UNITY IN VARIETY

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AS

Deduced from the Vegetable Kingdom;

BEING

AN ATTEMPT AT DEVELOPING THAT ONENESS WHICH IS DISCOVERABLE
IN THE HABITS, MODE OF GROWTH, AND PRINCIPLE
OF CONSTRUCTION OF ALL PLANTS.

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PREFACE.

THE present work has resulted from a somewhat protracted study of the modes in which vegetable structures increase themselves by growth; the external appearances of plants during their enlargement was carefully considered, as well as the principles upon which their enlargement is dependent. This inquiry had not long been pursued, before the author was impressed with the oneness of principle which pervaded all the works of the floral creation, and with the importance of a knowledge of this fact, and of the manner in which it can be traced throughout the vegetable kingdom, and, indeed, throughout all nature. The importance of this knowledge became more and more manifest, till ultimately the conviction forced itself upon the author's mind, that no view of the vegetable kingdom could be got which tended more to expand the intellect, and elevate man to his true dignity, than that which is taken from the most lofty eminence, and looks down upon all members of the great system of vegetable creation, and regards their mutual relations.

This view of the vegetable kingdom necessarily brings forward many considerations which tend much to simplify the study of scientific botany in all its branches; hence it is of the greatest importance to the student: general principles are here traced out amidst numberless isolated facts, and great truths deduced from apparently trifling incidents.

A special or primary advantage is also gained from this view of nature; for by it the student becomes acquainted with those general principles upon which all plants grow, and, as he extends his knowledge, he becomes familiar with other laws, all of which are of wide general application, till ultimately he branches into minor considerations, which relate to special cases or individuals. To more fully illustrate the intention of the last clause, a figure may be employed: thus, the first great principle may be figuratively set forth by the small circular wave which is caused by a stone being cast into water, and each succeeding principle by the successive annular circles which rise around that first wave, in obedience to those laws which govern all things with which we are acquainted. The circles become augmented, and appear as a wide-spreading series, which know no interruption, and present no break, till they reach the recesses between the prominences of the coast, when the great circle is broken, and one part extends up one recess, and one up another; yet it must be remembered that it is a circle still, although in parts. So with our subject; principle after principle is considered, which, collectively, form a regular series, passing from that which occupies the most central position outwards, till ultimately the general principle appears to become broken, in order to meet individual cases; yet still it is a circle, although that circle is in parts. Then, wherever our knowledge may cease, it is still perfect as far as it goes, and does not consist in the possession of a few isolated facts which bear little relation to each other.

Desirable as it may be to get the general view of the works of creation with which this volume specially deals, it must be remembered that it cannot be got with advantage without, at least, an elementary knowledge of the principles of botany. For this reason the author first prepared a "Rudiments of Botany," being an introduction to the study of the vegetable kingdom, which it is hoped will be found to yield that information which is most required by the student, in order to his satisfactory progress. It also contains a slight glance at the theme of the present work, which, it is hoped, will prepare the mind for that extension of the subject which will be found in the present volume. Then, after mastering the "Rudiments," the student may safely pass to the present work, which is a deduction from the former.

The conviction that such a work as the present should succeed a "Rudiments," tempted the author to employ a certain amount of technical phraseology, which, though fully explained in the "Rudiments," and familiar to every botanical student, will compel those who would read the present work, to gain first a little knowledge of the botanical science (unless that is possessed already), the possession of which alone can render the contents of this volume useful to them. While, then, this volume is not intended as a *first* book in botany, it is intended as a *second;* and it is hoped that a consideration of its contents will conduce to the rapid progress of the young student. And although it is intended, as has just been shown, for *students,* yet, as it is the only work on the subject, to the knowledge of the author, it is humbly hoped that those who have mastered a "second book" may be tempted to honour us by a glance at its contents.

It must, however, be remembered that the present work purports only to direct the mind in a given course, and to introduce it to a field of labour to which many have called attention; it does not pretend to exhaust the subject, or even to enter fully into it, for many branches are here left altogether unexamined—it professes only to open up a line of thought which is of advantage to the student, and which he must work out and extend for his own benefit.

In order to the prosecution of this branch of study, and, in fact, of any branch of botany, it is obvious that nature must be resorted to. The botanist must live amidst plants, and daily and hourly study their forms, and the principles upon which their growth is dependent. He must endeavour to elicit from nature, by his constant attendance upon her, the secrets of her hidden workings; the field, the wood, the heath, the bank, the garden, must be his home; he must study vegetable nature earnestly, devotedly, and yet with humility, as a humble, teachable student, desiring to gain all possible knowledge from the great book of nature. Books are good, for they teach what is now known of plants; but even this cannot be correctly understood, or properly appreciated, without the reader himself goes to the great source from the study of which our knowledge has proceeded, and they are most unlikely to teach any lesson, or any law, which has not been learned or understood before. Hence, it is scarcely more preposterous to think of living without food, than it is to dream of becoming learned in the botanical science without studying nature.

The considerations of the view of the vegetable kingdom contemplated in the present work are of value in another point of view; for while we trace a unity amidst all the works of creation, the mind, by an effort of its own, informs us that *one* system resulted from *one* intelligence, and thus the heart is led up from the manifold works of the beauteous creation to the one God who rules over all.*

The author has received valuable assistance in the present volume from Dr. Hooker, the authorities of the British Museum, and other gentlemen, which he desires respectfully to acknowledge.

The present work has been somewhat copiously illustrated, in order to aid as fully as possible the tyro, or those who are going through a novitiate period. The chief illustrations are quite new, having been prepared expressly for this work: of these, Fig. 53 was drawn by the author's respected colleague in the training school of the Department of Science and Art, Mr. Collinson; Figs. 41, 42, 43, and 44, are the

* The author here has in view the idea that the present considerations of nature tend to rebut the doctrine of the plurality of gods, as taught by ancient philosophy, but not the doctrine of the Trinity, which he considers as here confirmed by the consideration of that unity in nature which is made up of parts inseparably linked together by the very laws which govern all created things.

work of the old and much respected fellow-student of the author, Mr. J. Cuthbert, of Hugh Street, Pimlico; and Figs. 45, 46, 47, and 48, are by Mr. C. Armytage, of Albion Grove, Islington, also an old and respected fellow-student. The powers of these gentlemen need not be extolled by words, for their works do that; the author would simply thank them most heartily for their great kindness in thus rendering most valuable aid. The remainder of the new illustrations are by the pencil of the author. Some of the cuts have been borrowed, as has been already implied—thus, Figs. 1, 2, 4, 5, 6, 7, 49, 50, 51, 260, 261, and 297 (twelve in all), are from the *Art-Journal;* Figs. 8, 9, 10, 11, 12, have been procured from Dr. Scoffern's "Botany," by Cassell; and the remainder of those which do not appear for the first time in this book are borrowed from the "Rudiments." The whole of the new cuts have been engraved by Mr. Howard Dudley, of Holford Square, Pentonville, whose powers and kindness I cannot too much extol; with the exception of Figs. 45 and 46, which are by Mr. R. C. West, of the Harrow Road: to these gentlemen, with Mr. Virtue and those artists already named, the appearance of this work is due, for which the author tenders them his best thanks.

DEPARTMENT OF SCIENCE AND ART,
SOUTH KENSINGTON MUSEUM,
April 16th, 1859.

UNITY IN VARIETY.

DEDUCED FROM THE VEGETABLE KINGDOM.

CHAPTER I.

ON THE SIMILARITY WHICH EXISTS BETWEEN ALL PLANTS AT SOME PERIOD OF GROWTH.

1. Plants are organized beings, possessed of a power of growth.

2. The extent to which various vegetable objects develop, by virtue of this power, is extremely various.

Thus the *Protococcus* is an individual consisting of one cell only,* this constituting the entire living organism; however, this simple structure ultimately becomes divided into four cells, each of which is then a living individual. The *Oscillatoria spiralis* is a simple vegetable thread, formed by cells cohering at their extremities. Similar threads are united

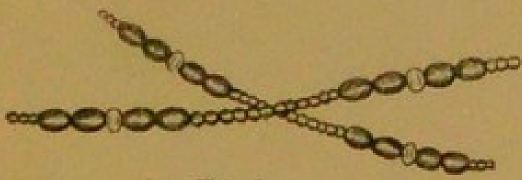

Fig. 1.

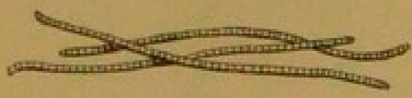

Fig. 2.

so as to form meshes, as those of a net, in *Hydrodictyon,* and plates in *Ulva,* or the cells are united into masses in *Laminaria*

Fig. 1.—*Sphærozyga Berkeleyana* (two plants are here shown), an extremely simple form of plant, consisting of cells touching at their extremities. It belongs to the order Confervaceæ, and the alliance of Algals, and to the class of Thallogens.

Fig. 2.—*Oscillatoria nigro-viridis* (three plants are shown in our figure). This exceedingly simple vegetable structure consists of cells united by their extremities into little threads. It belongs to the order Confervaceæ, of the Algal alliance, and to the class of Thallogens.

Fig. 3.—Magnified representation of a cell.

Fig. 3.

* A cell is a little bladder-like body (*Fig.* 3), which may be compared to a soap-bubble. The tissue of which the cell is formed is elastic, irritable, adhesive, and extensible; it also possesses vitality, and is highly hygrometrical.

Agaricus. This process of development increases in complexity till ultimately we have such cellular formations as those of the Mushroom (*Agaricus*); these, however, are only cellular plants, but soon vessels also appear, then a fully formed leaf, and, ultimately, an organized flower.

The progress of development in the vegetable kingdom is set forth to an extent by *Figs.* 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12.

Fig. 4.

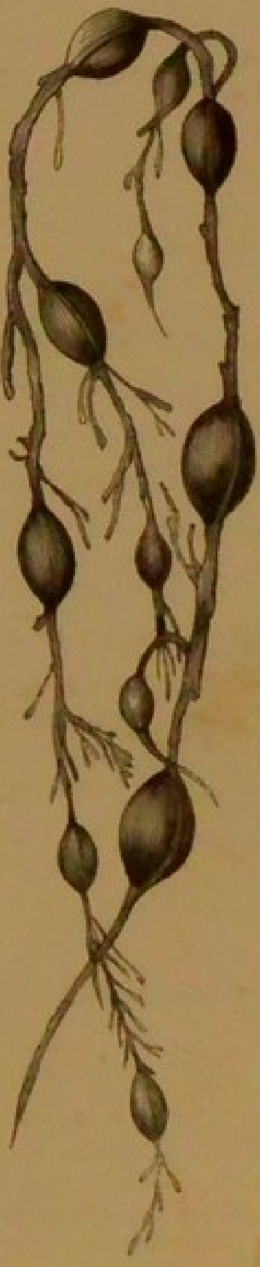

Fig. 5.

Fig. 4.—*Dictyota atomaria*, a species of sea-weed. It belongs to the order Fucaceæ, to the alliance of Algals, and to the class of Thallogens.

Fig. 5.—*Fucus nodosus*, a common species of sea-weed. It also belongs to the order Fucaceæ, and the Algal alliance.

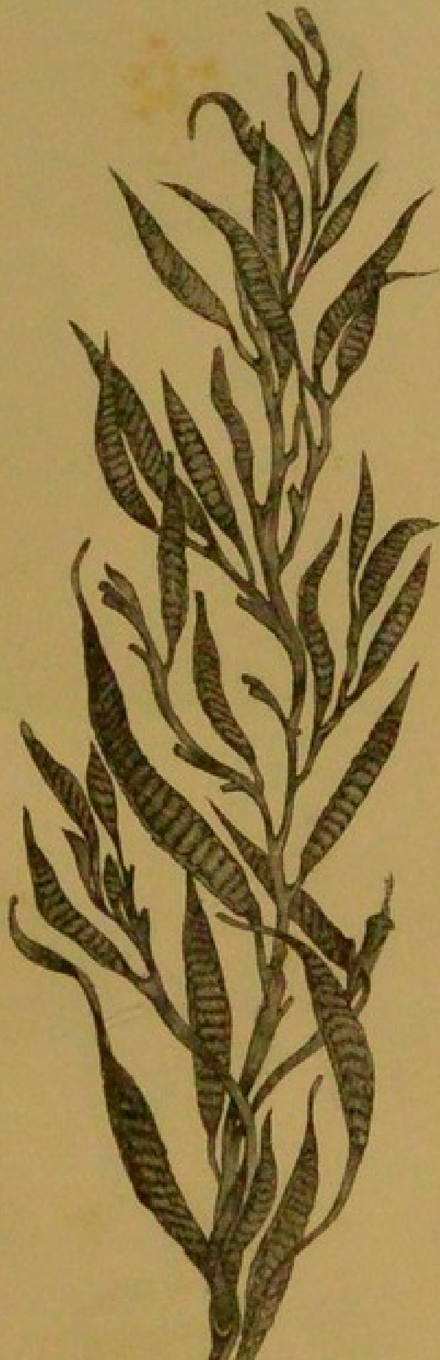

Fig. 7.

Fig. 6.

Fig. 6.—Portion of *Desmarestia ligulata*, a species of sea-weed. It belongs to the natural order Fucaceæ.

Fig. 7.—*Halidrys siliquosa*, a species of sea-weed. It also belongs to the natural order Fucaceæ.

Fig. 8.

Fig. 9.

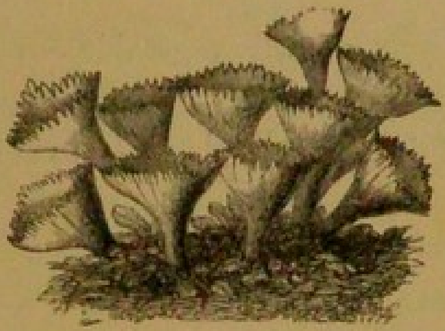

Fig. 10.

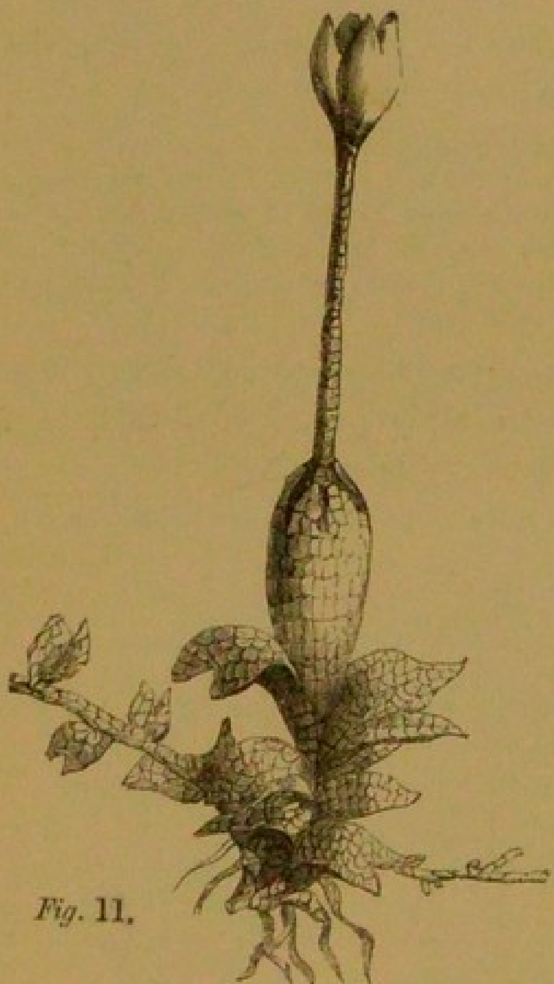

Fig. 11.

Fig. 12.

Fig. 8.—*Agaricus Muscarius*, Fly-blown Agaric (small specimen). This plant belongs to the natural order Agaricaceæ, of the Fungal alliance, of Thallogens. It may be considered as the next alliance in advance of Algals.

Fig. 9.—*Marchantia Polymorpha*, Star-headed Liverwort. It belongs to the natural order Marchantiaceæ, of the Muscal alliance, of the class of Acrogens, which class is in advance of Thallogens.

Fig. 10.—*Cladonia Fimbriata*, Fringed Cup-Moss. This plant belongs to the Lichenal alliance, of the class of Thallogens, which may be regarded as the next alliance in advance of that of Fungals.

Fig. 11.—*Jungermannia Turbinata*, Pear-shaped Scale-Moss. This plant belongs to the order Jungermanniaceæ, of the Muscal alliance. This plant is a little in advance of our last figure.

Fig. 12.—Hair-Moss (*Polytrichum*). It belongs to the order Bryaceæ (Urn Mosses), the alliance of Muscals, and the class of Acrogens. It is in advance of our last figure.

3. The prototype of all vegetable structures is a cell (*Fig.* 3).

4. As the prototype of all plants is a cell,* the units of all vegetable structures are similar; or, all vegetable objects when in their first state are uniform.

The unit of all vegetable structures is a cell, or every plant is at first a cell, which may ultimately be added to, to any extent.

5. And they are all influenced, more or less, by that vital force which causes them to grow.

This growth of the original cell, or protoplast, takes place to a very variable extent, as is shown by the note to Prop. 2; thus the growth of a unicellular plant simply enlarges the cell of which it consists, and ultimately causes it to separate into a given number of new individuals; in other cases, by growth, the original cell is multiplied, either to a small extent or indefinitely.

6. Thus all plants may be regarded as coincident, some of which are arrested at an early period of development, while others evolve to a considerable extent.†

Thus, the form manifested in the *Protococcus* (see note to Prop. 2), is the

* There are frequently crystals in the cells of plants; thus, in those of the Dock (*Fig.* 13) there are groups of acicular or needle-like crystals (raphides). Also the cells of the Beet-root (*Fig.* 14) contain conglomerate crystals. These crystals tend to link the vegetable with the mineral kingdom.

† This principle of the growth being arrested at various periods, also applies to the different parts of plants. Thus a capitulum (*Fig.* 15) may be regarded as a spike (*Fig.* 16), the develop-

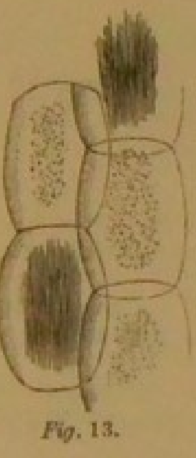

Fig. 13.

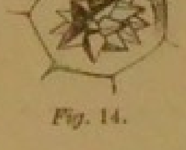

Fig. 14.

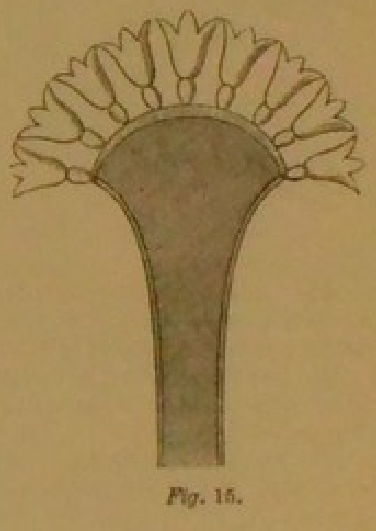

Fig. 15.

Fig. 13.—Cells from the Dock (*Rumex*), containing raphides, or crystals.
Fig. 14.—Cells from the root of the Beet (*Beta vulgaris*).
Fig. 15.—Ideal sectional figure of a capitulum.

original or simple form of all vegetable objects, and its development

ment of which has been arrested; a spike, as a raceme (*Fig.* 17), the development of which has been stopped; and a raceme, as a panicle (*Fig.* 18), the growth of which has been restrained.

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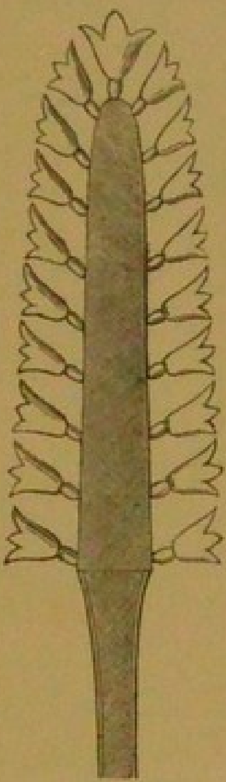


Fig. 16.

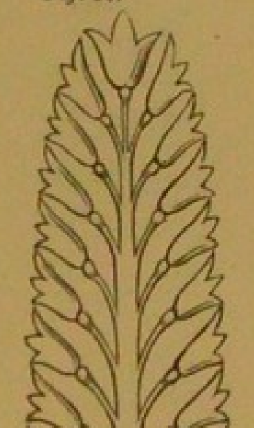


Fig. 17.

Fig. 18.

Fig. 16.—Ideal sectional figure of a spike.
Fig. 17.—Ideal sectional figure of a raceme.
Fig. 18.—Panicle of Sycamore (*Acer Pseudoplatanus*).

may be regarded as arrested at the very commencement of growth,

The entire leaf (*Fig.* 19) may also be regarded as a toothed leaf (*Fig.* 20), the development

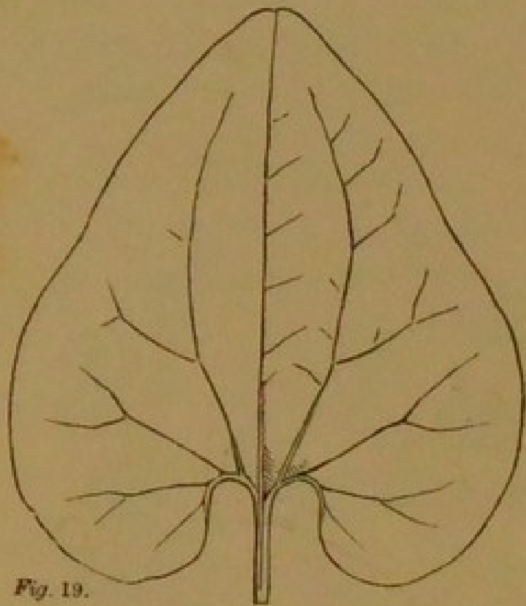


Fig. 19.

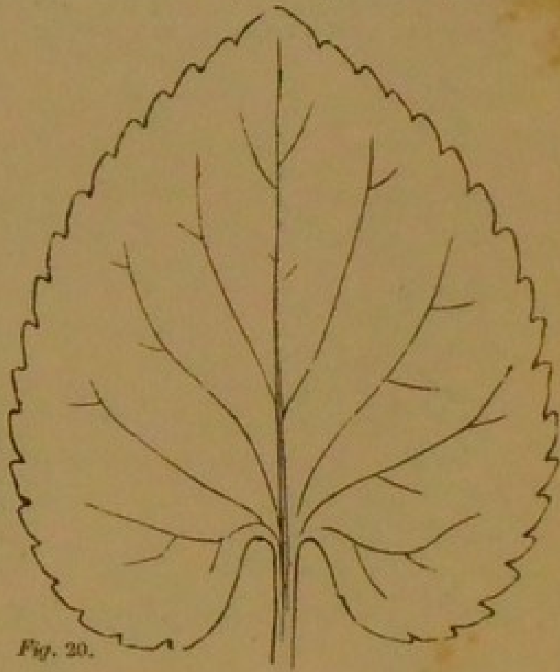


Fig. 20.

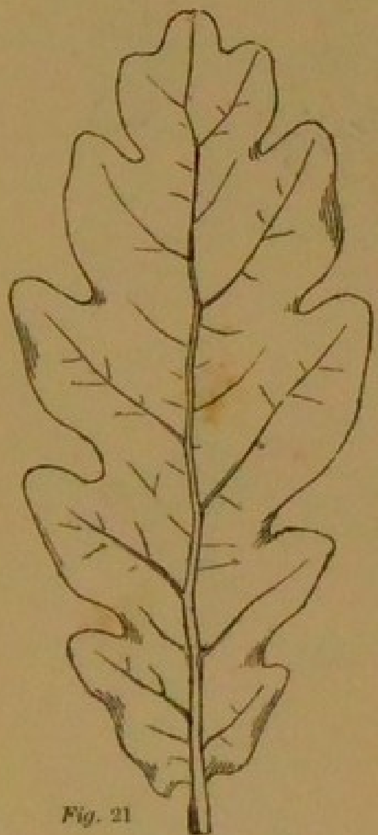


Fig. 21

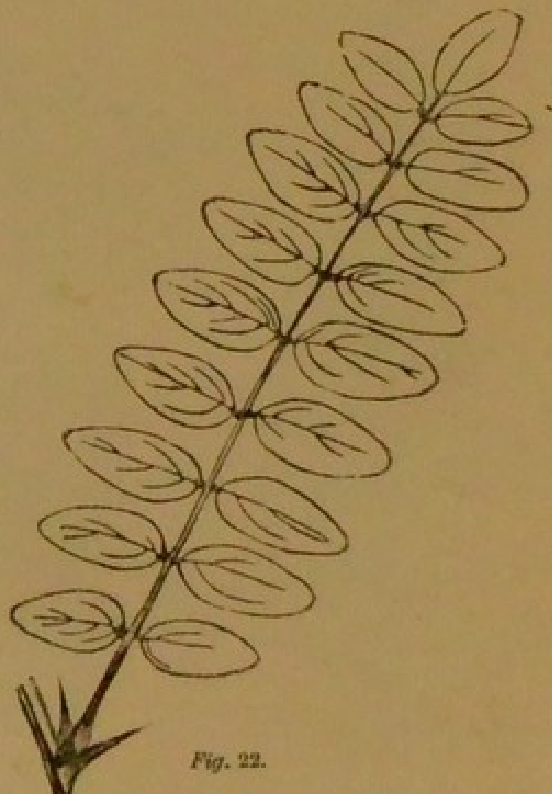


Fig. 22.

Fig. 19.—Leaf of the Birthwort (*Aristolochia Clematitis*), which is entire, or undivided.
Fig. 20.—Leaf of the Sweet Violet (*Viola odorata*), which is serrated, or toothed.
Fig. 21.—Leaf of Common Oak (*Quercus pedunculata*), which is lobed.
Fig. 22.—Leaf of *Robinia*, which is compound (pinnate).

whereas the *Oscillatoria* develops a little further before its growth is arrested; the *Hydrodictyon* further still, and so on.

7. Or the rudimentary condition of one plant may be considered as the ultimate condition of another.*

of which has been checked; a toothed, as a lobed leaf (*Fig.* 21), the evolution of which has been arrested; and a lobed, as a compound leaf (*Fig.* 22) partly developed.

The orthotropous ovule (*Figs.* 23, 24) may also be regarded as a campylotropous ovule (*Fig.* 25), the development of which is arrested, and so on.

* This also applies to the parts of plants; thus the unifloral cyme, as that of the Pansy (*Fig.* 26), may be regarded as a bifloral cyme, as that of the Convolvulus (*Fig.* 27), or as a polyfloral cyme, which is found in the Cerastium (*Fig.* 28), and so on.

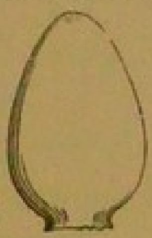
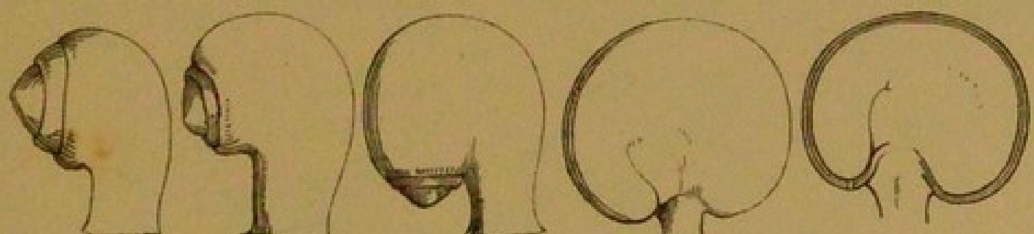


Fig. 23.

Fig. 24.



1. 2. 3. 4. 5.

Fig. 25.

Fig. 26.

Fig. 27.

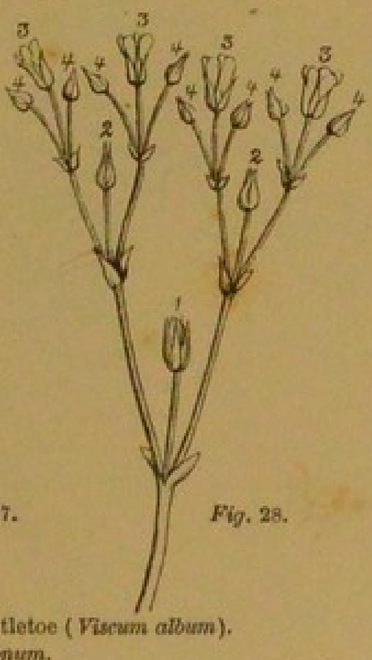


Fig. 28.

Fig. 23.—Orthotropous, or orthotropal, ovule of the Mistletoe (*Viscum album*).

Fig. 24.—Orthotropous, or straight, ovule of the *Polygonum*.

Fig. 25.—Various stages in the development of the campylotropous ovule of the Mallow (*Malva*); 1. being the youngest and 4. the oldest; 5. is a section.

Fig. 26.—Unifloral cyme of the Pansy (*Viola tricolor*). *e*, bracts. For further detail see "Rudiments," Props. 831, 844, 848.

Fig. 27.—Bifloral cyme of the Field Convolvulus (*Convolvulus arvensis*). *b*, bracts. The bud in the axil of one is undeveloped.

Fig. 28.—Polyfloral cyme of the Mouse-ear Chickweed (*Cerastium*). The flower 1. opens first, the flowers 2. second, 3. third, and so on.

Thus, the rudimentary condition of a higher plant is the ultimate condition of a lower; the rudimentary condition of the *Conferva Monilia* is the ultimate condition of the *Protococcus*, and so on.

8. Hence all plants, at some period of their lives, are coincident, for which reason there is a unity existing between all vegetable structures.

CHAPTER II.

ON THE SIMILARITY OF THE MODE OF GROWTH OF ALL PLANTS.

9. It has now been shown that plants at given periods of their lives are similar. This similarity is departed from by growth or development, as has been implied (Prop. 6).

10. And experience teaches that the ultimate conditions of vegetable structures are exceedingly unlike: nevertheless,

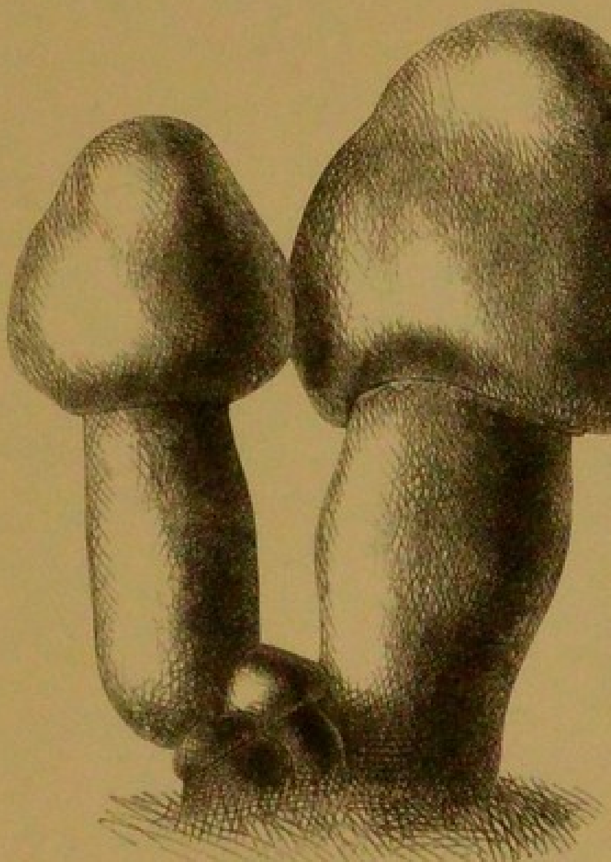


Fig. 29.

the principle upon which they all increase or grow is identical.

Fig. 29.—A species of *Agaricus*. It represents the class of Thallogens.

A Fungus (*Fig.* 29), a Fern (*Fig.* 30), a Grass (*Fig.* 31), and a Geranium (*Fig.* 32), may be said to give the distinctly different forms of vegetation.

11. Thus, all vegetables increase by developing in a centrifugal manner.

If the lower classes of plants be consulted, as Lichens and Fungi, which develop little in height, we find that their growth is merely a regular radiation from a common centre outwards in a more or less horizontal manner (*Fig.* 33). This principle of growth is manifest in what is called the "fairy-ring" (*Fig.* 34), which is a circle formed by Mushrooms in meadows; its origin is this: a Mushroom plant appears and generates its myselium or spawn in a regular concentric manner, at various points on the

Fig. 31.

Fig. 30.

Fig. 30.—Common Polypody Fern (*Polypodium vulgare*). It represents the class of Acrogens.

Fig. 31.—Ear of Spelt (*Triticum Spelta*), which represents the class of Endogens.

Fig. 32.

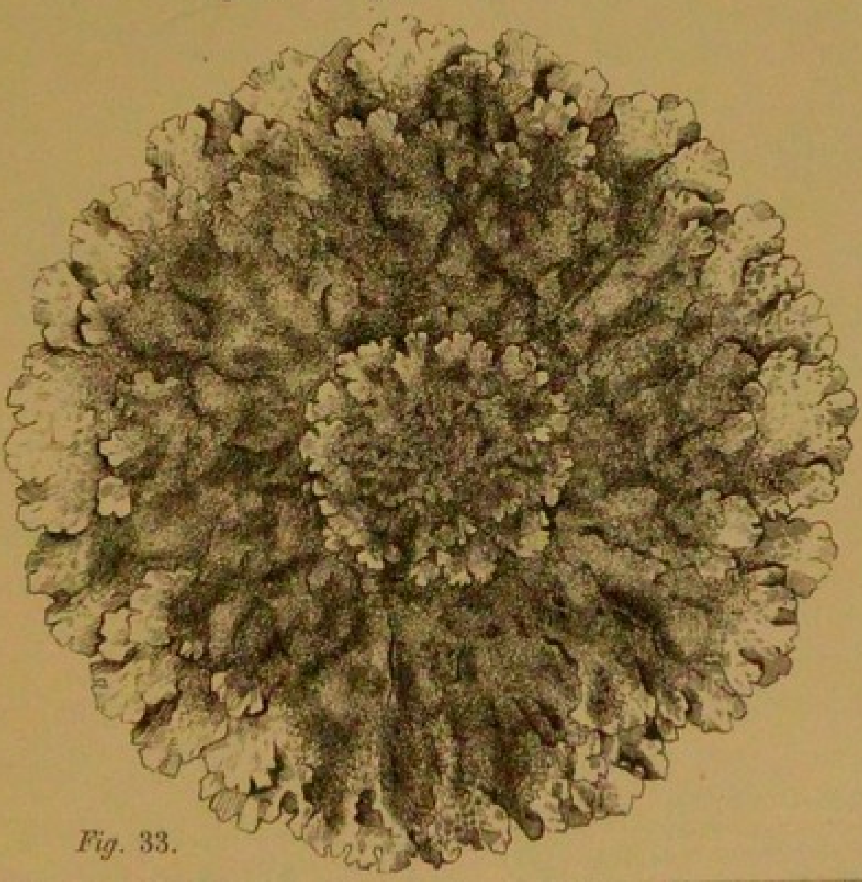


Fig. 33.

Fig. 32 —*Erodium cicutarium*, a Wild Geranium. It represents the class of Exogens.
Fig, 33.—*Parmelia saxatilis*.

circumference of which new plants are generated; the parent plant now dies, and the ring only remains, which is the "fairy-ring."

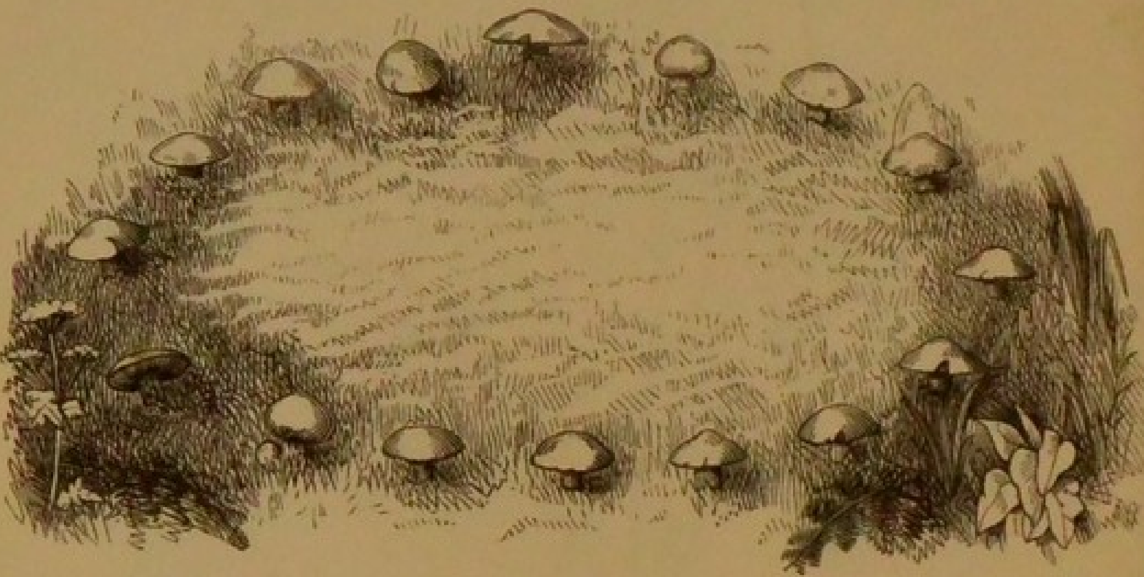


Fig. 34.

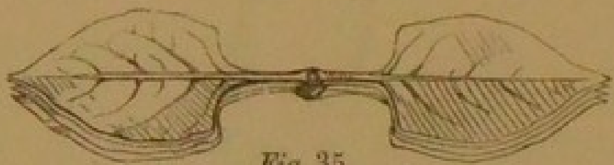


Fig. 35.

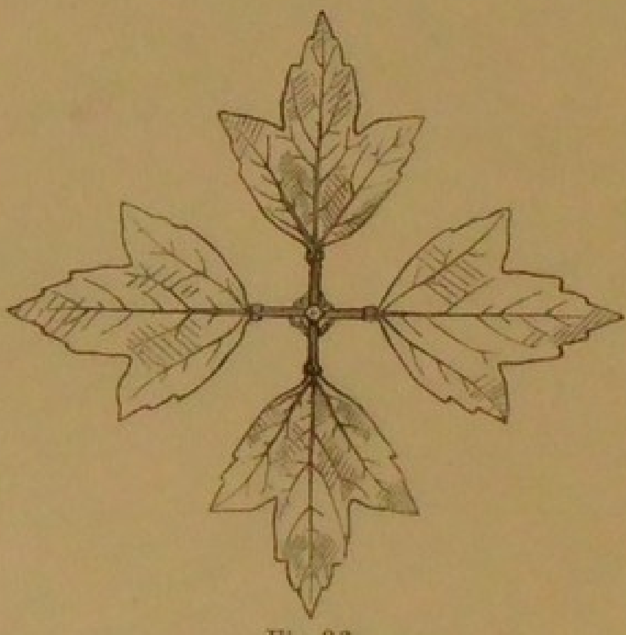


Fig. 36.

Fig. 34.—Fairy Ring.
Fig. 35.—*Polygonum cuspidatum.* Top view of a portion of a branch.
Fig. 36.—Guelder Rose (*Viburnum Opulus*). Top view of a portion of a branch.

If we examine more perfectly developed structures, which increase perpendicularly as well as horizontally, we find that all branches proceed from an elongated centre, viz., the central or primary ascending axis of the plant.

Every primary branch is also a centre to its particular branches, and every

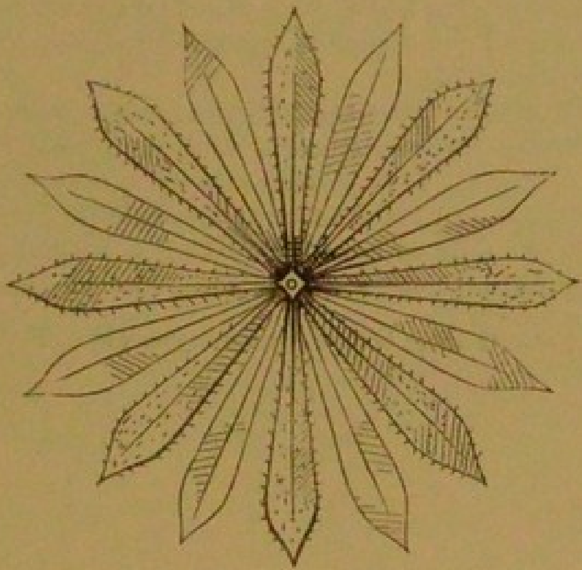


Fig. 37.

twig to its leaves. The trunk of a tree may be said to bear the same relation to the branches, in this respect, that the sun does to the solar

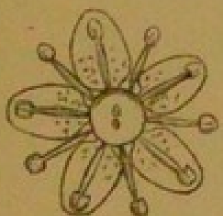


Fig. 38.

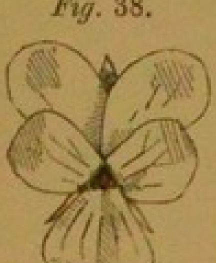


Fig. 40.

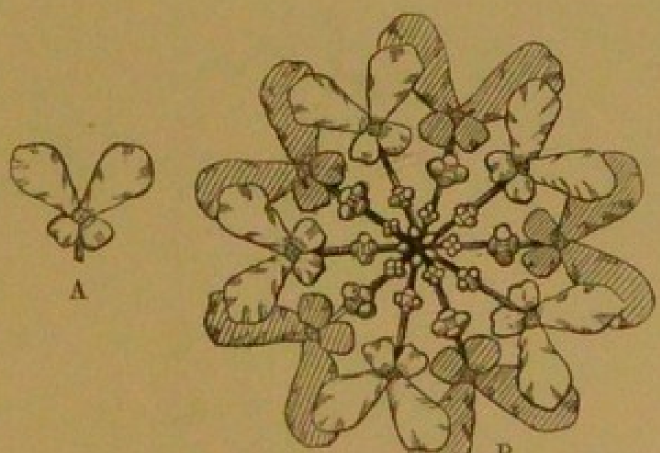


Fig. 39.

system, and the primary branches to their members that the planets do to their satellites.

Fig. 37.—Goose-grass (*Galium Aparine*). Top view of a portion of a branch.
Fig. 38.—London Pride (*Robertsonia umbrosa*).
Fig. 39.—Candy Tuft (*Iberis umbellata*). A, a flower. B, top view of inflorescence.
Fig. 40.—Flower of the Pansy (*Viola tricolor*).

It matters not what may be the principle of disposition in which the lateral organs are arranged, for whatever their arrangement may be, our proposition evidently holds good. If the leaves and branches are developed alternately, they proceed in opposite directions from a centre (*Fig.* 35), and never in one direction only; if they are opposite, they usually proceed in four or more ways from a common centre (*Fig.* 36), and in spiral and verticillate leaves this radiation is also prominently manifest (*Fig.* 37).

The parts of a flower also radiate from a common centre (*Fig.* 38), which is obvious, experience set aside, when we consider that a flower is a stunted branch. In some cases, however, by the abnormal development of certain floral parts, the flower loses that regular radiating symmetry which it usually possesses.* We have an illustration of this in the Candy Tuft (*Fig.* 39), where the flower does not consist of a series of

* That class of symmetry which is most common in plants is least common in animals;

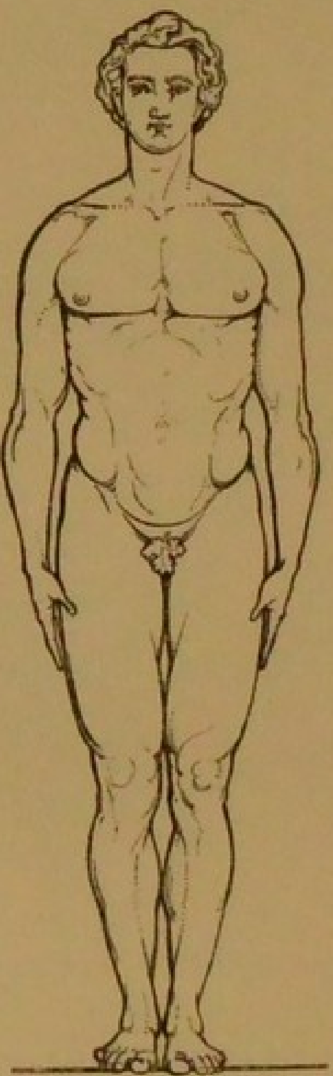


Fig. 41.

Fig. 41.—Front view of Man (*Bimana*).

similar units, but has its halves only alike; here, however, this regular

thus, the majority of plants consist of a series of similar arms radiating from a common

Fig. 42.

Fig. 43.

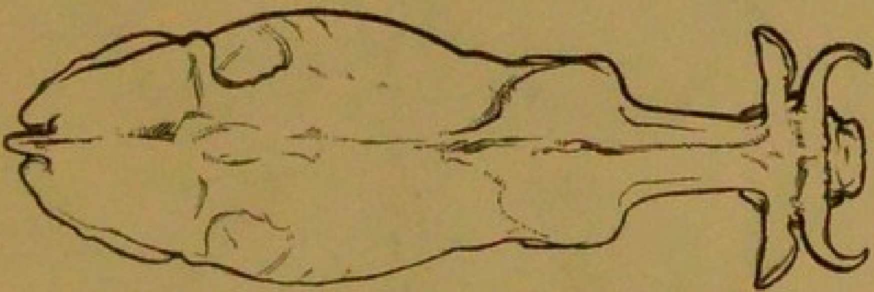


Fig. 44.

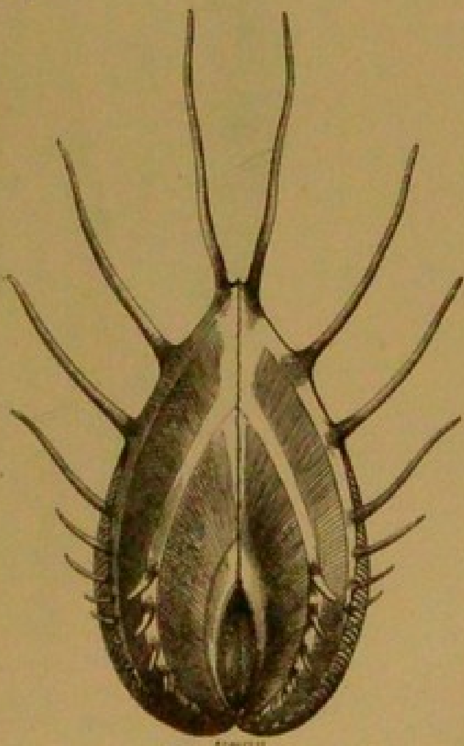


Fig. 45.

