pentamerous symmetry, the whorls being isomerous. Such a flower as that of Sedum (fig. 180) would be represented by the formula $S_5P_5St_{5+5}C_5$, where St_{5+5} indicates that the staminal whorl consists of two rows of five parts each. A flower such as the male flower of the Nettle (fig. 188) would be expressed $S_4P_0St_4C_0$. It is also possible to indicate, in cases where members of a whorl are absent, which of them are wanting; thus, in the flower of an Orchis we have $S_3P_3St_{1+0}C_3$. Here St_{1+0} indicates that the anterior stamen of the outer row is present, the other two stamens of the row, marked as dots, are wanting, as also all the stamens of the inner row. In Cypripedium, on the other hand, the formula is $S_3P_3St_{0+2}C_3$, for here all the stamens of the outer row and the anterior one of the inner row are absent. When no other mark is appended the whorls are supposed to be alternate; but if it is desired to mark the position of the whorls special symbols are employed. Thus, to express the superposition of one whorl upon another, a line is drawn between them, *e.g.*, the symbol $S_2P_2 \mid St_2C_2$ is the formula of the flower of Primulaceæ. To indicate the interposition of a row of parts in a whorl a dot is placed between the coefficients, thus $S_2P_2St_{2.2}C_2$ indicates that an extra row of five stamens has been interposed between those already in existence. To represent adhesions and cohesions leads to complicated formulæ, but in many cases cohesion can be easily indicated. Thus in the formula $\hat{S}_2\hat{P}_2St_2\hat{C}_2$, we have the arrangement of the parts of the flower in Veronica indicated, the sepals and the petals being united and the two carpels also being united into one pistil. The papilionaceous flower, of which fig. 186 is a diagram, may be formulated $\hat{S}_1P_2St_{\hat{5}+(4+1)}C_1$. We thus learn that there are five sepals united, five free petals, ten stamens in two rows, of which nine are united and one is free, and there is one carpel. When the parts of the flower are arranged spirally on the floral axis, as in Magnoliaceæ and other flowers, the formula is prefixed by a curved line thus ⊃, and then the angle of divergence of the members may be marked in addition to their number. Many other points in the arrangement of the flower may be attached to the formula by different symbols, according to the object which one has in view.

Fig. 188.

Fig. 189.

Fig. 190.

Fig. 188.—Tetramerous male (unisexual) flower of the Nettle (*Urtica*). It is incomplete, as it wants petals and pistil; and it is said to be monochlamydeous. One sepal is next the axis, and is called posterior or superior, another is next the bract, called anterior or inferior, and two are lateral, that is, to the right and left of the axis.

Fig. 189.—Diagram to illustrate valvular or valvate æstivation, in which the parts are placed in a circle, without overlapping or folding.

Fig. 190.—Diagram to illustrate imbricative or indupicate æstivation in which the parts of the verticil are slightly turned inwards at the edges.

To the flower-bud the name *alabastrus* is sometimes given, and its period of opening has been called *anthesis*, whilst the manner in which the parts are arranged with respect to each other before opening is the *æstivation* or *præfloration*. The latter terms are applied to the flower-bud in the same way as vernation is to the leaf-bud, and distinctive names have been given to the different arrangements exhibited, both by the leaves individually and in their relations to each other. As regards each leaf of the flower, it is either spread out, as the sepals in the bud of the Lime-tree, or folded upon itself (conduplicate), as in the petals of some species of Lysimachia, or slightly folded inwards or outwards at the edges, as in the calyx of some species of Clematis, and of some herbaceous plants, or rolled up at the edges (involute or revolute), or folded transversely, becoming *crumpled* or *corrugated*, as in the Poppy. When the parts of a whorl are placed in an exact circle, and are applied to each other by their edges only, without overlapping or being folded, thus resembling the valves of a seed-vessel, the æstivation is *valvate*, as in the calyx of Guazuma ulmifolia (fig. 189). The edges of each of the parts may be turned either inwards or outwards; in the former case, the æstivation is *induplicate*, as in the corolla of Guazuma ulmifolia (fig. 190), in the latter case, *reduplicate*, as in the calyx of Althæa rosea (fig. 191). When the parts of a single whorl are placed in a circle, each of them exhibiting a torsion of its axis, so that by one of its sides it overlaps its neighbour, whilst its side is overlapped in like manner by that standing next to it, the æstivation is *twisted* or *contortive*, as in the corolla of Althæa rosea (fig. 192). This arrangement is characteristic of the flower-buds of

Fig. 191.

Fig. 192.

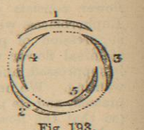

Fig. 193.

Fig. 191.—Diagram to illustrate reduplicative or reduplicate æstivation, in which the parts of the whorl are slightly turned outwards at the edges.

Fig. 192.—Diagram to illustrate contortive or twisted æstivation, in which the parts of the whorl are overlapped by each other in turn, and are twisted on their axis.

Fig. 193.—Diagram to illustrate the quincuncial æstivation, in which the parts of the flower are arranged in a spiral cycle, so that 1 and 2 are wholly external, 4 and 5 are internal, and 3 is partly external and partly overlapped by 1.

