - - - -	IX.	14
Pansy - - - - -	XVII.	13
Pinus sylvestris - - - - -	III.	5, 6
Poppy - - - - -	XIII.	7, 8
Primrose - - - - -	XXII.	7
Snap-dragon - - - - -	XXIV.	12
Sweet Pea - - - - -	XXI.	10
Wall-flower - - - - -	XIV.	9
Willow - - - - -	X.	28
Sepals of Fox-glove - - - - -	XXIV.	5
Fumitory - - - - -	XIV.	6
Geranium - - - - -	XVI.	4
Orchis - - - - -	IX.	8
Pansy - - - - -	XVII.	5
Wall-flower - - - - -	XIV.	4
Spikelet of Poa - - - - -	IV.	2
Stamens of Barberry - - - - -	XIII.	3
Birch - - - - -	X.	4
Bramble - - - - -	XIX.	6
Buttercup - - - - -	XII.	4
Chickweed - - - - -	XV.	6

	PLATES.	FIGS.
Stamens of Crocus - - - - -	VIII.	7
Fumitory - - - - -	XIV.	8
Geranium - - - - -	XVI.	6
Hazel - - - - -	X.	11
Hogweed - - - - -	XVIII.	9
Lilium Martagon - - - - -	V.	6
Nymphæa - - - - -	XI.	7
Pansy - - - - -	XVII.	7
Pinus sylvestris - - - - -	II.	4
Polyanthus Narcissus - - - - -	VII.	5
Poppy - - - - -	XIII.	5
Salvia pratensis - - - - -	XXIII.	9
Sweet Pea - - - - -	XXI.	7
Taxus - - - - -	II.	7, 8
Wall-flower - - - - -	XIV.	6
White Dead-Nettle - - - - -	XXIII.	4
Zamia muricata - - - - -	I.	7
Stem of Bramble - - - - -	XIX.	1
Carex - - - - -	IV.	10
Crocus, a Corm - - - - -	VIII.	5
Hogweed - - - - -	XVIII.	5
White Dead-Nettle, and Foliage-		
Leaves - - - - -	XXIII.	1
Stigma of Crocus - - - - -	VIII.	8
Lilium Martagon - - - - -	VI.	4
Style of Fritillaria Imperialis - - - - -	VII.	5
Sundew in Flower - - - - -	XXVI.	13



## APPENDIX.

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INSTRUCTIONS TO TEACHERS OF BOTANY, FROM THE DIRECTORY OF THE SCIENCE AND ART DEPARTMENT.

### I.—PRESERVING SPECIMENS.

Some trouble might be saved, and teaching made more effective, if a small collection of structural specimens were kept to serve as illustrations. Such things as bark, thorns, seed-vessels, etc., can be kept in card-board boxes or drawers. Others, such as tubers, rhizomes, the inflorescence and fruit of Arum, and fruits generally, must be kept in bottles in some preservative solution, and the following answers very well:—

#### *Goadby's Solution.*

1 lb. common salt.  $\frac{1}{2}$  lb. potash-alum. 16 grains corrosive sublimate. 1 gallon distilled water.

### II.—APPARATUS REQUIRED FOR DISSECTING FLOWERS.

*A sharp knife* for making sections.

*Dissecting needles.* The best are glovers' needles which are three-edged. They may be conveniently mounted in pieces of *fresh twigs*. Push the end of the needle into the pith cavity, and put the needle, now furnished with a handle, aside for a few weeks. The wood will contract in drying and hold the needle firmly. [The wood of the Elder is very handy for this purpose.]

*A simple microscope.* This may be nothing more than a lens magnifying about four times, which should be mounted on a small stand, so that the pupil when looking through it with one eye *has the hands free to dissect a flower placed beneath the lens*. For examining the structure of ovaries (habitually ignored by the pupils who present themselves for the Department's examinations), a higher magnifying power, such as a Coddington lens similarly mounted, will be found needful.