Fig. 42.—Front view of Cow (*Bos Taurus*).

Fig. 43.—Back view of Cow.

Fig. 44.—Top view, or plan, of Cow.

Fig. 45.—*Dione Veneris*, a bivalve shell.

radiating symmetry is restored by the flowers being arranged in rings, and, in all cases, having one end of that line which would separate the like halves of the flower directed to the centre of the ring, and

centre (*Figs.* 36, 37, 38), the exception being when only the two sides are alike (*Fig.* 40);

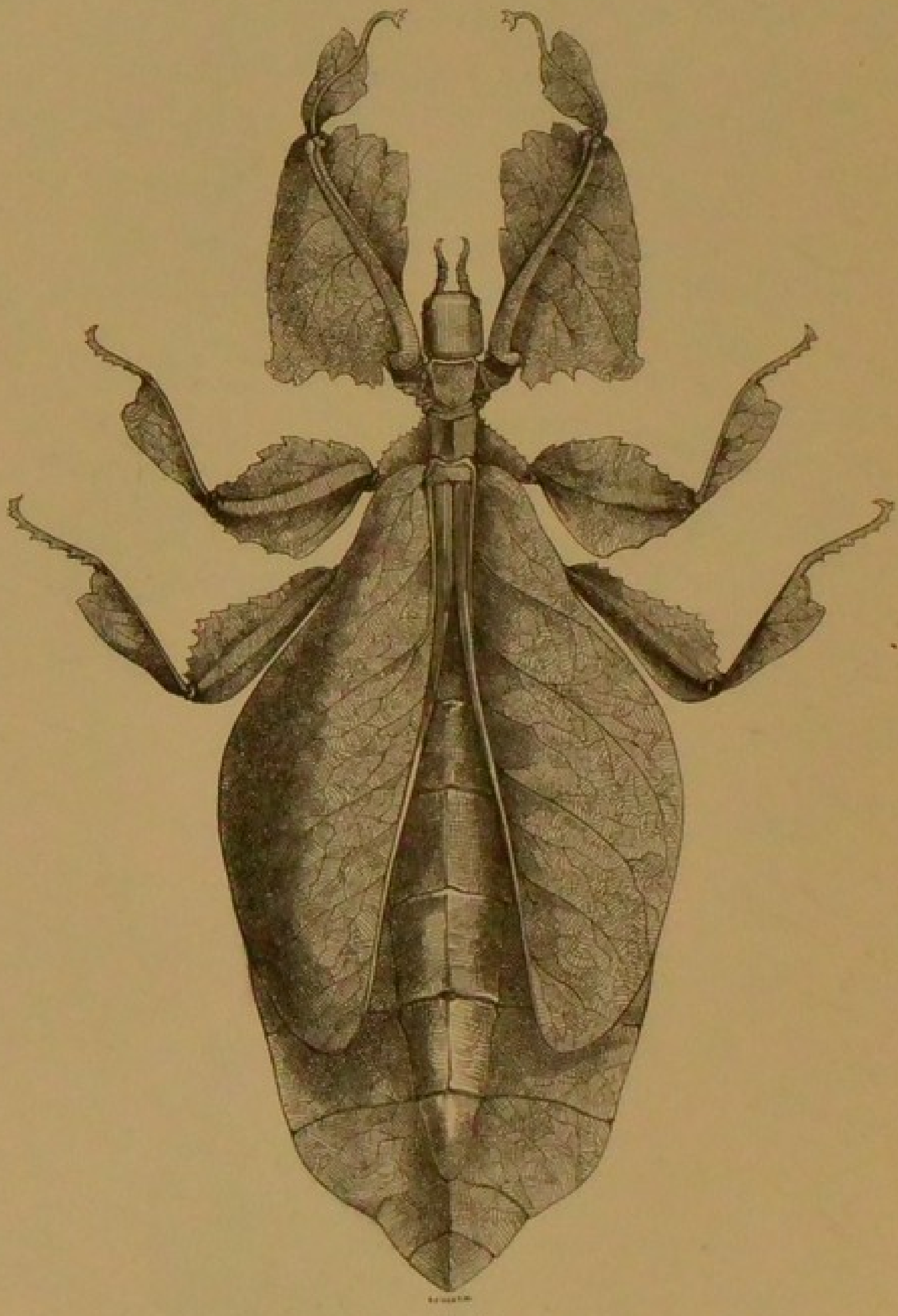


Fig. 46.

Fig. 46.—*Phyllium Scythe*, the Leaf Insect.

the other to its circumference, like the radii of a circle. The only deviations from this rule appear to be in those cases where one of these comparatively dissymmetrical flowers stands alone, as in the Violet (*Fig.* 40), in which case, however, the flower does not lie hori-

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whereas in animals the two halves only are usually alike (*Figs.* 41, 42, 43, 44, 45, 46, 47),

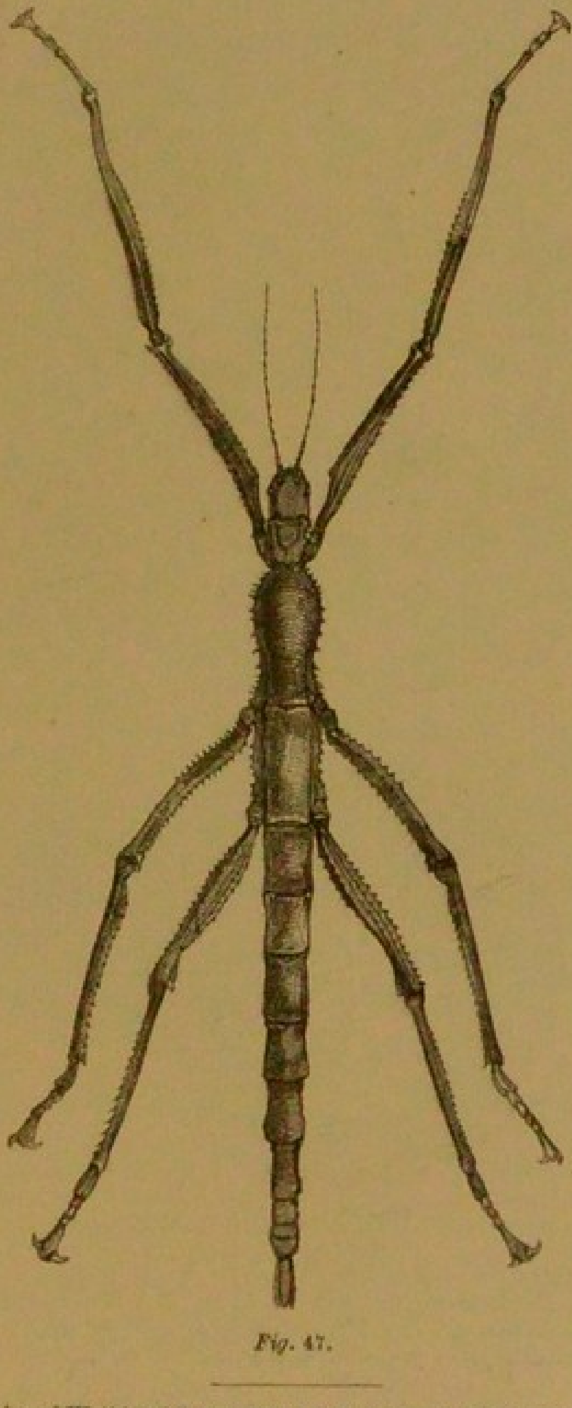


Fig. 47.

Fig. 47.—A species of Walking Stick, *Phasma* (*Phibalosoma*) *Pythonius* (*Westwood*), female, one-third of natural length.

zontally, but stands vertically; nevertheless, the parts of

the exceptions being those cases which consist of a series of similar members (*Figs.* 48, 49, 50, 51).

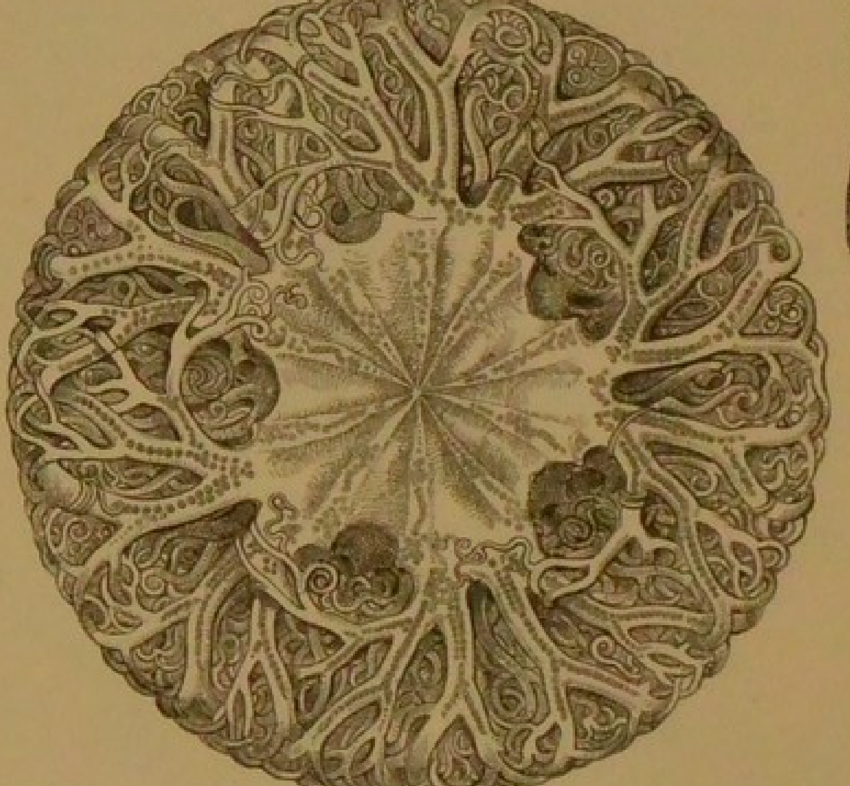


Fig. 48.

Fig. 49.

Fig. 50.

Fig. 48.—*Astrophyton*, a species of Star Fish.

Fig. 49.—*Cidaris Blumenbachii*, found in the Jura. This is a fossil belonging to the class Radiata, and illustrates the radiate form of animal structure. This cut is from a paper published in the *Art-Journal* by Professor Hunt.

Fig. 50.—*Encrinites moniliformis*, or Lily Encrinites, a fossil belonging to the Radiate class. This cut is also from Professor Hunt's paper in the *Art-Journal* on fossil plants and animals.

the flower in question do radiate from a common centre, only the parts thus radiating are dissimilar in form and size.

12. And a top view of all vegetable structures gives a centre, with organs radiating from that centre, which shows their principle of development to be similar (*Figs.* 33, 39, 52, 53).

All vegetable structures are, in top view, more or less circular.

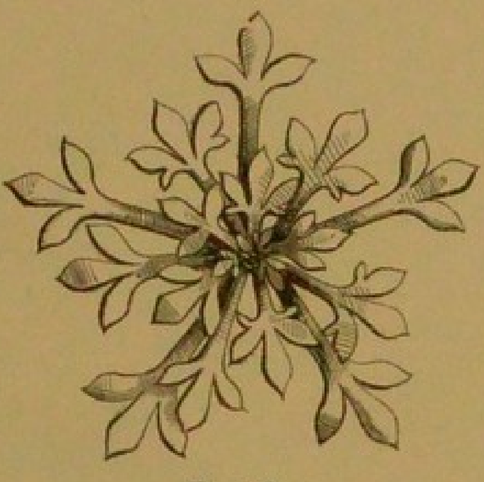


Fig. 52.

13. The statement that the principle of growth, or increase, is similar in all plants, may be yet further shown.

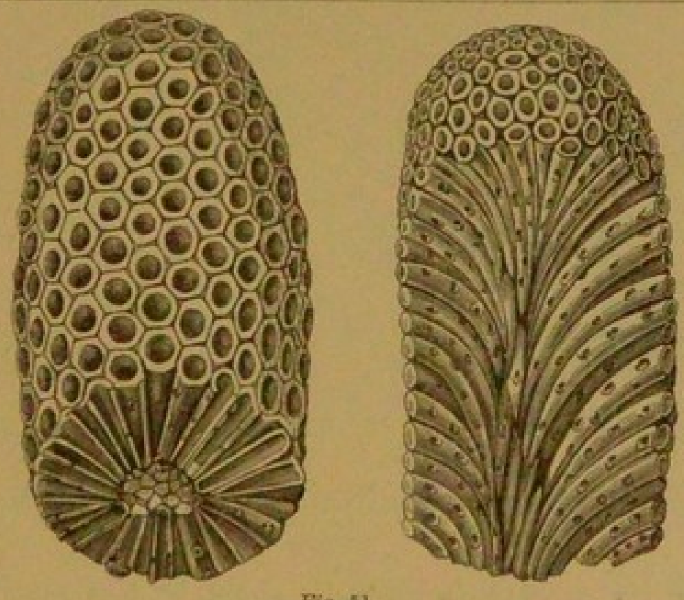


Fig. 51.

Fig. 51.—*Calamopora polymorphus*, a fossil coral allied to those which now exist in the Pacific. It is interesting to see that the laws which now govern the development of animal forms are coincident with those which governed the development of animal beings throughout remote periods of time. This fossil is found at Combe Martin, Ilfracombe, and Plymouth. Our cut is from a paper of deep interest which appeared in the *Art-Journal* a few years back by Professor Hunt. The author of that paper remarks, in language which I cannot improve upon, that "these beautiful creations are produced by animals of the polyp kind, who, possessed of a power of separating the carbonate of lime from sea-water, are constantly engaged in building up around themselves those stone structures, which, if not geometrical in all their arrangements, are strikingly varied and beautiful. The coral animal has left traces of its work on the earliest fossil rocks, but in the more recent or oolitic series the corals are most abundant."

Fig. 52.—Top view of Rue-leaved Saxifrage (*Saxifraga tridactylites*).

14. Thus, if the growth of any young plant be noted, which consists only of a central axis furnished with leaves

Fig. 53.

(*Fig.* 54), it will be found by development simply to repeat itself.

15. For its growth is brought about by the production of buds (*Fig.* 56).

16. And buds are shortened axes possessed of leaves (either scales or leaves proper), which pass down woody matter from their bases (*Fig.* 55).

17. Moreover, whatever is the arrangement of the leaves on the parent axis, such is the arrangement of the leaves (whether rudimentary or perfect) in the bud (*Figs.* 55, 56).

Fig. 53.—Top view of a tree.

18. Hence, when a plant produces a bud, it merely repeats itself.

Fig. 54.

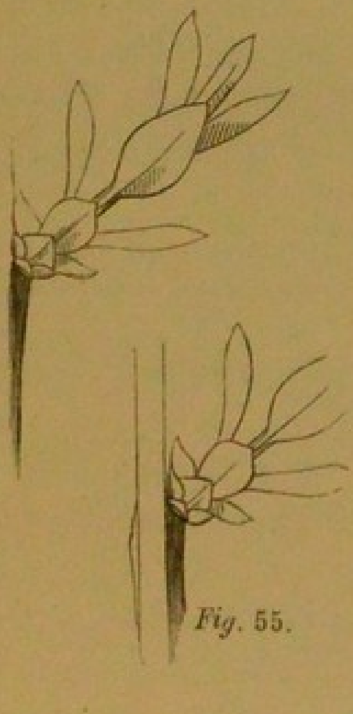


Fig. 55.

Fig. 56.

Fig. 54.—Lilac (*Syringa vulgaris*).
Fig. 55.—Lilac (*Syringa vulgaris*). Leaf-buds passing down wood.
Fig. 56.—Lilac (*Syringa vulgaris*). Branch with buds.

19. And, by the evolution of the bud, the plant will also be found to be repeated.

20. For buds by evolution produce axes which are similar to that by which they have been generated (*Fig.* 57).

Fig. 57.

21. Therefore, whatever is the nature of the parent axis, such will be the nature of the offspring axes, and whatever is the disposition of the foliaceous appendages and buds of the parent axis, such will also be the disposition of the leaves and buds of the young axes.

Thus, if the leaves or buds are "opposite" on the parent axis, they will be thus arranged on the offspring axes; if they are alternate on the parent they will be alternate on the offsprings, and so on.

22. And when a plant produces an inflorescence, or head of flowers, it still only repeats itself.

23. For flowers are simply shortened, and somewhat metamorphosed branches, from which the power of elongating is withdrawn.

This is proved by the fact that all the parts of the flower, viz., the calyx,

Fig. 57.—Lilac (*Syringa vulgaris*), evolving leaf-buds.

the corolla, the andræceum, and the pistil, will readily change into normal leaves, and the peduncle into a normal branch; also by the gradual transition of leaves proper into floral parts.

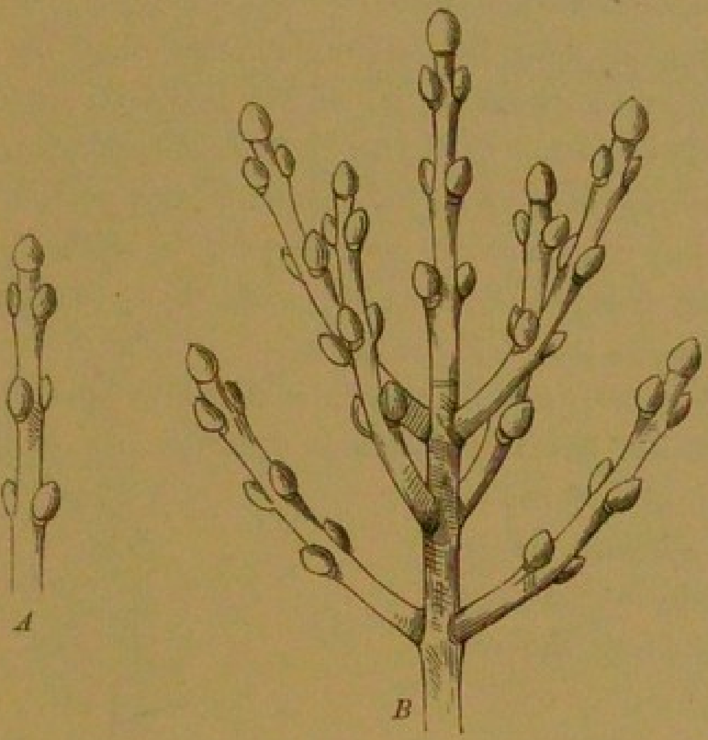


Fig. 58.

24. And when a plant produces seeds it still only repeats itself.

25. For a seed is a body which contains an embryo capable of growing into a matured plant (*Fig.* 59).

By the shedding of the seeds these repetitions of the parent are dispersed,

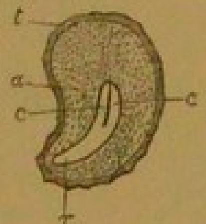


Fig. 59.

Fig. 60.

Fig. 58.—Ideal axis. A, is one year old. B, two.
Fig. 59.—Seed of Poppy (*Papaver*), in section. *c*, *c*, *r*, embryo. *a*, albumen. *t*, testæ.
Fig. 60.—Tiger Lily (*Lilium tigrinum*), showing its deciduous buds.

and then commence to exist as dissociated individuals; whereas, when a plant produces a new bud or branch the repetition thus produced remains in union with the parent, save in those cases where the buds are deciduous (*Fig.* 60).

26. Also, a plant in its simple form—that is, when it consists of an axis (one portion of which is destined to ascend, and another portion to descend), with appendages (*Fig.* 61)—may be regarded as an individual, or as a perfect, or complete plant; then we say, by the growth of the plant this individual becomes multiplied, and thus the parent by growth repeats itself (*Fig.* 62).

27. Thus, by growth its buds evolve into ascending axes, and from the bases of the buds descending axes are given forth in the form of woody streams, which unitedly form the stem, and ultimately the root (*Fig.* 62.)

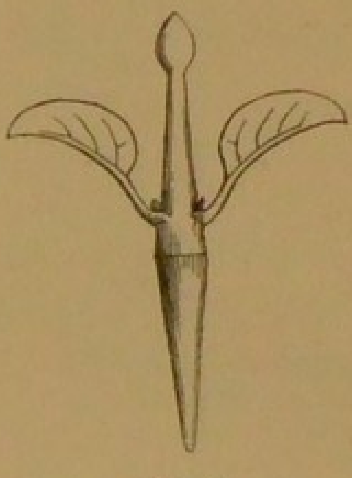


Fig. 61.

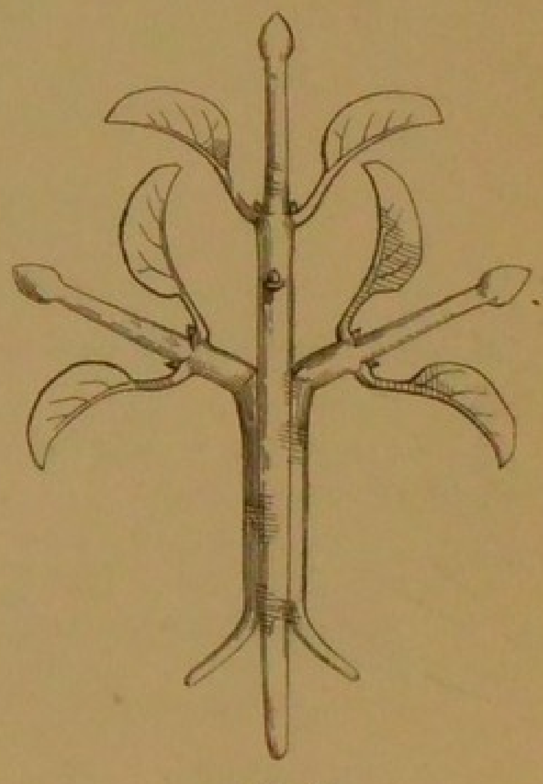


Fig. 62.

This can be illustrated by comparing a plant which consists of a central axis, together with certain secondary axes which proceed from it (a plant of any of our common trees, two years old), with a bundle of rods or twigs: the rods (*Fig.* 63) are of equal length and thickness;

Fig. 61.—A simple form of plant (ideal).
Fig. 62.—An ideal plant.

the central rod (*Fig.* 63, *a*) of the bundle represents the central axis of the young plant, and the external rods (*b*, *b*, *c*, *c*), the lateral axes; the rods all run parallel for a given distance in the centre of the bundle (between *d* and *e*), and then both their bases and apices consecutively diverge from the central twig (*a*), which maintains its central and vertical position; here, then, we have a central portion (*d*, *e*, *f*), which represents the thickest part of the axis of the plant, then we have the branches (*b*, *b*, *c*, *c*); now it is manifest that the thickening of the parent axis results solely from the union of the lateral axes (*b*, *b*, *c*, *c*) with

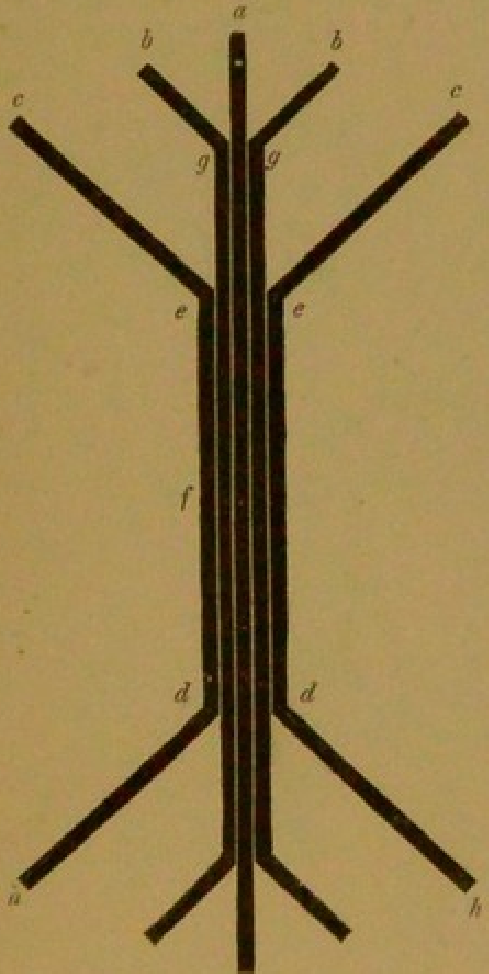


Fig. 63.

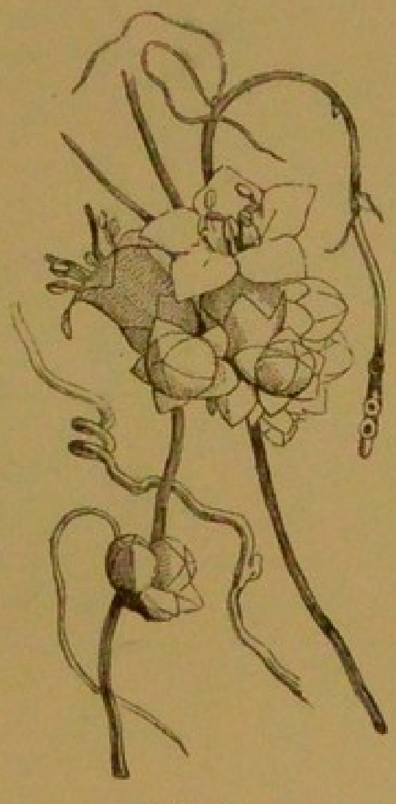


Fig. 64.

the truly central and vertical portion (*a*). The secondary ascending axes leave the primary, or parent axis, where the lateral rods diverge from the central twig (at *e*, *e*, *g*, *g*); thus the upper divergent portion of the rod (*e*, *c*) represents the normal branch which has resulted from the development of a bud, and the lower portion of the twig, or that portion which runs parallel with the others (*e*, *d*), as well as that portion which diverges below and is analogous to the root (*d*, *h*), represents the stream of wood formed by the branch during its evolu-

Fig. 63.—An ideal figure.

Fig. 64.—Dodder (*Cuscuta*), a leafless parasitic plant.

tion, and is, therefore, its descending axis, and had it been developed

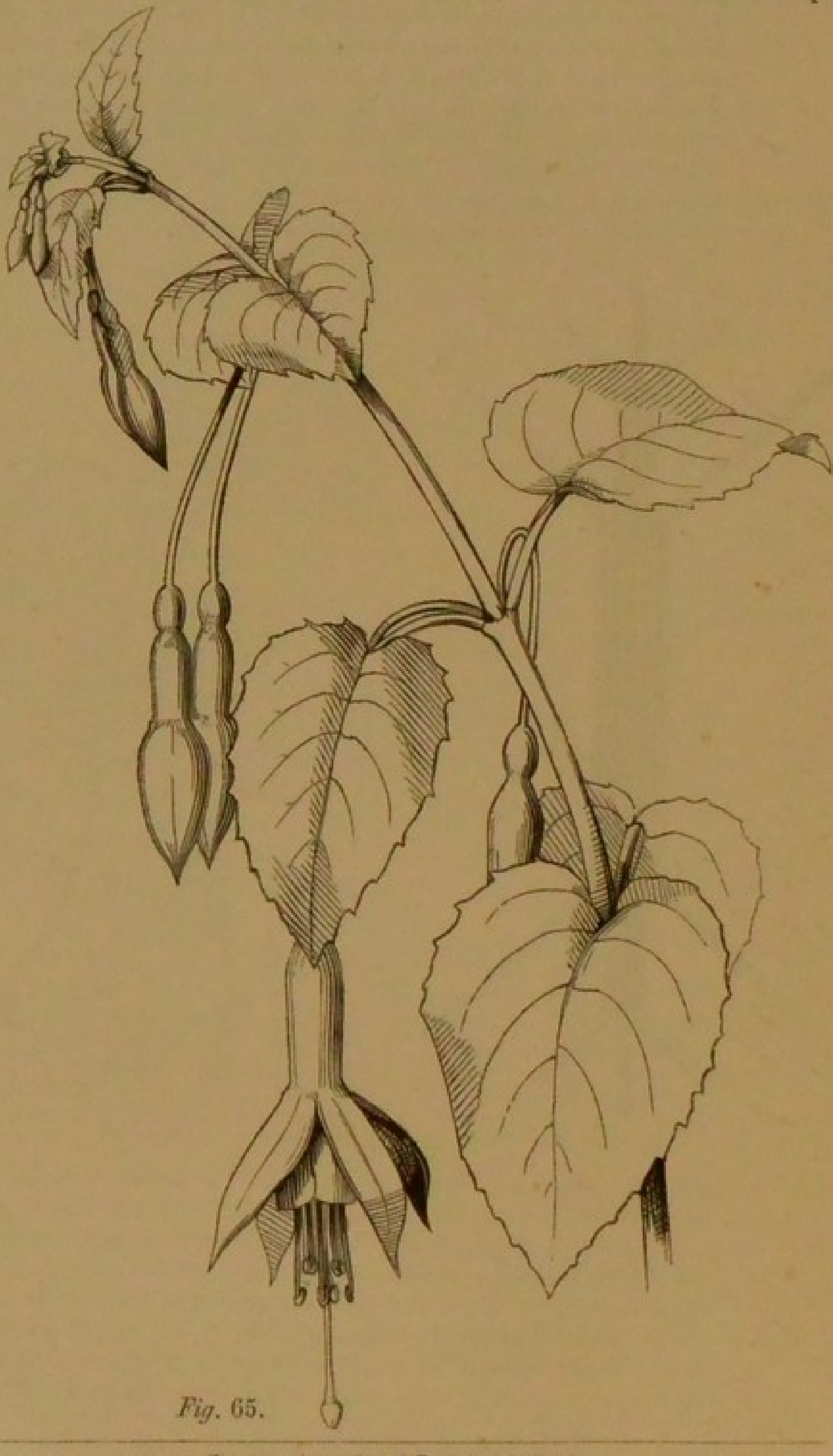


Fig. 65.

Fig. 65.—A species of Fuchsia (*Fuchsia*).

directly into the earth, instead of first in connection with other similar streams, it would have been a normal descending axis. Each branch, then, with its downward stream of wood, which latter forms part of the parent ascending axis, may justly be regarded as a distinct and complete individual, and hence the entire plant as a congeries of individuals; and as the result of growth is the production of new axes, we say that

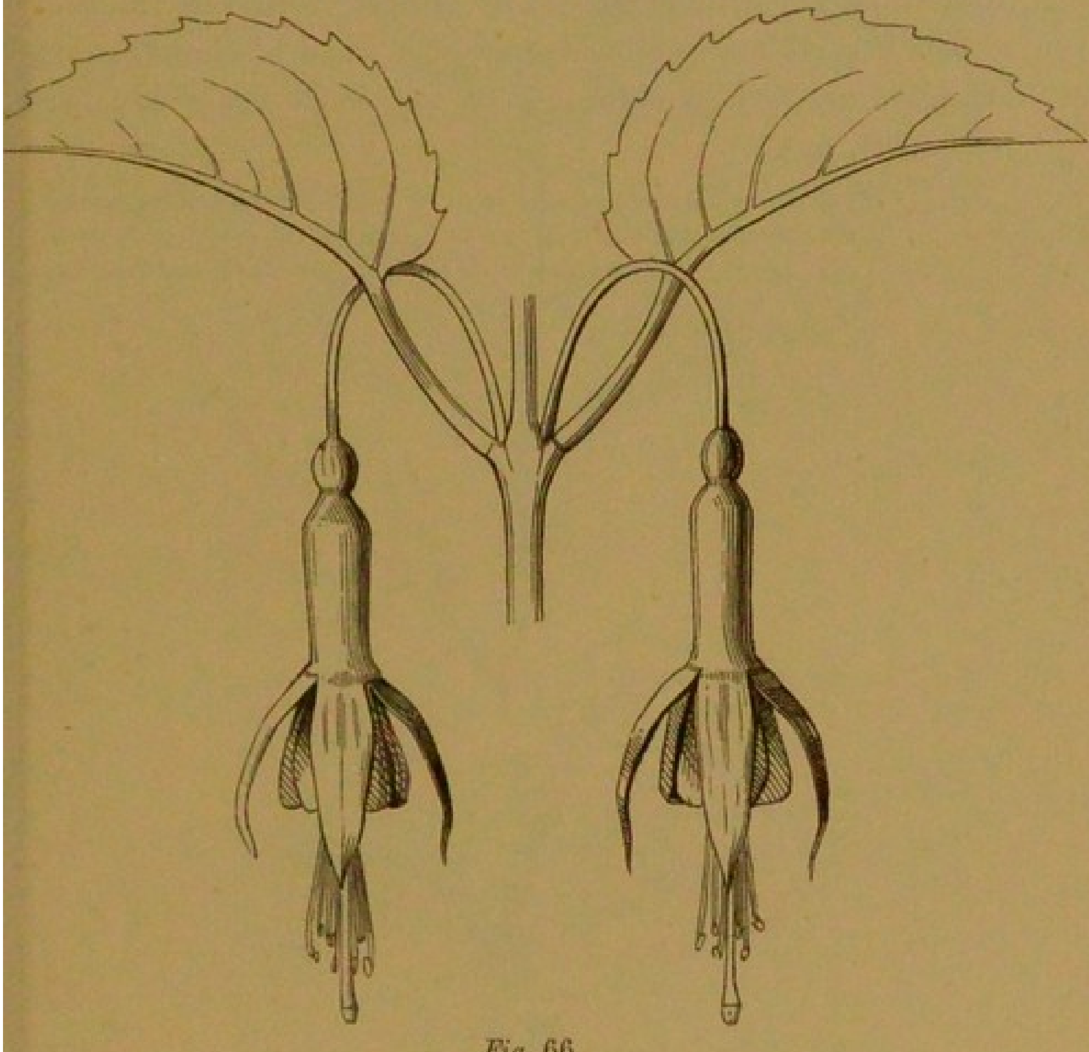


Fig. 66.

a plant by growth multiplies the original prototype; also, as buds, which by growth become branches, are always necessarily given off by an axis which already exists, and is the parent of the members which it generates, it follows that a plant, with its branches, is a parent with its progeny.

There are obviously certain exceptions to our propositions; thus the axis of the Dodder (*Fig.* 64) has no leaves, and many of the lower plants have no axis, strictly so named (*Fig.* 33), and have no buds; also many of the lower races of plants are entirely destitute of woody matter (*Figs.* 4, 29, 33). This proposition, then, must be understood to

Fig. 66.—A unit of a species of Fuchsia, as shown in the last figure.

relate to the more highly developed and completely organized vegetable structures. Nevertheless, in principle it applies to all plants, save a few of the lowest, which seem to possess no definite form or certain arrangement of their parts.

28. Moreover, every individual axis, whether ascending or descending, central or lateral, by growth repeats itself.

29. For all axes are composed of a series of similar units, or phytons, and growth merely augments their members (*Figs.* 65, 66).

For illustration we may select a spray or branch possessed of leaves which are arranged alternately, as that of a grass, or the *Polygonum cuspidatum*, and it is manifest that if the axis were cut through between every

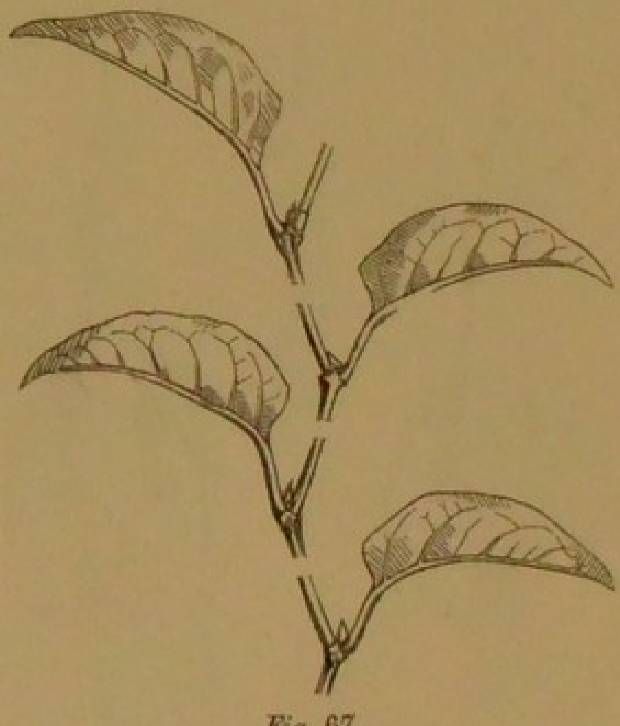


Fig. 67.

node, that all the portions into which this branch would thus be divided would be similar (*Fig.* 67). The same would occur were an axis similarly divided, the leaves of which were arranged oppositely (*Fig.* 68) or verticillately (*Fig.* 69). It might seem that if the axis were divided between every unit of the leaf arrangement,—that is, in decussate opposite leaves between every second pair of leaves (*Fig.* 70), in spiral arrangements between every unit of the spiral cycle, as in the $\frac{2}{5}$ arrangement between the fifth and sixth leaves (*Fig.* 71), thus dividing the axis into portions, each of which would be possessed of five leaves, and in alternate leaves between every second leaf (*Fig.* 72),—that all the parts

Fig. 67.—*Polygonum cuspidatum.*

would then be similar; but it is evident, that were we yet further to divide these axes, as we did in the first case, and sever the axes

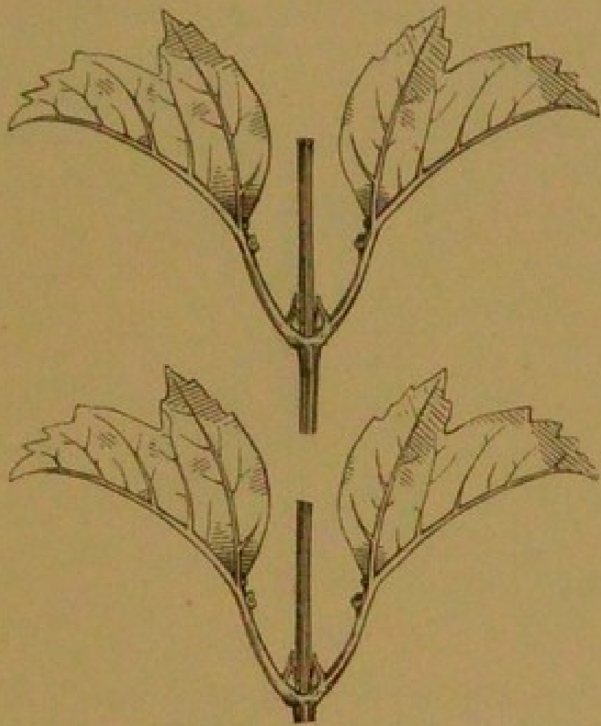


Fig. 68.

possessed of opposite and verticillate leaves between every node, and the axes with spiral leaves between every leaf, and hence between

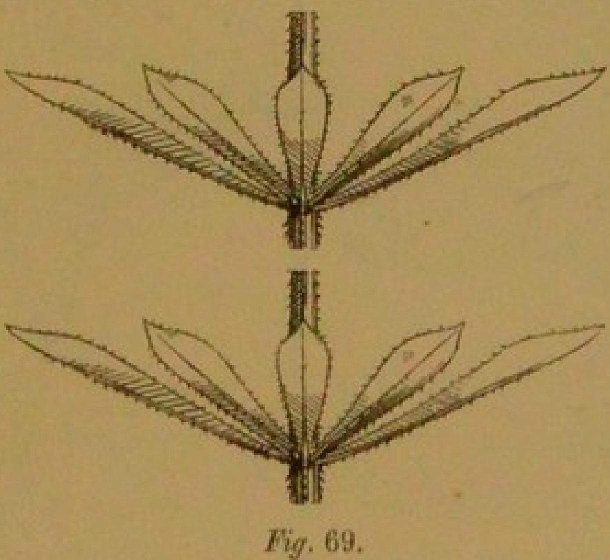


Fig. 69.

every node, and the branch with alternate leaves, as we have already done, between every leaf, hence every node, that even then the units

Fig. 68.—Guelder Rose (*Viburnum Opulus*).
Fig. 69.—Goosegrass (*Galium Aparine*).

would all be similar, the compound units, or the units of the leaf arrangement being formed by a given number of these primary or simple

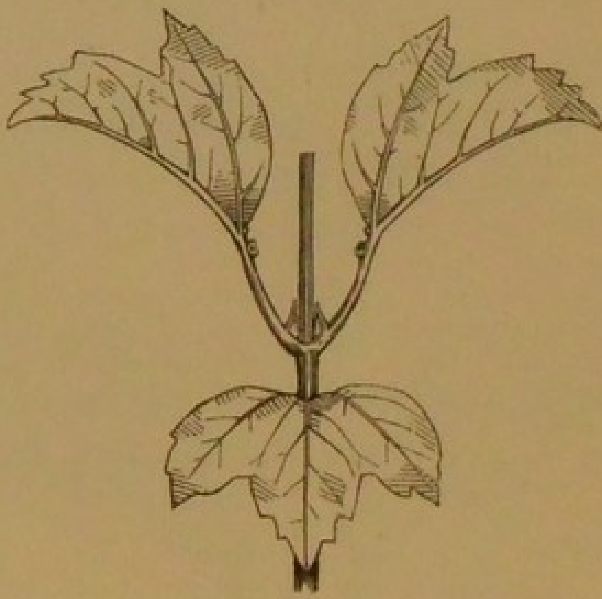


Fig. 70.

units being aggregated in a methodical manner. But our Proposition states not only that all axes are composed of a series of similar parts, or

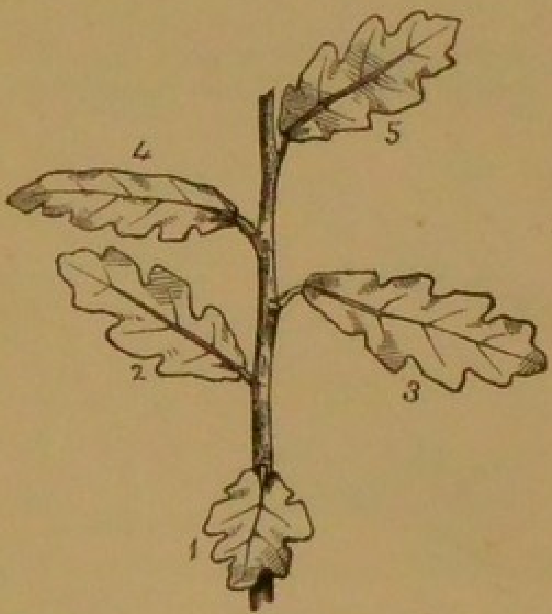


Fig. 71.

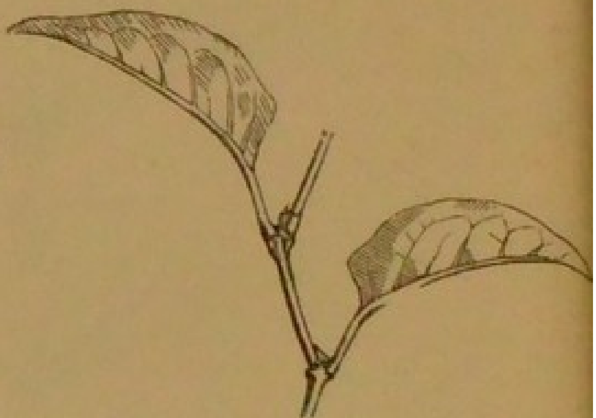


Fig. 72.

phytons, but also that growth only augments their numbers. This is manifest, as the growth of an axis is only similar to the drawing out of

Fig. 70.—Guelder Rose (*Viburnum Opulus*).
Fig. 71.—Common Oak (*Quercus pedunculata*).
Fig. 72.—*Polygonum cuspidatum.*

a telescope—thus, at first it is a short branch, say with one leaf, or it is a branch consisting of one phyton, or unit, only; by growth, however, a similar phyton or unit is developed at the extremity of the

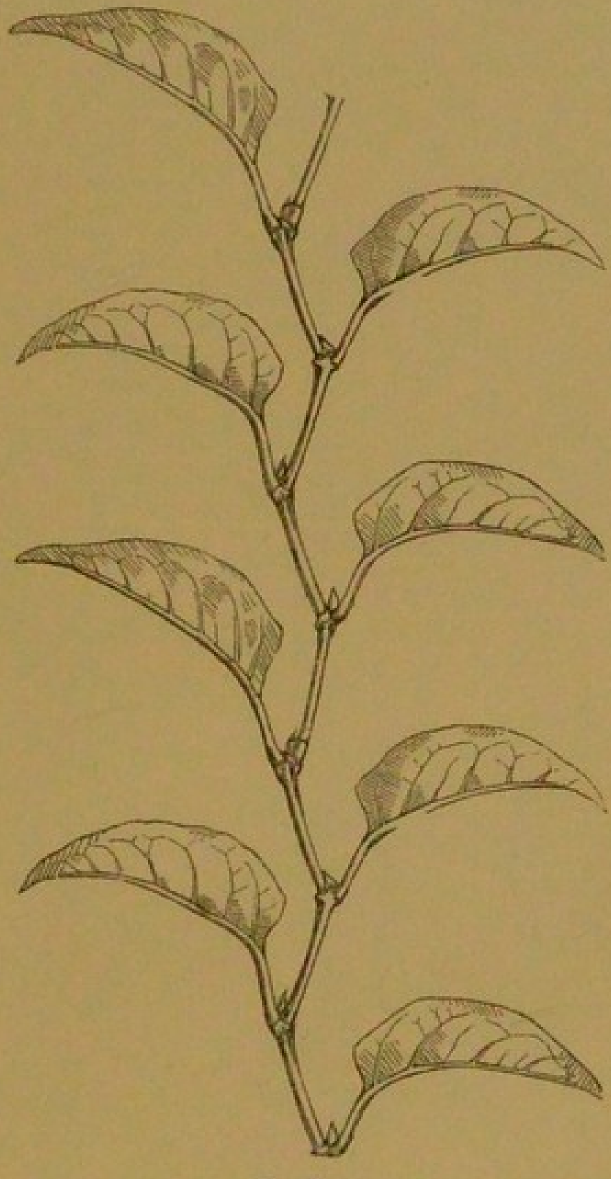


Fig. 73.

branch, or beyond it, and in this manner the branch grows; but the growth in principle consists in nothing more than the addition of successive units at the apex of the elongating axis (*Fig.* 73).