Malvaceæ and Apocynaceæ, and it is also seen in Convolvulaceæ and Caryophyllaceæ. When the flower expands, the traces of twisting often disappear, but sometimes, as in Apocynaceæ, they remain. Those forms of æstivation are such as occur in cyclic flowers, and they are included under *circular* æstivation. But in spiral flowers we have a different arrangement, the leaves of the calyx of Camellia japonica cover each other partially like tiles on a house. This æstivation is *imbricate*. At other times, as in the petals of Camellia, the parts envelope each other completely, so as to become *convolute*. This is also seen in a transverse section of the calyx of Magnolia grandiflora, where each of the three leaves embraces that within it. When the parts of a whorl are five, as occurs in many Dicotyledons, and

Fig 194.

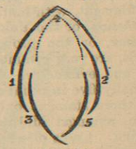

Fig 195.

Fig. 194.—Diagram to illustrate imbricative or imbricated æstivation, in which the parts are arranged in a spiral cycle, following the order indicated by the figures 1, 2, 3, 4, 5.

Fig. 195.—Diagram of a papilionaceous flower, showing vexillary æstivation. 1 and 2, the alæ or wings; 3, a part of the carina or keel; 4, the vexillum or standard, which, in place of being internal, as marked by the dotted line, becomes external; 5, the remaining part of the keel. The order of the cycle is indicated by the figures.

the imbrication is such that there are two parts external, two internal, and a fifth which partially covers one of the internal parts by its margin, and is in its turn partially covered by one of the external parts, the æstivation is *quincuncial* (fig. 193). This quincunx is common in the corolla of Rosaceæ. In fig. 194 a section is given of the

bud of Antirrhinum majus, showing the imbricate spiral arrangement. In this case it will be seen that the part marked 5 has, by a slight change in position, become overlapped by 1. This variety of imbricate æstivation has been termed *cochlear*. In flowers, such as those of the Pea (fig. 187), one of the parts, the vexillum, is often large and folded over the others, giving rise to *vexillary* æstivation (fig. 195), or the carina may perform a similar office, and then the æstivation is *carinal*, as in the Judas-tree (Cercis Siliquastrum). The parts of the several verticils often differ in their mode of æstivation. Thus, in Malvaceæ the corolla is contortive and the calyx valvate, or reduplicate; in St John's-wort the calyx is imbricate, and the corolla contortive. In Convolvulaceæ, while the corolla is twisted, and has its parts arranged in a circle, the calyx is imbricate, and exhibits a spiral arrangement. In Guazuma the calyx is valvate, and the corolla induplicate. The circular æstivation is generally associated with a regular calyx and corolla, while the spiral æstivations are connected with irregular as well as with regular forms.

I. Protective Organs.

1. *Calyx.*

The calyx is the external envelope of the flower, and consists of verticillate leaves, called *sepals*, *foliola*, or *phylla*. These calycine leaves are sometimes separate from each other, at other times they are united to a greater or less extent; in the former case, the calyx is *dialysepalous* or *eleutherosepalous*, *polysepalous* or *polyphyllous*, or *aposepalous*; in the latter, *gamosepalous* or *gamophyllous*, *monosepalous* or *monophyllous*, or *synsepalous*. The divisions of the calyx present usually all the characters of leaves, and in some cases of monstrosity they are converted into the ordinary leaves of the plant. Their structure consists of cellular tissue or parenchyma, traversed by vascular bundles, in the form of ribs and veins, containing spiral vessels, which can be unrolled, delicate woody fibres, and other vessels, the whole being enclosed in an epidermal covering, having stomata and often hairs on its outer surface, which corresponds to the under side of the leaf. In the great divisions of the vegetable kingdom the venation of the calyx is similar to that of the leaves,—parallel in Monocotyledons, reticulated in Dicotyledons. The leaves of the calyx are usually entire, but occasionally they are cut in various ways, as in the Rose, and they are sometimes hooked at the margin, as in Rumex uncatus. It is rare to find the leaves of the calyx stalked. They are usually sessile leaves, in which the vaginal portion is only slightly developed, and frequently the laminar part is alone present. Sepals are generally of a more or less oval, elliptical, or oblong form, with their apices either blunt or acute. In their direction they are erect or reflexed (with their apices downwards), spreading outwards (*divergent* or *patulous*), or arched inwards (*connivent*). They are usually of a greenish colour, and are called *foliaceous* or *herbaceous*; but sometimes they are coloured, as in the Fuchsia, Tropæolum, Globe-flower, and Pomegranate, and are then called *petaloid*. Whatever be its colour, the external envelope of the flower must be considered as the calyx. The nature of the hairs on the calyx gives rise to terms similar to those already mentioned as applied to the surfaces of other parts of plants. The vascular bundles sometimes form a prominent rib, which indicates the middle of the sepal; at other times they form several ribs. The venation is useful as pointing out the number of leaves which constitute a gamosepalous calyx. In a polysepalous calyx the number of the parts is marked by Greek numerals prefixed. Thus, a calyx which has three sepals is *trisepalous*; one with five sepals is *pentasepalous* or *pentaphyllous*. The sepals occasionally are of different forms and sizes. In Aconite one of them is shaped like a helmet, and has been called *galeate*. In a gamosepalous calyx the sepals are united in various ways, sometimes very slightly, and their number is marked by the divisions at the apex. These divisions either are simple projections in the form of acute or obtuse teeth; or they extend down the calyx as fissures about half way, the calyx being *trifid* (three-cleft), *quinquefid* (five-cleft), (fig. 196), &c., according to their number; or they reach to near the base in the form of partitions, the calyx being *tripartite*, *quadripartite*, *quinquepartite*, &c. The union of the parts may be complete, and the calyx may be quite entire or *truncate*, as in some Correas, the venation being the chief indication of the different parts. The cohesion is sometimes irregular, some parts uniting to a greater extent than others; thus a two-lipped or *labiate* calyx is formed, which, when the upper or posterior lip is arched becomes *ringent*. The upper lip is often composed of three parts, which are thus posterior or next the axis, while the lower has two, which are anterior. The part formed by the union of the sepals is called the *tube* of the calyx; the portion where the sepals are free is the *limb*.