30. Not only does a plant by developing branches repeat itself, but the branches generated usually leave their parent, or parents, at the same angle.

Fig. 73.—*Polygonum cuspidatum.*

Thus, branches leave their parents at the following angles, according to Dr. M'Cosh :—

Lime	40°
Raspberry	42°

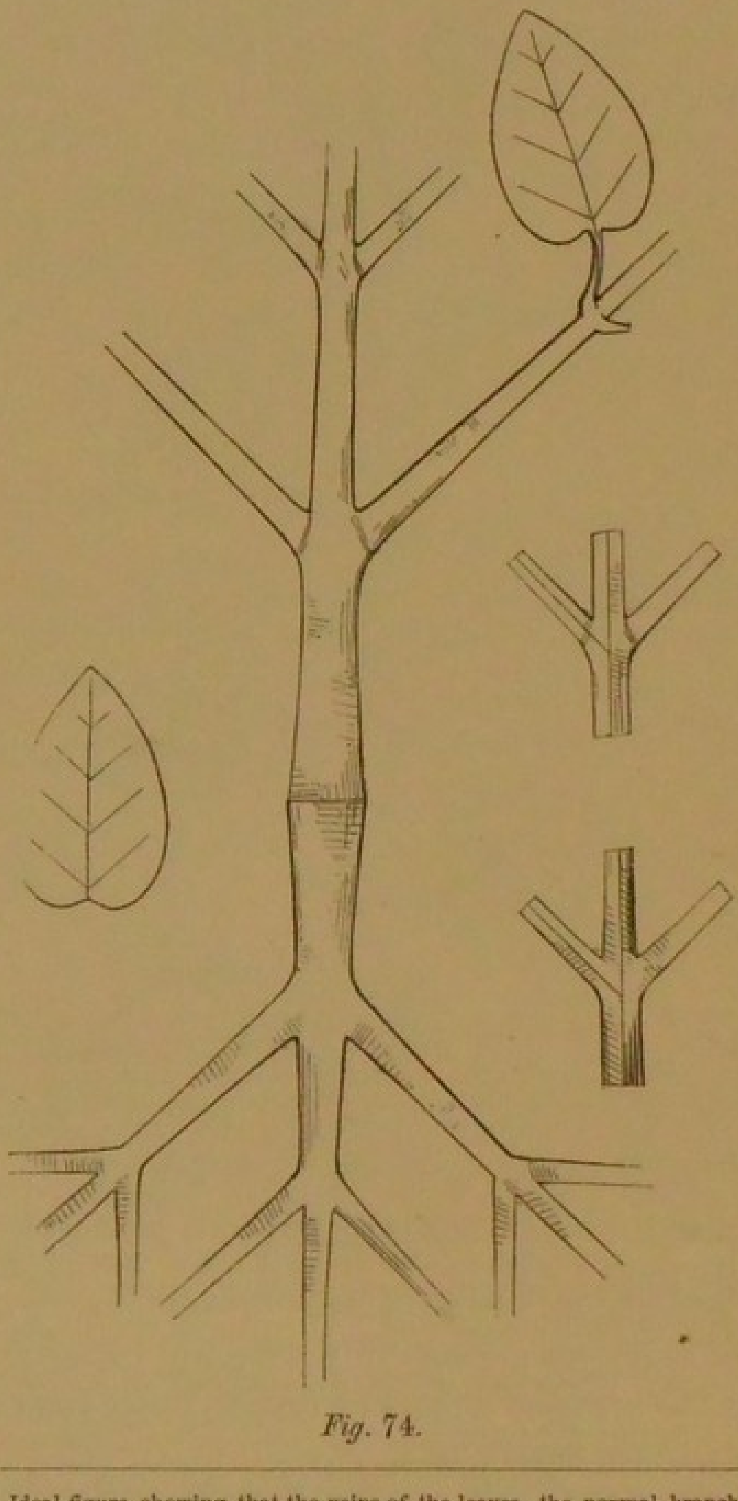


Fig. 74.

Fig. 74.—Ideal figure, showing that the veins of the leaves, the normal branches, and the branches of the root, leave their parents at the same angle.

Beech, Mountain Ash, Sycamore, and Red Dog-wood	45°
Alder, Cherry, Elm, Privet, and Rose	50°
Holly	55°
Lilac	58°
Ash, Bird Cherry, Box, Fuchsia, and Rhododendron	60°

There are exceptions to this, as implied in the Proposition; thus, the primary branches of the Oak diverge at an angle of 50°, while the small branches and veins form angles of from 65° to 70° with their generators.

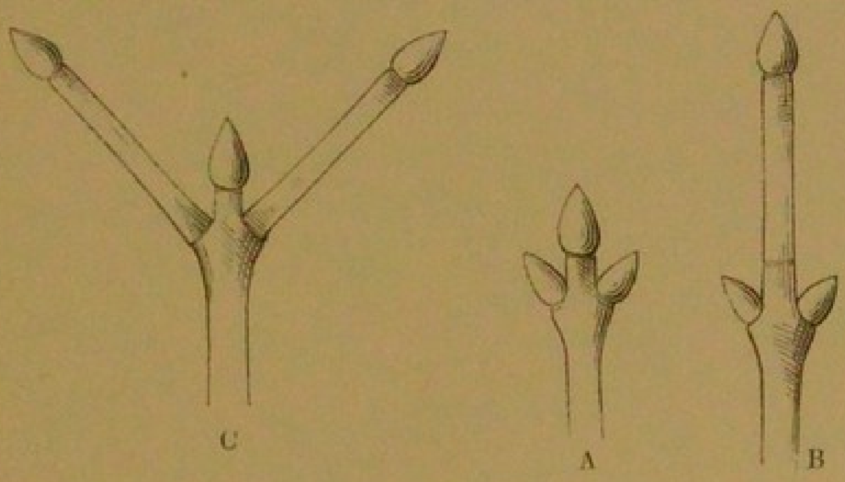


Fig. 75.

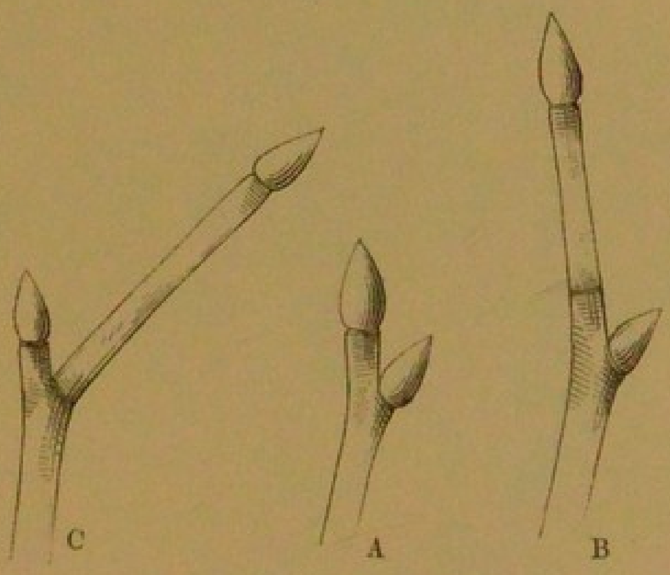


Fig. 76.

31. According to Dr. M'Cosh, the veins of the leaves, as

Fig. 75.—Ideal figure, in which the buds are opposite, illustrating modes of growth. A, axis. B, indefinite growth. C, definite.

Fig. 76.—An ideal figure. A, axis. B, indefinite growth. C, definite growth. In this cut the buds are alternate. For further particulars see "Rudiments of Botany," Prop. 182, &c.

well as the ramifications of the root, also leave their parents at angles which coincide with the angles formed by the branches and their parents (*Fig.* 74).

Dr. M'Cosh considers that there are three homotropal parts, which are morphologically allied, and are representatives of each other—viz., the root, with its ramifications; the stem, with its branches; and the leaf, with its veins.

Fig. 77.

This being admitted, the angle of either the branches, or the ramifications

Fig. 77.—Axis of the Vine, the growth of which is determinate, or definite. For full explanation see "Rudiments of Botany," Prop. 182, &c.

of the root, or the veins of the leaf being ascertained, the others are also known, which is a point affording great facilities for certain researches.

32. Hence, in this particular also, the principle of development in the diversified plants is similar.

33. To further support the latter clause of Prop. 10, we notice that from all the dissimilar habits of growth presented by vegetable structures, we deduce but two principles—viz., the definite and the indefinite.

34. The indefinite being that in which the terminal bud is developed in preference to all others (*Figs.* 75 B, 76 B), and the definite that in which lateral buds are developed at the expense of the terminal bud (*Figs.* 75 C, 76 C).

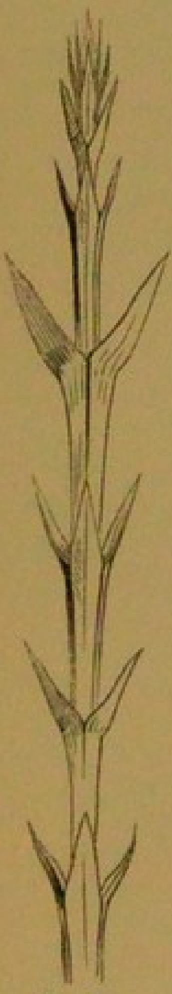


Fig. 78.

Fig. 79.

Fig. 78.—Indefinite axis of Arbor Vitæ (*Thuja orientalis*).
Fig. 79.—Definite rhizome of the Iris (see "Rudiments of Botany," Prop. 259).

35. As these are the only principles of development found among plants, we find them alike manifested in the stem

Fig. 80.

Fig. 80.—Indefinite rhizome of Primrose (*Primula acaulis*).

proper, in underground stems, and in the inflorescence (see note to next Prop.).

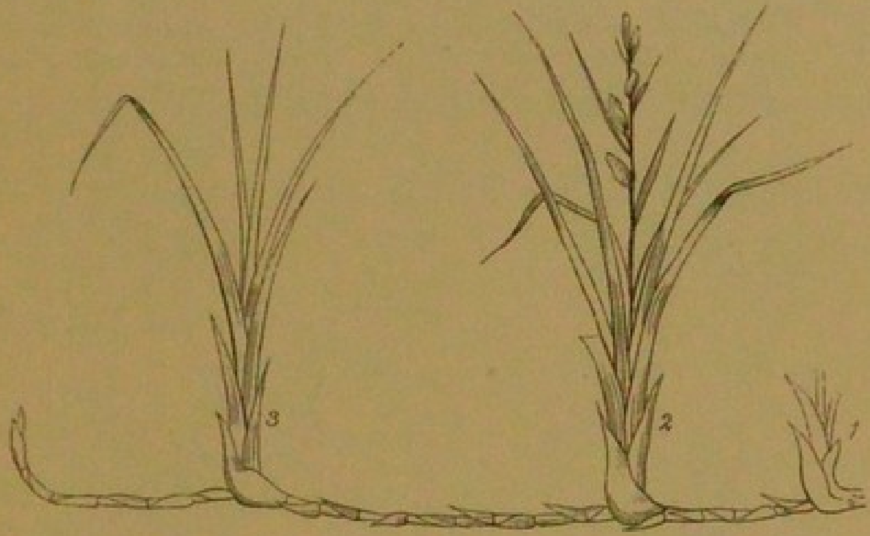


Fig. 81.

We find the definite principle in the stem proper of the Vine (*Fig.* 77), where the bud by evolution produces an axis furnished with one normal node, after the formation of which the parent axis only further evolves

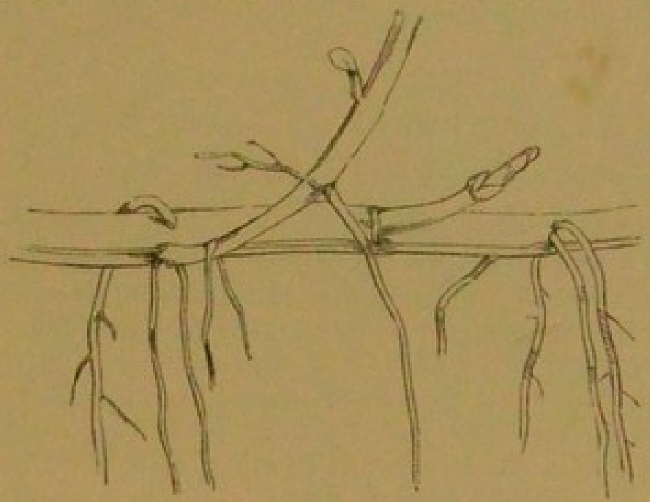


Fig. 82.

as a tendril; the bud in the axil of the leaf given off at the node develops and continues the general axis; here, then, the lateral axis, or bud, is developed in preference to the terminal. The indefinite principle of growth occurs in the axis of the Arbor Vitæ (*Fig.* 78). The definite

Fig. 81.—Definite creeping stem of *Carex arenaria*. The head 1. terminates an axis, and gives rise to a lateral bud, which evolves as an axis, and is terminated by 2; this axis in its turn gives off 3, and 3, 4.

Fig. 82.—Underground creeping stem of the Spearmint (*Mentha viridis*).

principle of growth also occurs in the rhizome of the Iris (*Fig.* 79); and the indefinite principle in the rhizome of the Primrose (*Fig.* 80). The definite principle occurs in the creeping stem of the Carex (*Fig.* 81), and the indefinite in the creeping stem of the Mint (*Fig.* 82), and so on. We also find these principles manifested in the inflorescence; thus, the cyme of the Chickweed (*Fig.* 83) is of definite growth, while the raceme of the Ribes (*Fig.* 84) is of indefinite.

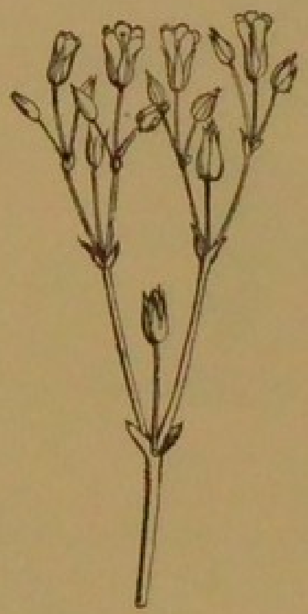


Fig. 83.

Fig. 84.

36. Nor are these two widely remote, for they differ only in the direction taken by the developing energy.

Both definite and indefinite axes (*Figs.* 75, 76) may have a terminal bud and lateral buds; but in the former case the central bud is developed with the least power, while the lateral buds are generated with energy; and in the latter case the terminal bud is evolved with power, whereas the lateral buds are not so strongly developed. Also, if the energy of the plant is not sufficient for the development of all the buds in the definite axes (*Figs.* 75 C, 76 C), the lateral buds would have the preference, and in the indefiuite axes (*Figs.* 75 B, 76 B) the terminal bud is that which would be favoured.

Fig. 83.—Definite inflorescence of the Mouse-ear Chickweed (*Cerastium*).
Fig. 84.—Indefinite inflorescence of the Currant (*Ribes*).

CHAPTER III.

ON THE UNITY TRACEABLE IN ALL VARIETIES OF THE ROOT.

37. A HIGHLY organized plant consists of a series of parts

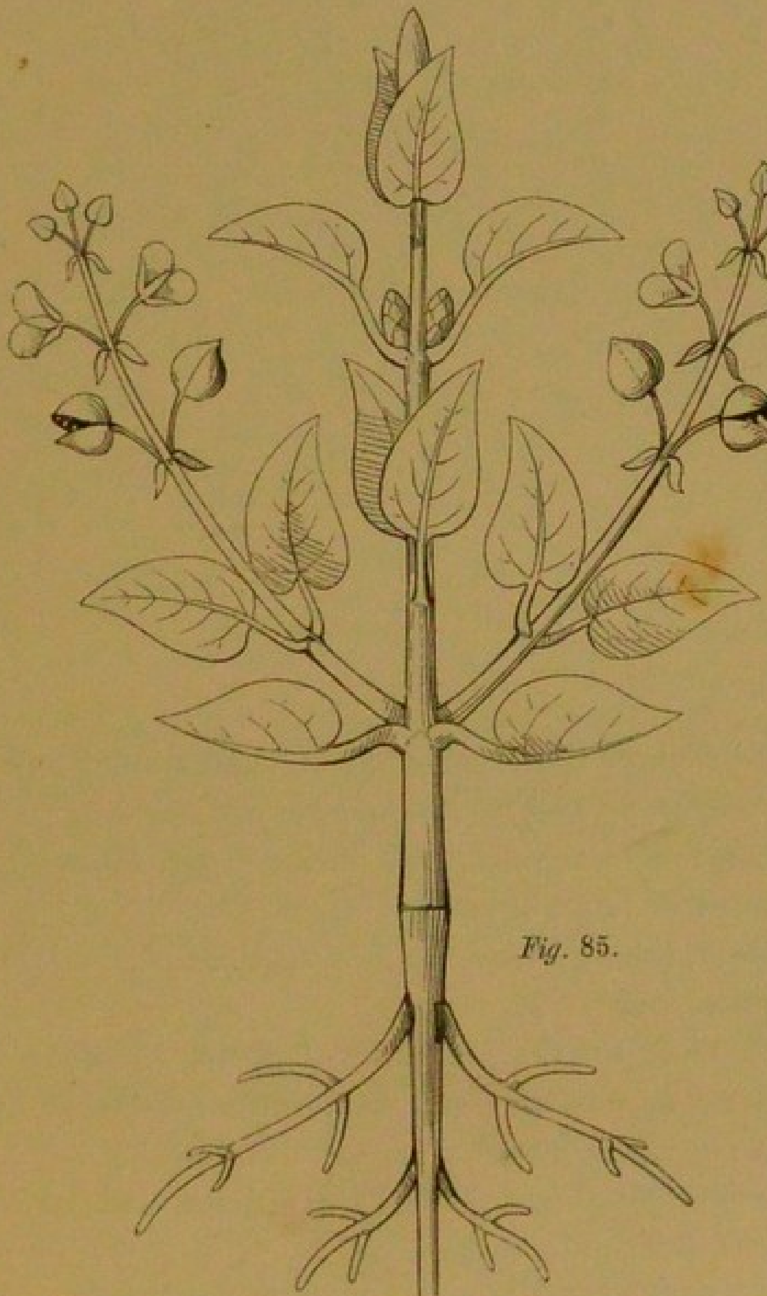


Fig. 85.

Fig. 85.—Ideal figure of a plant, showing its parts.

—viz., the root, stem, bud, leaf, inflorescence, flower, fruit, and seed (*Figs.* 85, 86).

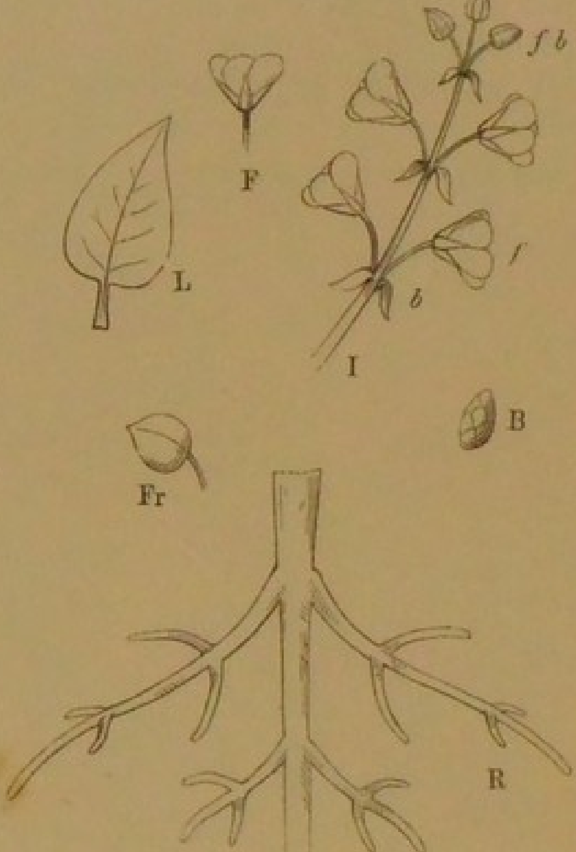


Fig. 86.

38. And each of these parts has an almost infinite variety of modifications, as well as a number of distinct organs.

39. Thus the root consists of fibrils, fibres, lateral roots, and the tap-root (*Fig.* 87).

40. Nevertheless, these are not distinct, differently organized members.

41. For fibrils are the first state of fibres, fibres the early form of lateral roots, and so on, however far the principle of growth may have caused them to be extended.

42. Hence the tap-root, lateral roots, fibres, and fibrils are similar, and differ only in age.

Fig. 86.—Same figure as the last with the parts separated. R, root. B, bud. L, leaf. I, inflorescence. *b*, bract. *f*, flower. *f b*, flower-bud. F, flower. Fr, fruit.

43. Moreover, they cannot be said to be materially altered by age.

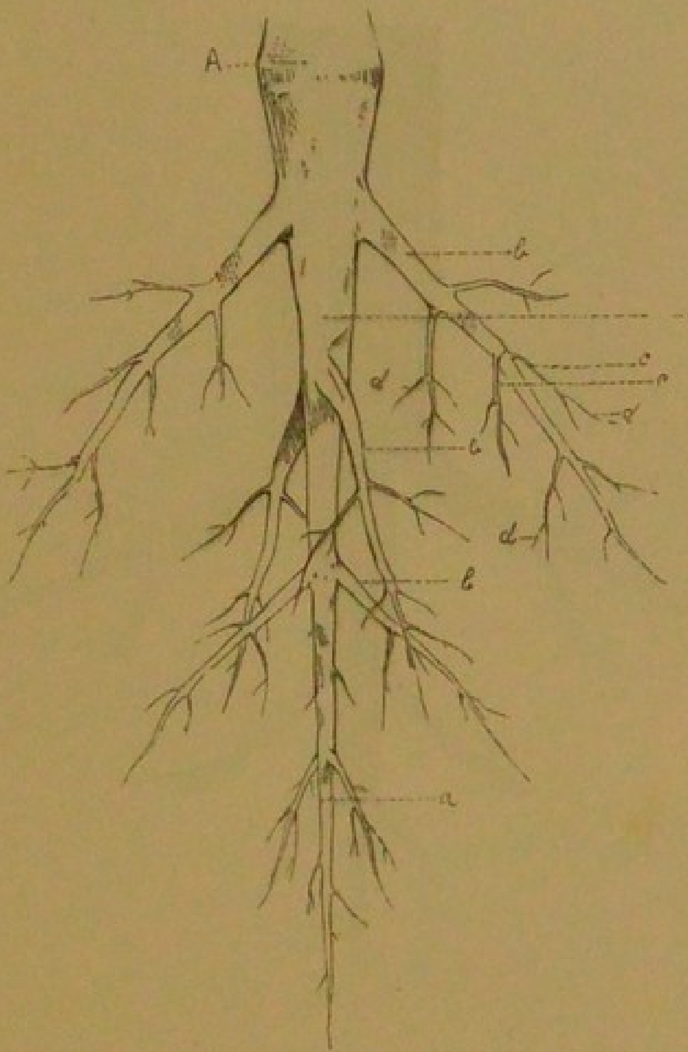


Fig. 87.

44. For the change which they undergo may be considered as consisting chiefly in their augmentation.

45. Thus, a lateral root may be regarded as a bundle of fibres, and the tap-root as a bundle of lateral roots (*Fig.* 88).

46. But roots are frequently possessed of fleshy lobes, or consist of succulent or farinaceous tubercles (*Fig.* 90).

47. Yet these are not distinct organs, for they are merely distended fibres (*Fig.* 89).

The lobes of the root of Orchis excepted. (See "Rudiments," Prop. 51).

Fig. 87.—Ideal figure of a root. *a*, tap-root. *b*, lateral roots. *c*, fibres. *d*, fibrils.

48. Hence what has been said of fibres is equally applicable to the lobes of the root.

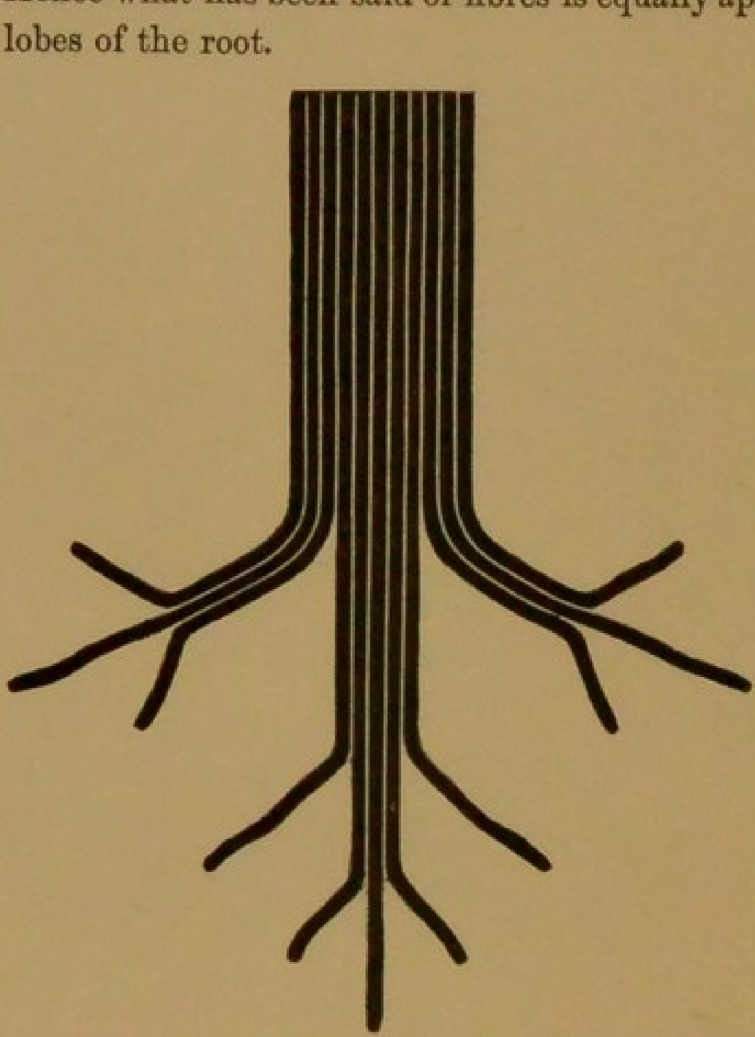
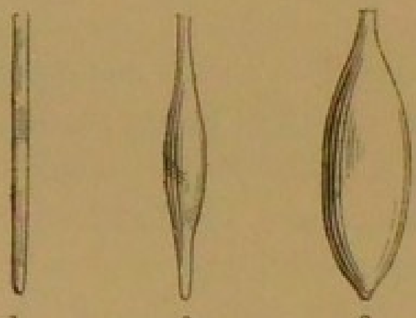


Fig. 88.



1. 2. 3.

Fig. 89.

Fig. 88.—Ideal figure, showing the formation of the root.

Fig. 89.—1, fibre of the root of *Dahlia*. 3, lobe of the root of Dahlia. 2, showing the transition from the state of the fibre to that of the lobe.

49. From the preceding it is obvious that all forms of the root, and all parts of this organ, although so diversely

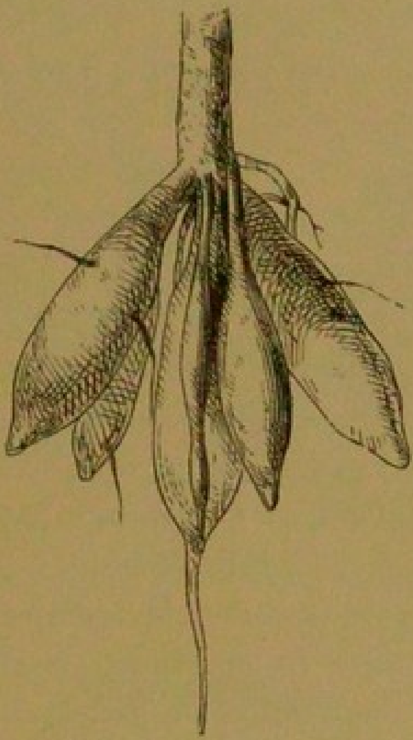


Fig. 90.

modified, are merely modifications and arrangements of one simple organ, or type.

Fig. 90.—Root of *Dahlia*.

CHAPTER IV.

THE STEM.

50. The stem also appears in many forms, and its surface is much diversified.

51. But its diversified external appearance results chiefly from the modifications which the skin (with which all stems are at first covered) undergoes.

52. Thus we have a smooth stem; but this only results from the skin (epidermis) being even.

53. In other cases the stem is more or less hairy; this, however, only results from certain cells of the epidermis being somewhat abnormally, or over-powerfully developed, or by given cells being augmented in number.

54. In other cases it is thorny; * but this only results from the epidermal hairs becoming indurated.

55. And all modifications of the surface of herbaceous stems have a somewhat common origin.

56. In internal structure, however, the stem presents certain typical forms.

57. Thus we have the exogenous formation, or that in which the wood is added externally in concentric zones (*Fig.* 91); the endogenous formation, or that in which the wood is deposited internally in bundles (*Fig.* 92); and the acrogenous formation, or that which is formed by the leaf-stalks uniting around the growing cellular axis (*Fig.* 93).

The exogenous formation is found in the stems of all our common trees, as the Elm (*Ulmus*), Birch (*Betula*), Willow (*Salix*), and Oak (*Quercus*),

* There is great analogy existing between the hair of plants and of animals. Thus, the hair of the Chinchilla is soft, of the Sable stiff, of the Hog rigid, of the Hedgehog indurated, and of the Porcupine spiny; so the hairs of plants are soft, stiff, rigid, indurated, and spiny. Feathers are varieties of hairs.

and in very many herbaceous stems, as Balsam (*Balsamina*), Wallflower (*Cheiranthus Cheiri*), Ragged Robin (*Lychnis Flos Cuculi*), and Mallow (*Malva sylvestris*). The endogenous formation occurs in the stem of the Palm, Banana (*Musa sapientum*), Bamboo (*Bambusa arun-*

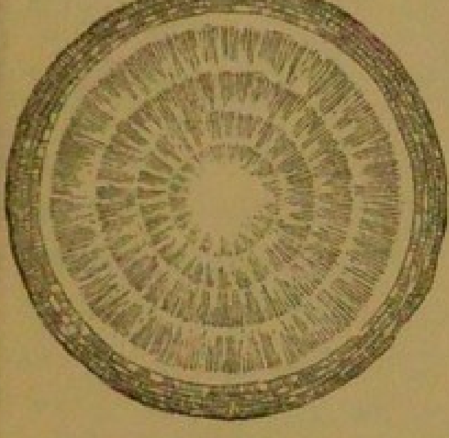


Fig. 91.

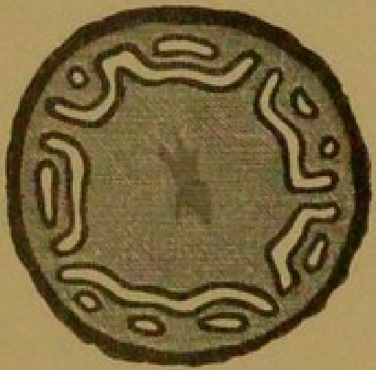


Fig. 93.

dinacea), and Grasses. The acrogenous stem occurs in the East Indian Tree Fern (*Alsophila perrotetiana*), and in Ferns generally.

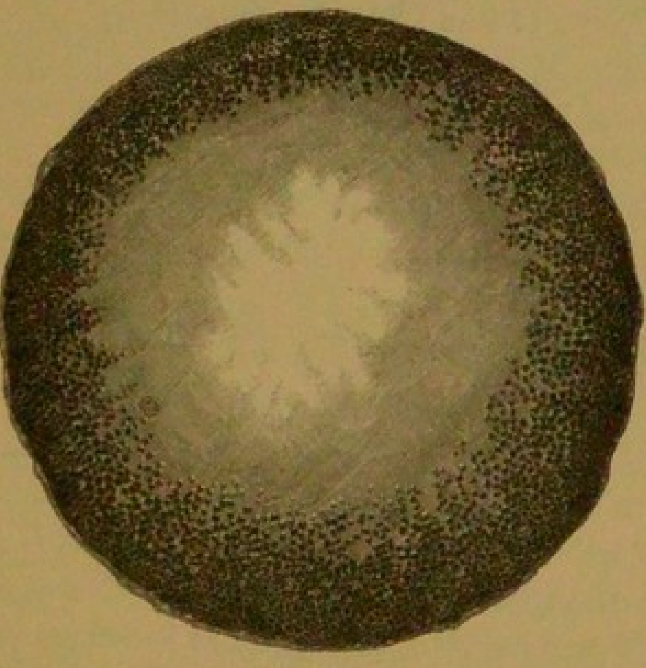


Fig. 92.

The exogenous stem characterizes the class of Exogens, the endogenous stem the class of Endogens, and the acrogenous stem the class of Acrogens.

Fig. 91.—Transverse section of the stem of an Exogen.
Fig. 92.—Transverse section of the stem of a Palm.
Fig. 93.—Tree-fern (*Cyathea*), transverse section of stem.

The exogenous stem is usually much branched, and bears leaves with a reticulated venation; its flowers also usually consist of whorls, which are made up of four or five parts; and the embryos of the seeds of Exogens are either di- or polycotyledonous.

The stem of the Endogen is usually little branched, and bears leaves with a parallel venation; its flowers are on the number three, and its seed is monocotoledonous.

The acrogenous stem is usually little-branched, and bears fronds, and produces spores as the analogues of seeds.

58. Although we have these three distinct types, as well as the entirely cellular stem of Thallogens (*Fig*. 29), if it may be regarded as a stem, yet these are not so remote from each other in principle of construction as might be expected.

The thallogenous stem occurs in the Mushroom (*Agaricus campestris*), and in Fungals generally (*Figs*. 8, 29). It characterizes the class of Thallogens.

59. Thus, in all cases, the growing point of the stem is cellular, and the stem in all cases first appears as a cellular mamilla (Props. 174 and 82 "Rudiments").

The stem, like all other vegetable organs, first appears as a little cellular mamilla, or papilla; and all the varieties, which it ultimately presents, are the result of after influences.

60. The thallogenous stem is simply this original tumor enlarged, or the growing point elongated, in which no woody bundles are deposited.

61. The acrogenous stem (*Fig*. 93) results from the bundles of woody fibre of the leaves being passed downwards into the cellular centre; or from the wood resulting from the naked terminal bud of the axis being passed downwards around the cellular growing point ("Rudiments," Prop. 310).

62. The endogenous stem (*Fig*. 92) results also from the wood of the petiolæ, or of the terminal leaf-bud, being transmitted downwards into the original cellular axis ("Rudiments," Prop. 299).

It is generally believed that the woody bundles of the stem of an Endogen first appear in the axis, and rise into the leaf; but unless the whole theory, relative to the office of the leaf, be false, woody matter is formed in this organ, and returned to the stem.

63. And the exogenous stem (*Fig.* 91) results from the woody bundles of its leaves, or buds, being passed downwards into the cellular tumor ("Rudiments," Prop. 283).

If the bark be carefully separated from the internal portion of a young exogenous stem, in the early part of the year, the stream of wood can be distinctly seen proceeding from the base of the leaf, which has been formed by the latter, and passed down into the stem.

64. Yet these stems differ materially.

65. Nevertheless, all bundles of woody matter are strikingly homologous.

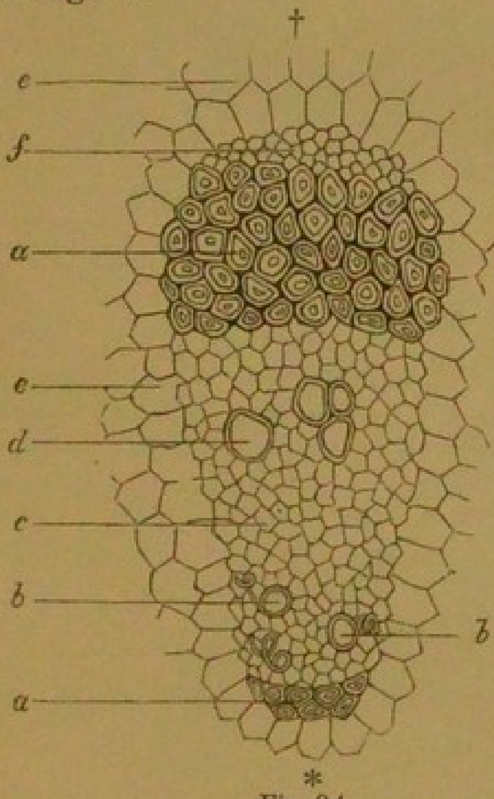


Fig. 94.

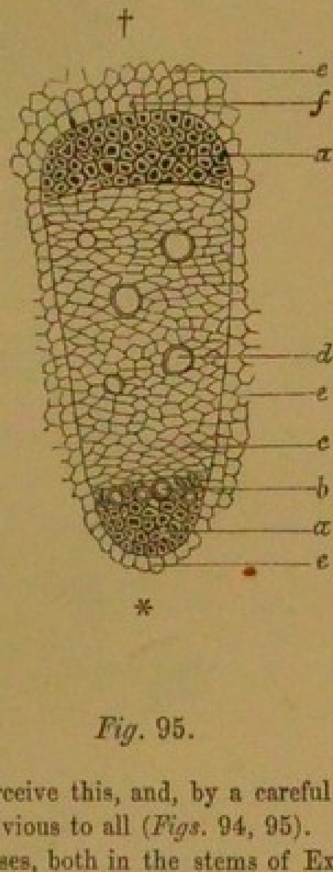


Fig. 95.

The advanced student will at once perceive this, and, by a careful comparison of our sketches, it will be obvious to all (*Figs.* 94, 95).

It must also be observed that, in all cases, both in the stems of Exogens and Endogens, the same relative position of the bundle of woody matter is maintained; thus, in both the portion * faces the centre of the stem, and in both the portion † the exterior, and this is the position of all woody bundles, whether external or internal.

Fig. 94.—Fibro-vascular bundle from the stem of a Palm-tree (an Endogen). *Fig.* 95.—A similar bundle from the stem of the Mellon (an Exogen). In both * is nearest the centre of the stem. *a* is fibrous thickened woody vessels (the liber in Exogens). *b*, spiral vessels. *c*, woody fibres. *d*, large dotted vessels. *e*, cellular matter. *f*, laticiferous vessels.

66. And the differences chiefly result from their distribution, or mode of deposition.

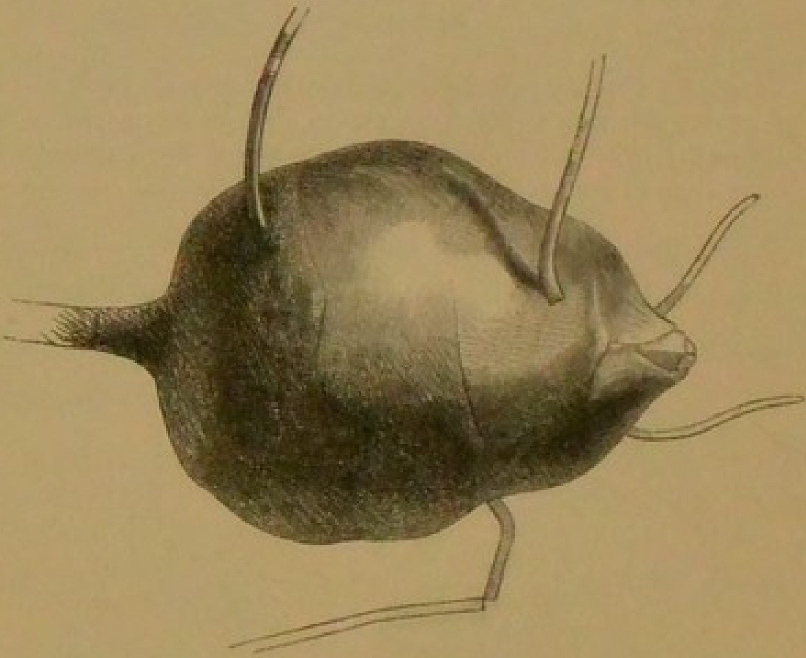


Fig. 96.

Thus, in Exogens, they are disposed in regular concentric circles; whereas in Endogens, they are more or less irregularly arranged; nevertheless, both in Exogens and Endogens, a given portion of each woody bundle faces the exterior as well as the interior of the stem, as has been shown in the note to our last Proposition.

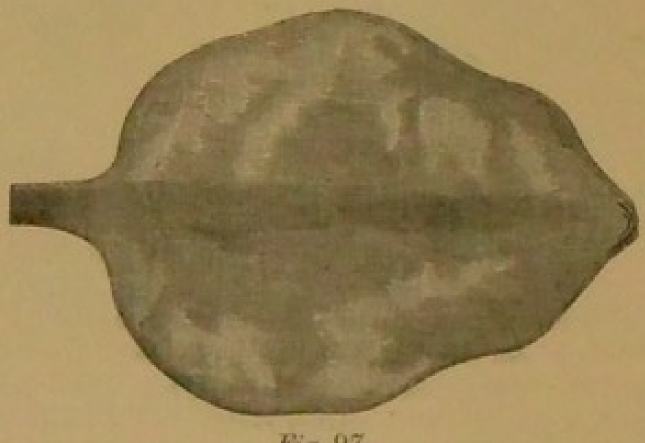


Fig. 97.

67. Also, in all cases the wood descends, and has a common origin.

Fig. 96.—Tuber of the Jerusalem Artichoke (*Helianthus tuberosus*).
Fig. 97.—Section of the tuber of the Jerusalem Artichoke (*Helianthus tuberosus*).

That is, all wood is formed in the leaves. (See "Rudiments," Props. 641 and 642).

Fig. 98.

Fig. 98.—Scaly tuber of the Arrowroot (*Maranta arundinacea*).

68. It follows then, as a corollary, that all stems are mere modifications of one type, or principal.

69. But we have not only diversified forms of the stem proper, but also of underground stems.

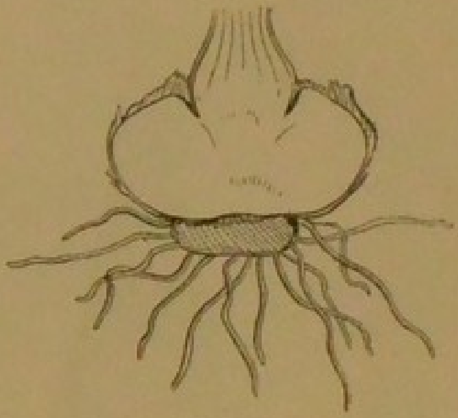


Fig. 99.

70. Thus we have the tuber, corm, bulb, rhizome, and creeping stem.

71. Yet the tuber (*Figs.* 96, 97, 98) and corm (*Figs.* 99,

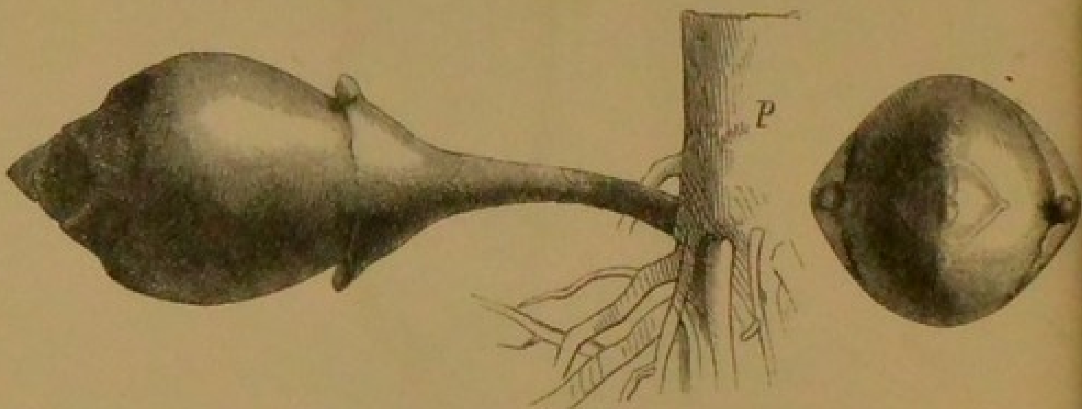


Fig. 100.

103, 104) are allied ; for both are distended stems, which are reservoirs of nutriment, and are possessed of scales and buds.

The chief difference between the corm and the tuber lies here, that one is the distended apex of a branch (the tuber), *Fig.* 100, while the other is the distended base of a branch (the corm), *Fig.* 99.

Both are destined to store up food, both generate buds, both are possessed

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Fig. 99.—Corm of the Saffron (*Crocus sativus*), vertical section.

Fig. 100.—Tuber, side and front view, of the Jerusalem Artichoke (*Helianthus tuberosus*).

of scales, both feed their young with their own substance,* and both perish after their young are fully organized,† through being preyed on by their offsprings; both also generate adventitious roots.

Fig. 101.

Fig. 101.—Scaly bulb of the White Lily (*Lilium candidum*).

* The following extract is from a lable by Dr. Lyon Playfair, in the South Kensington Museum:—"The growth and support of an animal is now easily explained: when a flesh-eater, like the Tiger, lives on the flesh of another animal, it eats, in a chemical point of view, the substance of its own body, and requires only to give it a new place and form; when a child receives its mother's milk, it does the same thing, eating, in fact, its mother, and giving her flesh a new place and form on its own body." This strongly unites these underground stems with animals, for both nourish their young with their own substance.

† This also occurs in animals; for illustration we may take the Silk-worm Moth (*Bombyx mori*), which, after laying its eggs, and thus in a sense generating its young, perishes.

72. And the corm and bulb (*Figs.* 101, 102) are allied, for both have an axis which is furnished with scales, and both store up food (the former in the axis, the latter in the scales), and in both the normal descending axis is absent. They also both reproduce themselves by the generation of buds, and are destroyed by being preyed on by their young.

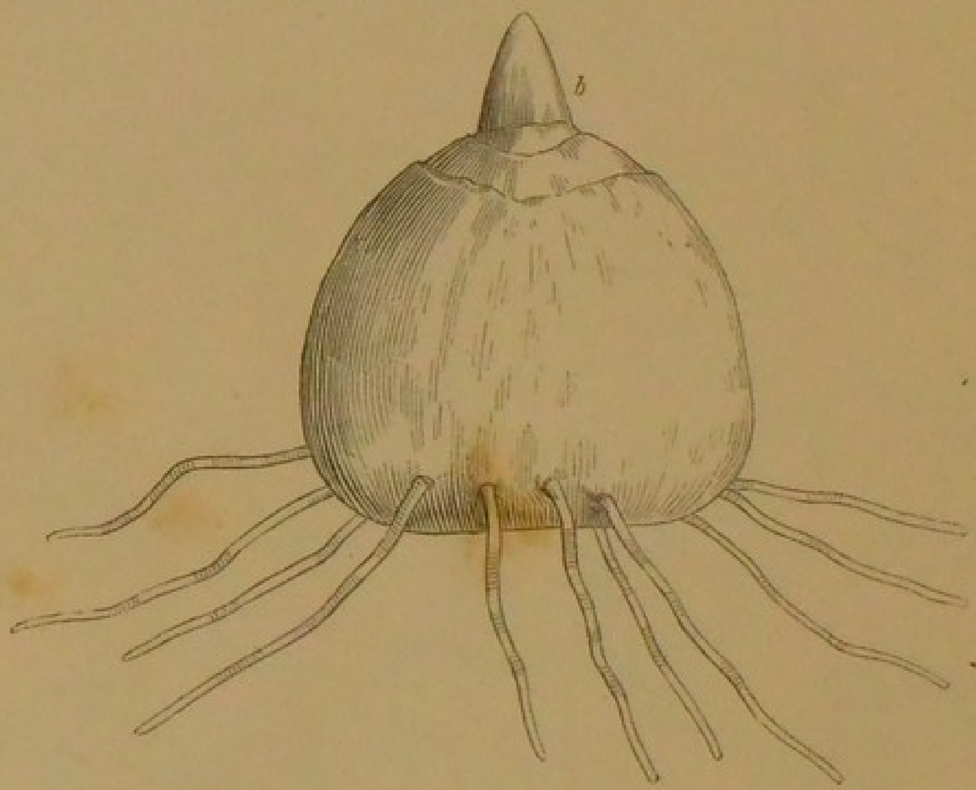

Fig. 102.

See Prop. 1281 "Rudiments."

Both the corm and bulb generate adventitious, and not regular roots, and both occur in their normal form only among Endogens. The corm is also allied to the rhizome, by such corms as those of the Autumn Crocus (*Colchicum autumnale*), *Figs.* 103, 104, and Cuckoo-pint (*Arum maculatum*), *Fig.* 105, where both grow in a horizontal direction.

73. The bulb and the rhizome (*Fig.* 80) are also allied, for in both the normal descending axis has perished, and they both protrude adventitious rootlets, and elongate or grow in an upward or onward direction only. They also both store up food (the bulb in its scales, and the rhizome in its substance).

Fig. 102.—Tunicated bulb of Crown Imperial (*Fritillaria imperialis*).

Dr. Balfour remarks, "The *corm* may be regarded as a rhizome increasing vertically, and not laterally;" hence the corm and rhizome are also directly allied. This also gives this view of a *rhizome*—that it is the result of the growth of the stem in the sense that the corm is, and not

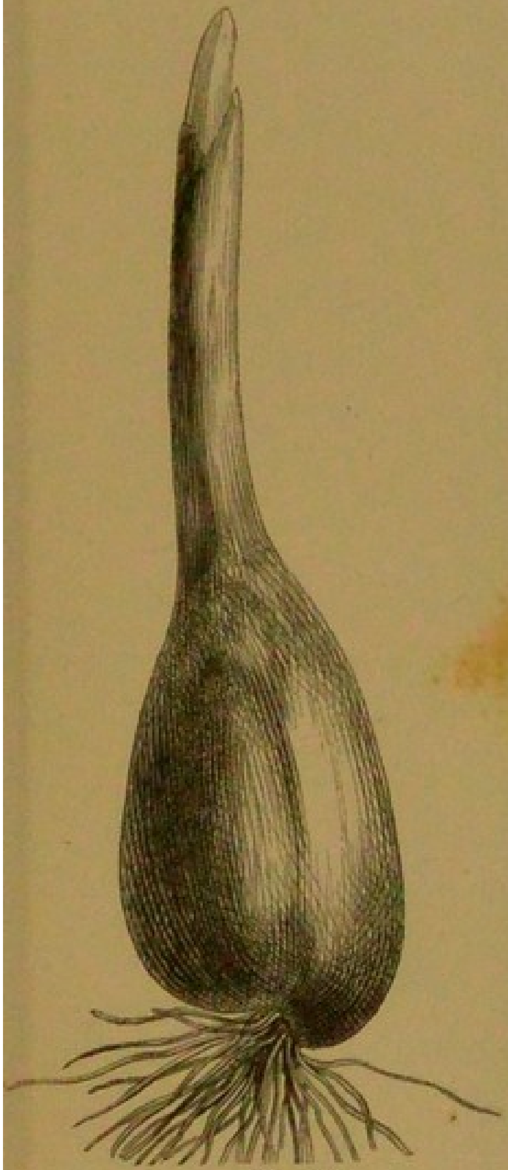

Fig. 103.

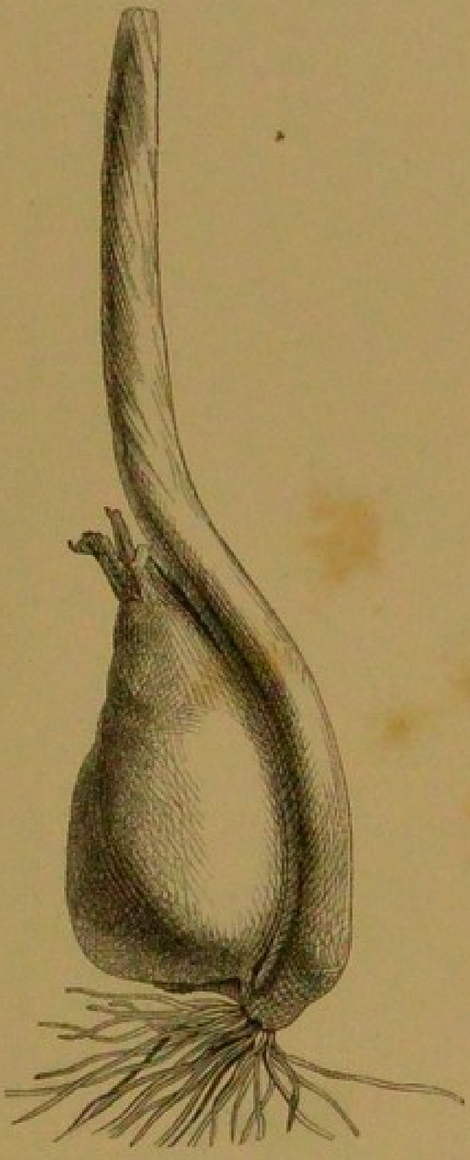

Fig. 104.

only in that which all stems are, that is, the substance of both the corm and the rhizome is a special deposit of matter which is organized in the growing end of the stem.

The rhizome is allied to the normal corm by such root-stocks as increase vertically, and not horizontally, as that of the Devil's-bit Scabious (*Scabiosa succisa*), *Fig.* 106; this latter is usually erroneously called a præmorse root ("Rudiments," Prop. 253).

Fig. 103.—Corm of the Meadow Saffron (*Colchicum autumnale*).
Fig. 104.—Corm of Meadow Saffron (*Colchicum autumnale*), without its skins or investments.

Fig. 105.

Fig. 105.—Corm of the Cuckoo-pint or Wake Robin (*Arum maculatum*).

74. The rhizome and creeping stem (*Figs.* 81, 82) are also allied, for both are marked by the scars of leaves, develop regular buds, and generate adventitious roots,—they, in fact,

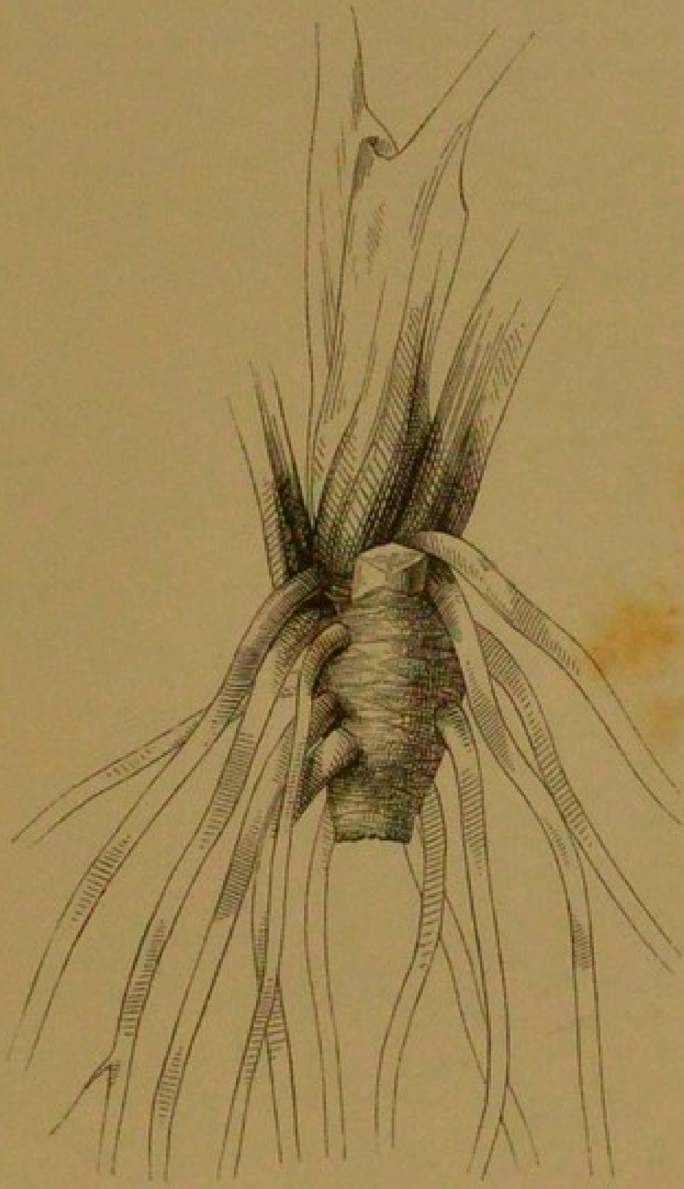

Fig. 106.

differ only in this, that one is elongated and feeble, while the other is shortened and fleshy.

They may also both be definite and indefinite in their principle of growth. (See Props. 33, 34, 35.)

Fig. 106.—Vertical rhizome of the Devil's-bit Scabious (*Scabiosa succisa*).

75. Then, although we have five varieties of the underground stem, yet all are modifications of one type, or of each other.

The bulb, though usually regarded as a stem, and here treated as such, is strictly a bud, and should not be considered as an underground stem. (See "Rudiments," Prop. 279, note, and Prop. 114.)

CHAPTER V.

THE BUD.

76. The stem produces buds of varied forms, &c.

The arrangements of the scales of buds are very various; but scales are rudimentary leaves; hence, whatever are the arrangements of leaves, such are also the arrangements of scales; and as it is here-

Fig. 107.

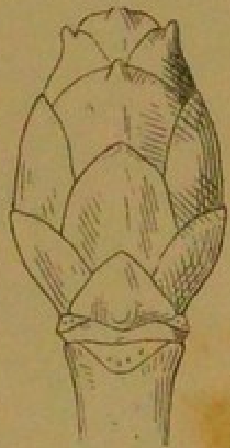

Fig. 108.

after shown that there is a unity in all the arrangements of leaves, it follows that there is a unity in the arrangements of scales also.

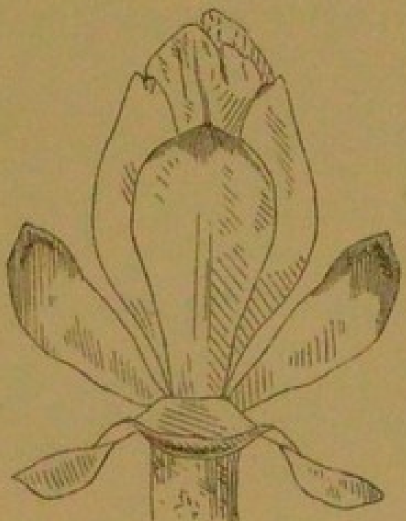

Fig. 109.

Fig. 107.—Bud of the Ash (*Fraxinus excelsior*).
Fig. 108.—Bud of the Horse-chestnut (*Æsculus Hippocastanum*).
Fig. 109.—Evolving leaf-bud of the Horse-chestnut (*Æsculus Hippocastanum*).

77. Nevertheless, all buds are homologous, for all are shortened axes, which are possessed of rudimentary leaves.

The bud of the Dodder, however, is an exception to this (Rud. Prop. 80). The leaves of the bud may either be scales or embryonic leaves proper.

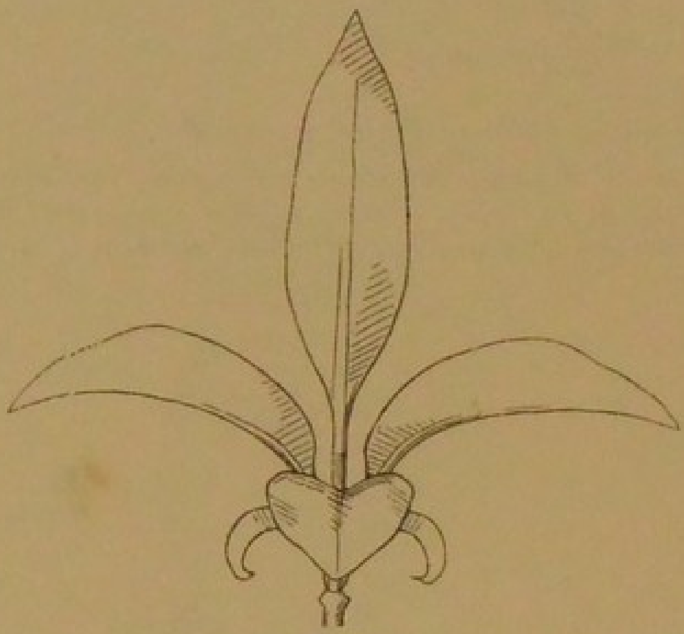

Fig. 110.

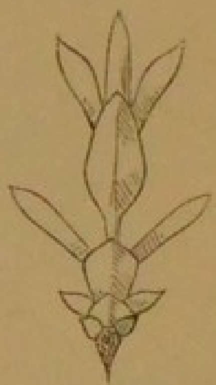

Fig. 111.

78. And buds have the power of forming vegetable matter.

When the matter formed by the bud is passed into the body by which it is supported, it bears its common designation (viz., that of a bud); but when the matter is passed directly into the ground, it is termed a bulb.

Fig. 112.

Fig. 113.

Fig. 110.—An evolving bud of the Honeysuckle (*Caprifolium perfoliatum*).
Fig. 111.—Evolving bud of the Lilac (*Syringa vulgaris*).
Figs. 112, 113.—Buds of a species of Honeysuckle (*Lonicera involucrata*).

Both the bulb (*Fig.* 102) and deciduous bulbels, as those of the *Lilium tigrinum* (*Fig.* 114), are strikingly similar to seeds; thus they are capable of independent existence, and both feed their roots, while developing, with matter which is stored up in their leaves (the scales of the bulb and the cotyledons of the embryo, *Fig.* 115).

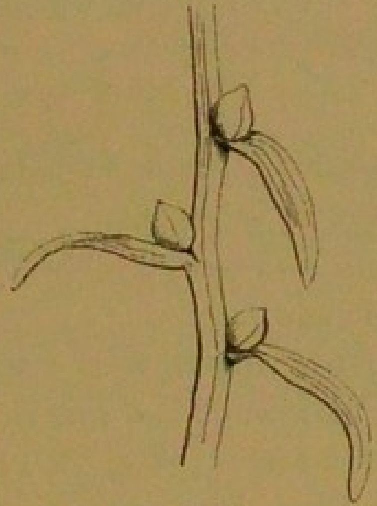

Fig. 114.

From the preceding it is obvious that the scales of bulbels and bulbs are similar to the cotyledons of exalbuminous seeds, for both are fleshy, are charged with nourishment, and are impoverished by the growth of the rootlets.

The bulbiferous Lily, shedding its bulbs, resembles a plant dispersing its seeds.

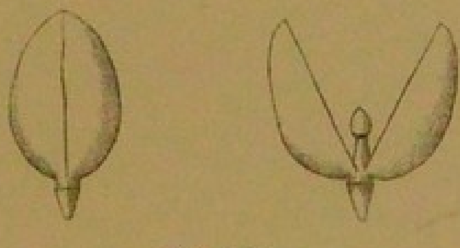

Fig. 115.

79. It hence follows that there is a unity between all buds.

Fig. 114.—Tiger Lily (*Lilium tigrinum*).
Fig. 115.—Diagram of a dicotyledonous seed.

CHAPTER VI.

THE LEAF.

80. The leaf occurs, perhaps, in more diversified forms than any other vegetable organ.

81. Its variations, however, are chiefly in form, texture, and extent of development.

82. Thus, we have simple and compound, rough and smooth, long and narrow, broad and short leaves.

83. Yet compound leaves (*Figs.* 22, 119) are not organs which are distinct from simple leaves (*Figs.* 116, 117): on the contrary, they differ only in degree of development.

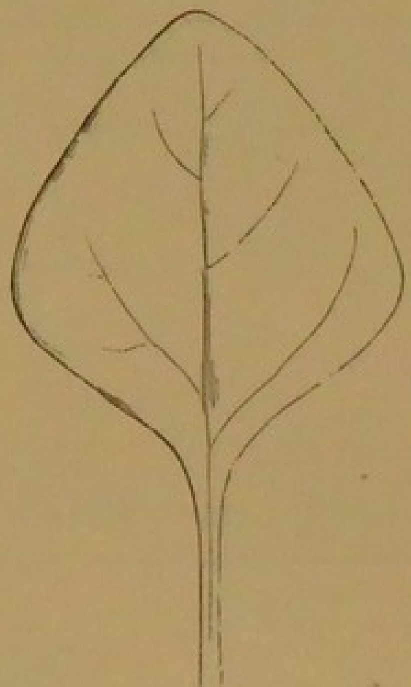

Fig. 116.

Fig. 117.

84. But we have not only compound, but also decompound

Fig. 116.—Rhomboid leaf of New Zealand Spinage (*Tetragonia expansa*).
Fig. 117.—Roundish leaf of Aspen (*Populus tremula*).

(*Fig.* 120) and supra-decompound (*Fig.* 121) leaves. Yet these also differ from compound leaves only in degree of development.

85. And the diversified forms of simple leaves differ from each other only in degree and mode of evolution.

86. For all leaves are at first simple and similar.

87. If this original form of the leaf, by development, becomes little more than enlarged, the leaf is then entire (*Fig.* 116).

88. If, however, development proceeds one step further, then the margins of the leaf are toothed (*Fig.* 117).

89. If one step further still, then the leaf is lobed (*Fig.* 118).

90. If farther yet, the leaf is compound (*Fig.* 119).

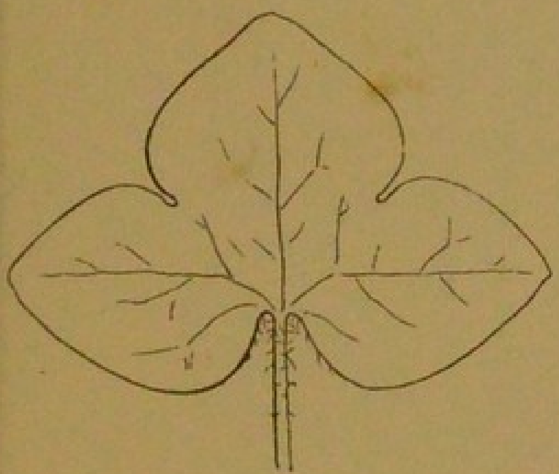

Fig. 118.

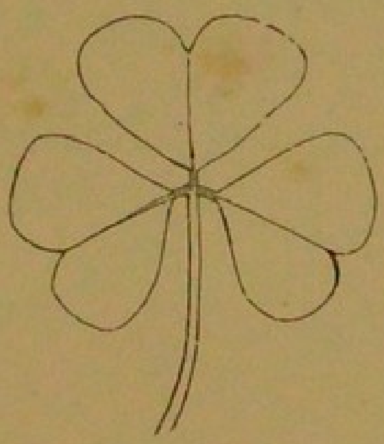

Fig. 119.

91. And, from the highest powers of development, we have the decompound (*Fig.* 120) and supra-decompound (*Fig.* 121) leaves.

This can also be traced in long leaves (*Figs.* 122, 123, 124, 125).

92. Then, all leaves are similar, only some are more developed than others, or the development of certain leaves is arrested earlier than that of others.

This also agrees with Prop. 6, which says that all plants are similar, only the growth of some is arrested earlier than that of others.

Fig. 118.—Trilobate, or three-lobed, leaf of *Hepatica triloba*.
Fig. 119.—Compound leaf of the Wood-sorrel (*Oxalis Acetosella*).

93. The general form of the leaf also varies; yet all its forms result only from the varied directions taken by the developing energy.

The following illustrations (*Figs.* 126—136) give its most characteristic forms. (See Props. 390—412 in the "Rudiments.")

94. And although there are thousands of modifications of form presented by this organ, yet all are referred by botanists to about twenty types.

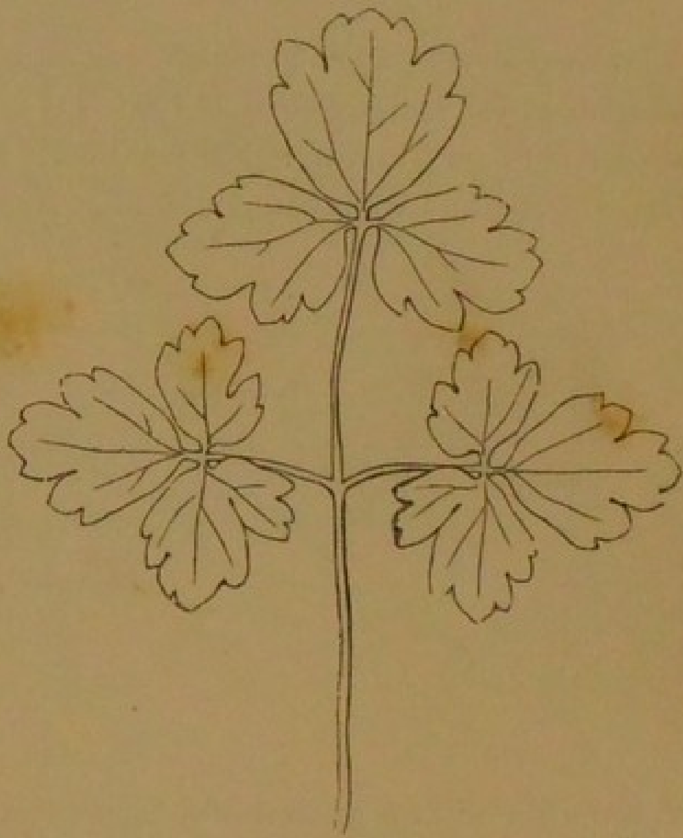

Fig. 120.

The typical forms that are most commonly distinguished are the acicular (*Fig.* 126), linear (*Fig.* 127), linear lanceolate (*Fig.* 128), lanceolate (*Fig.* 122), elliptical (*Fig.* 129), oblong (*Fig.* 130), oval (*Fig.* 131), ovate (*Fig.* 132), obovate, spatulate (*Fig.* 133), rhomboid (*Fig.* 116), roundish (*Fig.* 117), orbicular (*Fig.* 134), angular (*Fig.* 135), reniform (*Fig.* 136), and cuneate.

95. Nor are these types distinct, for the linear lanceolate leaf is merely a long lanceolate, the lanceolate is merely a

Fig. 120.—Decompound leaf of the Columbine (*Aquilegia vulgaris*).

long ovate, the ovate merely an elongated orbicular leaf, and so on.

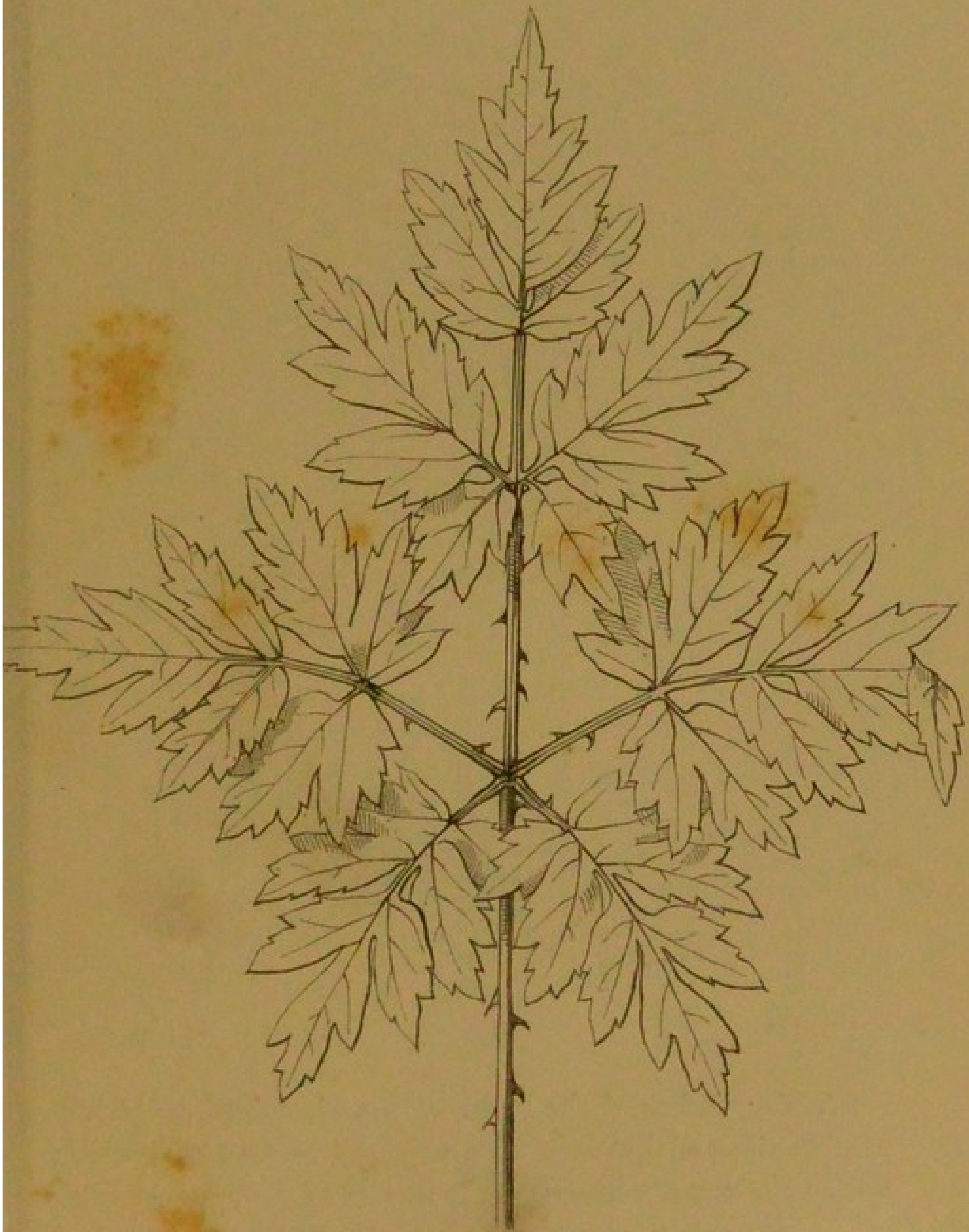

Fig. 121.

96. Thus, all the forms of leaves may be said to result

Fig. 121.—Somewhat supra-decompound leaf of a species of Bramble (*Rubus laciniatus*).

from one prototype, which is elongated, or compressed, or otherwise modified.

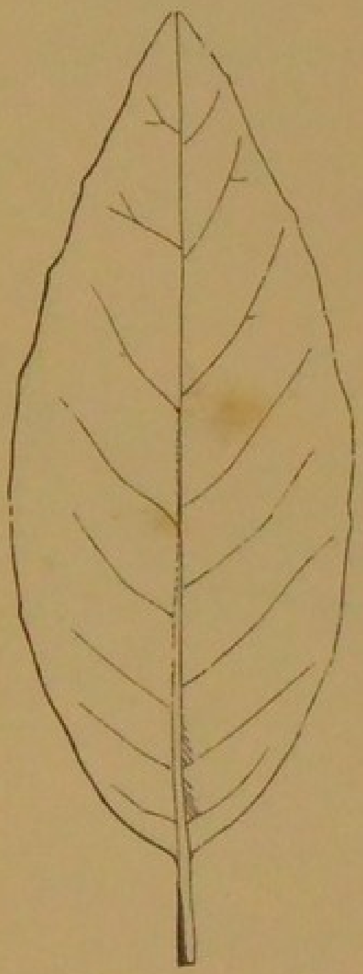

Fig. 122.

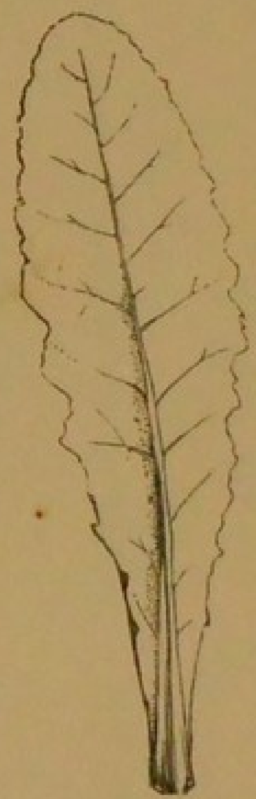

Fig. 123.

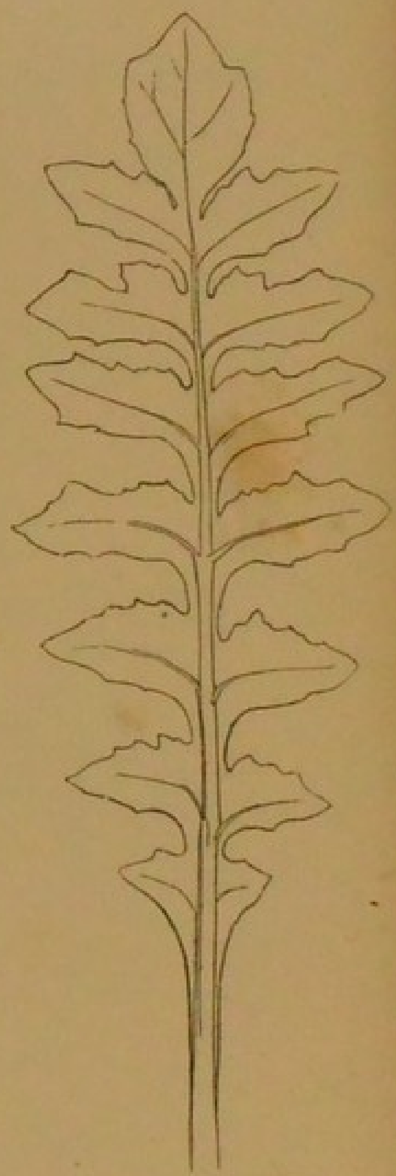

Fig. 124.

97. The surface of the leaf becomes diversified by certain modifications of that skin with which all leaves are invested; just in the same manner that the surface of the stem is varied.

This might be expected, as the leaf is a distention of the bark of the stem.

Fig. 122.—Lanceolate leaf of Evergreen Oak (*Quercus Ilex*).
Fig. 123.—Leaf of the Primrose (*Primula acaulis*).
Fig. 124.—Leaf of Shepherd's Purse (*Capsella Bursa Pastoris*).

98. In some cases the entire growth of the leaf is arrested

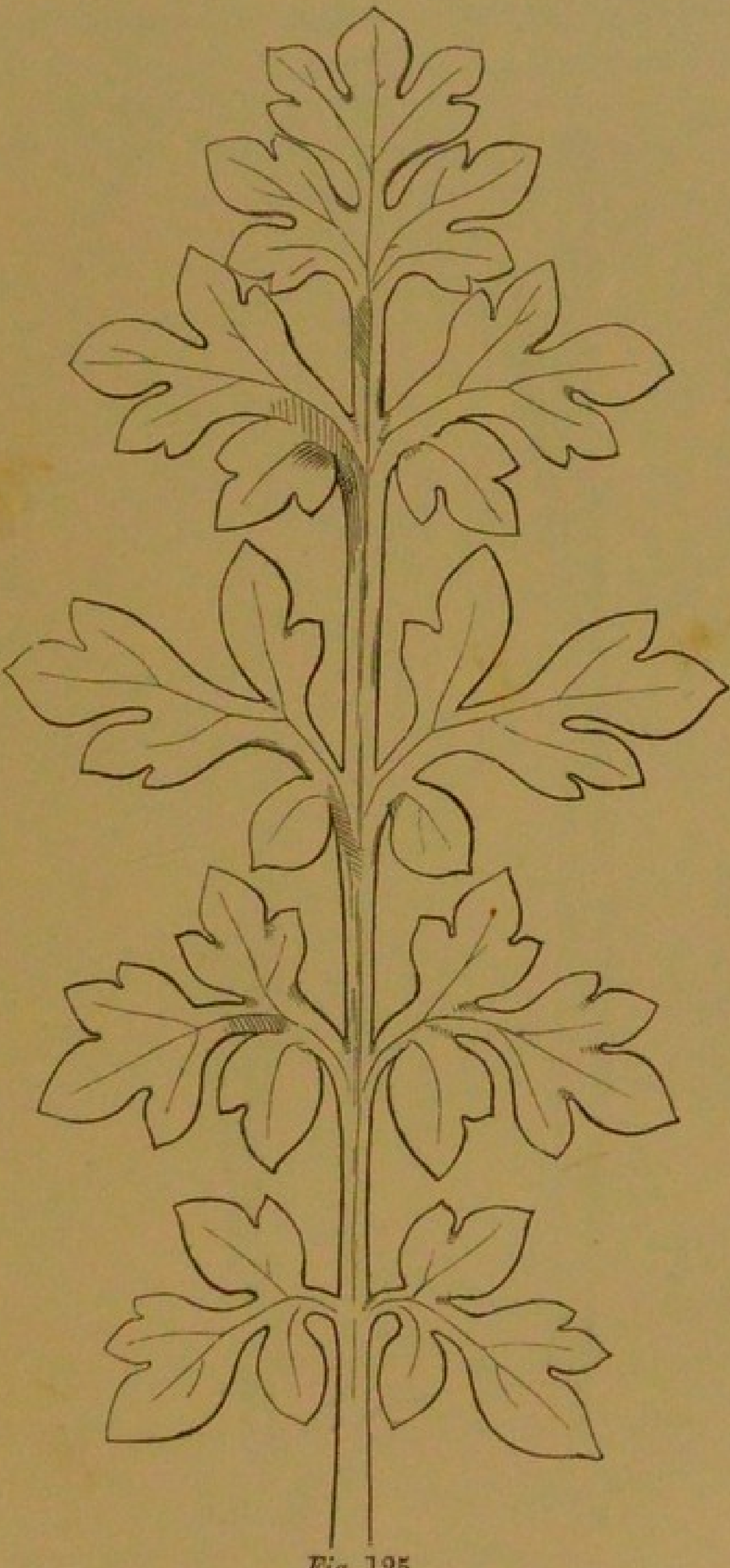

Fig. 125.

Fig. 125.—Leaf of a species of Poppy (*Papaver Rhœas*).

at an early period, by which means both perulæ (*Fig.* 109) and bracts (*Fig.* 137) are produced.

Fig. 127. *Fig.* 126.

Fig. 126.—Acicular leaves of the Weymouth Pine (*Pinus Strobus*).
Fig. 127.—Linear leaf of a species of Grass.

99. Hence perulæ and bracts are not distinct organs, but are leaves in a somewhat rudimentary state.

Also by a modification of growth, sepals, petals, stamens, and carpels, are produced, for all these organs are but modified leaves.

100. The veins of leaves are variously arranged.

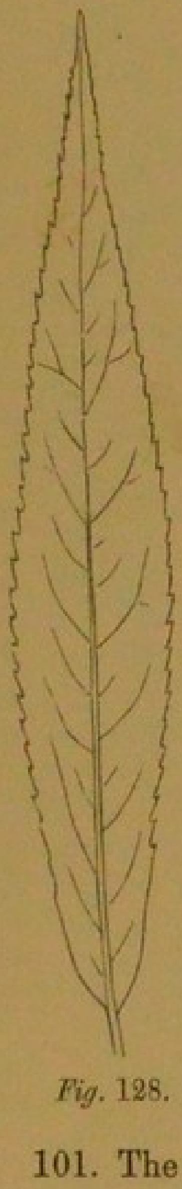

Fig. 128.

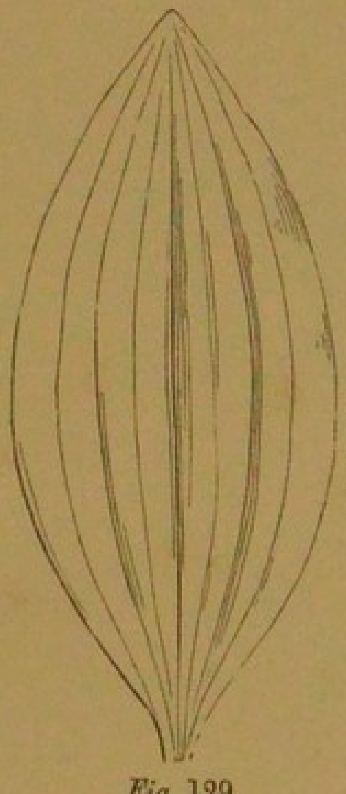

Fig. 129.

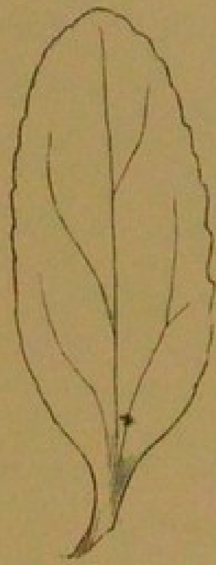

Fig. 130.

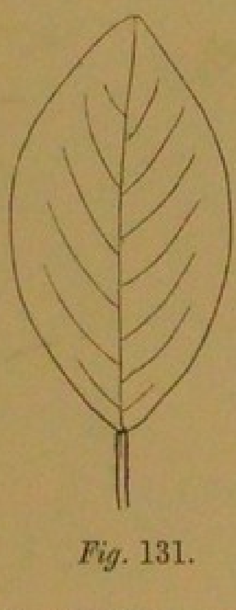

Fig. 131.

101. The two typical forms of their distribution are the reticulated (*Fig.* 138) and the parallel (*Fig.* 139).

Fig. 128.—Linear lanceolate leaf of the Willow (*Salix*).
Fig. 129.—Elliptical leaf of the Solomon's Seal (*Polygonatum multiflorum*).
Fig. 130.—Oblong leaf of Brooklime (*Veronica Beccabunga*).
Fig. 131.—Oval leaf of Snow-berry (*Symphoricarpus vulgaris*).

102. Nevertheless, these forms are somewhat homologous.

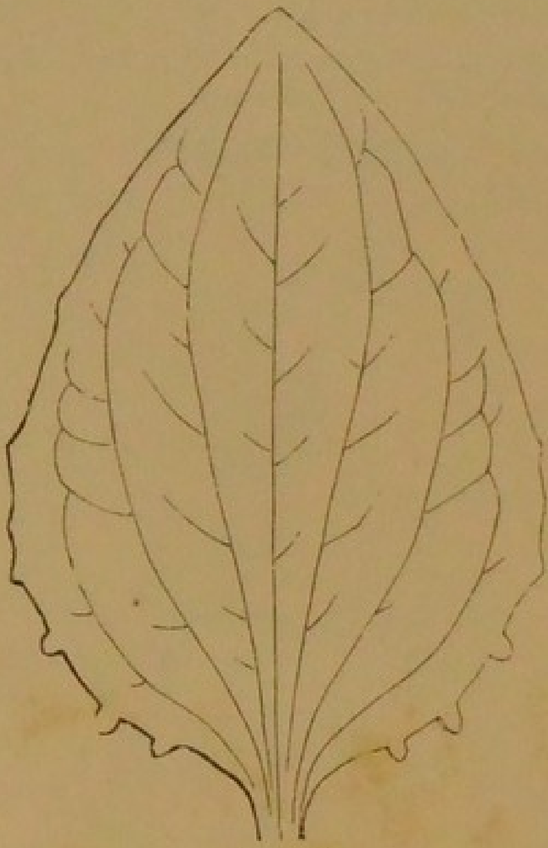

Fig. 132.

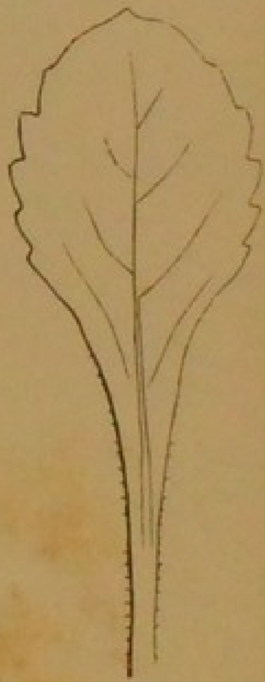

Fig. 133.

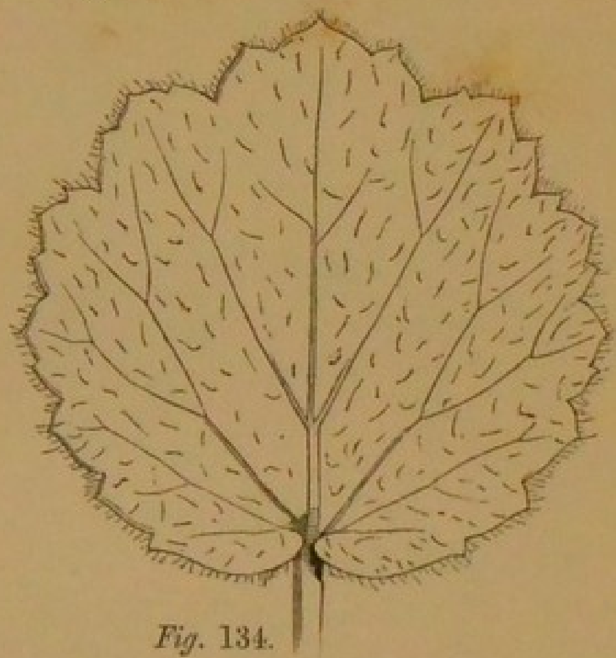

Fig. 134.

Fig. 132.—Ovate leaf of a species of Plantain (*Plantago major*).
Fig. 133.—Spatulate leaf of London Pride (*Robertsonia umbrosa*).
Fig. 134.—Orbicular leaf of Mother of Thousands (*Saxifraga sarmentosa*).

103. For, in a sense, no veins are branched.

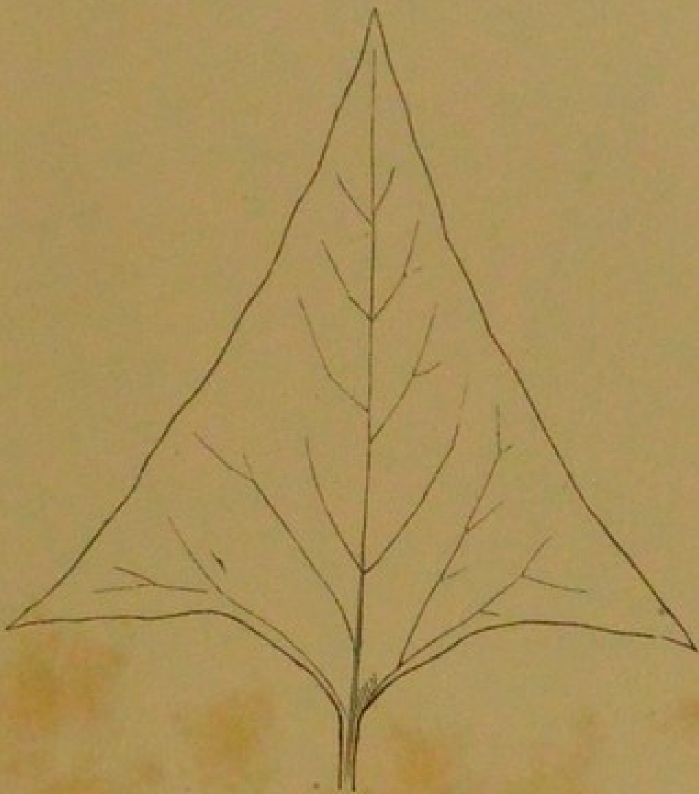

Fig. 135.

This will be at once seen by our diagram (*Fig.* 140). The ribs of the leaf are also formed in the same manner that our illustration (*Fig.* 140) shows the midrib to be.

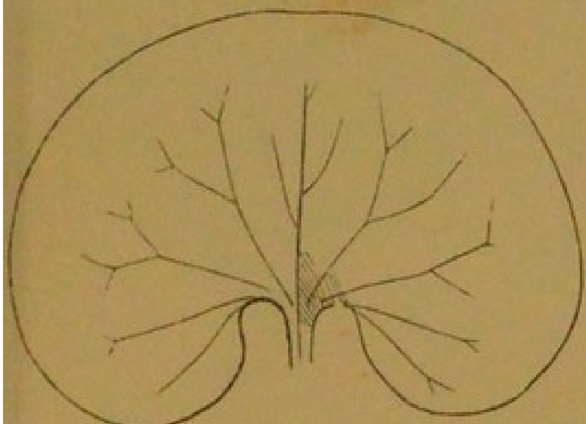

Fig. 136.

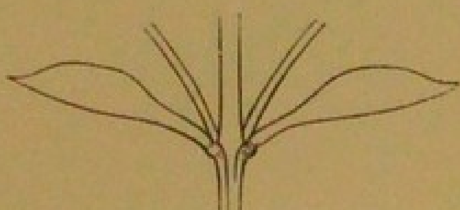

Fig. 137.

A comparison of the veins of the leaf, and their principle of branching,

Fig. 135.—Angular leaf of Henricus (*Chenopodium Bonus*).
Fig. 136.—Reniform leaf of Asarabacca (*Asarum europæum*).
Fig. 137.—Bracts from the inflorescence of the Lilac (*Syringa vulgaris*).

with the ramification of the root and stem, and their principles of branching (*Figs.* 88, 63), will at once show that a unity exists between them all.