Occasionally, certain parts of the sepals undergo marked enlargement. In the Violet the calycine segments (*laciniæ*) are prolonged downwards beyond their insertions, and in the Indian Cress (Tropæolum) this prolongation is in the form of a spur (*calcar*), formed by three sepals; in Delphinium it is formed by one. When one or more sepals are thus enlarged, the calyx is *calcarate* or *spurred*. In Pelargonium the spur from one of the sepals is adherent to the flower-stalk. When an epicalyx is present, as in the Mallow order, the flower appears to be provided with a double calyx, and has been denominated *caliculate*. Degenerations take place in the calyx, so that it becomes dry, scaly, and glumaceous (like the glumes of grasses), as in the Rush tribe; hairy, as in Compositæ; or a mere rim, as in some Umbelliferæ and Acanthaceæ, and in Madder (Rubia tinctorum, fig. 198), when it is called *obsolete* or *marginate*. In Diplolæna it is reduced to five scales. In Compositæ,

Fig. 196.

Fig. 198.

Fig. 197.

Fig. 199.

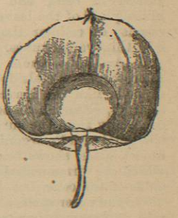

Fig. 200.

Fig. 196.—Gamosepalous five-toothed (quinquè-dentate) calyx of Campion (*Lychnis*).

Fig. 197.—Feathery pappus attached to the fruit of Salsafy (*Tragopogon porrifolius*). The calyx adheres to the fruit, and its limb is pappose.

Fig. 198.—Calyx of Madder (*Rubia*), adherent to the pistil, its limb appearing in the form of a rim. The calyx is called obsolete.

Fig. 199.—Caducous calyx of Poppy (*Papaver*). It is composed of two sepals which fall off before the petals expand.

Fig. 200.—Bladder-like calyx of the Winter Cherry (*Physalis Alkekengi*), slit open to show the mode in which it surrounds the fruit without adhering to it. The calyx is persistent, but not adherent. It enlarges after the flower withers, and is called accrescent.

Dipsacaceæ, and Valerianaceæ, the calyx is attached to the pistil, and its limb is developed in the form of hairs called *pappus* (fig. 197). This pappus is either simple (*pilose*) or

feathery (*plumose*). In Valeriana the superior calyx is at first an obsolete rim, but as the fruit ripens it is shown to consist of hairs rolled inwards, which expand so as to waft the fruit. The calyx sometimes falls off before the flower expands, as in Poppies, and is *caducous* (fig. 199); or along with the corolla, as in Ranunculus, and is *deciduous*; or it remains after flowering, as in Labiatæ, Scrophulariaceæ, and Boraginaceæ; or its base only is persistent, as in Datura Stramonium. In Eschscholtzia and Eucalyptus the sepals remain united at the upper part, and become disarticulated at the base or middle, so as to come off in the form of a lid or funnel. Such a calyx is *operculate* or *calyptrate*. The existence or non-existence of an articulation determines the deciduous or persistent nature of the calyx. In the case of Eschscholtzia the axis seems to be prolonged so as to form a sort of tube, from which the calyx separates. In Eucalyptus the calyx consists of leaves, the laminæ or petioles of which are articulated like those of the Orange, and the separation between the parts occurs at this articulation. The receptacle bearing the calyx is sometimes united to the pistil, and enlarges so as to form a part of the fruit, as in the Apple, Pear, Pomegranate, Gooseberry, &c. In these fruits the withered calyx is seen at the apex. Sometimes a persistent calyx increases much after flowering, and encloses the fruit without being incorporated with it, becoming *accrescent*, as in various species of Physalis (fig. 200); at other times it remains in a withered or *marcescent* form, as in Erica; sometimes it becomes *inflated* or *vesicular*, as in Sea Campion (Silene maritima).