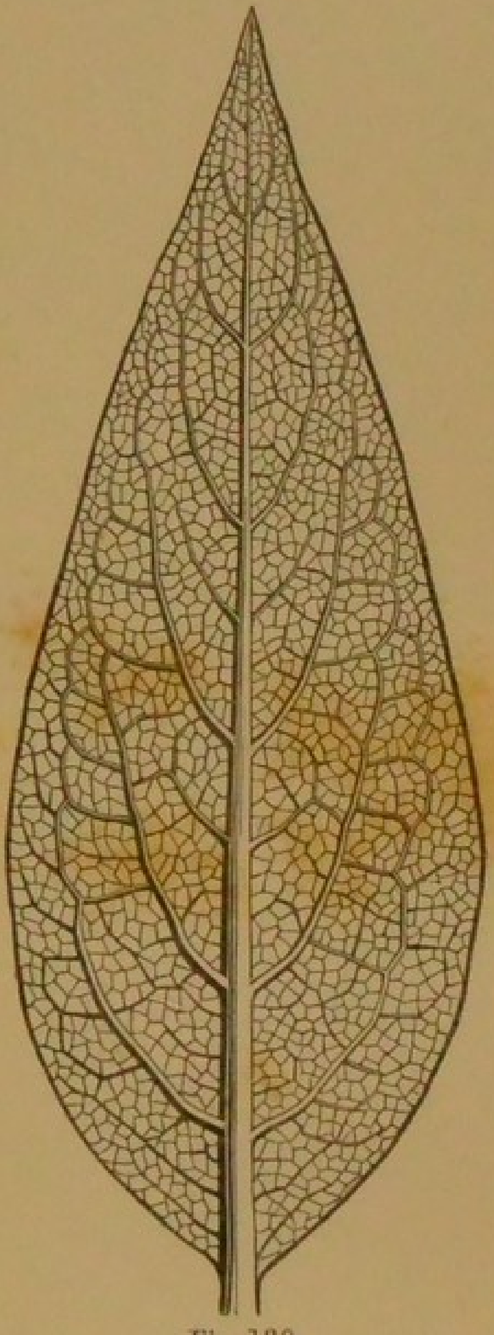

Fig. 138.

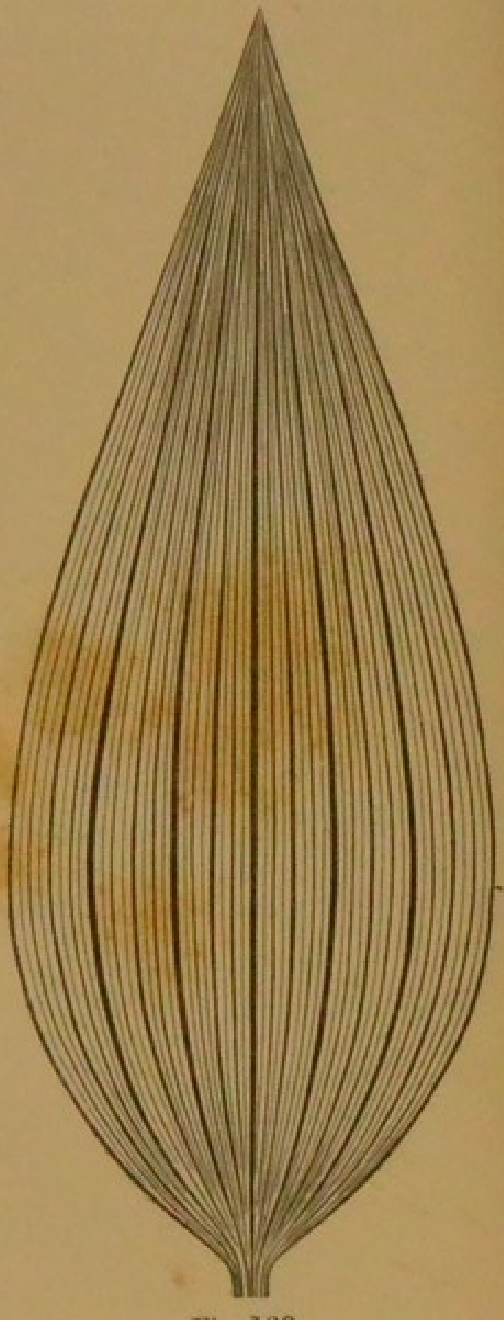

Fig. 139.

104. Thus, a vein may be said to be a simple bundle of vessels; a rib, a bundle of veins; and the midrib, a bundle of ribs, or a decompound, or twice compound, bundle of veins.

Fig. 138.—Diagram illustrating reticulated venation.
Fig. 139.—Diagram setting forth parallel venation.

105. The exogenous or reticulated venation results from the veins running parallel, and in contact, for a certain distance, and then diverging.

106. And the endogenous venation from the veins running parallel, but not quite in approximation.

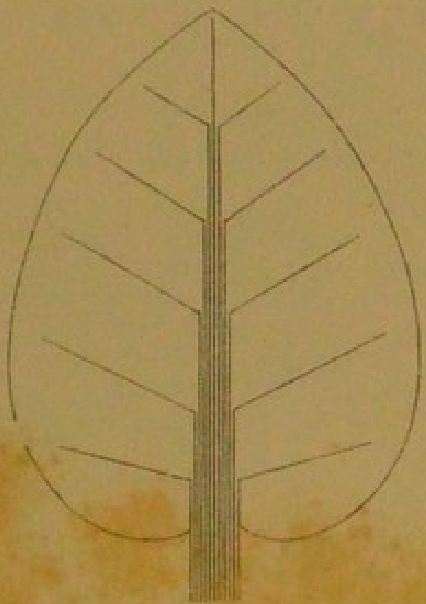

Fig. 140.

107. Hence these two forms of venation, when thus viewed, are similar.

108. It follows, then, that there is a unity existing between all leaves.

Fig. 140.—Diagram illustrating the formation of veins.

CHAPTER VII.

THE INFLORESCENCE.

109. NEXT we notice the inflorescence, of which many forms exist. The characteristic varieties of this organ are the

Fig. 141.

capitulum, spike, catkin (*amentum*), spadix, raceme, panicle, thyrsus, corymb, cyme, umbel, and fascicle.

Fig. 141.—Corn Bluebottle (*Centaurea Cyanus*), showing its capitula.

110. The capitulum (*Figs.* 141, 142, 143) and spike (*Figs.* 144, 145), however, differ only in this, that in the former the axis is shortened, while in the latter it is elongated.

These are beautifully connected by such intermediate forms of inflorescence as that of the Purple Clover (*Trifolium pratense*), and by certain monster spikes of the Plantain (*Plantago*).

Fig. 142.

111. And the catkin (*Fig.* 146) differs from the spike only in its flowers being unisexual, and its bracts scaly.

112. And the spadix (*Fig.* 147) differs from the spike and catkin only in being more succulent (which is doubtless owing to its being enclosed in a spathe).

Fig. 142.—Dandelion (*Taraxacum Dens Leonis*).

The spadix, however, frequently produces flowers only at its base, whereas the spike and catkin produce flowers throughout their entire length.

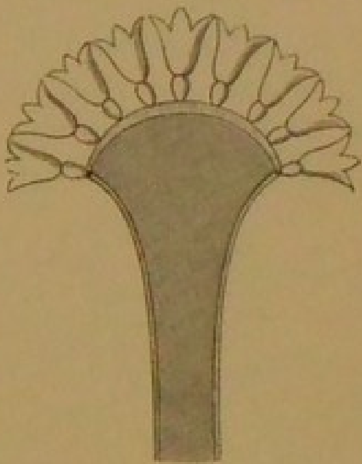

Fig. 143.

113. The raceme (*Figs.* 148, 149) differs from the spike simply in having its flowers elevated on short pedicels.

Fig. 144.

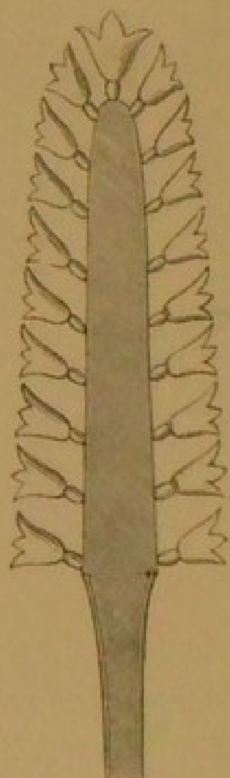

Fig. 145.

Fig. 143.—Ideal figure of a capitulum.
Fig. 144.—Spike of Vervain (*Verbena officinalis*).
Fig. 145.—Ideal figure of a spike.

The raceme is, in fact, a spike the flowers of which have become pedicellate by the development of an elongated node between the rachis and the floral whorls.

The raceme bears the same relation to the spike that the umbel does to the capitulum, and that the pinnate leaf does to the simple leaf.

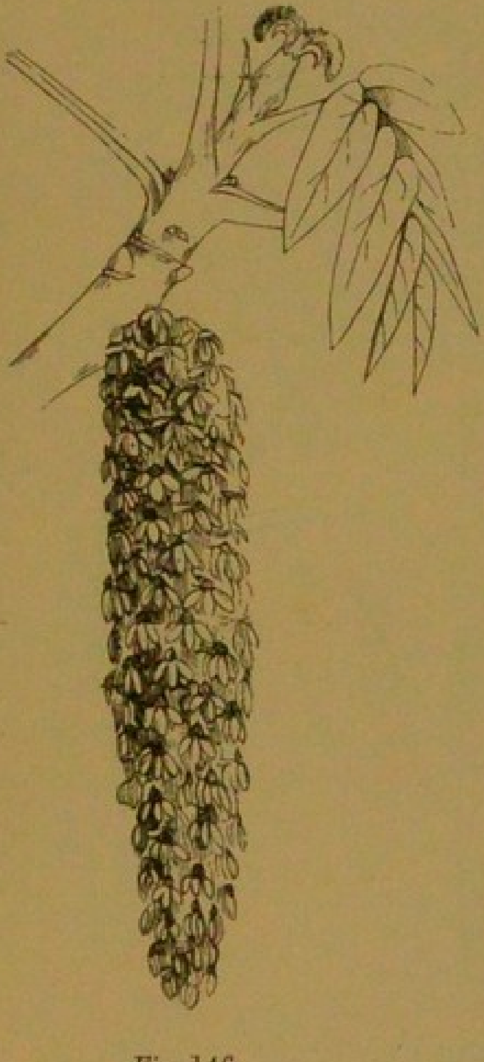

Fig. 146.

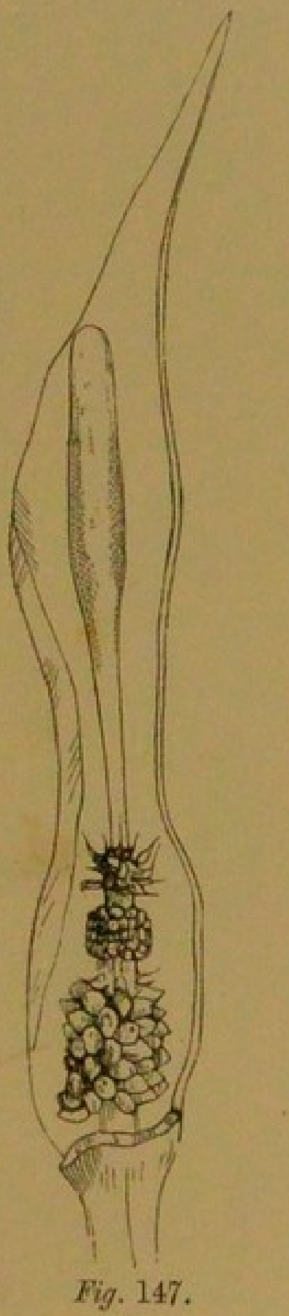

Fig. 147.

114. And a panicle (*Fig.* 150) is a loosely-spreading raceme, the pedicels of which have generated branches.

Fig. 146.—Catkin or amentum of the Walnut (*Juglans regia*).

Fig. 147.—Cuckoo-pint (*Arum italicum*), showing its spadix.

The panicle bears the same relation to the spike that the decompound leaf does to the simple leaf.

115. A thyrsus (*Fig.* 151) is a panicle, the flowers of which

Fig. 148.

are more "set," owing to the pedicels which support them being of a more solid consistence.

Fig. 148.—Raceme of Fraxinella (*Dictamnus Fraxinella*).

116. A corymb (*Fig.* 152) is a raceme or thyrsus, the lowest pedicels of which are the longest.

If the corymb is simple—that is, consists only of branches from the parent—it is a raceme, the lowest pedicels of which are the longest; if it is compound—that is, consists of branches which are themselves branched—it is a thyrsus, the lowest branches of which are the longest, so that the whole has nearly a flat top.

Fig. 150.

Fig. 149.

117. A cyme (*Fig.* 153) is a corymb, the growth of which is definite.

118. The umbel (*Fig.* 154) is a capitulum, the flowers of

Fig. 149.—Ideal figure of a raceme.
Fig. 150.—Panicle of the Sycamore (*Acer Pseudoplatanus*).

which are elevated on radii, or it is a raceme the central axis of which has not elongated.

Were the central axis of a raceme undeveloped, it is obvious that an umbel would be the result; or were the flowers of the capitulum pedicellate, it is obvious that the same would be brought about.

Fig. 151.

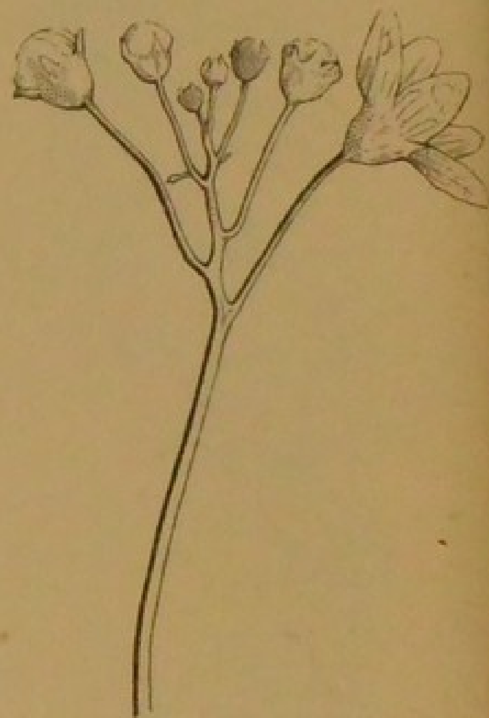

Fig. 152.

119. And the fascicle (*Fig.* 155) is an umbel, the pedicels of which are of unequal lengths.

120. Hence all the forms of inflorescence are not so many types, but are simply modifications of one type, or of each other.

They may all be regarded as modifications of the raceme, which may hence be taken as the type; in some cases, however, its pedicels must

Fig. 151.—Thyrsus of the Horse-chestnut (*Æsculus Hippocastanum*).
Fig. 152.—Corymb of the Bryony (*Bryonia dioica*).

be regarded as undeveloped, and in others its primary axis as being abortive.

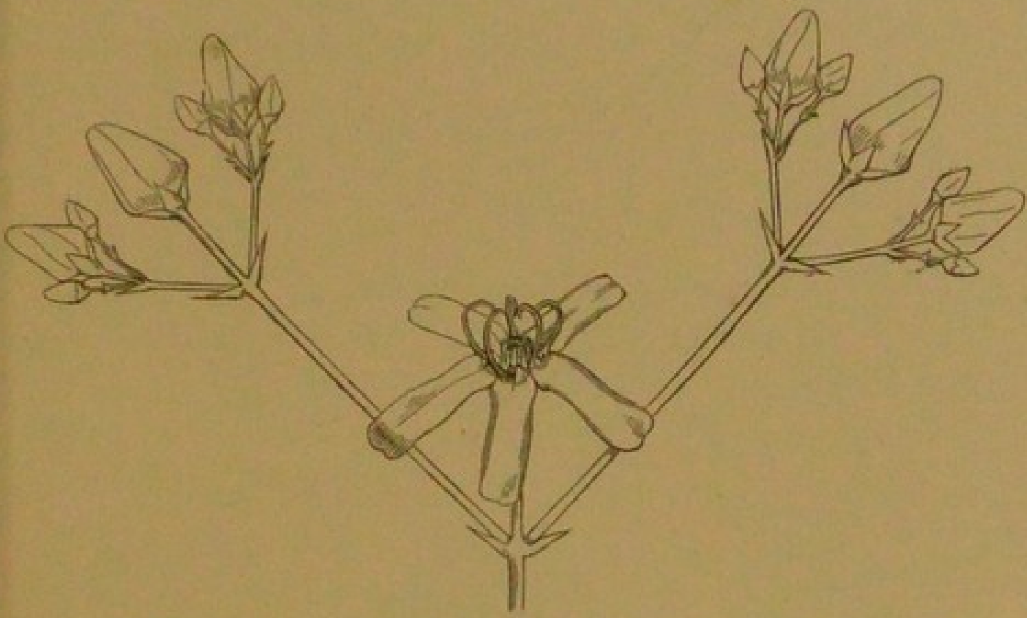

Fig. 153.

Fig. 154.

Fig. 155.

Fig. 153.—Cyme of *Periploca Græca*.
Fig. 154.—Umbel of Cherry (*Cerasus communis*).
Fig. 155.—Fascicle of Mallow (*Malva sylvestris*).

CHAPTER VIII.

THE FLOWER.

121. The flower appears in many forms.

122. Nevertheless, it usually has four sets of parts (*Fig.* 156).

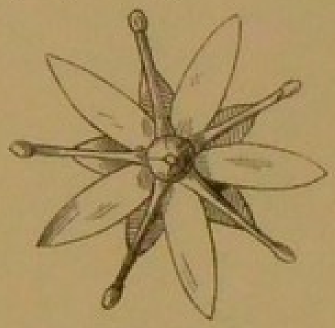

Fig. 156.

Fig. 157.

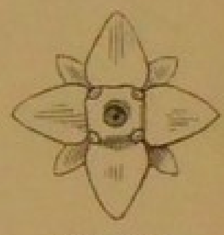

Fig. 158.

123. And its numberless diversified forms result solely from modifications of these organs.

124. Thus the flower may be constructed on the number two, *Ex.* Enchanter's Nightshade; on the number three, *Ex.* Lily and Spiderwort (*Fig.* 157); on the number four, *Ex.* Alchemilla (*Fig.* 158) and Fuchsia (*Fig.* 159); on the number five, *Ex.* Stonecrop (*Figs.* 160, 161) and Strawberry (*Figs.* 162, 163); and so on.

125. Also, if the flower is on any set number, as the number five, for example, and there are five sepals and five petals, there may be only five stamens (*Fig.* 156), or there may be ten (*Figs.* 160, 161), or an indefinite number (this number being, however, a multiple of five), *Fig.* 163.

126. The same also holds good with the carpels; thus,

Fig. 156.—Ideal figure of a flower.
Fig. 157.—Flower of Virginian Spiderwort (*Tradescantia virginica*).
Fig. 158.—Flower of Ladies' Mantle (*Alchemilla vulgaris*).

they may be five in number and consolidated, *Ex.* Nigella (*Fig.* 164); or separate, *Ex.* Stonecrop (*Sedum*), *Fig.* 161; or many in number, Ex. Strawberry (*Fig.* 163).

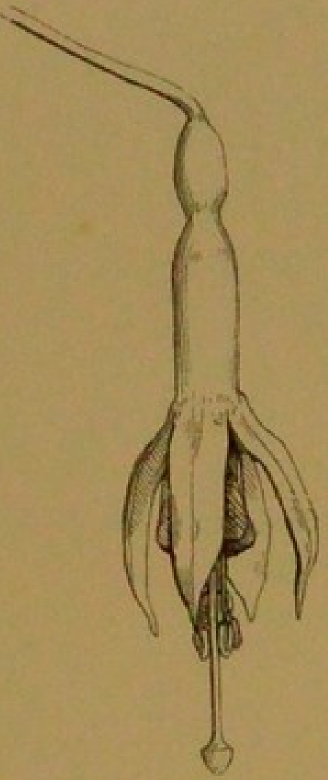

Fig. 159.

127. Yet in all these cases we have but the four sets of parts.

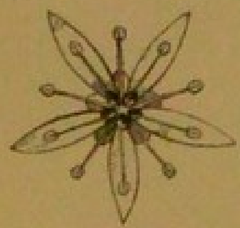

Fig. 160.

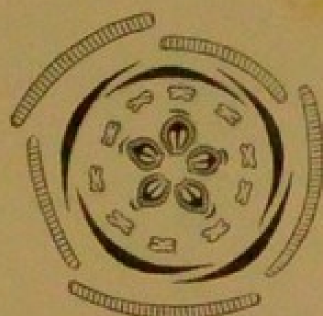

Fig. 161.

Fig. 162.

128. In the flower we distinguish the calyx, corolla,

Fig. 159.—Flower of *Fuchsia*.
Fig. 160.—Flower of Stonecrop (*Sedum acre*).
Fig. 161.—Diagram of the Stonecrop (*Sedum acre*).
Fig. 162.—Flower of the Strawberry (*Fragaria vesca*).

andræceum, and pistil—these being the four floral verticils (*Fig*. 156).

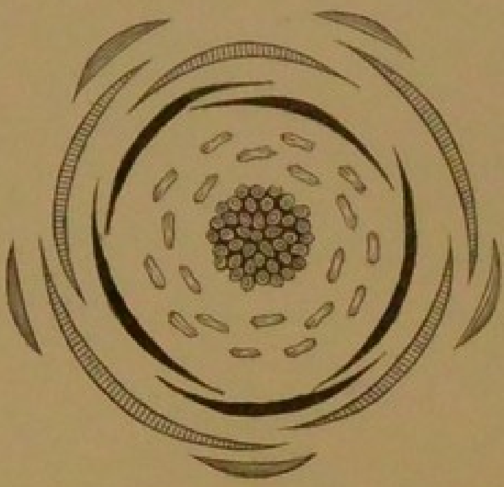

Fig. 163.

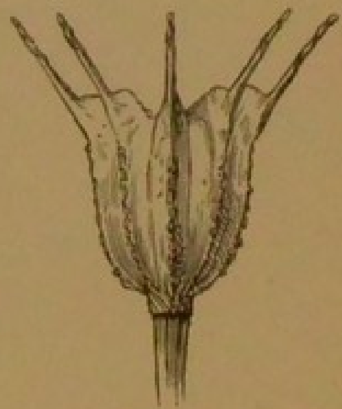

Fig. 164.

129. Nevertheless, these are not distinct organs—that is, organs of separate origins.

This is distinctly proved by monster sepals, petals, stamens, and carpels.

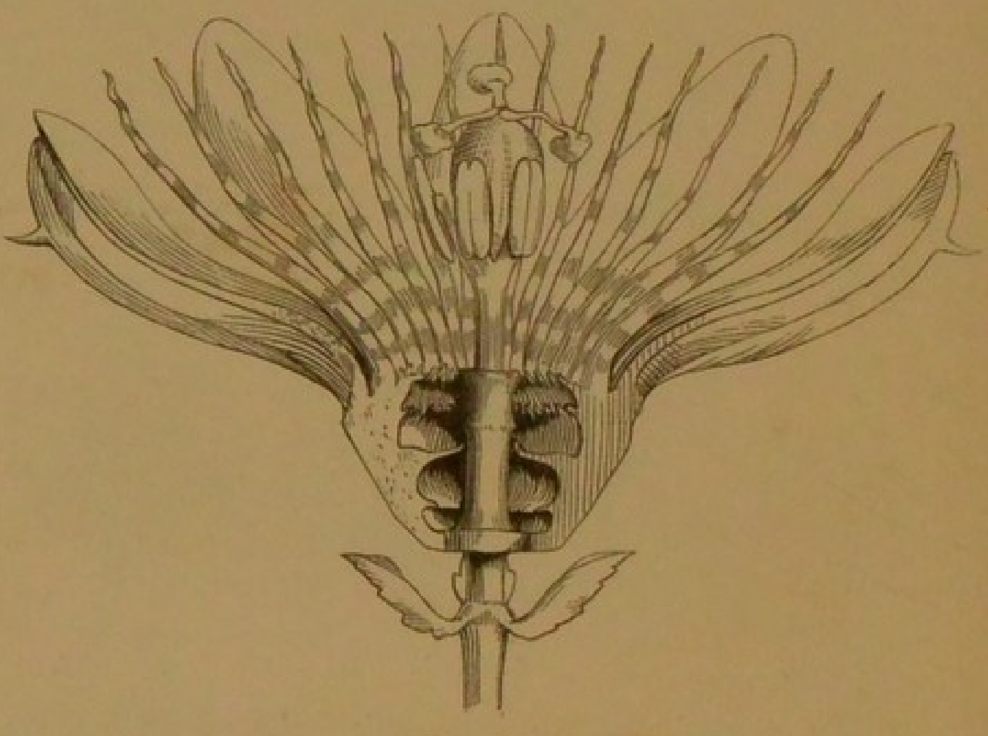

Fig. 165.

Fig. 163.—Diagram of the Strawberry (*Fragaria vesca*).
Fig. 164.—Capsule of *Nigella*.
Fig. 165.—*Passiflora alata*, portion of the flower.

130. For they are all modifications of leaves.

131. And they all gradually pass into each other.*

132. Therefore all the floral organs are synonymous, or equal.

133. Added to the organs just enumerated we sometimes have the coronet (*Fig.* 165) and the disk (*Figs.* 166, 167).

Fig. 166.

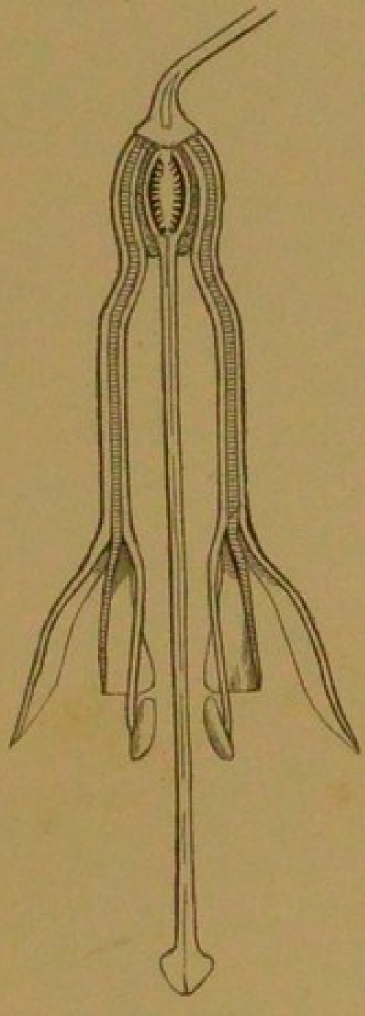

Fig. 167.

134. These, however, are merely modified staminal whorls.

135. Hence they are also one with the other floral parts.

Fig. 166.—Portion of the flower of Bindweed (*Calystegia sepium*), showing the disk.
Fig. 167.—Section of a *Fuchsia*, showing the disk.

* A petal may be said to be a certain state of a leaf, just as the allatropic state of a chemical element (of phosphorus, for example) is a condition of the body. A stamen and a carpel may also be regarded as other states of a leaf, just as there are two abnormal variations of chemical elements, as is known in the case of oxygen and of carbon.

136. The diversities of form of the sepals and petals correspond with those of leaves.

Thus they are lanceolate, ovate, obovate, cordate, &c.; bifid, trifid, and so on.

137. Yet there are certain of these organs of somewhat abnormal shapes.

Fig. 168.

138. Thus the petal of the Columbine is calcarate, or spurred (*Fig.* 168).

Fig. 168.—Columbine (*Aquilegia vulgaris*).

139. Yet this calcar is not a distinct organ, but is merely a distension or protrusion of the centre of the petal, and in formation is only very slightly removed from many others (*Fig.* 169).

Fig. 169.

Thus, the petal of the Crown Imperial (*Fig.* 170) has a large concave alveolar gland near its base; the petals of the Cajophora (*Fig.* 171) are very hollow; and in the Columbine (*Aquilegia*) this is carried one step farther.

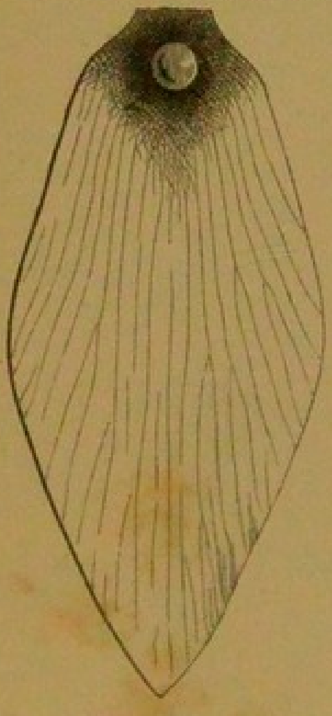

Fig. 170.

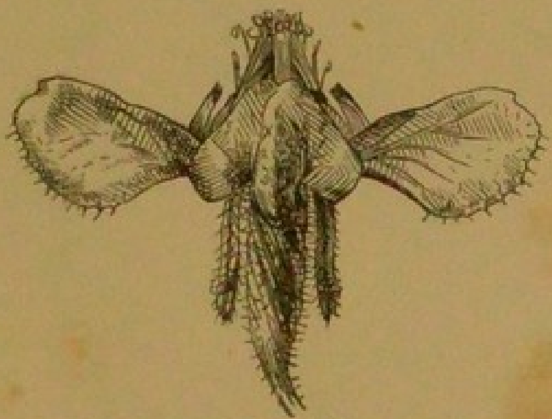

Fig. 171.

The following is extracted from my note-book:—" The nectariferous pore or depression at the base of the petal of the Crowfoot (*Ranunculus*) is doubtless the commencement of a tubular petal, such as occurs in the

Fig. 169.—Showing the formation of the petal of the Columbine (*Aquilegia*).
Fig. 170.—Petal of Crown Imperial (*Fritillaria imperialis*).
Fig. 171.—Flower of *Cajophora lateritia*.

Christmas Rose (*Helleborus*). In the former, one side is much developed, while the other is small; and in the tubular petals of the latter

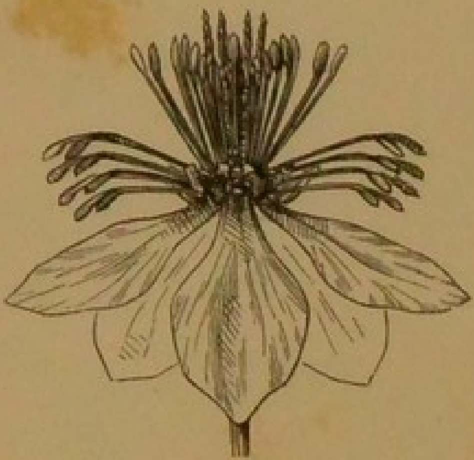

Fig. 172.

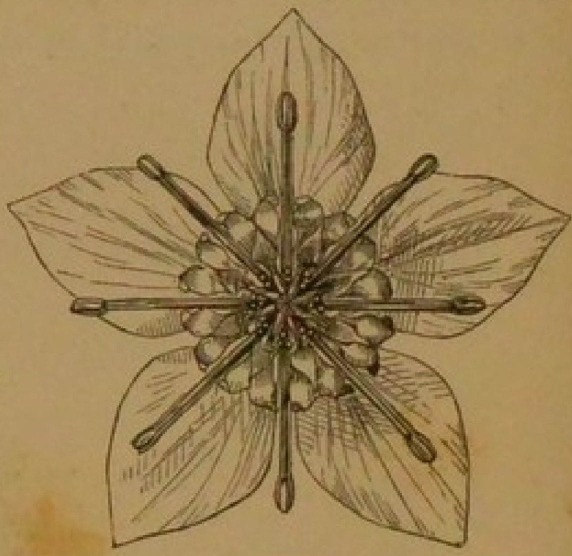

Fig. 173.

this occurs to a small extent. The petals of the Nigella (*Figs*. 172,

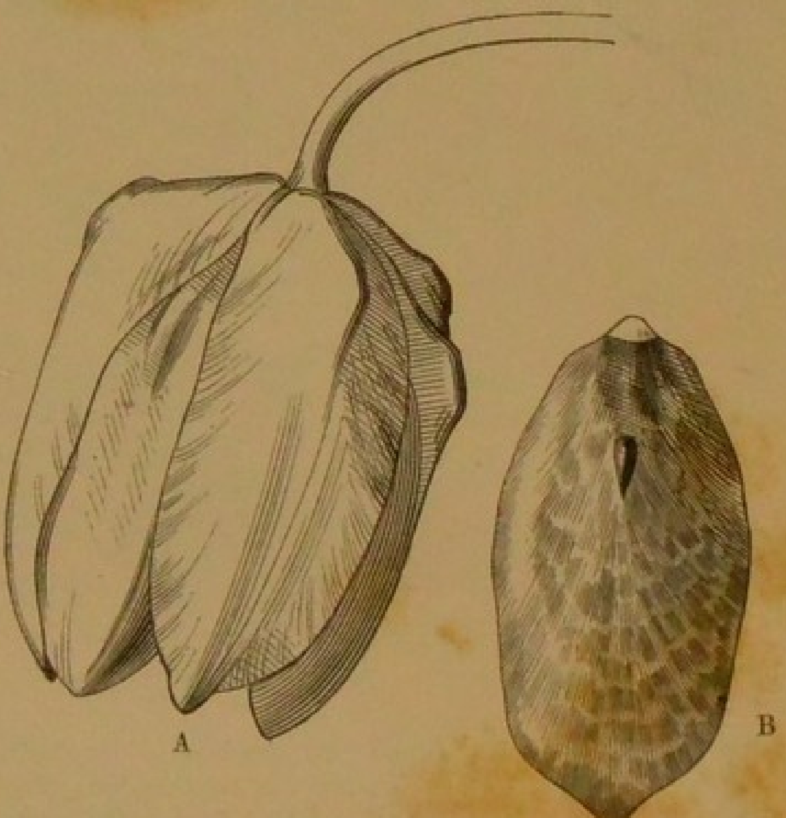

Fig. 174.

Figs. 172, 173.—Two views of the flower of a species of *Nigella*.
Fig. 174.—A, flower of *Fritillaria latifolia*. B, a separate leaf.

173) furnish an intermediate stage. See petals of Crown Imperial (*Fri-*

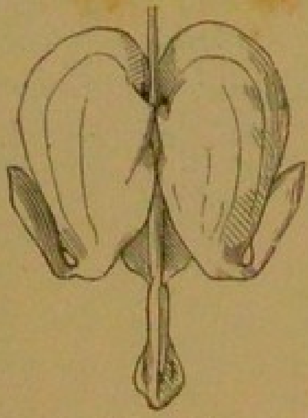

Fig. 175.

tillaria imperialis), Fritillary (*Fritillaria latifolia*), *Fig.* 174, Orange

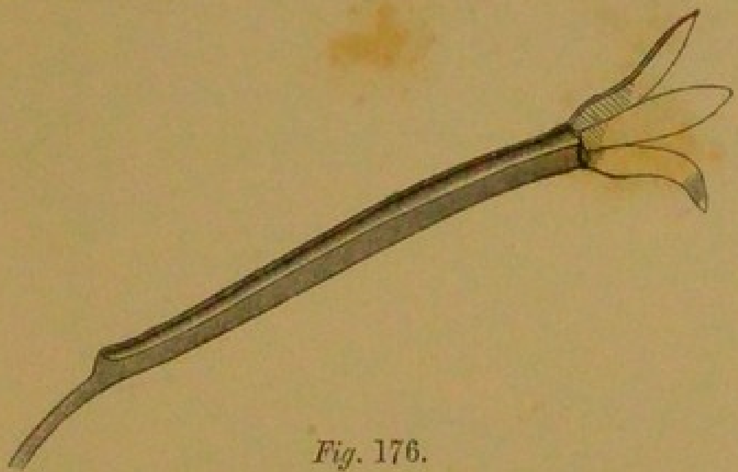

Fig. 176.

Lily (*Lilium bulbiferum*), *Dielytra* (*Fig.* 175), and Columbine (*Aqui-*

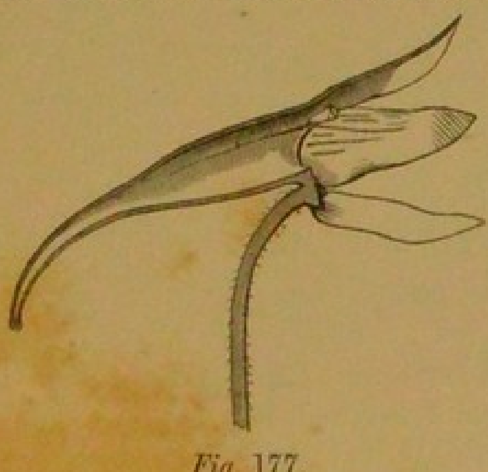

Fig. 177.

Fig. 175.—Flower of *Dielytra spectabalis.*
Fig. 176.—Section of the peduncle of a Geranium (*Pelargonium*).
Fig. 177.—Section of the calcarate calyx of the Nasturtium (*Tropæolum majus*).

legia vulgaris), *Fig.* 168; also the tube in the peduncle of Garden Geraniums (*Pelargonium*), *Fig.* 176, and calcar of Nasturtium (*Tropæolum majus*)," *Fig.* 177.

140. There are also many varieties of the floral envelopes.

141. They are polyphyllous (*Fig.* 178) or gamophyllous

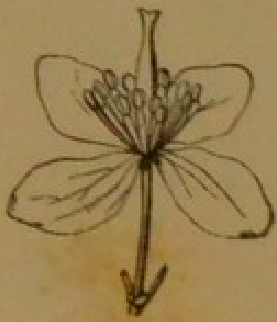

Fig. 178.

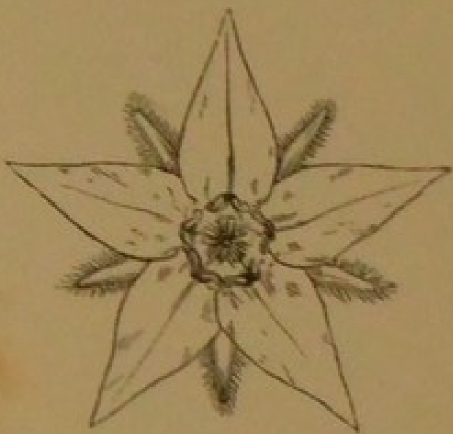

Fig. 180.

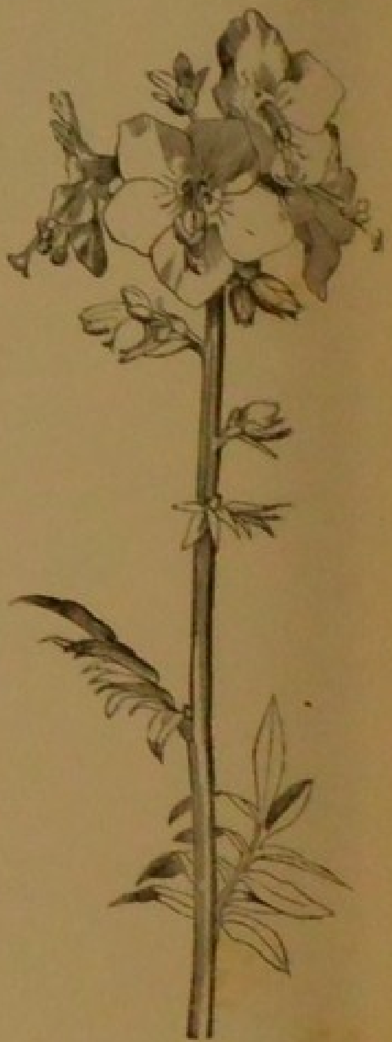

Fig. 179.

(*Fig.* 179), regular (*Fig.* 180) or irregular (*Fig.* 181), tubular, campanulate, infundibuliform, saccate or calcarate, lobed or entire.

Thus, the corolla is tubular in the Marygold (*Fig.* 182), campanulate in the Canterbury Bells (*Fig.* 183), infundibuliform in the Convolvulus (*Fig.* 184), saccate in the Snapdragon (*Fig.* 185), calcarate in the Toad-flax

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Fig. 178.—Flower of the Celandine (*Chelidonium majus*).
Fig. 179.—Greek Valerian, or Jacob's Ladder (*Polemonium vulgare*).
Fig. 180.—Flower of the Borage (*Borago officinalis*).

(*Fig.* 186), lobed in the Kalmia (*Fig.* 187). The calyx also appears in similar forms: thus, it is calcarate in the Nasturtium (*Fig.* 188), lobed in the Dead-Nettle (*Fig.* 189), and entire in the Madder (*Fig.* 190).

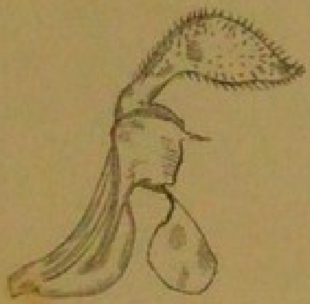


Fig. 181.

Fig. 182.

142. Yet all these modifications result only from varied unions and developments of the leaves entering into their composition, or from certain directions and forms of the disunited phyllous organs.

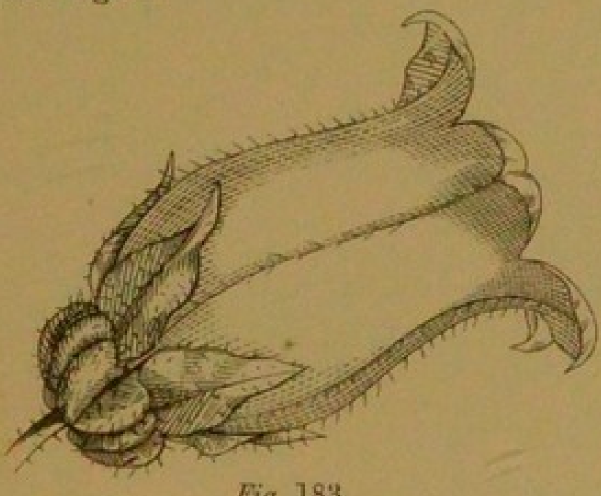


Fig. 183.

143. Thus, the tubular, campanulate, and infundibuliform gamophyllous floral envelopes result from floral leaves of dissimilar forms uniting by growth.

144. And lobed and entire gamophyllous floral envelopes differ only in the forms of the members entering into their composition, and the extent to which these members are united.

Fig. 181.—Corolla of White Dead-Nettle (*Lamium album*).
Fig. 182.—Tubular floret of the Marygold (*Calendula officinalis*).
Fig. 183.—Flower of the Canterbury Bells (*Campanula Medium*).

145. Also the saccate and calcarate forms differ only in the extent of their basal protrusions.

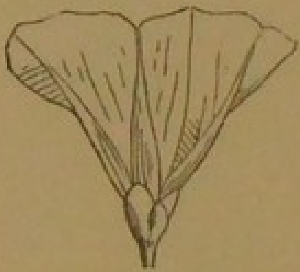


Fig. 184.

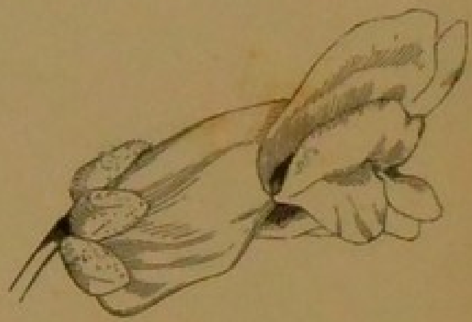


Fig. 185.

The following is extracted from my note-book:—"The gibbous and cal-

Fig. 186.

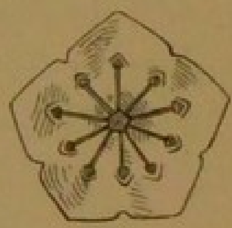


Fig. 187.

carate corollas are allied, for the basal protuberance of the former may

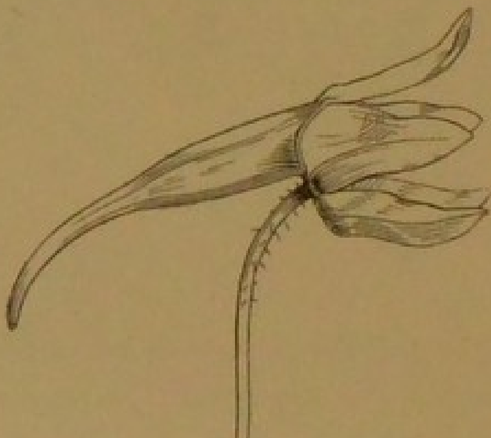


Fig. 188.

Fig. 184.—Flower of the Field Convolvulus (*Convolvulus arvensis*).
Fig. 185.—Flower of the Snapdragon (*Antirrhinum majus*).
Fig. 186.—A species of Toadflax (*Linaria macroura*).
Fig. 187.—Flower of the *Kalmia*.
Fig. 188.—Calyx of Nasturtium, or Indian Cress (*Tropæolum majus*).

be regarded as the rudiment of a spur; thus, the Snapdragon (*Antirrhinum*) and Toadflax (*Linaria*) both occur in one natural family, and they contain these two varieties. The calcarate corolla is connected with the corolla of the Columbine by pelorian varieties."

Fig. 189.

Fig. 190.

146. And all gamophyllous floral envelopes are similar, as all are composed of united floral leaves.

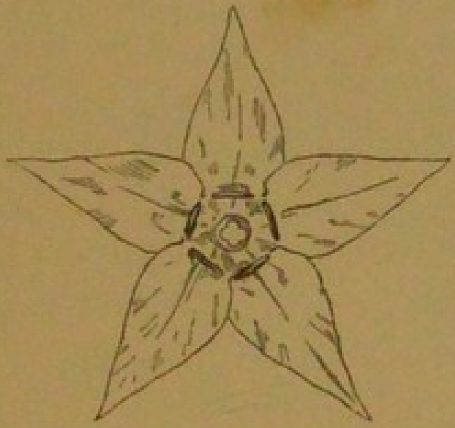


Fig. 191.

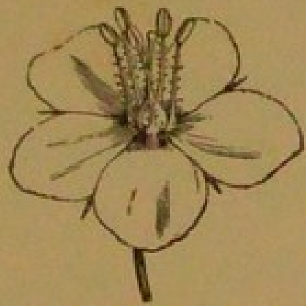


Fig. 192.