2. *Corolla.*

The corolla is the more or less coloured inner floral envelope, forming the whorl of leaves between the calyx and the stamens. It is generally the most conspicuous whorl. The gay colours and fragrant odours of flowers are resident in it. It is present in the greater number of Dicotyledons. Petals differ more from leaves than sepals do, and are much more nearly allied to the staminal whorl. In some cases, however, they are transformed into leaves, like the calyx, and occasionally leaf-buds are developed in their axil. They are seldom green, although occasionally that colour is met with, as in some Cobæas, Hoya viridiflora, Gonolobus viridiflorus, and Pentatropis spiralis. As a rule they are highly coloured, the colouring matter being contained in cells, and differing in its nature from the chlorophyll of the leaves. As regards their structure petals consist of cellular tissue, traversed by true spiral vessels and thin-walled tubes. In delicate flowers, as Convolvulus and Anagallis, these vessels are easily seen under the microscope. Petals do not usually present numerous layers of cells like the leaves, neither is the epidermis always distinct, although in some instances it may be detached, especially from the surface next the calyx. The cuticle of the petal of a Pelargonium, when viewed with a $\frac{1}{2}$ or $\frac{1}{4}$-inch object glass, shows beautiful hexagons, the boundaries of which are ornamented with several inflected loops in the sides of the cells

On the outer surface of petals, corresponding to the lower side of leaves, stomata are sometimes found. Petals are generally glabrous or smooth; but, in some instances, hairs are produced on their surface. Petaline hairs, though sparse and scattered, present occasionally the same arrangement as those which occur on the leaves; thus, in Bombaceæ they are stellate. Coloured hairs are seen on the petals of Menyanthes, and on the segments of the perianth of the Iris. Although petals are usually very thin and delicate in their texture, they occasionally become thick and fleshy, as in Stapelia and Rafflesia; or dry, as in Heaths; or hard and stiff, as in Xylopia. A petal often consists of two portions—the lower narrow, resembling the petiole of a leaf, and called the *unguis* or *claw*; the upper broader, like the blade of a leaf, and called the *lamina* or *limb*. These parts are seen in the petals of the Wallflower (fig. 201), where *c* is the claw and *l* the limb. The claw is often wanting, as in the Crowfoot (fig. 202) and the Poppy, and the petals are then *sessile*. Petals having a claw are *unguiculate*. According to the development of veins and the growth of cellular tissue, petals present varieties similar to those already noticed in the case of leaves. Thus the margin is either entire or divided into lobes or teeth. These teeth sometimes form a regular fringe round the margin, and the petal becomes *fimbriated*, as in the Pink; or *laciniated*, as in Lychnis Flos-cuculi; or *crested*, as in Polygala. Sometimes the petal becomes pinnatifid, as in Schizopetalum. The median vein is occasionally prolonged beyond the summit

Fig. 201.


Fig. 202.


Fig. 203.


Fig. 204.


Fig. 205.

Fig. 201.—Unguiculate or stalked petal of Wallflower (*Cheiranthus Cheiri*). *c*, the claw or unguis; *l*, the blade or lamina.

Fig. 202.—Petal of Crowfoot (*Ranunculus*), without a claw, and thus resembling a sessile leaf. At the base of the petal a nectariferous scale is seen.

Fig. 203.—Tubular petal of Hellebore (*Helleborus*), formed by folding and adhesion in the same manner as pitchers

Fig. 204.—Horn-like hollow petal of Columbine (*Aquilegia vulgaris*), formed by folding and adhesion of the edges.

Fig. 205.—Part of the flower of Aconite (*Aconitum Napellus*), showing two irregular horn-like petals *p*, supported on grooved stalks *o*. These used to be called nectaries. *s*, the whorl of stamens inserted on the thalamus, and surrounding the pistil.

of the petals in the form of a long process, as in Strophanthus hispidus, where it extends for 7 inches; and at other times it ends in a free point or *cuspis*, and the petal becomes *cuspidate*; or the prolonged extremity is folded downwards or inflexed, as in Umbelliferæ, so that the apex approaches the base. The limb of the petal may be flat or concave, or hollowed like a boat. In Hellebore the petals become folded in a tubular form, resembling a horn (fig. 203); in Aconite (fig. 205) some of the petals resemble a hollow-curved horn, supported on a grooved stalk; while in Columbine (fig. 204), Violet, Snapdragon, and Centranthus, one or all of them are prolonged in the form of a spur, and are *calcarate*. In Valeriana, Antirrhinum, and Corydalis, the spur is very short, and the corolla or petal is said to be *gibbous*, or *saccate*, at the base.

A corolla rarely consists of one petal, and when this occurs, as in Amorpha, it depends on the abortion or non-development of others. Such a corolla is *unipetalous*, a term quite distinct from monopetalous. A corolla is *dipetalous*, *tripetalous*, *tetrapetalous*, or *pentapetalous*, according as it has two, three, four, or five separate petals. The general name of *polypetalous*, *dialypetalous*, *eleutheropetalous*, or *apopetalous*, is given to corollas having separate petals, while *monopetalous*, *gamopetalous*, or *sympetalous* is applied to those in which the petals are united. This union generally takes place at the base, and extends more or less towards the apex; in Phyteuma the petals are united at their apices also. In some polypetalous corollas, as that of the Vine, the petals are separate at the base, and

adhere by the apices. When the petals are equal as regards their development and size, the corolla is *regular*; when unequal, it is *irregular*. When a corolla is gamopetalous, it usually happens that the claws are united into a tube, while the upper parts are either free or partially united, so as to form a common limb, the point of union of the two portions being the *faux* or *throat*, which often exhibits a distinct constriction or dilatation. The number of parts forming such a corolla can be determined by the divisions, whether existing as teeth, crenations, fissures, or partitions, or if, as rarely happens, the corolla is entire, by the venation. The union may be equal among the parts, or some may unite more than others.

Amongst regular polypetalous corollas may be noticed the *rosaceous* corolla (fig. 206), in which there are five spreading petals, having no claws, and arranged as in the single Rose and Potentilla; the *caryophyllaceous* corolla, in which there are five petals with long narrow tapering claws, as in many of the Pink tribe; the *alsinaceous*, where the claw is less narrow, and there are distinct spaces between the petals, as in some species of Chickweed; the *cruciform*, having four petals, often unguiculate, placed opposite in the form of a cross, as seen in Wallflower, and in other plants called *cruciferous*. Of irregular polypetalous corollas the most marked is the *papilionaceous* (fig. 187), in which there are five petals:—one superior (posterior), *st*, placed next to the axis, usually larger than the rest, called the *vexillum* or *standard*; two lateral, *a*, the *alæ* or wings; two inferior (anterior), partially or completely covered by the alæ, and often united slightly by their lower margins, so as to form a single keel-like piece, *car*, called *carina* or keel, which embraces the essential organs. This form of corolla is characteristic of British Leguminous plants. Among the irregular polypetalous corollas might be included the *orchideous* (fig. 207), although it is really the perianth of a Monocotyledon. This perianth consists of three outer portions equivalent to the calyx, and three inner parts alternating with them, constituting the petals. The latter are often very irregular, some being spurred, others hooded, &c.; and there is always one, called the *labellum* or lip *l*, which presents a remarkable development, and gives rise to many of the anomalous forms exhibited by these flowers.


Fig. 206.


Fig. 208.


Fig. 207.

Fig. 206.—Rosaceous corolla of the Strawberry (*Fragaria vesca*), composed of five petals without claws

Fig. 207.—Flower of Twayblade (*Listera ovata*), seen in front, showing a large bifid labellum *l*, which is different from the other five divisions of the perianth. The divisions of the perianth are in two rows of three each. The essential organs of reproduction are placed on a column opposite the labellum. The perianth is irregular polyphyllous, and is denominated orchideous.

Fig. 208.—Regular gamopetalous bell-shaped (campanulate) corolla of Harebell (*Campanula rotundifolia*). It is composed of five petals united. The ovary is inferior, and is united to the calyx *c*.

Regular gamopetalous corollas are sometimes *campanulate* or *bell-shaped*, as in Campanula rotundifolia (fig. 208); *infundibuliform* or *funnel-shaped*, when the tube is like an inverted cone, and the limb becomes more expanded at the apex, as in Tobacco; *hypocrateriform* or *salver-shaped*, when there is a straight tube surmounted by a flat spreading limb, as in Primula (fig. 209); *tubular*, having a long cylindrical tube, appearing continuous with the limb, as in Spigelia and Comfrey; *rotate* or *wheel-shaped*, when the tube is very short, and the limb flat and spreading, as in Myosotis (when the divisions of the rotate corolla are very acute, as in Galium, it is sometimes called *stellate* or *star-like*); *urceolate* or *urn-shaped*, when there is scarcely any limb, and the tube is narrow at both ends, and expanded in the middle, as in Bell-heath (Erica cinerea). Some of these forms may become irregular in consequence of certain parts being more developed than others. Thus, in Veronica, the rotate corolla has one division much smaller than the rest, and in Digitalis there is a slightly irregular campanulate corolla which some have called *digitaliform*. Of irregular gamopetalous corollas there may be mentioned the *labiate* or *lipped* (fig. 210), having two divisions of the limb in the form of what are called *labia* or lips (the upper one, *u*, composed usually of two united petals, and the lower, *l*, of three), separated by a *hiatus* or gap. In such cases the tube varies in length, and the parts in their union follow the reverse order of what occurs in the calyx, where two sepals are united in the lower lip, and three in the upper. When the upper lip of a labiate corolla is much arched, and the lips separated by a distinct gap, it is called *ringent* (fig. 210). The labiate corolla characterizes the

Fig. 209.

Fig. 210.

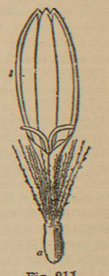

Fig. 211.

Fig. 209.—Regular gamopetalous sympetalous hypocrateriform corolla of Oxlip (*Primula elatior*). *c*, calyx; *p*, corolla; *t*, tube of corolla; *l*, limb; *a*, anthers.