147. Moreover, polyphyllous and gamophyllous floral envelopes are not remote from each other.

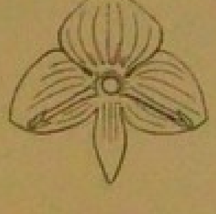


Fig. 193.

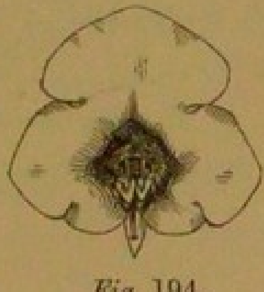


Fig. 194.

Fig. 189.—Calyx of Dead-Nettle (*Lamium*).
Fig. 190.—Madder (*Rubia tinctorum*), showing its entire calyx.
Fig. 191.—Back view of the corolla of the Borage (*Borago officinalis*).
Fig. 192.—Flower of the Pimpernel (*Anagallis*).
Fig. 193.—Corolla of the Germander Speedwell (*Veronica Chamedrys*).
Fig. 194.—Flower of the *Alonsoa elegans*.

148. For the union of floral leaves takes place to varied extents.

Thus, in partite corollas, for example (*Figs.* 191, 192, 193), the petals are united at their bases only; in lobed corollas (*Figs.* 194, 181) they are united throughout half their length; and in cleft (*Figs.* 195, 183) they are united throughout the greater part of their length.

Fig. 195.

149. Also the calcarate gamophyllous floral envelope is connected with the calcarate polyphyllous envelope (as that of the Columbine, *Aquilegia*) by monsters, which frequently occur (Pelorian varieties).

Pelorian varieties commonly occur in the Toadflax (*Linaria*).

Fig. 195.—Tobacco (*Nicotiana Tabacum*).

CHAPTER IX.

THE FRUIT.

150. Of the fruit there are many varieties.

151. Thus we have dehiscent and indehiscent, simple and compound fruits.

152. Of simple (unicarpous) dehiscent fruits we have the follicle (*Fig.* 196) and legume (*Fig.* 198).

153. Of simple indehiscent fruits we have the drupe (*Fig.* 200), achene (*Fig.* 201), caryopsis (*Fig.* 202), and utricle.

154. Of compound indehiscent fruits we have the hesperidium (*Fig.* 203), nuculanium (*Fig.* 205), pepo (*Fig.* 206), berry (*Fig.* 207), balausta (*Fig.* 208), pome (*Fig.* 209), nut (*Fig.* 210), samara (*Fig.* 211), and cremocarp (*Fig.* 212).

155. Of compound dehiscent fruits we have the siliqua (*Fig.* 213), silicula (*Fig.* 214), capsule (*Fig.* 216), and pyxis (*Fig.* 217).

156. But the follicle (*Figs.* 196, 197) and legume (*Figs.* 198, 199), both of which are simple dehiscent fruits, are not remote from each other; for they differ only in the former dehiscing at one suture (the ventral), while the latter dehisces at both.

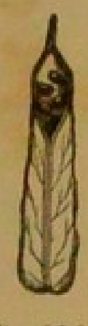


Fig. 196.

157. Neither are the drupe (*Fig.* 200), achene (*Fig.* 201), caryopsis (*Fig.* 202), and utricle constructed on different types.

158. Thus, the achæneum is a drupe, the pericarp of which is not succulent, and hence does not separate into three layers.

Fig. 196.—Follicle of the Columbine (*Aquilegia vulgaris*).

159. The caryopsis is an achæneum the pericarp of which is membranous, and adheres to the seed.

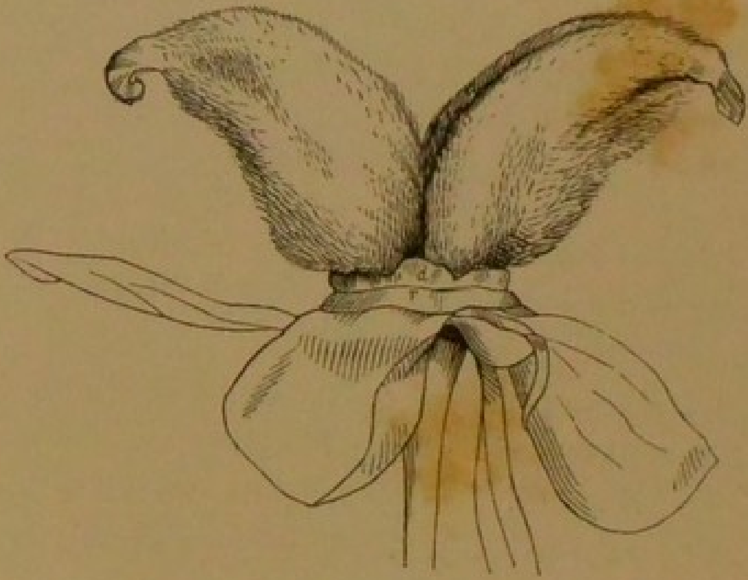


Fig. 197.

160. And the utricle is a caryopsis or achæneum the pericarp of which contracts no adhesion with the integuments of the seed.

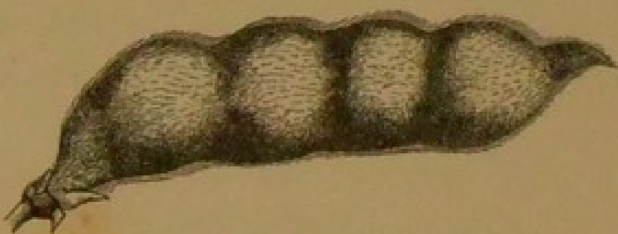


Fig. 198.

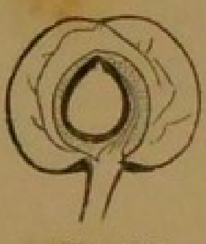


Fig. 200.

Fig. 201.

Fig. 199.

Fig. 197.—Follicles of the Peony (*Pæonia*).
Fig. 198.—Legume of a species of Lupine (*Lupinus*).
Fig. 199.—Legume of the *Lotus*.
Fig. 200.—Drupe of the Cherry (*Cerasus Communis*).
Fig. 201.—Achene of the Crowfoot (*Ranunculus*).

161. Then these are but four modifications of one type.

162. Also of indehiscent compound fruits, the hesperidium (*Figs.* 203, 204) and nuculanium (*Fig.* 205) are so closely allied as to need no comments. The pepo (*Fig.* 206), berry (*Fig.* 207), and balausta

Fig. 202.

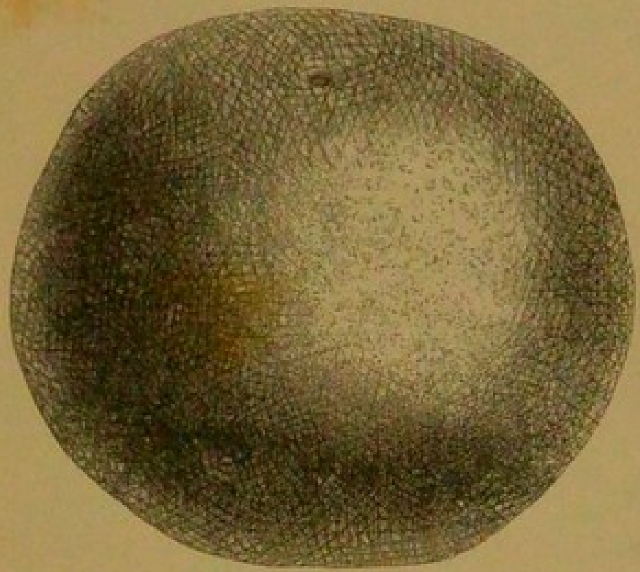


Fig. 203.

(*Fig.* 208), are also mere modifications of each other (the

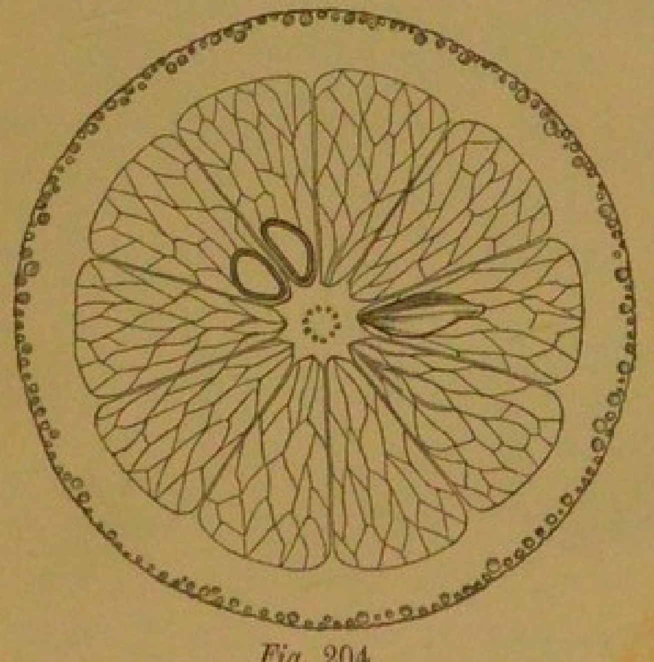


Fig. 204.

Fig. 202.—Caryopsis of the Indian Corn (*Zea Mays*).
Fig. 203.—Hesperidium of the Orange (*Citrus Aurantium*).
Fig. 204.—Hesperidium of the Orange (*Citrus Aurantium*).

seeds in each case being enveloped in pulp). The pome

Fig. 206.

(*Fig.* 209) is a berry, or pepo, in the parts of which juices

Fig. 205.

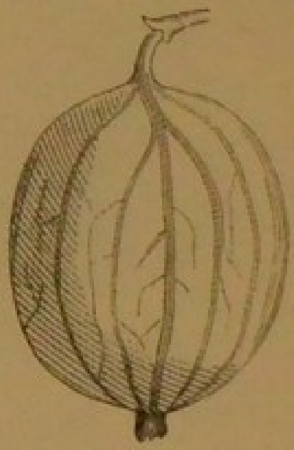


Fig. 207.

Fig. 205.—Nuculanium of the Grape (*Vitis vinifera*).
Fig. 206.—Pepo of the Vegetable Marrow (*Cucurbita ovifera*).
Fig. 207.—Berry of the Gooseberry (*Ribes Grossularia*).

are not so abundantly secreted. The nut (*Fig.* 210) is a pome with a hard pericarp, or a pericarp from which the juices have departed during the process of ripening; the samara (*Fig.* 211) is merely a nut with one side distended into the form of a wing; and the cremocarp (*Fig.* 212) is a modified nut, the constituent carpels of which disunite.

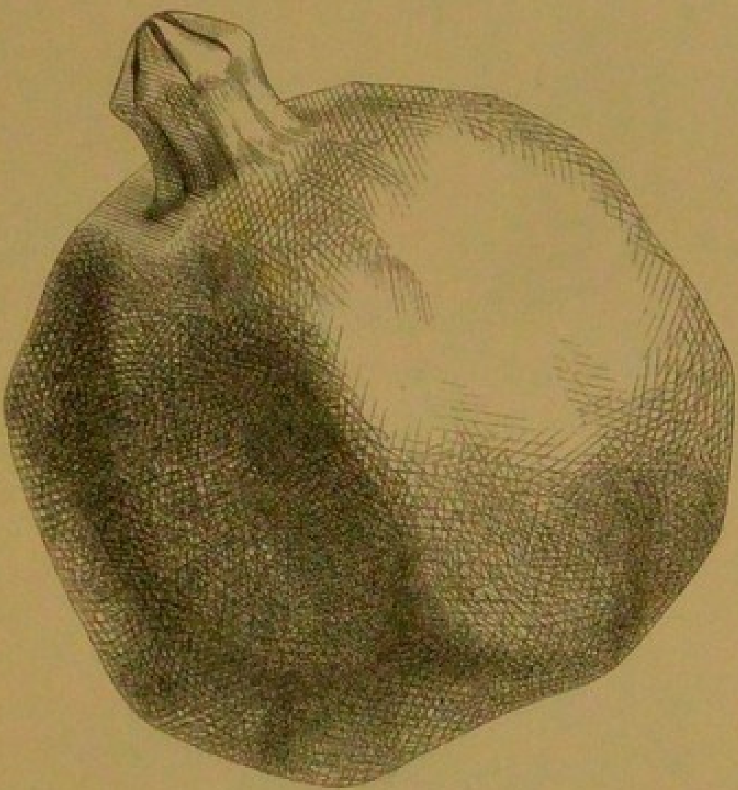


Fig. 208.

163. And the nuculanium (*Fig.* 205), when formed by an inferior pistil, in which case the floral envelopes enter into its composition, is a pepo (*Fig.* 206), or berry (*Fig.* 207); a pepo, with the pericarp slightly more consolidated, is a pome (*Fig.* 209); and we have shown in the last proposition that the nut (*Fig.* 210), samara (*Fig.* 211), and cremocarp (*Fig.* 212) are modifications of each other. It follows, then, that all compound indehiscent fruits are modifications of one another.

Fig. 208.—Balausta of the Pomegranate (*Punica Granatum*).

164. Of compound dehiscent fruits, the siliqua (*Fig.* 213) and silicula (*Fig.* 214) differ in no other particular than in this, that one is long while the other is short; and the

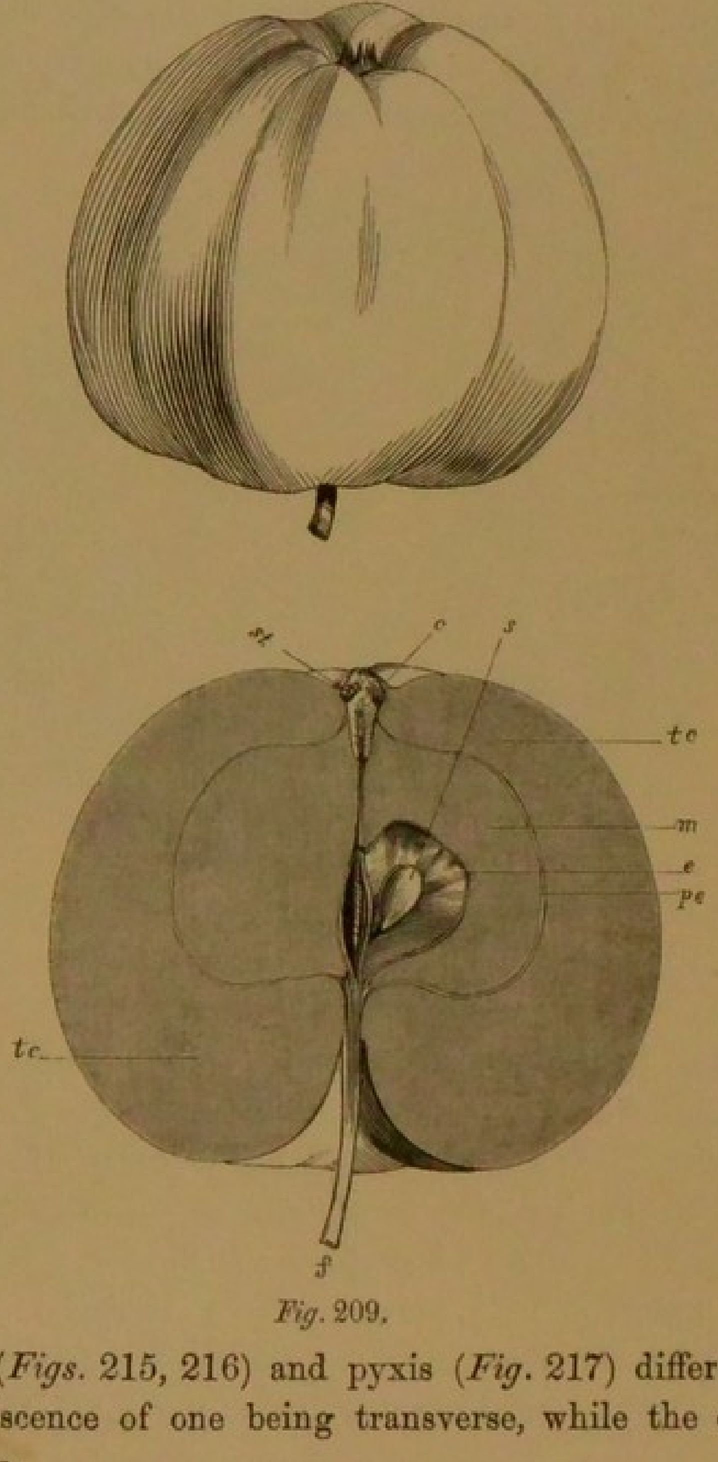


Fig. 209.

capsule (*Figs.* 215, 216) and pyxis (*Fig.* 217) differ only in the dehiscence of one being transverse, while the other is otherwise.

Fig. 209.—Pome of the Apple (*Pyrus Malus*). *c*, calyx. *st*, stamens. *tc*, fleshy sides of the calyx-tube. *pe*, epicarp. *m*, mesocarp. *e*, endocarp. *s*, seed.

165. And the silicula (*Fig.* 214) differs from the capsule

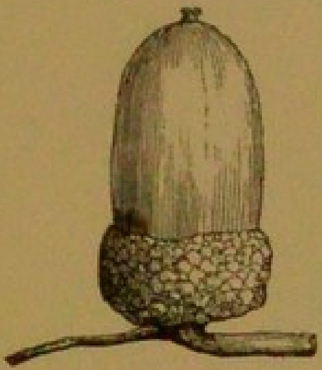


Fig. 210.

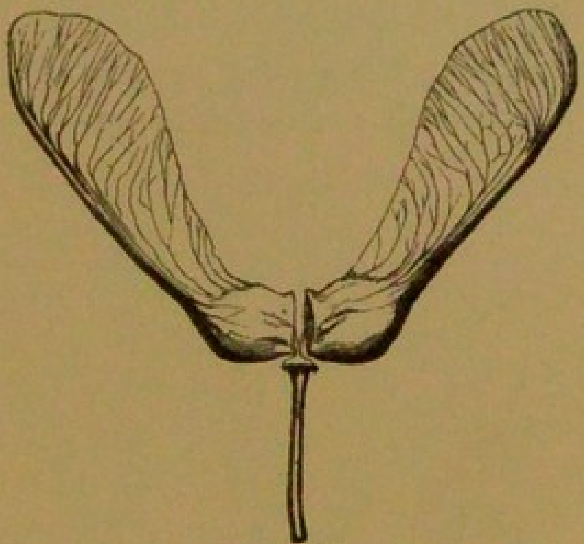


Fig. 211.

(*Fig.* 215) only in the latter being formed of more than two carpels, while the former is formed of two only.

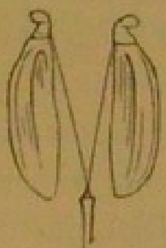


Fig. 212.

Fig. 213.

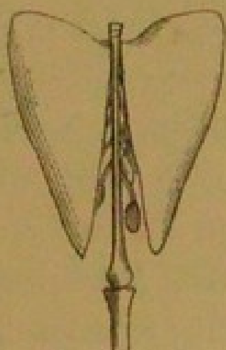


Fig. 214.

Fig. 210.—Nut of the Oak (*Quercus pedunculata*).
Fig. 211.—Samara of the Maple (*Acer*).
Fig. 212.—Cremocarp of the Fennel (*Fœniculum vulgare*), in the act of dehiscence.
Fig. 213.—Siliqua of the Wallflower (*Cheiranthus Cheiri*).
Fig. 214.—Silicula of the Shepherd's Purse (*Capsella Bursa Pastoris*).

166. More than this, simple dehiscent fruits are not distinct from syncarpous dehiscent fruits; for they differ only in this, that the former consists of one carpel only, while the latter consists of two or more.

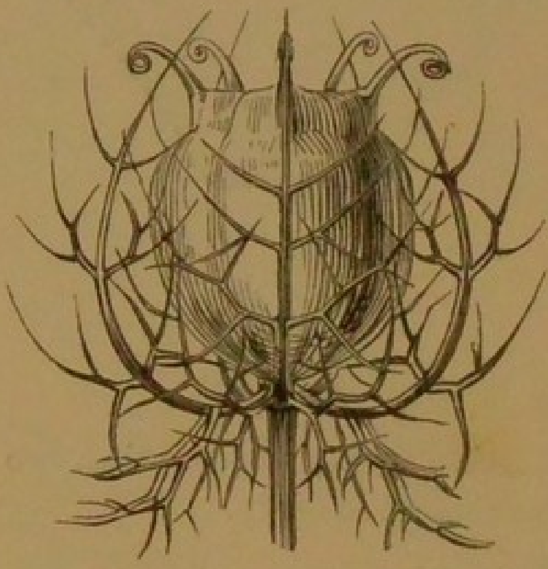


Fig. 215.

Fig. 216.

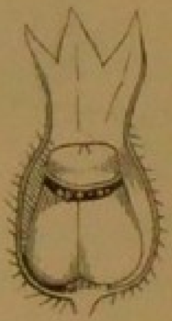


Fig. 217.

167. And the habits of the solitary carpel and of the aggregated carpels are precisely similar.

168. Nor are simple indehiscent fruits remote from syncarpous indehiscent fruits; for they differ only in the one consisting of one carpel, while the other consists of more than one.

169. Also the habits of the carpels are the same, whether separate or conjoined, for we have a succulent carpel forming a simple fruit, and we have succulent carpels forming a syncarpous fruit; also we have a dry carpel forming a simple fruit, and we have dry carpels forming a polycarpous fruit.

170. Moreover dehiscent and indehiscent fruits are not widely remote. Thus we have certain legumes which, instead of dehiscing normally, fall into separate portions, each of which contains one seed, and is indehiscent, *Ex.* Sainfoin

Fig. 215.—Capsule of a species of Love in a Mist (*Nigella*).
Fig. 216.—Capsule of the Bachelor's Button (*Lychnis dioica*).
Fig. 217.—Pyxis of the Henbane (*Hyoscyamus niger*).

(*Hedysarum*); also we have succulent indehiscent legumes, which are hence closely allied to the drupe, *Ex. Detarium.*

When the legume falls into distinct portions, the seed in each division becomes liberated by the destruction of its investments, just as in indehiscent fruits.

171. Taking a general summary of simple fruits, starting with the follicle, we say that the legume is related to the follicle by its being formed of one carpel, and being dehiscent, also by those legumes which dehisce only by the ventral suture. The drupe is allied to the legume by its being formed of one carpel, and by those legumes the pericarp of which becomes succulent, *Ex. Detarium.* The achene is allied to the drupe by its being a monospermous indehiscent fruit, formed of one carpel, also by their frequent aggregation, *Ex.* Crowfoot (*Ranunculus*), and Blackberry (*Rubus*). The caryopsis is allied to the achene by its being an indehiscent monospermous fruit formed of one carpel, and the utricle is related to the caryopsis by being unilocular and one-seeded.

172. Of compound fruits, starting with the hesperidium, the nuculanium is related to the hesperidium by being a succulent syncarpous indehiscent fruit, the result of a superior pistil; the pepo is allied to the nuculanium by being a succulent syncarpous indehiscent fruit; the berry is allied to the pepo by being a succulent syncarpous fruit formed from an inferior pistil; the balausta is allied to the berry by being formed from an inferior pistil, and by being a succulent indehiscent fruit; the pome is allied to the balausta by being syncarpous and indehiscent, as well as by being formed from an inferior ovary; the nut is allied to the pome by being a syncarpous indehiscent fruit; the samara is allied to the nut by being indehiscent, also by the winged nut of the Elm, and of *Fig.* 218; the cremocarp is allied to the samara by separating into cocci—it is also the transition to the dehiscent fruits; the siliqua is related to the cremocarp by being syncarpous and dehiscent; the silicula is allied to the silica by being

syncarpous, dehiscent, and unilocular, or spuriously bilocular; the capsule is allied to the siliqua by being a short, dehiscent, syncarpous pod; and the pyxis is allied to the capsule by being dehiscent, dry, and syncarpous.

173. As, then, all dehiscent fruits are allied to each other, or are mere modifications of one another, and all indehiscent fruits are also mere modifications of one type, and there is no wide division between dehiscent and indehiscent fruits, but,

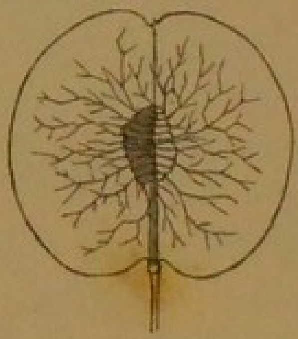


Fig. 218.

on the contrary, they are mere modifications of each other, it follows that all fruits are simply modifications of one type, or of each other.

174. And the fruit is the matured pistil, or the pistil in its ultimate condition.

175. Hence, the fruit is one with the other floral parts; that is, all the floral members have a common origin, and are all mere modifications of leaves.

Fig. 218.—Winged nut of the *Ptelea trifoliata*.

CHAPTER X.

THE SEED AND OVULE.

176. THROUGHOUT the variety of seeds which we discover we can also trace a unity.

177. Thus all contain an embryo plant, or a germ of life.*

178. And all contain nourishing matter with which to suckle the infantine plant,† only in some instances this is incorporated with the substance of the embryo (*Fig.* 219), while in others it more or less envelops it (*Fig.* 59).

Fig. 219.

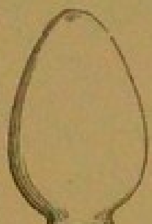


Fig. 220.

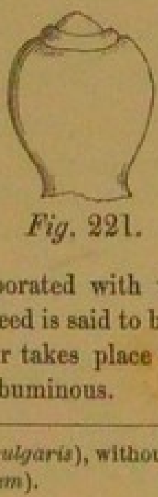


Fig. 221.

The food stored up in seeds is either incorporated with the substance of the embryo (in the cotyledons), when the seed is said to be exalbuminous, or a distinct deposit of organizable matter takes place within the integuments of the seed, when the latter is albuminous.

Fig. 219.—Exalbuminous seed of the Garden Bean (*Faba vulgaris*), without its investments.
Fig. 220.—Orthotropal ovule of the Mistletoe (*Viscum album*).
Fig. 221.—Orthotropal ovule of a species of Polygonum.

* This relates plants to animals, for seeds which are of vegetable origin contain a germ of life, and are capable of reproducing or perpetuating their species; so eggs, which are of animal origin, contain a germ of life, and have the power of perpetuating the species. In both, the principle of life is latent till it is brought into action by external influences.

† The milk in a cocoa-nut furnishes nourishment for the young plant, just as the yolk of an egg is the early food of the chicken; this also links vegetables with animals.

179. And in all cases the embryo of the seed can be stimulated into active life by exposure to similar influences, viz. heat, air, and moisture.

180. It hence follows that all seeds are homologous.

181. But not only can a oneness be traced among seeds, but it can also be found in ovules from which seeds result.

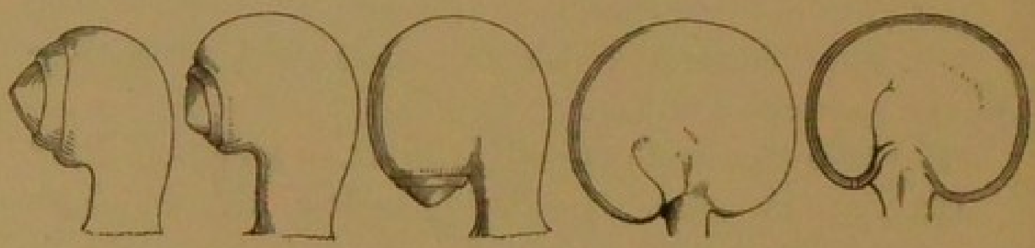


Fig. 222.

182. Thus we have the orthotropal (*Figs.* 220, 221), the campylotropal (*Fig.* 222), and the anatropal (*Fig.* 223)

Fig. 223.

ovule; yet all these may be said to be one, only that development has been arrested at various periods of their growth.

The growth of the orthotropous, or straight ovule, is arrested first, or at the earliest period.

Fig. 222.—Campylotropal ovule of the Mallow (*Malva*). Various stages of development.

Fig. 223.—Anatropal ovule of the Celandine (*Cheladonium majus*). Stages of development. *f*, funiculus or umbilical cord. *r*, raphe. *c*, chalaza. *n*, nucleus. *s*, secundine. *p*, primine.

CHAPTER XI.

BEING A SUMMING UP OF THE LAST CHAPTERS, OR TRACING A UNITY BETWEEN THE PARTS THEREIN CONSIDERED.

183. It has now been shown that a oneness exists between all the varieties of the root, stem, bud, leaf, inflorescence, flower, fruit, and seed. A unity can, moreover, be established between all these members.

184. Thus a root and stem are not remote from each other, for the root is a downward prolongation of the stem (*Figs.*

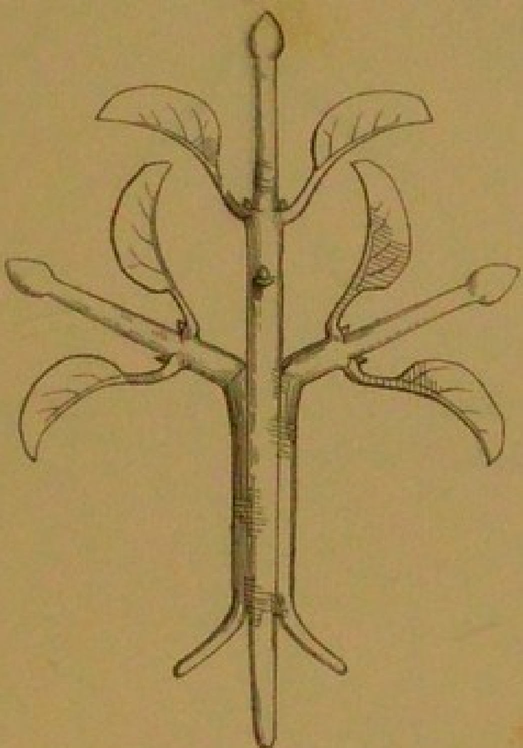


Fig. 224.

224, 225); also both may be said to result from the evolution of leaf-buds and the growth of leaves (*Fig.* 226).

Dr. M'Cosh states that the angles at which branches diverge from the stem, and those at which rootlets diverge from the root, are equal; this further establishes the unity between roots and stems. (Prop. 31).

Fig. 224.—An ideal plant.

185. A stem and bud are not widely separated, for the

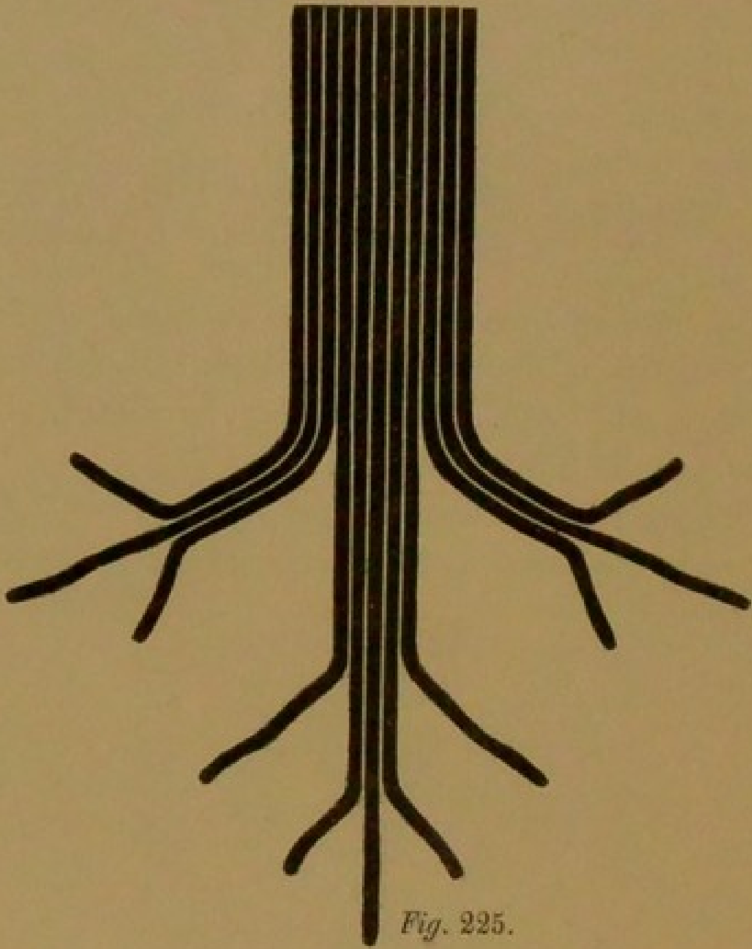


Fig. 225.

latter is but a shortened stem, or the former but an elongated bud (*Figs.* 227, 228, 229).

Fig. 226.

Fig. 225.—Ideal figure of a root.

Fig. 226.—Bud of Lilac (*Syringa vulgaris*), sending down its stream of wood.

A stem produces leaf-buds, or, in other words, leaf-buds are generated by stems (*Fig.* 229), and leaf-buds by evolution produce branches (*Fig.* 230); they produce them by evolving into such, or as such, and also by forming wood which by transmission downwards forms the stem and root (*Fig.* 224).

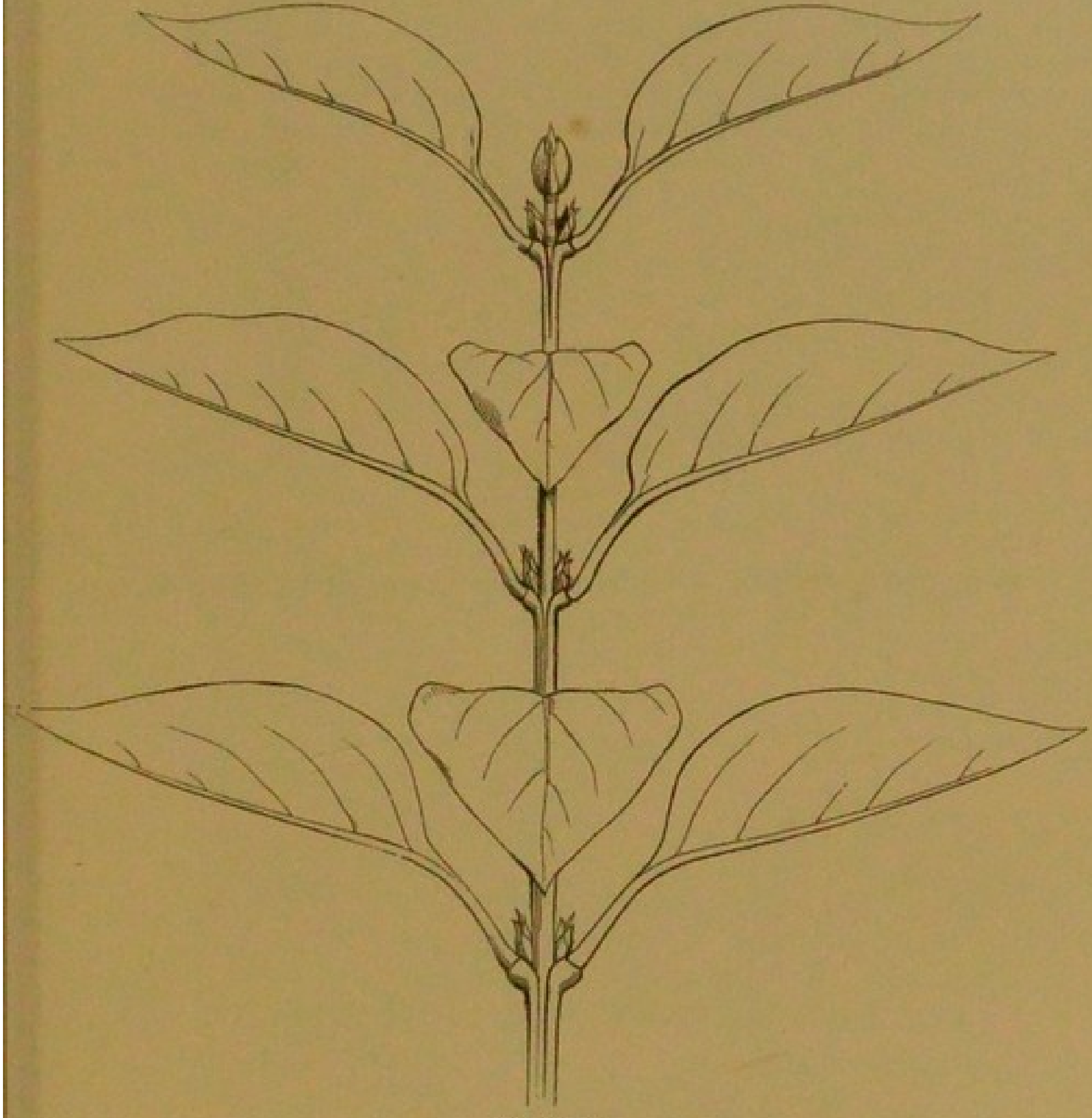


Fig. 227.

Neither does a flower-bud differ widely from a leaf-bud, for the rudiments of both are precisely similar; however, the power of elongating is not possessed by the flower-bud, whereas it is by the leaf-bud; hence the flower-bud may be said to be a quasi-paralyzed leaf-bud, or a leaf-bud from the growing-point of which the power of elongating is withdrawn.

186. Neither are buds and leaves widely dissimilar, for

Fig. 227.—Branch of the Lilac.

both contribute woody matter to the stem; also leaves, in

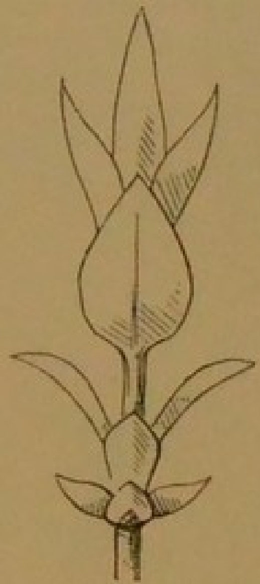


Fig. 228.

Fig. 229.

some cases, as well as buds, possess one or more vital centres,

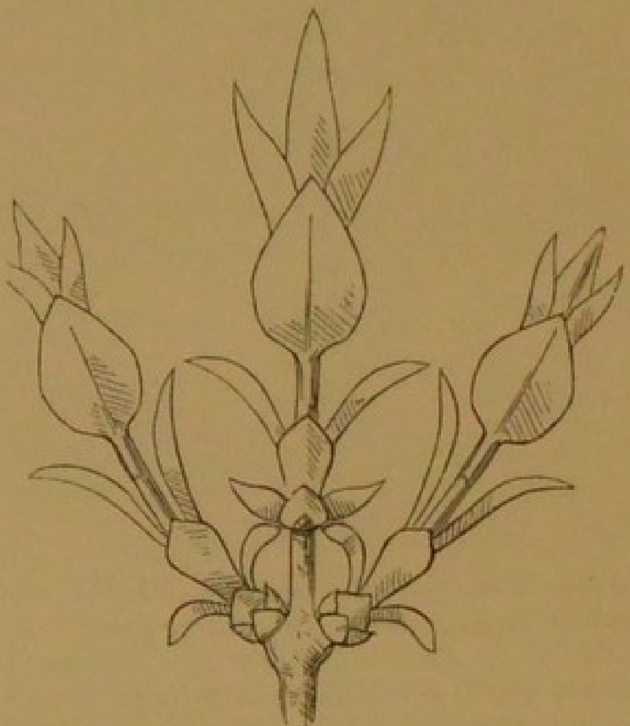


Fig. 230.

Fig. 228.—Bud of the Lilac.
Fig. 229.—Branch of Lilac.
Fig. 230.—Lilac (*Syringa vulgaris*).

which have the power of elongating, and thus forming branches, *Ex.* Proliferous Ferns and Bryophyllum (*Fig.* 231).

There is a marvellous unity existing between stems (which are elongated buds) and leaves; thus, stems produce buds, so do leaves; stems are composed of a woody system and cellular matter, leaves are also; leaves are furnished with stomates, so are young stems; and stems produce regular and adventitious buds, so do leaves (regular, Bryophyllum, and adventitious, Proliferous Ferns). It is, in fact, probable that every leaf is a modified branch, and that the crenatures of its margins are the result of nodes.

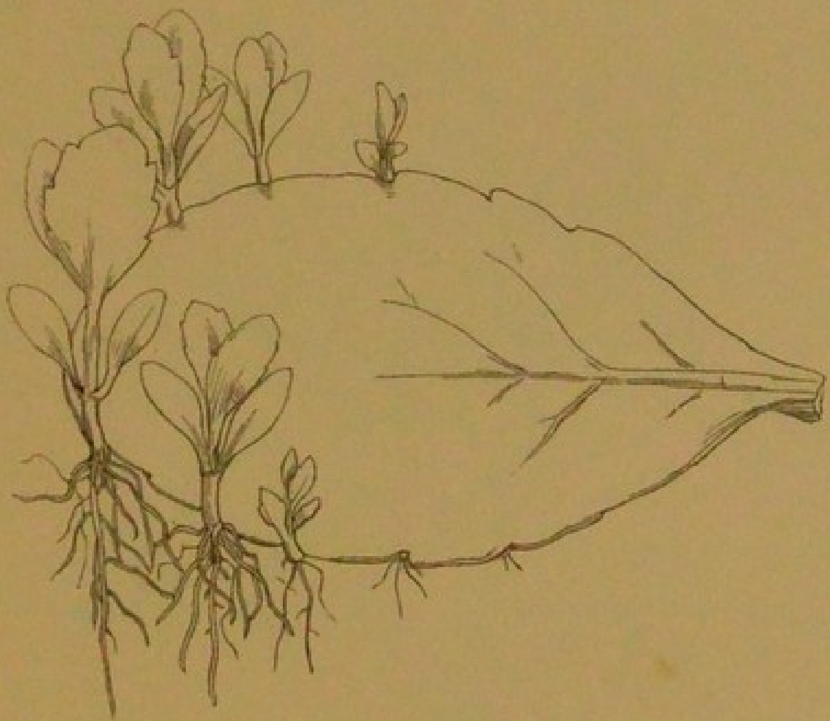


Fig. 231.

187. An inflorescence is merely one or more branches.

The inflorescence-bud of a polyfloral inflorescence (*Fig.* 232) is analogous to such leaf-buds as have a plurality of growing-points.

188. And a flower is simply a stunted axis with its leaves.

The rudiments of a flower-bud and of a leaf-bud are precisely similar.

The flower and inflorescence are also allied in an ornamental point of view, for if we commence with the much-branched inflorescence, as the panicle, we may say that this is contracted into the thyrsus, and this again into the raceme, and the raceme into the umbel and spike, and these latter into the capitulum, and the capitulum apes being one flower, for its flowers of the ray produce the same ornamental effect as petals

Fig. 231.—Leaf of *Bryophyllum calycinum*.

(*Ex.* Marygold, *Fig.* 233, and Mesembryanthemum, *Fig.* 234), and the flowers of the disk as the stamens. Also by cultivation, flowers of the disk pass into flowers of the ray, just as stamens pass into petals.*

189. And the fruit is but one series of the floral leaves.

190. Also seeds are but dissociated buds, or branches.

A seed is very similar to a bulbel: these bodies chiefly differ in this—that the former is a plant concealed in a sac or skin, and the latter is a plant enclosed in scales. See notes to Prop. 78.

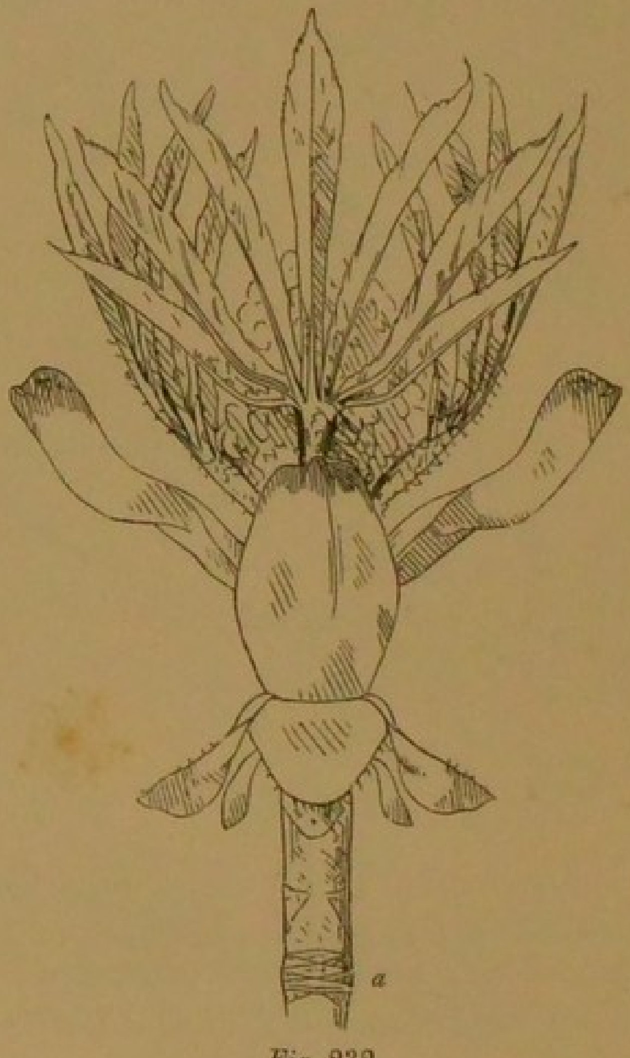


Fig. 232.

191. It hence follows that a unity exists between all the members of the floral organism, as well as between all the varieties of each floral part.

Fig. 232.—Inflorescence bud of the Horse-chestnut (*Æsculus Hippocastanum*).

* The capitulum, and, in fact, the natural order Compositæ, or Asteraceæ, as a whole, is analogous to such animal aggregations as sponge and coral.

192. Moreover, this unity can be yet further traced.

193. For all plants bear seeds, and fruits, and flowers, and leaves, and stems, and roots, hence they are all strikingly homologous.

We now speak of phœnogamous (flowering) plants only; this Proposition we cannot apply to cryptogamic plants in the state in which the science is now found; however, the most distinguished botanists seem to think that there are parts in the lower plants which are analogous to the parts of the higher vegetable organisms.

Fig. 233.

194. And similar parts on all plants, however dissimilar the plants may be, are strikingly analogous.

195. Thus all seeds have one or more cotyledons.

Spores have no cotyledons, but they are not true seeds.

The only exceptions to this Proposition which can be admitted occur in such plants as the Dodder, the embryo of which is an axis destitute of cotyledonary appendages. This plant, however, is leafless and parasitical.