Fig. 210.—Irregular gamopetalous labiate corolla of the Dead-nettle (*Lamium album*). The upper lip *u* is composed of two petals united, the lower lip *l*, of three. Between the two lips (labia) there is a gap (hiatus). The throat is the part where the tube and the labiate limb join. From the arching of the upper lip this corolla is called ringent.

Fig. 211.—Irregular gamopetalous ligulate flower of Ragwort (*Senecio*). It is a tubular floret, split down on one side, with the united petals forming a strap-like projection *i*. The lines on the flat portion indicate the divisions of the five petals. From the tubular portion below, the bifid style projects slightly. The terete fruit (achænium) *a* is surmounted by pilose pappus, which is the metamorphosed calycine limb. The flower is female, having no stamens.

natural order Labiatæ. When the lower lip is pressed against the upper, so as to leave only a chink or *rictus* between them, the corolla is said to be *personate* or *mask-like*, as in Frogsmouth, Snapdragon, and some other Scrophulariaceæ, and the projecting portion of the lower lip is called the *palate*. In some corollas the two lips become hollowed out in a remarkable manner, as in Calceolaria, assuming a slipper-like appearance, similar to what occurs in the labellum of some Orchids, as Cypripedium. The *calceolate* corolla of Calceolaria may be considered as consisting of two slipper-like lips. When a tubular corolla is split in such a way as to form a strap-like process on one side with several tooth-like projections at its apex, it becomes *ligulate*, or *strap-shaped* (fig. 211).

This corolla occurs in many Composite plants, as in the florets of Dandelion, Daisy, and Chicory. The number of divisions at the apex indicates the number of united petals, some of which, however, may be abortive. Occasionally some of the petals become more united than others, and then the corolla assumes a *bilabiate*, or two-lipped form, as seen in the division of Compositæ called Labiatifloræ.

In Grasses and Sedges, in place of verticillate leaves forming the flower, there are alternate scales or glumes. The flowers of Grasses usually occur in spikelets (fig. 212), which consist of one or two glumes *a*, covering several flowers *b*. The spikelets are associated in spikes or panicles. In Wheat these spikelets are arranged alternately along a common rachis. Each spikelet consists of two empty glumes *a*, *a*, having the form represented in fig. 212, and enclosing flowers composed of scales (*palæ* or *glumellæ*), which are placed at different heights in an alternate manner. In the flower of the Oat (fig. 213), after removing the outer pale or *glumella*, the inner one *pi* is seen with two scales (*lodiculæ* or *squamæ*) *sq*, at the base, enclosing the essential organs of reproduction. The palæ of grasses are called by some flowering glumes, while hypogynous scales (lodiculæ) within them are considered as the rudimentary perianth. In Wheat (Triticum) there are two empty glumes and two flowering glumes, or, as some say, one flowering glume and one pale. In the Oat (Avena) there are two empty glumes, usually three flowering glumes with awns, and two lodicules representing the perianth. In Sedges (Carices) the male flowers are borne on scales, and so are the female, as shown in fig. 214, in which the scale *s* is placed on one side. Within the scale the female flower is situated, having a peculiar bag-like covering *u*, termed perigynium.

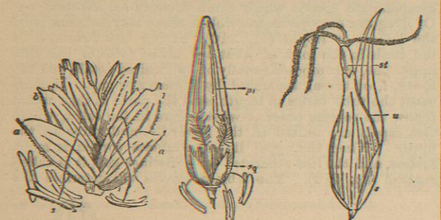

Fig. 212. Fig. 213. Fig. 214.

Fig. 212.—A spikelet of Wheat (*Triticum*), consisting of two glumes *a*, *a*, enclosing several flowers *b*, *b*, which are composed of two pales (palæ) covering the essential organs of reproduction. The stamens *s* hang out by long, slender, thread-like filaments. The individual glumes and palæ are placed alternately on the floral axis.

Fig. 213.—Flower of Oat (*Avena sativa*), with the two glumes, and the outer glumella or palea removed. The inner glumella, flowering glume, or palea *pi*, is seen, of a lanceolate form, and bidentate at the apex. By removing the outer glumella there are seen two scales (lodiculæ, squamæ) *sq*, with the three stamens and two feathery styles.

Fig 214.—Pistilliferous or pistillate flower of a Sedge (*Carex*) with a single glume or scale *s*. The pistil is covered by an urceolate glumaceous bag *u*, called perigynium. There is one style *st*, with three stigmas at its summit.

The parts of the corolla frequently adhere to those of the calyx, and any change in the latter causes also an alteration in the former. Petals are sometimes suppressed, and sometimes the whole corolla is absent. In Amorpha and Afzelia the corolla is reduced to a single petal, and in some other Leguminous plants it is entirely wanting. In the natural order Ranunculaceæ, some genera, such as Ranunculus, Globe-flower, and Pæony, have both calyx and corolla, while others, such as Clematis, Anemone, and Caltha, have only a coloured calyx. Flowers become double by the multiplication of the parts of the corolline whorl. This arises in general from a metamorphosis of the stamens. Union of separate flowers (*synanthos*) occasionally occurs, and the adhesion which thus takes place causes various changes in the whorls. Flowers may be united by their peduncles, as seen in some anomalous specimens of Dandelion, Hyacinth, and Centaury; or by their outer parts, such as the calyx. At other times there is a complete fusion, as it were, of all the parts of the flowers, some continuing normal, others being suppressed or abortive.

Certain abnormal appearances occur in the petals of some flowers, which received in former days the name of *nectaries*. The term nectary was very vaguely applied by Linnæus to any part of the flower which presented an unusual aspect, as the crown (*corona*) of Narcissus, the fringes of the Passion-flower, &c. If the name is retained it ought properly to include only those parts which secrete a honey-like matter, as the glandular depression at the base of the perianth of the Fritillary, or on the petal of Ranunculus, or on the stamens of Rutaceæ. The honey secreted by flowers attracts insects, which, by conveying the pollen to the stigma, effect fertilization. What have usually, however, been called nectaries, are mere modifications of some part of the flower, especially of the corolla and stamens, produced either by degeneration or outgrowth, or by *dilumination*, *chorisis*, or *deduplication*. Of this nature are the scales on the petals in Lychnis, Silene, Cynoglossum, and Ranunculus (fig. 202). Others consider these outgrowths of the petal to be formed in the same way as the ligules of Grasses. Corollas having these scaly appendages are sometimes denominated *appendiculate*. In Cuscuta and Samolus the scales are alternate with the petals, and may represent altered stamens. The parts formerly called nectaries are mere modifications of the corolla or stamens. Thus the so-called horn-like nectaries under the galeate sepal of Aconite (fig. 205) are modified petals, so also are the tubular nectaries of Hellebore (fig. 203). The nectaries of Menyanthes and of Iris consist of hairs developed on the petals. Those of Parnassia and the Passion-flower, Stapelia, Asclepias, and Canna, are fringes, rays, and processes, which are probably modifications of stamens; and some consider the crown of Narcissus as consisting of a membrane similar to that which unites the stamens in Pancratium. It is sometimes difficult to say whether these nectaries are to be referred to the corolline or to the staminal row. The paraphyses of the Passion-flower, the crown of Narcissus, and the coronet of Stapelia are referred sometimes to the one and sometimes to the other. In general, they may be said to belong to that series with which they are immediately connected. Some have given names indicating the parts of which they are modifications, by prefixing the term *para*, using such terms as *paracorolla* and *parastemones*.

Petals are attached to the axis usually by a narrow base, but occasionally the base is larger than the limb, as in the Orange flower. When this attachment takes place by an articulation, the petals fall off either immediately after expansion (*caducous*), or after fertilization (*deciduous*). A corolla which is continuous with the axis and not articulated to it, as in Campanula and Heaths, may be persistent, and remain in a withered or marcescent state while the fruit is ripening. A gamopetalous corolla falls off in one piece; but sometimes the base of the corolla remains persistent, as in Rhinanthus and Orobanche.

II. Essential Organs.

These organs are the *stamens* and the *pistil*, the latter containing the seeds or germs of young plants, and corresponding to the female, while the former produces a powder necessary for fecundation, and is looked upon as performing the part of the male. The presence of both is required in order that perfect seed may be produced. A flower may have a calyx and corolla, but it will be imperfect if the essential organs are not present. The name of *hermaphrodite* or *bisexual* is given to flowers in which both these organs are found; that of *unisexual* or *diclinous* to those in which only one of these organs appears,—those bearing stamens only, being *staminiferous* or male; those having the pistil only, *pistilliferous* or female. But even in plants with hermaphrodite flowers it is rare that self-fertilization takes place, and this is provided against by the structure of the parts or by the period of ripening of the organs. For instance, in Primula and Linum some flowers have long stamens and a pistil with a short style, the others having short stamens and a pistil with a long style. The former occur in what are called thrum-eyed Primroses, the latter in those called pin-eyed. Such plants are called *dimorphic*. Other plants are *trimorphic*, as species of Lythrum, and proper fertilization is only effected by combination of parts of equal length. In some plants the stamens are perfected before the pistil; they are called *proterandrous*, as in Ranunculus repens, Silene maritima, Zea Mays. In other plants the pistil is perfected before the stamens, as in Potentilla argentea, Plantago major, Coix Lachryma, and they are *proterogynous* plants. Plants in which proterandry or proterogyny occurs are called *dichogamous*. When in the same plant there are unisexual flowers, both male and female, the plant is said to be *monœcious* or *monoicous*, as in the Hazel and Castor-oil plant. This is indicated by the symbol ♂ – ♀. When the male and female flowers of a species are found on separate plants, the term *dioecious* or *dioicous* is applied, as in Mercurialis and Hemp, and the symbol ♂ : ♀ is used; and when a species has male, female, and hermaphrodite flowers on the same or different plants, as in Parietaria, it is *polygamous*, for which ♂ ♀ ☿ is the symbol.