196. And all fruits are seed capsules.

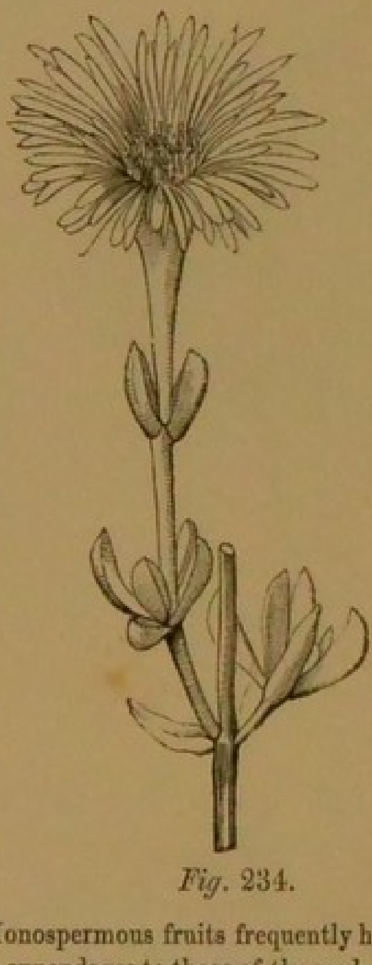
197. And all flowers contain set organs, and so on.

198. Also, the varied parts of all seeds are destined to

Fig. 233.—Inflorescence of Marygold (*Calendula officinalis*).

administer to the wants of the embryo plant therein contained.

Thus the integuments protect, the nutriment contained within nurtures. Also, it is so ordered that seeds shall be dispersed, to accomplish which various agencies are employed, as winds, currents of water, animals, &c. In order to answer to these requirements, some seeds are furnished with appendages, which render them buoyant, as wings, or como (*Fig.* 235 *a*); others have corky testæ, to enable them to float; others have a rough texture, to enable them to adhere to the coats of animals; while others have an adamantine integument, which enables them to pass through the stomach unhurt.



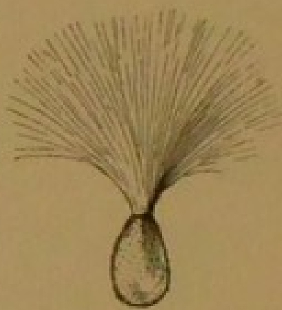


Fig. 235 *a.*

Fig. 235 *b.*

Fig. 234.

Monospermous fruits frequently have their pericarps furnished with similar appendages to those of the seed, by which means their transport is accomplished, hence that of the seed. Thus the fruit of the Maple, Ash, and Elm are winged; that of the *Galium Aparine* is furnished with hooks; while the fruits of Composites are generally furnished with pappose hairs.

199. And all pericarps have to feed, protect, nurture, and ultimately liberate the seeds which they enclose.

Fig. 234.—Flower of the *Mesembryanthemum falciforme.*

Fig. 235 *a*, Seed of a species of Asclepias. *Fig.* 235 *b*, Capsule of the Canterbury Bells (*Campanula medium*).

The mode in which pericarps liberate the seeds which they enclose varies: in all dehiscent fruits they are more or less liberated by the splitting or opening of the seed-vessel; still their liberation cannot be said to be fully accomplished by this agency in many cases—for when the capsule is erect, and it opens, by dehiscence, only at the summit, as in the *Lychnis dioica* (*Fig.* 216), for example, the seeds are not shed until the capsule is turned aside by the wind, or some other disturbing agent, or till the peduncle which supports it yields to decomposition; in other cases, dehiscence commences at the base of the capsule, *Ex.* Canterbury Bells (*Fig.* 235 *b*), by which opening of the seed-vessel the seeds are fully liberated; but instances occur in which the seeds are more decidedly scattered by dehiscence, as in the Balsam (*Impatiens noli-me-tangere*), and in the Spirting Cucumber (*Elaterium agreste*), in both of which cases, but especially the latter, the seeds are discharged with great violence. When the fruit is indehiscent, the seeds are liberated by the decay of the pericarp.

200. Also the parts of all flowers are destined to give rise to the rudiments of seeds, or to administer, either directly or indirectly, to their well-being; and to so organize them, or endow them with life, that development and maturation are the only necessities for their ultimately possessing the power of reproducing the individual.

The pistil generates ovules from its placentæ; these ovules are fertilized by pollen, which is generated by the staminal leaf, and the floral envelopes protect the sexual organs; so that directly or indirectly all parts of the flower administer to the well-being of the seed.

201. The leaves of all plants have to aërate the sap extracted from the surrounding soil by the root, and transmitted from the root to the leaves by the stem; they have also to originate new wood and other secretions, and thus administer to the wants and life of the vegetable.

202. All stems, also, have to transmit the absorbed fluids of the root into the leaves, to develop buds if wanted, and to remove the leaves to a suitable and desirable distance from each other, as well as to perform other works necessary to the well-being of the entire structure.

203. And the roots of all plants have to extract nutriment from the medium in which they are called to exist, on which the whole organism feeds, and out of which it forms its new organs.

204. As then, all seeds, fruits, flowers, leaves, stems, and roots, perform similar purposes relative to the well-being of the respective plants to which they belong, it follows that between them all there is a concord or oneness of action.

205. Moreover, in order to the fulfilment of their duty, all roots have their fibres terminated by spongioles, and covered with capillary tubes.

206. And all stems are composed of matter which is fitted and so arranged as to enable them to carry out their duties.

207. And all leaves, flowers, fruits, and seeds have similar organs for the performance of a similar work; hence in these particulars also these diversified vegetable members are wondrously united.

CHAPTER XII.

ON THE UNITY EXISTING BETWEEN PLANTS, AS DEDUCED FROM CLASSIFICATION.

208. This unity can be yet further shown from general resemblances which exist between plants.

209. Although when looking at plants individually we are struck with their great diversity,

210. Yet when looking at plants collectively we are impressed with the fact, that there is a vast unity subsisting between all the plants of creation.

Fig. 236.

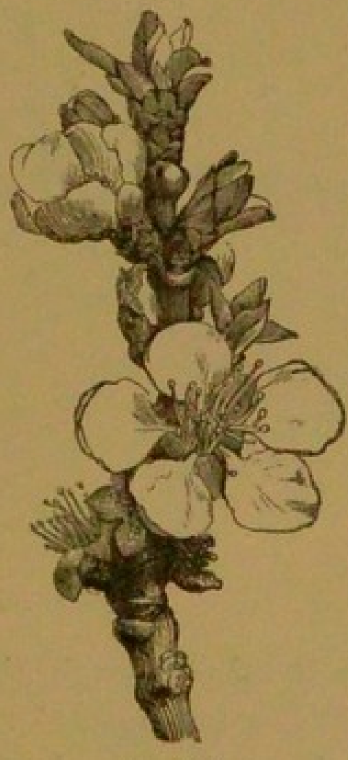


Fig 237.

211. Still there are about one hundred thousand known species of plants, besides varieties of species.

Fig. 236.—Pansy, or Hearts'-ease (*Viola tricolor*).
Fig. 237.—Apricot (*Prunus Armeniaca*).

212. Yet all the varieties of a species are identically the same in construction, form, and all other essential properties, the variation occurring usually in colour only, or in some minor habit; hence there is a strong unity existing between all the varieties of a species.

There are a great number of varieties of some of our cultivated plants, as of Verbenas, Geraniums (*Pelargoniums*), and Pansies (Heart's-ease); thus all the varieties of the Pansy with which we meet have sprung from one—the *Viola tricolor* (*Fig.* 236), hence they are all varieties of it; yet all have a flower of which the two halves only are alike, and all have the same number of stamens, petals, and sepals, and all have these diversified organs of similar forms. Most "variegated flowers" are varieties.

Fig. 238.

213. Species through their affinities resolve themselves into small groups (genera).

Thus the Dog Violet (*Viola canina*), the Sweet Violet (*Viola odorata*), and the Heart's-ease, or Pansy (*Viola tricolor*), are three distinct species which enter into the composition of the genus *Viola*. There are, however, many other Violets which also belong to this genus. *Figs.* 237, 238, also belong to one genus.

Fig. 238.—Sloe, or Blackthorn (*Prunus spinosa*).

214. As, then, there is a natural affinity existing between the members of each genus (which affinity necessarily arises out of points of resemblance existing between the individuals composing the group), it follows that a certain amount of unity exists between the species composing genera.

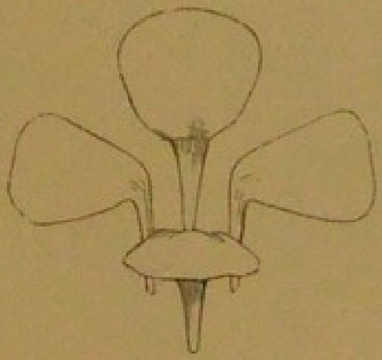


Fig. 239.

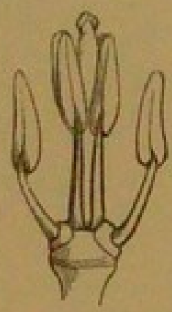


Fig. 240.

215. And genera arrange themselves into tribes or orders, owing to resemblances which exist between them.

Fig. 241.

Thus, all the species in the genera which unite to form the natural order Cruciferæ (the order of Cress-worts), have four petals with claws, and six stamens, two of which are short, while four are long, and so on

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Fig. 239.—Corolla of the Wallflower (*Cheiranthus cheiri*).
Fig. 240.—Stamens of the Wallflower (*Cheiranthus cheiri*).
Fig. 241.—Pear (*Pyrus communis*).

(*Figs.* 239, 240). Also *Figs.* 237, 238, 241, 242, 243, belong to the natural order Rosaceæ, and *Figs.* 244, 245, to the order Fabaceæ.

Fig. 242.

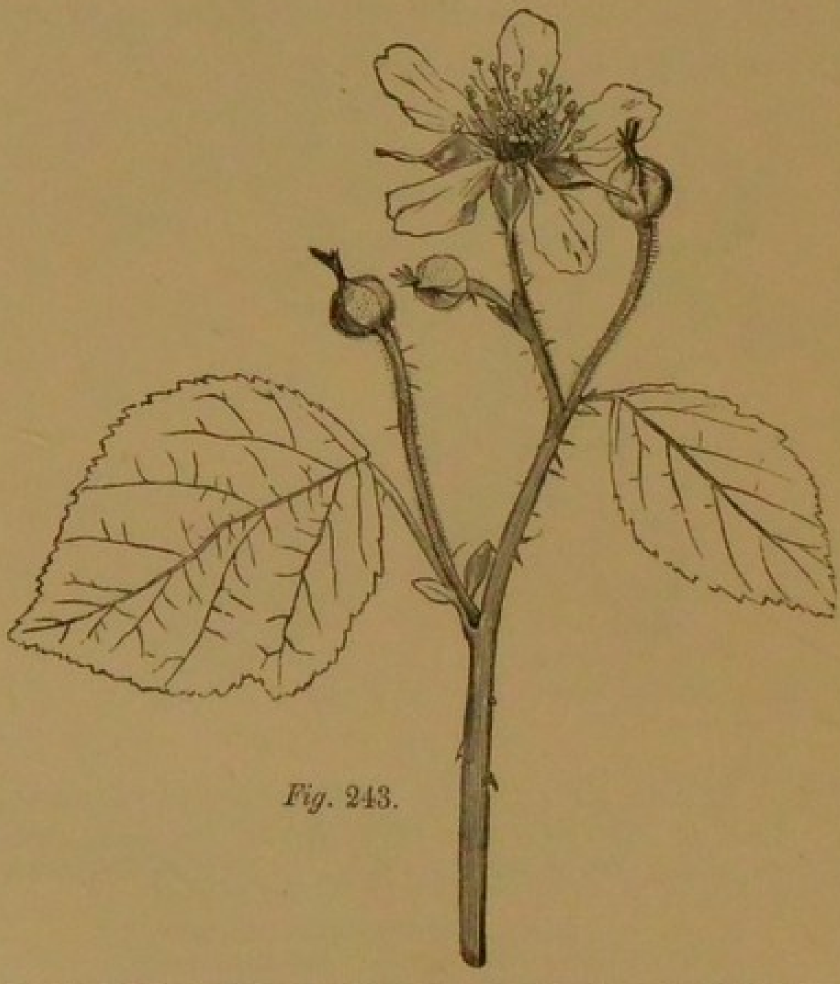

Fig. 243.

Fig. 242.—Peach (*Amygdalus Persica*).
Fig. 243.—Blackberry (*Rubus*).

216. There is a marked unity existing between all the

Fig. 244.

Fig. 244.—Pea (*Pisum sativum*). 2, stamens. 3, corolla.

genera in a tribe or order, for all are constructed on the same principle.

See note to last Proposition.

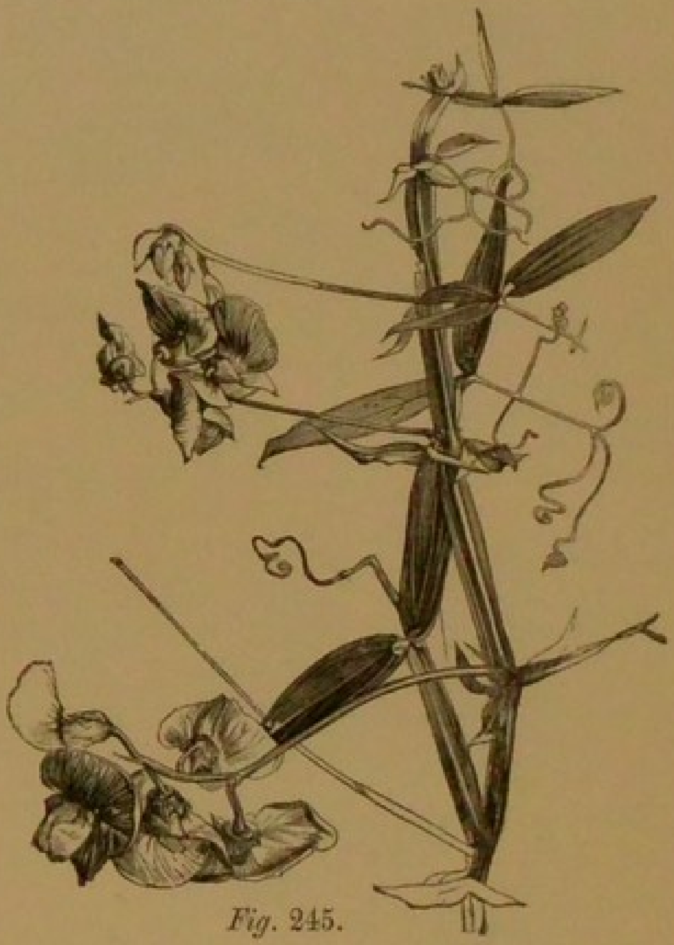

Fig. 245.

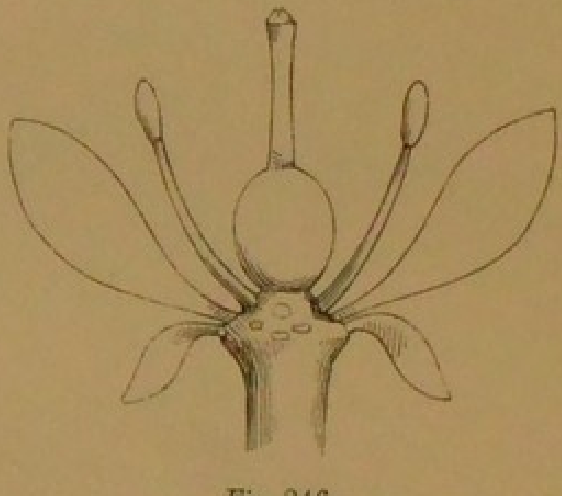

Fig. 246.

Fig. 245.—Nosegay Vetch (*Lathyrus latifolius*).

Fig. 246.—Diagram of a flower belonging to the sub-class Thalamifloræ of Exogens.

217. Owing to similarities of construction, orders group themselves into sub-class or classes.

Among Exogens, there are a series of orders all the members of which have their parts springing from the apex of the peduncle (from the thalamus), *Fig.* 246, these form the sub-class Thalamifloræ; there are also a series which have their parts apparently springing from the calyx (*Fig.* 247), these constitute the sub-class Calycifloræ; and so on.

The class of Endogens, according to the present classification, is without sub-classes, according to some authors, while others divide it into two sub-classes—Petaloideæ and Glumaceæ.

218. And between all the orders which unite to form a sub-class or class, there is a manifest coincidence of structure and organization.

This is obvious from the note to the last Proposition.

219. Sub-classes (when they exist) unite to form classes, and classes unite to form the two great divisions of plants,

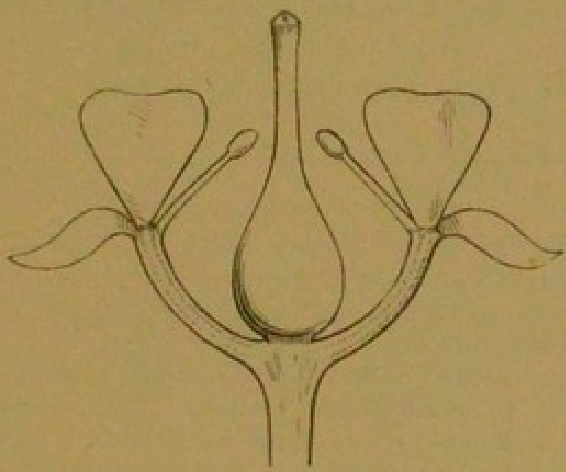

Fig. 247.

viz. those of Phanerogamic (flowering) and Cryptogamic (flowerless) plants.

Up till within the last few years, the classes which were distinguished were three in number; they were thus named and characterized:—

1. *Exogens.*—Stem exogenous; leaves with a reticulated venation; flowers on the number four or five, or some power of that number; seeds di- or polycotyledonous, and occasionally acotyledonous. Germination exorhizal (*Figs.* 251, 248, 249).

Fig. 247.—Diagram of a flower belonging to the sub-class Calycifloræ of Exogens.

2. *Endogens.*—Stem endogenous; leaves with a parallel venation; flowers on the number three, or a power of three; embryo monocotyledonous. Germination endorhizal (*Figs.* 252, 250).
3. *Acrogens*, or *Cryptogams.*—Plants without flowers (*Figs.* 29, 30).

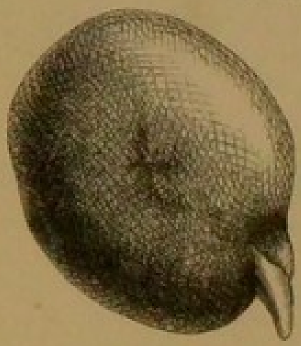

Fig. 248.

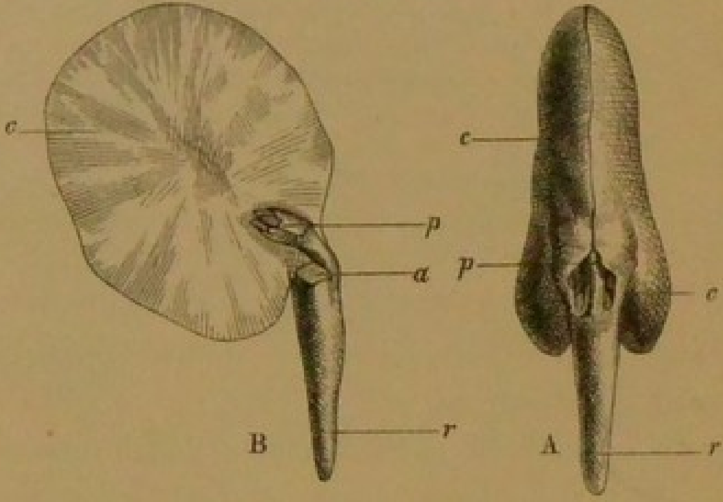

Fig. 249.

The present classification, as improved by Lindley, stands thus:—

Asexual, or Flowerless Plants.	
Stems and leaves undistinguishable . . .	1. Thallogens. *Figs.* 4, 8, 10.
Stems and leaves distinguishable . . .	2. Acrogens. *Figs.* 30, 93.
Sexual, or Flowering Plants.	
Fructification springing from a thallus . .	3. Rhizogens.
Fructification springing from a stem.	
Wood of stem youngest in the centre; cotyledon single.	
Leaves parallel-veined, permanent; wood of the stem always confused . .	4. Endogens. *Figs.* 250, 252.
Leaves net-veined, deciduous; wood of the stem, when perennial, arranged in a circle, with a central pith . . .	5. Dictyogens. *Fig.* 276.
Wood of stem youngest at the circumference, always concentric; cotyledons two or more:—	
Seeds quite naked	6. Gymnogens. *Figs.* 282.
Seeds enclosed in seed-vessels . .	7. Exogens. *Figs.* 248, 249, 251.

220. And between the classes which thus unite there are the most palpable similarities of organization.

Fig. 248.—Garden Bean (*Faba vulgaris*) at the commencement of germination.

Fig. 249.—*Faba vulgaris.* A, embryo, or seed without testæ. B, embryo minus one cotyledon. *r*, radicle. *p*, plumule. *c*, cotyledon. *a*, point at which one cotyledon was cut off.

Thus the fact that those uniting to form the class of Exogens, for example, all have leaves with a reticulated venation, &c., fully establishes this assertion.

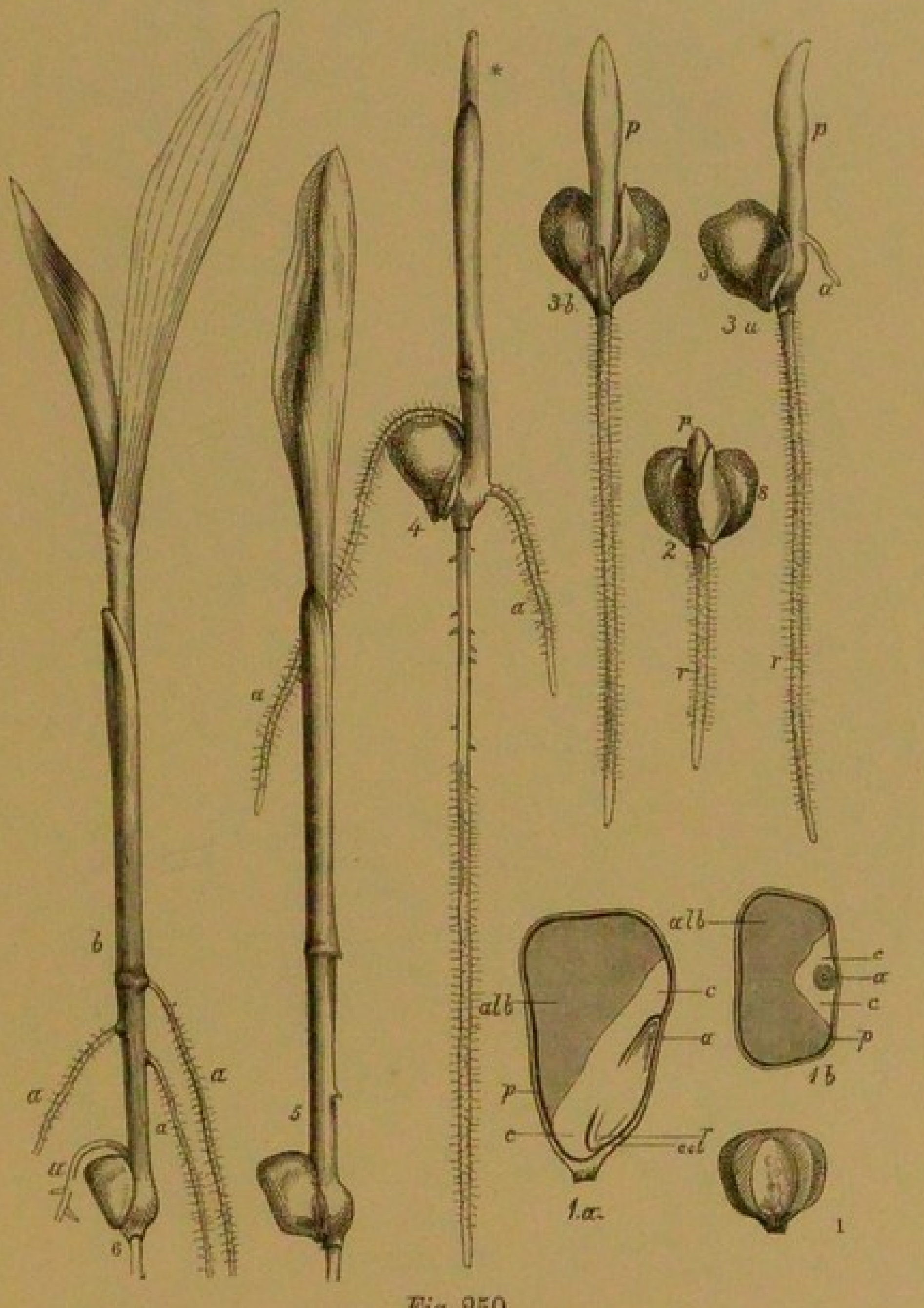

Fig. 250.

Fig. 250.—Indian Corn or Maize (*Zea Mays*). 1, dry seed. 1 *a*, longitudinal, and 1 *b*, transverse section of the same. *p*, pericarp and testa combined. *alb*, albumen. *c*, *a*, *r*, *col*, embryo. *c*, cotyledon. *a*, acrospire or plumule. *r*, radicle, or young root. *col*, coleorhiza, 2, 3, 4, 5, 6, give the progressive stages of germination. 3 *a*, 3 *b*, are side and front views of the same. *r*, radicle or root. *p*, plumule. *a*, adventitious roots. *b*, first leaf produced by plant. *, first normal leaf.

Also all plants possessed of flowers have obvious similitudes from this fact alone, and all without flowers are akin, as is at once manifest.

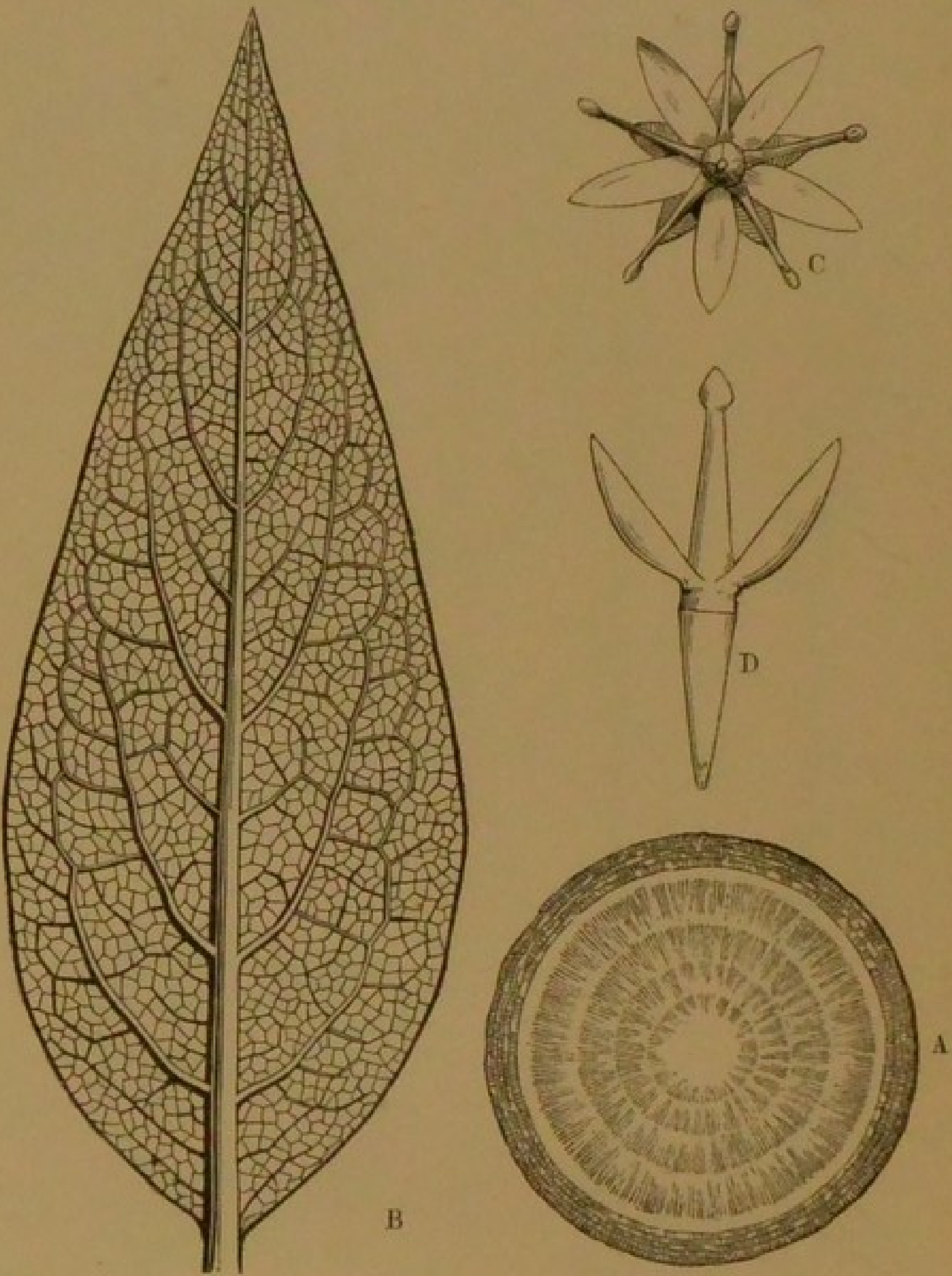

Fig. 251.

221. Moreover there are strong affinities existing between these two groups, for the subjects forming both are animated by one principle of life or vitality, they develop according to

Fig. 251.—Diagram illustrating the class of Exogens. A, stem. B, leaf. C, flower. D, embryo plant.

the same laws, and more than this, there is no strong line of demarkation between them.

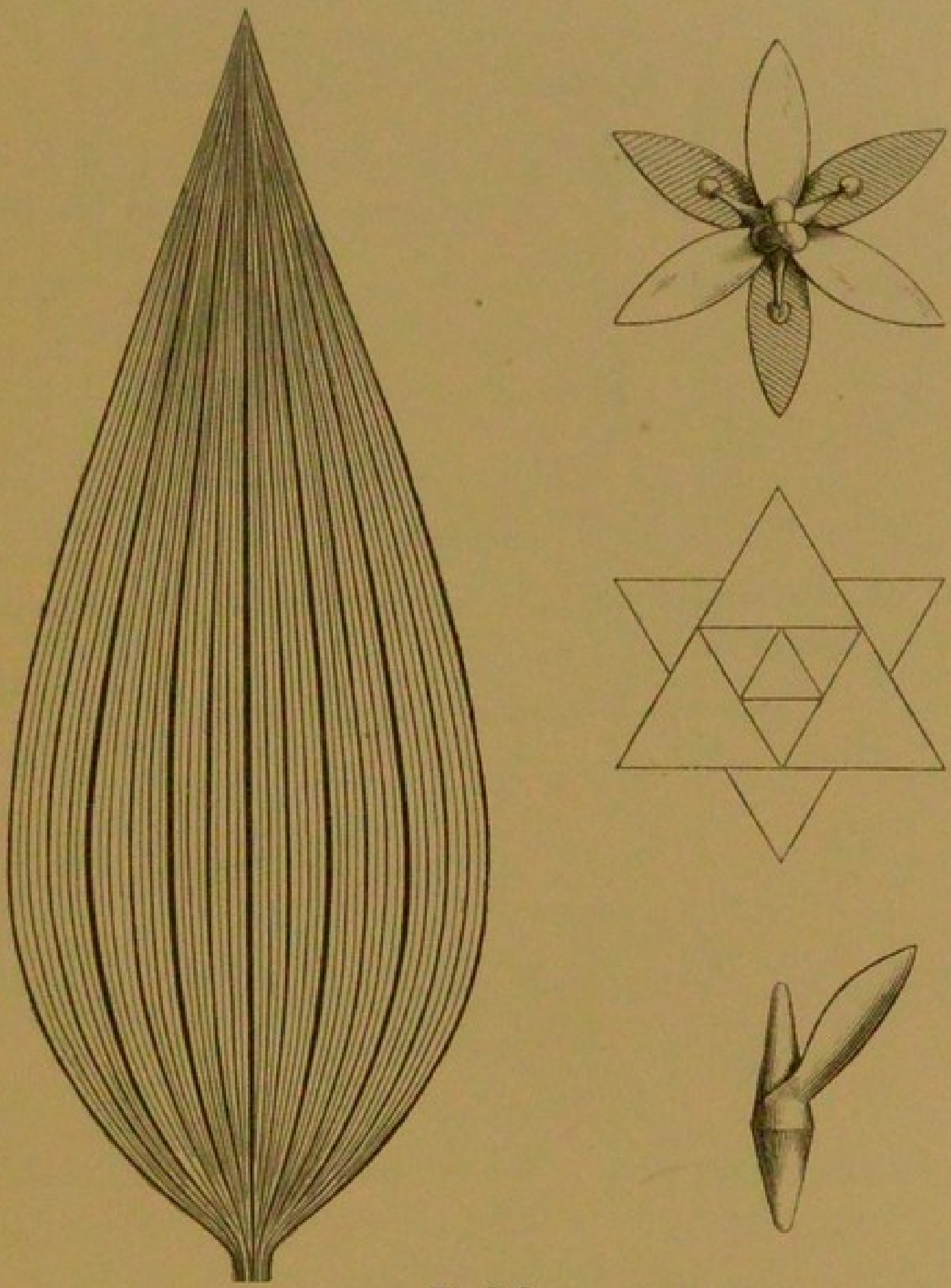

Fig. 252.

The Duckweed (*Lemna*), *Fig.* 253, for example, has a frond, or thallus, which bears flowers, hence it links Phanerogams with Cryptogams.

"Duckweed (*Lemna*) is the lowest known form of phænogamous vegetation. It consists of lenticular floating fronds composed of stem and leaf mixed together, and bearing the flowers in slits in the edge." *—*Lindley*.

Fig. 252.—Diagram illustrating the class of Endogens.

* School Botany, p. 151.

222. Then although we have (in round numbers) a hundred

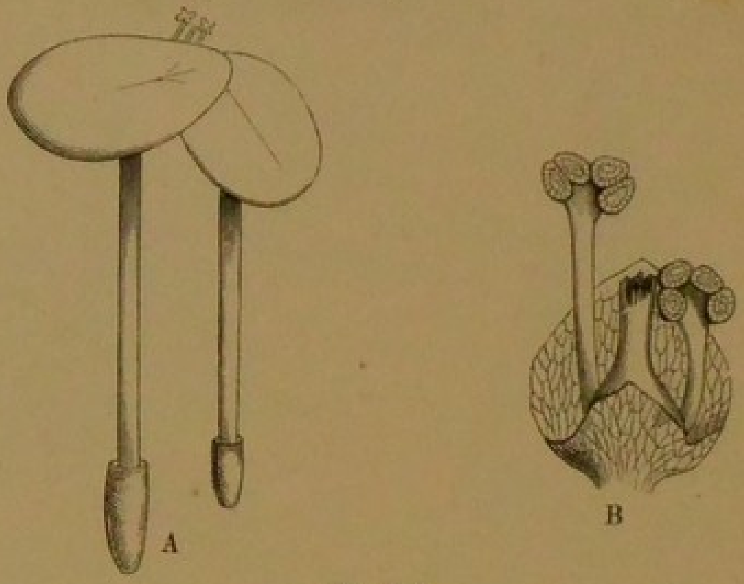

Fig. 253.

thousand species of plants, yet between them all there subsists a marvellous unity.

Fig. 253.—Duckweed (*Lemna*). A, two plants. B, a flower.

CHAPTER XIII.

ON THE UNITY EXISTING BETWEEN PLANTS, AS DEDUCED FROM THE ARRANGEMENTS OF THEIR PARTS.

223. THAT there is a unity subsisting between all plants can yet further be shown, for there is a oneness in the principle of arrangement of the varied vegetable organs.

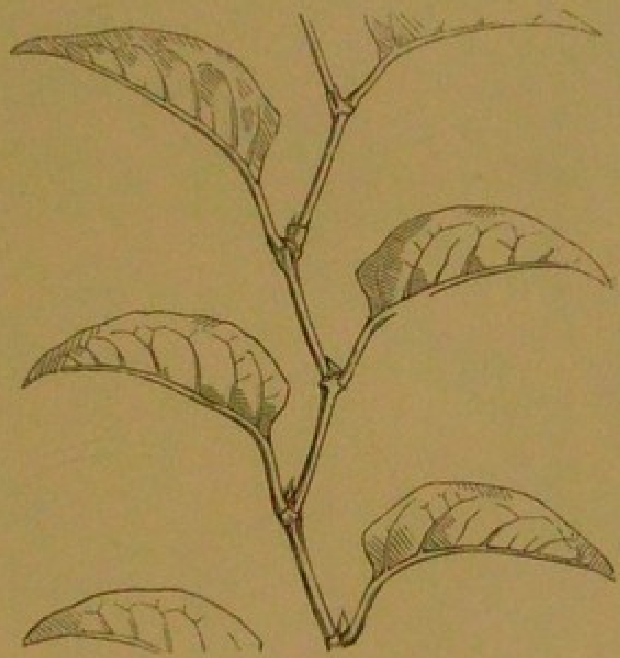

Fig. 254.

224. Thus leaves are alternate (*Fig.* 254), opposite (*Fig.* 255), verticillate (*Fig.* 256), and spiral (*Fig.* 257).

The arrangement of the leaflets of compound leaves is also similar to those of leaves; thus they are opposite, alternate, &c.

When a branch with spiral leaves receives light in one direction only (on one side, as when nailed against a wall), its leaves become alternate (*Fig.* 258); and a branch with opposite decussate leaves, when similarly situated, develops all its pairs of leaves in the same direction (*Fig.* 259).

It is interesting to know that the parts of compound phyllous organs were similarly developed comparatively early in the earth's history, which

Fig. 254.—*Polygonum cuspidatum*, the leaves of which are alternate.

fact will be at once seen from our figures of fossil ferns from the carboniferous period (*Figs.* 260, 261).

225. The parts of the flower are also arranged alternately (if the parts of the fructification of grasses be admitted as flowers), oppositely (*Ex.* Enchanter's Nightshade), verticillately, three in a whorl, *Ex.* Spiderwort (*Fig.* 157), four, *Ex.* Celandine (*Fig.* 178), five, *Ex.* Pimpernel (*Fig.* 192), and spirally (*Ex.* Stonecrop), *Fig.* 161.

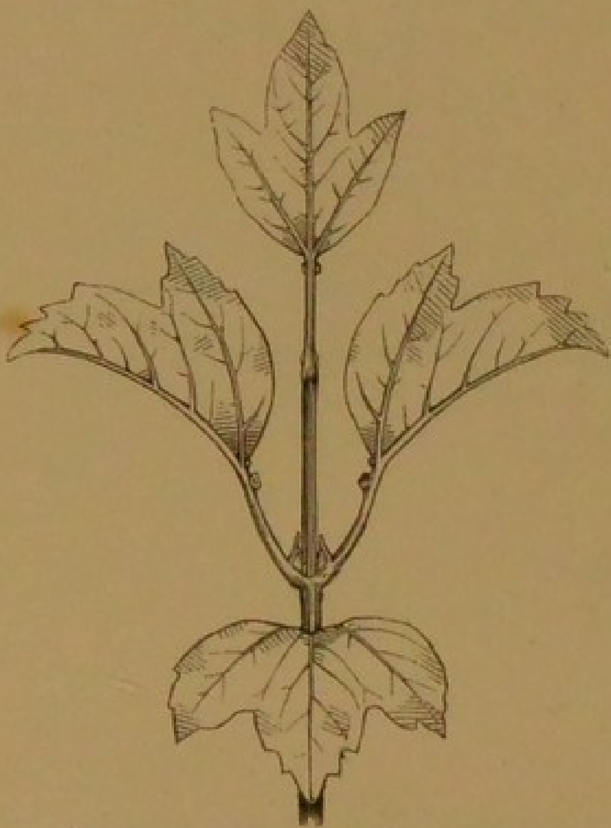

Fig. 255.

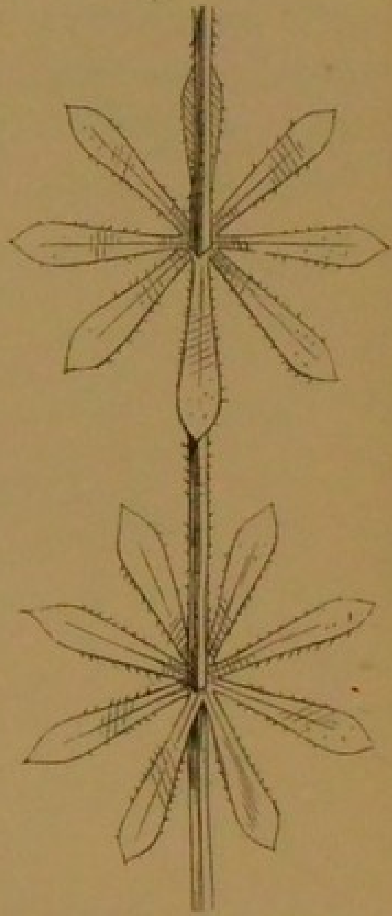

Fig. 256.

226. That there should be a coincidence between the arrangements of leaves and the parts of flowers is obvious, for the floral parts are metamorphosed leaves.

227. And bracts (*Fig.* 262) are leaves likewise, hence what-

Fig. 255.—Guelder Rose (*Viburnum Opulus*), the leaves of which are opposite.
Fig. 256.—Goose-grass (*Galium Aparine*), the leaves of which are verticillate.

ever is the arrangement of leaves, such is the arrangement of bracts, and *vice versâ*.

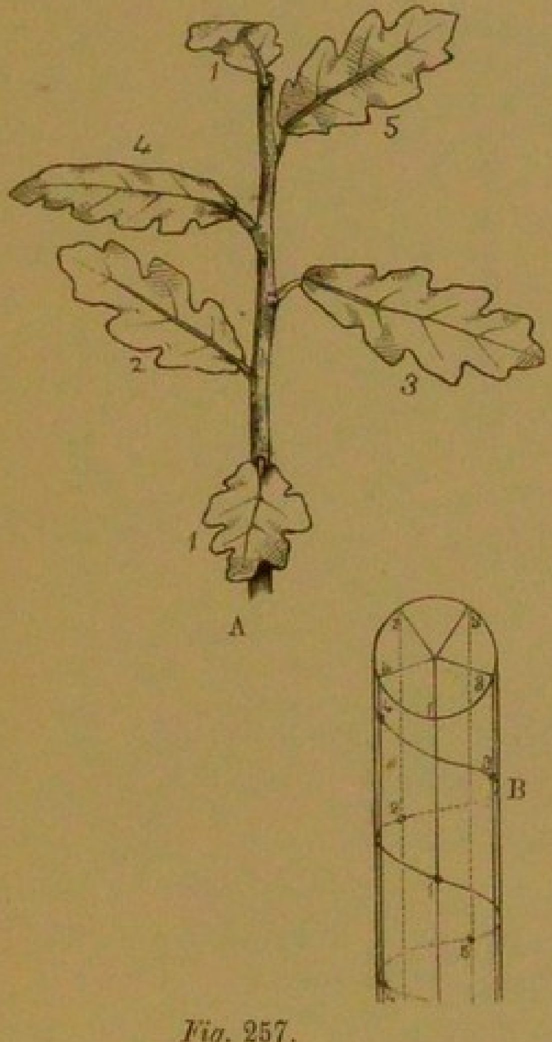

Fig. 257.

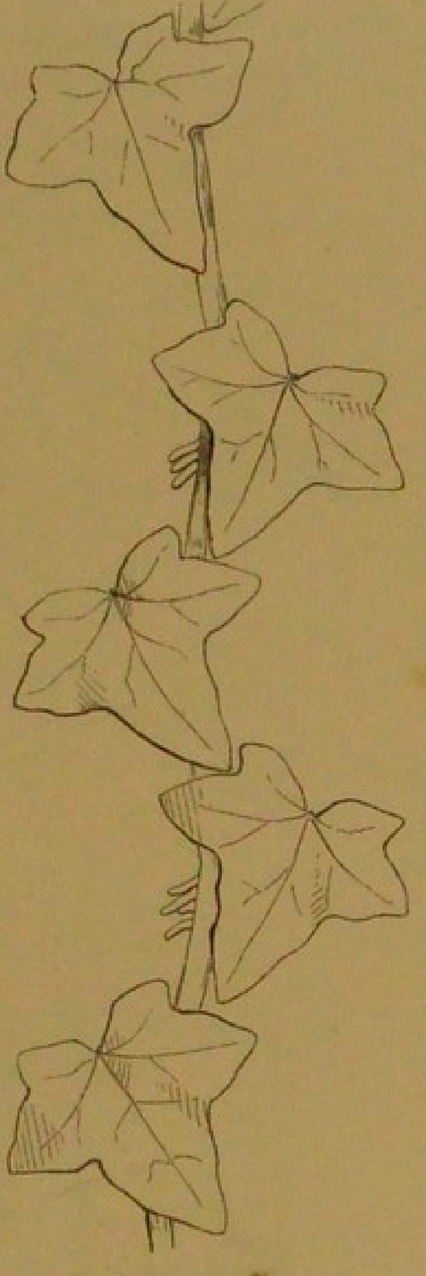

Fig. 258.

228. Moreover, buds appear in the axils of leaves, so whatever is the arrangement of leaves, such is the arrangement of buds (*Figs.* 227, 262).

Fig. 257.—A, Oak (*Quercus pedunculata*); the leaves of which are spiral. B, diagram showing the principle of the arrangement of the leaves.

Fig. 258.—Ivy (*Hedera Helix*).