1. *Male Organs in Phanerogams.*

The stamens (*stamina*) arise from the thalamus or torus within the petals, with which they alternate, forming one or more verticils or whorls, which collectively constitute the *androecium*, or the male organs of the plant. Their normal position is below the inner whorl or the pistil, and when they are so placed (fig. 215, *e*) upon the thalamus they are *hypogynous*. Sometimes they become adherent to the petals, or are *epipetalous*, and the insertion of both is looked upon as similar, so that they are still hypogynous provided they are independent of the calyx and the pistil. Frequently the margins of the thalamus bearing the floral envelopes and stamens elongates, and the gynœcium remains in the centre of the concave receptacle; thus the stamens as it were rise from the calyx, and they surround the ovary, and are *perigynous*; but when the ovary becomes completely inferior by the growing upwards and inwards of the receptacle, the parts of the flower rising from its summit, the stamens are *epigynous* (fig. 216). Numerous intermediate forms occur, especially amongst Saxifragaceæ, where the parts are *half superior* or *half inferior*. In the Orchis tribe, where the stamens become adherent to the pistil so as to form a column, the flowers are said to be *gynandrous*. The same is the case in Aristolochia (fig. 217). These arrangements of parts are of great importance in classification. The stamens vary in number, from one to many hundreds. Like the other parts of the flower they are modified leaves, resembling leaves in their structure, development, and arrangement. They consist of cellular and vascular tissues. They appear at first in the form of cellular projections, and are arranged in a more or less spiral form. In their general aspect they have a greater resemblance to petals than to the leaves, and there is often seen a gradual transition from petals to stamens, especially in spiral flowers, as Nymphæa alba. When flowers become double by cultivation, the stamens are converted into petals, as in the Pæony, Camellia, Rose, &c. When there is only one whorl the stamens are usually equal in number to the sepals or petals, and are arranged opposite to the former, and alternate with the latter. The flower is then *isostemonous*. When the stamens are not equal in number to the sepals or petals, the flower is *anisostemonous*. When there is more than one whorl of stamens, then the parts of each successive whorl alternate with those of the whorl preceding it. The staminal row is more liable to multiplication of parts than the outer whorls. A flower with a single row of stamens is *aplostemonous*. If the stamens are double the sepals or petals as regards number, the flower is *diplostemonous*; if more than double, *polystemonous*. The additional rows of stamens may be developed in the usual centripetal (acropetal) order, as in Rhamnaceæ; or they may be interposed between the pre-existing ones or be placed outside them, *i.e.*, develop centrifugally (basipetally), as in Geranium and Oxalis. When the stamens are neither equal to, nor a multiple of, the floral envelopes, but are less numerous, the flower is *miostemonous*. When the stamens are fewer than twenty they are said to be *definite*, and the flower is *oligandrous*; when above twenty they are *indefinite* or *polyandrous*, and are represented by the symbol ∞. The number of stamens is indicated by the Greek numerals prefixed to the term *androus*; thus a flower with

1 stamen is Monandrous (Hippuris, Centranthus);
2 stamens is Diandrous (Veronica, Calceolaria, Circæa);
3 stamens is Triandrous (Grasses, Iris, Valeriana);
4 stamens is Tetrandrous (Alchemilla, Galium, Plantago);
5 stamens is Pentandrous (Primula, Umbelliferæ, Campanula);
6 stamens is Hexandrous (Tulip, Lilium, Juncus);
7 stamens is Heptandrous (Trientalis, Horse-chestnut);
8 stamens is Octandrous (Heath, Fuchsia, Epilobium);
9 stamens is Enneandrous (Butomus, some Lauraceæ);
10 stamens is Decandrous (Saxifrage, Dianthus, Oxalis);
12 stamens is Dodecandrous (Asarum, Agrimonia, Reseda);
20 stamens is Icosandrous (Strawberry, Potentilla, Cratægus);
Numerous and indefinite stamens is Polyandrous ∞ (Poppy).

The simplest form of stamens is seen in Cycadaceous plants, where cataphyllary leaves (the scales of the cone) are the staminal leaves, bearing the pollen-sacs scattered over their under surface. The stamen usually consists of two parts, a contracted portion, often thread-like, termed the

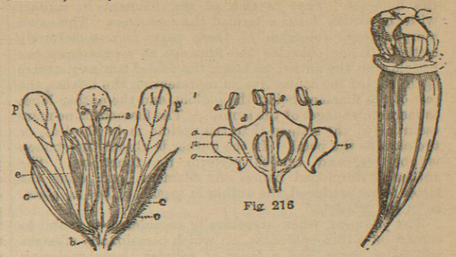

Fig. 215. Fig. 216 Fig. 217.

Fig. 215.—Section of a flower of *Geranium Robertianum*. *c*, *c*, calyx: *p*, petals: *e*, stamens. The pistil is composed of ovary *o*, and style and stigmata *s*. *t* is the torus or thalamus. The petals and stamens are hypogynous, and the latter are monadelphous.

Fig. 216.—Section of the flower of *Aralia spinosa*. Letters as in last figure. The petals and stamens are epigynous, attached to the torus *d*, which covers the summit of the ovary. The ovary is adherent to the torus, and has been laid open to show its loculaments and pendulous ovules.

Fig. 217.—Essential organs of Birthwort (*Aristolochia*). Above the ovary *b*, are the stamens united in a column with the style at *a*, so as to be gynandrous. On the summit is the stigma above the stamens.