229. And buds by development produce branches, hence

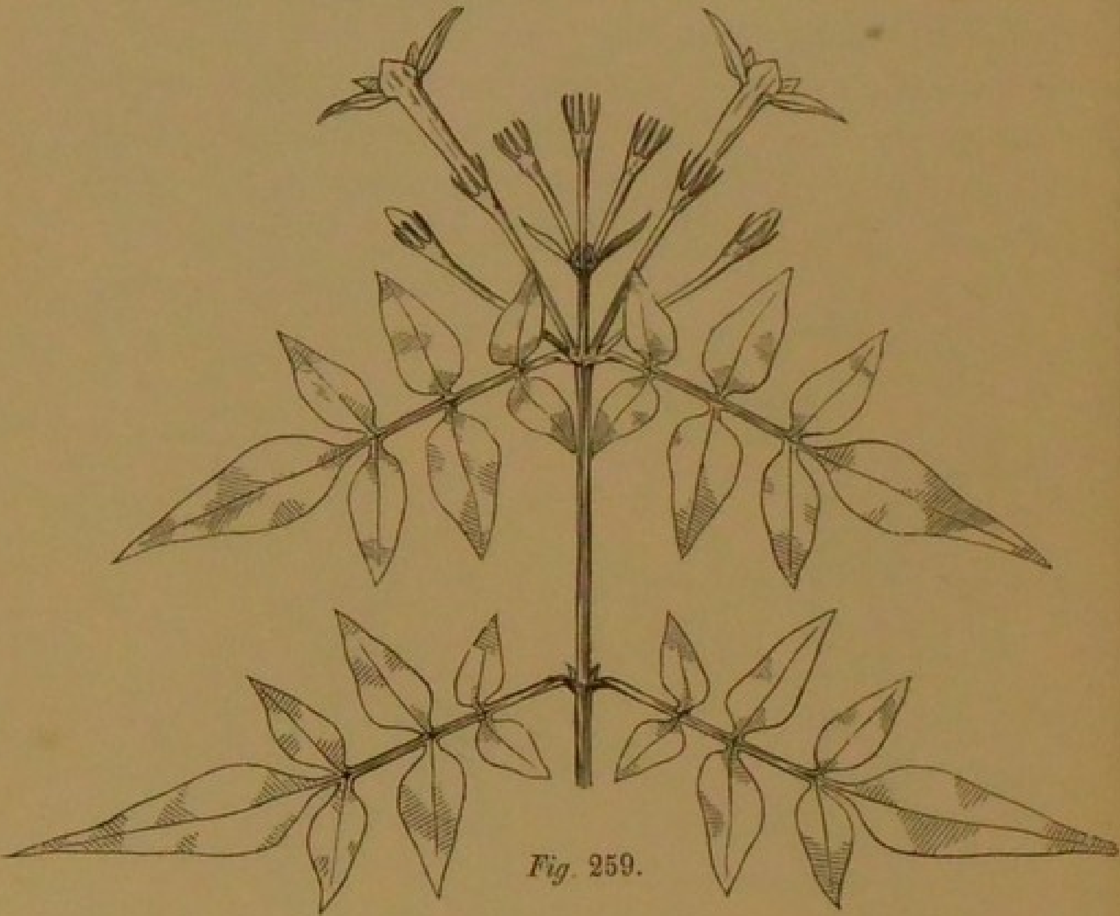

Fig. 259.

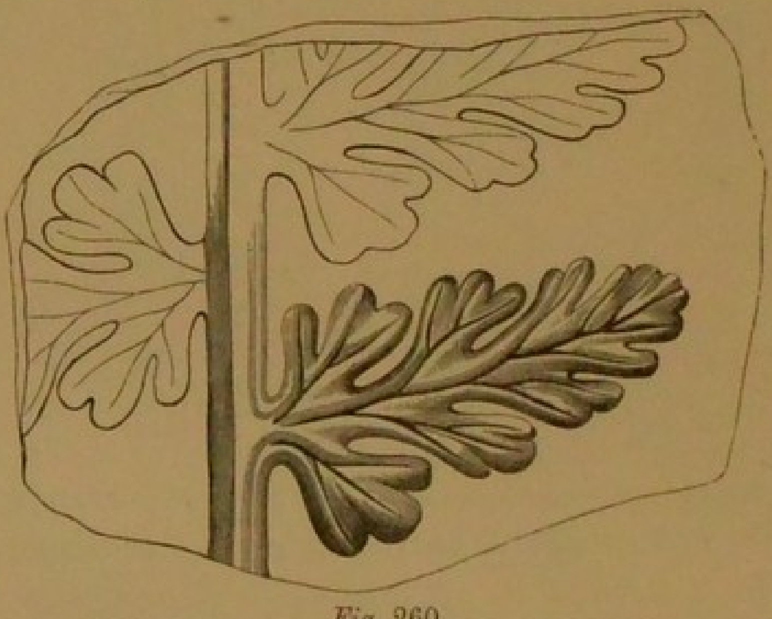

Fig. 260.

Fig. 259.—Jasmine (*Jasminum officinale*).

Fig. 260.—*Sphenopteris tridactylites;* a fossil fern of the carboniferous period, found abundantly in the shales of the mines of Montrelais.

whatever is the arrangement of buds, such is the arrangement of branches (*Figs.* 229, 230).

230. Also the members of those axes which result from the evolution of the buds of the parent axis, are disposed in the same order with the members of the parent (*Fig.* 230).

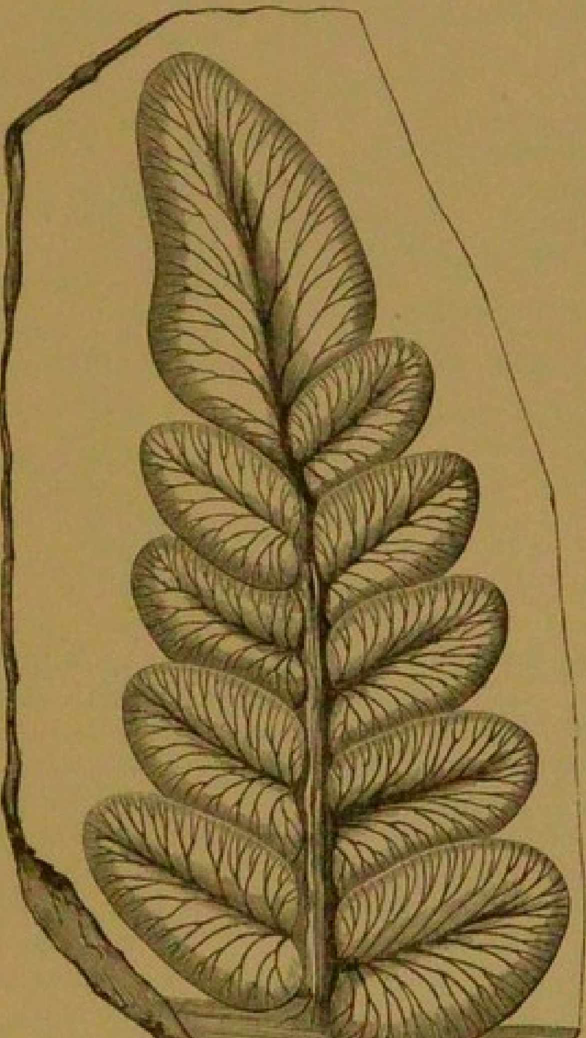

Fig. 261.

Fig. 262.

231. It follows then as a corollary that the arrangements of the floral parts, of leaves, of buds, of primary branches, and of those which are most remote, are coincident.

232. Prop. 224 shows that these varied members are

Fig. 261.—*Neuropteris Heterophylla*; a fossil fern found in the same district as our last figure.
Fig. 262.—*Ornithogalum nutans*. Flower-bud in the axil of bract.

arranged either alternately, oppositely, verticillately, or spirally, and hence that there are four modes of arrangement.

233. But there are many spiral arrangements, as $\frac{1}{2}$ (*Fig.* 263), $\frac{1}{3}$ (*Fig.* 264), $\frac{2}{5}$ (*Fig.* 257), $\frac{3}{8}$, $\frac{5}{13}$, and so on.

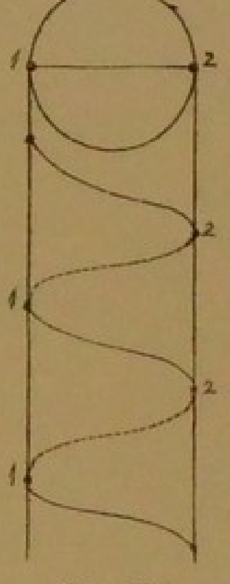

Fig. 263.

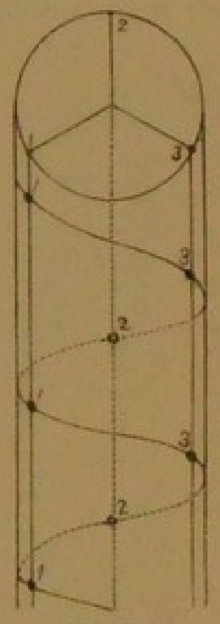

Fig. 264.

These fractions are employed as a sort of botanical symbolism; the numerators in all cases indicate the number of revolutions which the spiral thread makes round the axis before encountering the leaf which is situated over that with which we started, and the denominators in all cases indicate the number of leaves encountered in the revolution or revolutions; also the whole fraction gives the angular divergence of the leaves one from the other.

Dr. Balfour gives as the most common spiral arrangements the $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, $\frac{8}{21}$, $\frac{13}{34}$, and $\frac{21}{55}$, and then calls attention to the relation which they bear to each other. Thus the numerator of each fraction is equal to the sum of the numerators of the two preceding numerators, while the denominator is the sum of the two preceding denominators, and the numerator of each is likewise the denominator of the next but one preceding;* this would also tend to link more closely together these varieties of leaf arrangement (phyllotaxis).

234. Yet these principles of disposition are not so remote as might at first be expected.

Fig. 263.—Diagram illustrating the $\frac{1}{2}$ spiral arrangement.
Fig. 264.—Diagram illustrating the $\frac{1}{3}$ spiral arrangement.

* Balfour's Class Book, p. 99.

235. Thus the alternate arrangement is merely the most simple form of the spiral disposition.

236. And the opposite is simply the alternate, or spiral principle, in which every second internode of the axis is undeveloped; the result of which is, leaves which would otherwise be remote upon the axis are developed upon the same plane.

This is proved by the fact that, if a stem with opposite leaves is caused to grow with more rapidity than usual, it will then develop internodes between all its leaves, which latter, necessarily, then become alternate, or spiral; alternate if the pairs of leaves were over each other, and spiral if they were decussate or crossing.

237. Also verticillate leaves are the more complex spiral arrangements, in which the internodes between the successive cycles of the spiral are developed, and not those between the units of the cycle.

This is also proved in the same way that the last Proposition is; for if axes with verticillated leaves develop with more than usual energy, in which case internodes are formed between all the leaves, the members become spirally disposed upon the axis.

238. Therefore all leaves may be said to be developed in a spiral manner, which spiral disposition is, however, subject to certain interruptions.

These interruptions give rise to the opposite and whorled arrangements.

239. As, then, the arrangement of leaves, buds, branches, and floral parts are coincident, it follows that all these members are developed upon the spiral principle.

240. And as the members here enumerated constitute the entire plant (the root being excepted, which merely results from the growth of the other parts), it follows that the spiral principle of development is the only one known.

241. Yet there are many spiral arrangements, as shown by Prop. 233.

242. But all are attributed to a torsion of the stem upon its axis, hence all spiral arrangements result from the extent of the contortion of the developing body.

Dutrochet points out a revolving movement in the summits of stems, a spiral rolling of stems round their supports, a torsion of stems on themselves, and a spiral arrangement of leaves; all these being in the same direction on one plant. These phenomena he refers to an internal vital force, which causes a revolution round the central axis of the stem.

243. Then there are not so many different principles of arrangement upon which organs are developed, but one principle; only in some cases the twisting of the axis is greater than in others.

244. There is, therefore, a unity in the principle of arrangement of the varied vegetable members.

This obviously supposes that all the hypotheses involved are correct; we cannot, of course, go beyond the present state of knowledge.

CHAPTER XIV.

ON THE HABITS OF THE PARTS OF PLANTS.

245. THERE is, moreover, a unity in the habits of the parts of plants.

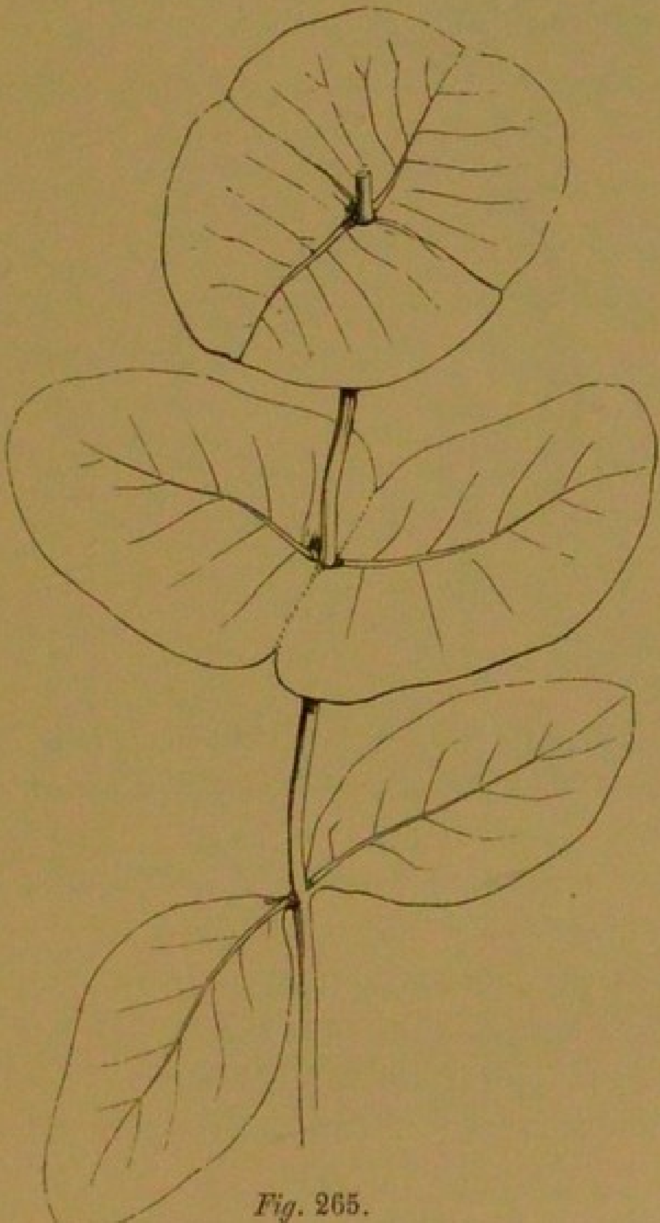

Fig. 265.

Fig. 265.—A species of Honeysuckle (*Lonicera Caprifolium*).

246. Thus, there is a proneness on the part of the varied vegetable members to grow together.

247. For we have connate leaves (*Fig.* 265), a gamo-

Fig. 267.

Fig. 266.

Fig. 268.

Fig. 269.

sepalous calyx (*Fig.* 266), a gamopetalous corolla (*Fig.* 267), monodelphous stamens (*Fig.* 268), and a syncarpous pistil (*Fig.* 269).

248. Also, a growing together of the parts of individual organs likewise takes place.

249. Thus, the lobes of a sessile leaf grow together (see Prop. 607, "Rudiments"), when a perfoliate leaf is formed (*Fig.* 270); the lobes of a petiolated leaf grow together, when a peltate leaf is formed (*Fig.* 271); the margins of stipules

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Fig. 266.—Calyx of the Lilac (*Syringa*).
Fig. 267.—*Crassula Coccinea.*
Fig. 268.—Stamens of the Wood Sorrel (*Oxalis Acetosella*).
Fig. 269.—Pistil of Orange Lily (*Lilium bulbiferum*).

grow together, when they are ochreate (*Fig.* 272), or calyptrate; the margins of leaves grow together and disunite at

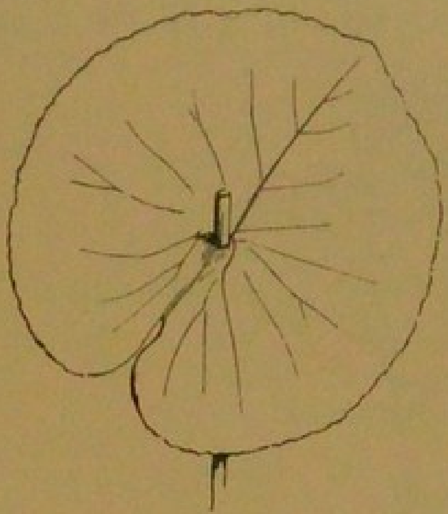

Fig. 270.

their expansion, *Ex.* Tulip-tree (*Liriodendron tulipifera*); and the margins of carpels grow together (*Fig.* 273).

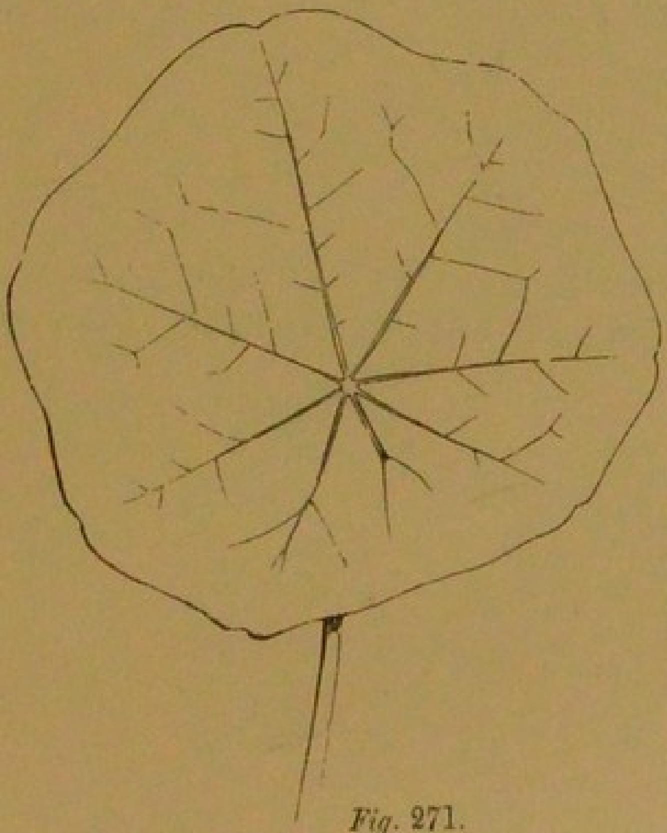

Fig. 271.

Fig. 270.—Leaf of *Smyrnium rotundifolium*.
Fig. 271.—Leaf of the Nasturtium or Indian Cress (*Tropæolum majus*).

250. And many elongated members have particularities of habit; thus they frequently become twining (*volubulis*).

251. The stem twines, as in the Hop (where it turns

Fig. 272.

Fig. 273.

from left to right), or the Convolvulus (where it turns from right to left), *Fig.* 274; tendrils of stipulary origin revolve,

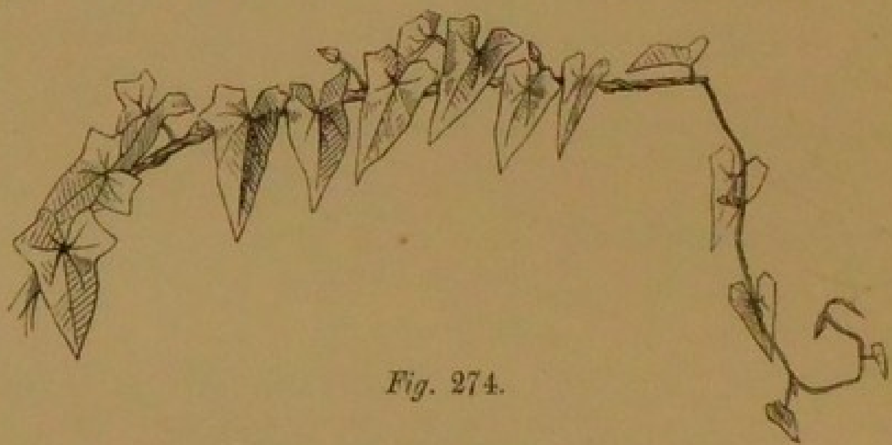

Fig. 274.

Fig. 272.—Ladies' Mantle (*Alchemilla vulgaris*).
Fig. 273.—Ideal figure of a carpel.
Fig. 274.—Bindweed (*Calystegia sepium*).

as in the Bryony (*Bryonia dioica*), *Fig.* 275, and Smilax (*Fig.* 276); tendrils, which are feeble axes or barren pe-

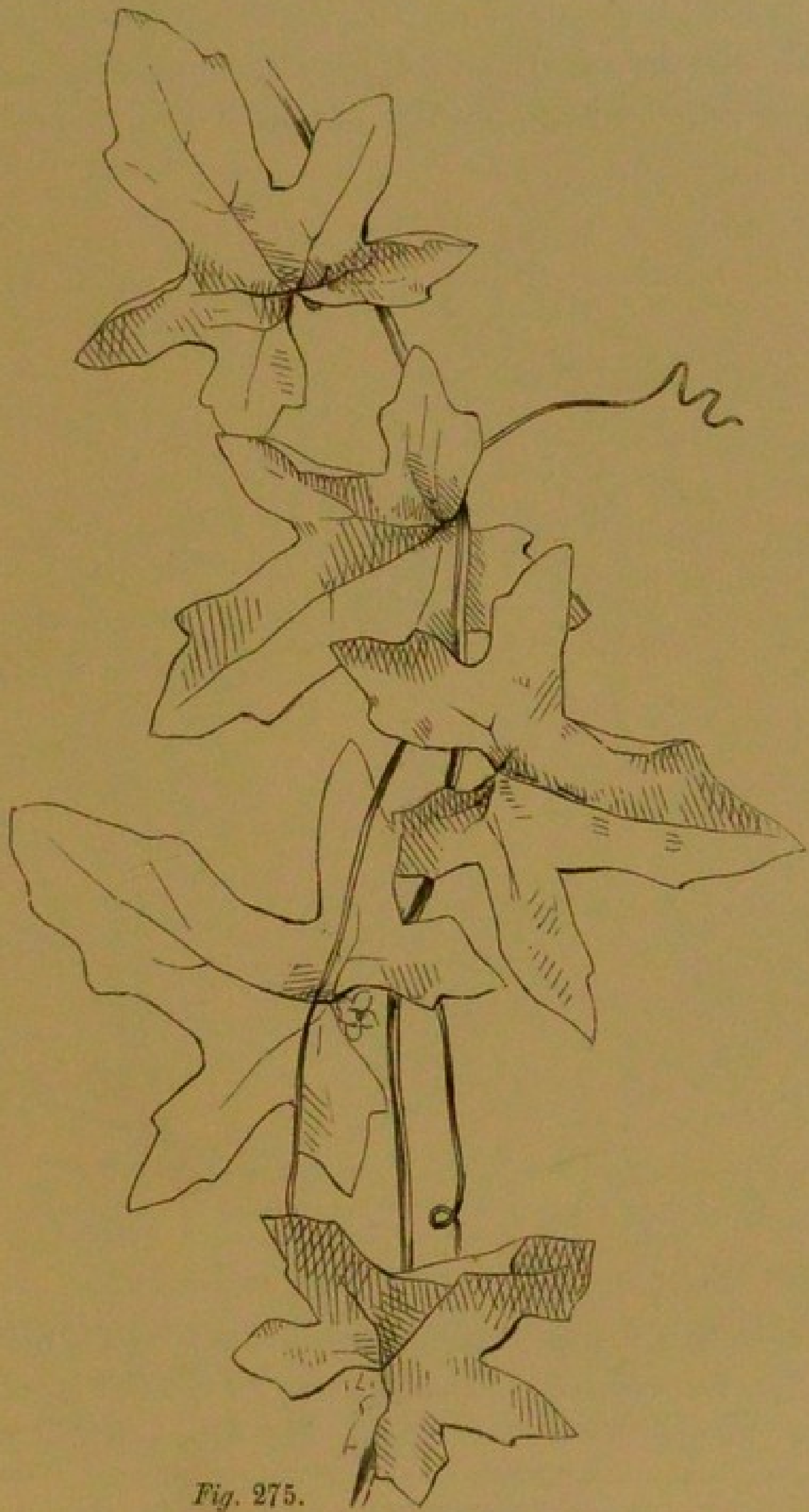

Fig. 275.

Fig. 275.—Bryony (*Bryonia dioica*).

duncles, twine, as in the Vine (*Vitis vinifera*), *Fig.* 287 ; and the petiole twines, as in Canariensis (*Tropæolum peregrinum*), *Fig.* 277.

252. Members frequently develop their sides into membranous phyllous projections, or wings.

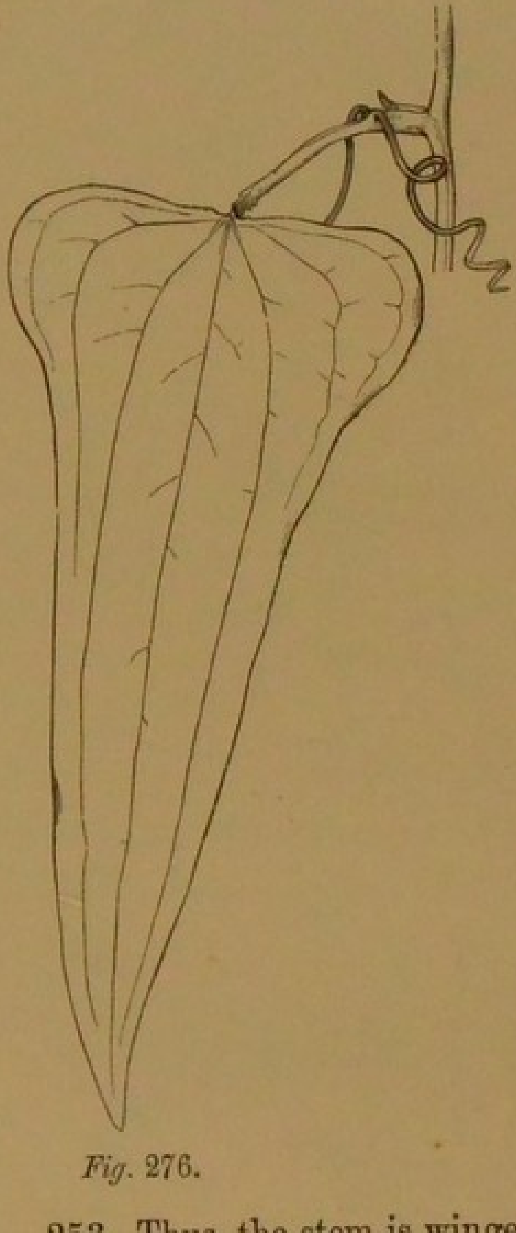

Fig. 276.

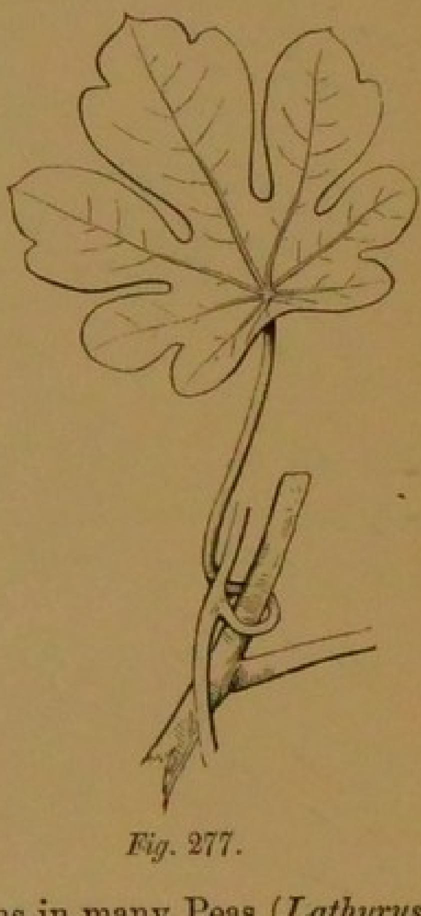

Fig. 277.

253. Thus, the stem is winged, as in many Peas (*Lathyrus latifolius*, for example), *Fig.* 278 ; the petiole is winged, as in the Orange (*Citrus aurantium*), *Fig.* 279, and *Nepenthes*

Fig. 276.—A species of *Smilax*.
Fig. 277.—Canariensis (*Tropæolum peregrinum*).

Phyllamphora; the peduncle is winged, as in the Lime-tree (*Tilia Europæa*), *Fig.* 280; the stamen is winged, as in the *Orinthogalum* (*Fig.* 281); the fruit is winged, as in the Maple (*Acer*), *Fig.* 211, and *Ptelea trifoliata*, *Fig.* 218; and the seed is winged in the Fir (*Pinus*), *Fig.* 282, and Toadflax (*Linaria vulgaris*).

Fig. 278.

The fruits of Composites are furnished with hairs, which surmount them (the pappus), and the seeds of the Asclepias are similarly mounted (with the como), Fig. 235.

254. And the parts are rolled up in similar ways.

255. Thus the vernation of the leaf-bud, and the æstivation of the flower-bud, are valvate, twisted, imbricate, &c.

256. There are also other similarities of habit which may be traced as existing between the operations of all plants.

Fig. 278.—*Lathyrus latifolius.*

257. Thus, they shed their root-fibres, they shed their leaves, their buds (in some cases), and their seeds.*

258. They also develop shortened and elongated axes: thus the primary axis of the root is elongated (when there is

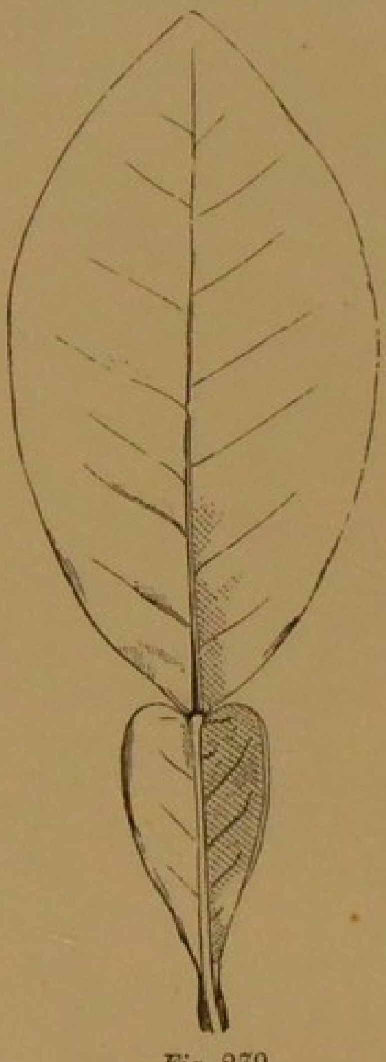

Fig. 279.

Fig. 280.

a tap-root), *Fig.* 283; the primary axis of the inflorescence is elongated (when there is a spike or raceme), *Figs.* 144, 148; and the primary axis of the stem is elongated (when its growth

Fig. 279.—Leaf of Orange (*Citrus Aurantium*).
Fig. 280.—Lime-tree (*Tilia Europæa*).

* A plant shedding its seeds is like an animal sending forth its progeny; a swarm of Bees, for example, leaving the hive; only here the old ones leave, whereas in plants, the young ones are dispersed.
The shedding of the members links plants to animals, for Crabs and their allies shed their claws.

is indefinite), *Fig.* 284; the primary axis of the root is undeveloped (when the root is fasciculate), *Fig.* 286; the primary axis of the inflorescence is undeveloped (when the umbel and capitulum are formed), *Figs.* 154, 142; and the primary axis of the stem is undeveloped (when we have the crown of the root, *Fig.* 285, or the definite growth, *Fig.* 287), and so on.

Fig. 281.

Fig. 282.

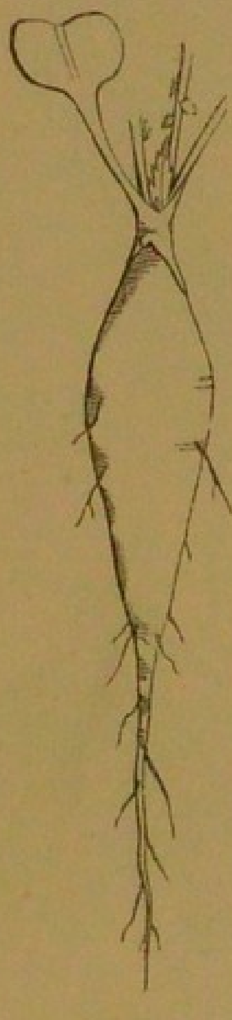

Fig. 283.

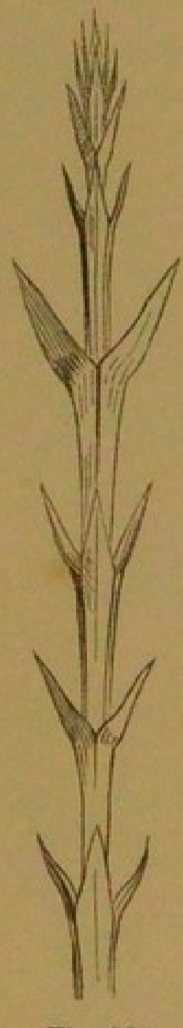

Fig. 284.

Also the spathe is fleshy, which is the primary axis of the inflorescence (*Fig.* 147); and the tap-root is fleshy (*Ex.* Turnip, *Fig.* 285), which is the primary axis of the root.

Fig. 281.—Stamen of the *Ornithogalum nutans.*
Fig. 282.—Seed of Fir (*Pinus*).
Fig. 283.—Root of the Radish (*Raphanus sativus*).
Fig. 284.—Arbor Vitæ (*Thuja orientalis*).

259. Also, various parts become succulent: thus, the pe-

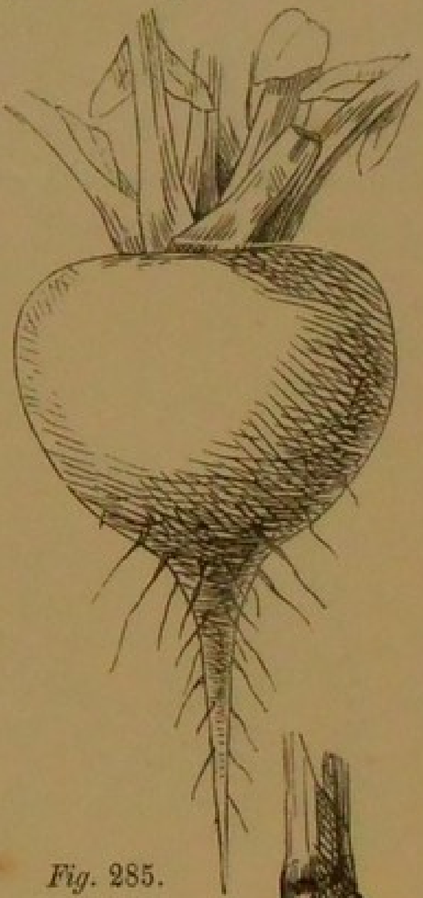

Fig. 285.

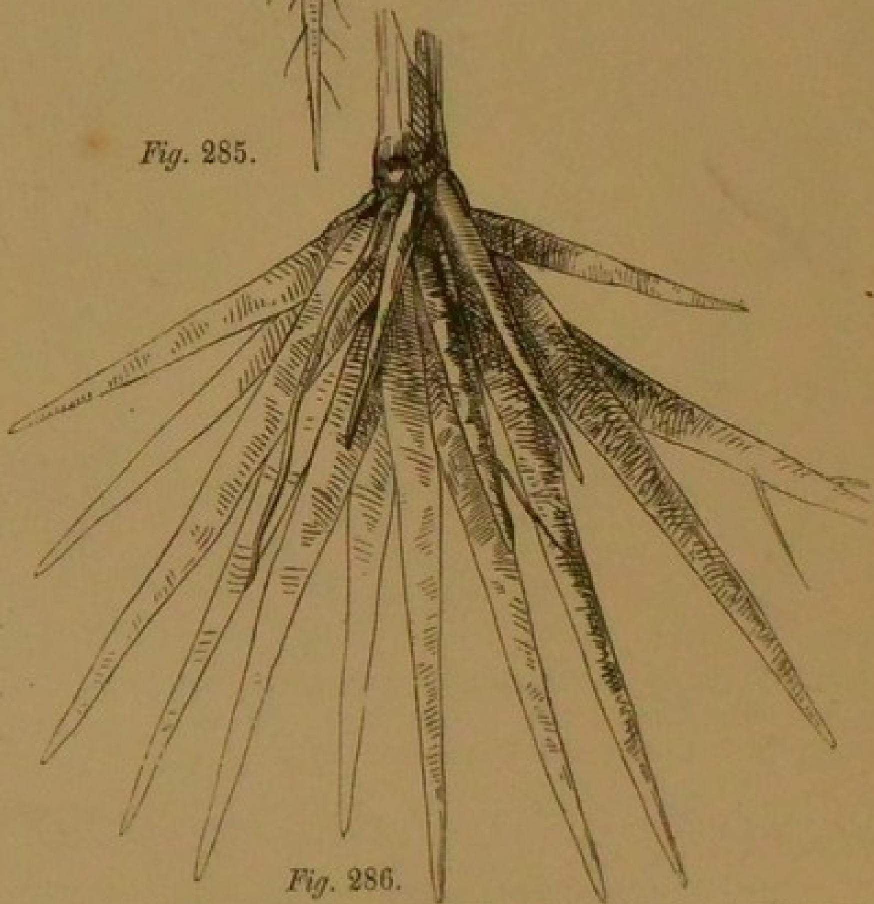

Fig. 286.

Fig. 285.—Turnip (*Brassica Napus*).
Fig. 286.—Asphodel (*Asphodelus luteus*).

duncle is succulent, *Ex.* Fig (*Ficus*), *Fig.* 288, and *Anacardium occidentale;* the receptacle becomes succulent, *Ex.* Strawberry (*Fragaria*), *Fig.* 289, the bracts, *Ex.* Pine-apple

Fig. 287.

(*Ananassa sativa*) and Yew (*Taxus baccata*), the calyx, *Ex.* Mulberry (*Morus nigra*), and the carpels, *Ex.* Raspberry (*Rubes Idæus*).

Fig. 287.—Vine (*Vitis Vinifera*).

In the Pine-apple the floral parts become succulent as well as the bracts. In the fruit of the Deadly Nightshade the mesocarp becomes succulent (*Fig.* 290), in the Orange (*Figs.* 203, 204) the endocarp, in the Tomato (*Solanum Lycopersicon*) the placenta, in the Wake-robin (*Arum maculatum*) the conducting tissue, and in the Gooseberry (*Ribes*), *Fig.* 207, and Pomegranate (*Puncia*), *Fig.* 208, the testa of the seed.

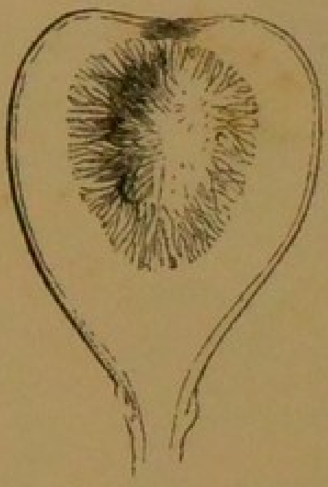

Fig. 288.

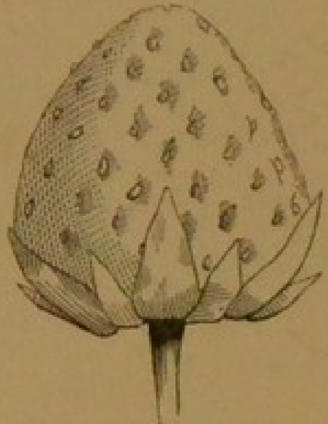

Fig. 289.

260. And some plants complete their existence in a few hours, others in many years: * some fruits ripen in a few

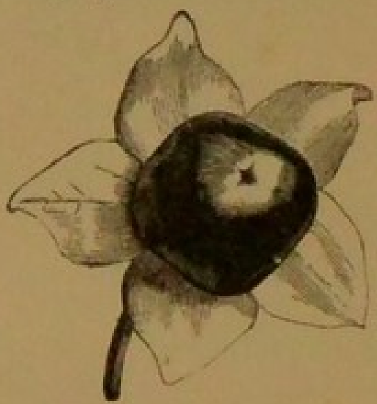

Fig. 290.

days, others in months; some flowers are expanded but for a few hours, others for days; some seeds germinate in a few hours, others in years; and so on.

261. Hence there is a unity in the habits of the parts of plants.

Fig. 288.—Fig (*Ficus Carica*).
Fig. 289.—Strawberry (*Fragaria*).
Fig. 290.—Deadly Nightshade (*Atropa Belladonna*).

* This fact link plants to animals, for certain of the latter live but for a few hours, and others for many years.

The fact that the matter of which plants are composed, after their death, becomes inert, or unorganized, links plants to the mineral kingdom.

CHAPTER XV.

ON THE RELATION OF PLANTS TO THE WORLD.

262. THE relation of plants to the world may be considered in order to discover that unity which subsists between all vegetable structures.

263. Thus, if we notice them in their relation to animals, we see that they unitedly administer to their wants.

They not only feed the herbiverous races, and partially nourish omniverous creatures, but to man they subserve a thousand other purposes; thus, they furnish timber of all kinds, linen, matting, paper, household utensils without number, perfumes, relishes, medicines, &c.

264. It is true that only a portion of our vegetation is edible, while other portions possess aromatic, purgative, astringent, and even poisonous properties.

265. Yet poisonous plants are only those which have medicinal properties in a high degree.

266. And all medicinal plants have for their object the restoration of animals to health, when their systems have been disordered by disturbing causes.

267. While edible plants have for their object the sustaining the physical frame of animals.

The following extracts are upon the authority of Dr. Lyon Playfair, President of the Royal Chemical Society, &c., &c., and are from labels in the South Kensington Museum.

As a general rule, a man in condition for hard manual labour, requires a daily supply of from 5 to 6 oz. of flesh-formers and 10 oz. of carbon, for he wastes 5 oz. of the organic parts of his body daily; the charcoal is required to keep up the heat.

"All the organs of the body contain the four elements, *Carbon*, *Hydrogen*, *Nitrogen*, and *Oxygen*, and no ingredients of food can be of use in building up the wasted parts of the body unless these four elements are present. The nutritive, or flesh-forming, parts of food, are called FIBRIN, ALBUMEN, and CASEIN; they contain the four elements in exactly the same proportions, and are found both in vegetable and in animal food.* Fibrin may be got either by stirring fresh-drawn blood, or from the juice of a Cauliflower; albumen, or white of egg, from eggs, from Cabbage-juice, or from flour; casein, or cheese, exists more abundantly in Peas and Beans than it does in milk itself. Fibrin, albumen, and casein, whether they are got from vegetable or animal bodies, have the same composition as dried flesh and blood. The growth and support of an animal is now easily explained: when a flesh-eater, like the Tiger, lives on the flesh of another animal, it eats, in a chemical point of view, the substance of its own body, and requires only to give it a new place and form; † when a child receives its mother's milk, it does the same thing, eating, in fact, its mother, and giving her flesh a new place and form on its own body. The nutrition of vegetable feeders is precisely the same; they find in vegetable fibrin, albumen, and casein, the substance of their flesh and blood actually formed, and have only to give it a place and position within their bodies. VEGETABLES ARE THE TRUE MAKERS OF FLESH; animals only arrange the flesh which they find ready formed in vegetables. The *nutritive* value of food depends upon its richness in flesh-forming matter."

"A class of ingredients in food, such as starch, gum, sugar, and fat, contain three elements, *Carbon*, *Oxygen*, and *Hydrogen*, the fourth element, *Nitrogen*, being absent; they are of no use in building up the structure of the body, or in repairing its waste, they are, in fact, the *fuel* which keeps up animal heat. The body of a man has a temperature of 98° Fahrenheit. This warmth results from the burning of these substances, which produce as much heat in the body as they would if burned in an open fire out of the body. A man inhales about 3000 gallons of air in 24 hours, in order to burn the daily amount of food-fuel, containing about 10 oz. of carbon, or charcoal. The products of combustion pass out by the mouth, just as they would fly up the chimney of an open fire, were the charcoal burned in it. Less food-fuel is required in hot weather than in cold, and less in hot climates than in cold ones. Tropical foods contain about 20 to 30 parts in the 100 of charcoal; Arctic blubber and fat from 80 to 90. The intense cold of the polar regions compels the inhabitants to devour large quantities of food-fuel to keep up the heat of the body to 98°. Arctic travellers state that 20 lbs. of blubber is not an uncommon meal for one person."

"Five ounces of flesh-formers, being the amount required to restore the daily waste of the body, are contained in the quantities given of each of the following vegetable substances:—

	lbs.	oz.
Wheat Flour	2	1
Barley meal	2	6
Oatmeal	1	13
Maize	2	9
Rye	2	3
Rice	4	13

* These facts tend strongly to unite plants with animals.

† The fact that the cloves of the bulb and the buds of the corm feed upon the substance of their parents, considered in relation to the fact here stated, tends to link together the members of the animal and of the vegetable kingdo ms.

	lbs.	oz.
Buckwheat	3	10
Lentils	1	3
Peas (dry)	1	5
Beans (dry)	1	5
Potatoes	20	13
Carrots	31	4
Parsnips	15	10
Turnips	17	13
Cabbage	10	6
Tea (dry)	1	11
Coffee (dry)	2	1
Cocoa (nibs)	3	2
Bread	3	13

These extracts show, beyond controversy, the bearing of the vegetable race, in a dietary point of view, upon the animal races, for whether animals are herbiverous or carniverous, it matters not: all flesh is first formed by plants.

268. Hence plants collectively administer to the well-being of animals.

269. In another sense they administer to the necessities of animals, for they purify the atmosphere.

270. Thus, animals by respiration exhale carbonic acid gas, which is to them poisonous; plants absorb this gas, assimilate its carbon to their own natures, and give out the oxygen, which is the stay of animal life.

This can be fully set forth by chemical symbols; thus, carbonic acid gas consists of charcoal (carbon),* and of oxygen,† of $C\,O_2$; thus, if the one equivalent of carbon is absorbed or separated from the two equivalents of oxygen, that is, if the C of our symbol is taken from the O_2, the latter will be again liberated in its pure form.

271. In relation to animals plants also perform another work, for they are the true flesh-formers of our world; and animals, by consuming vegetable matter, receive that flesh of which their own systems are composed, and only require to give it a new form, or position, in their own bodies.

See note to Prop. 267.

272. In relation to the earth they operate by shedding their leaves, &c., which then yield to chemical laws, and undergo decomposition, and thus form new earth as food for successive vegetation.

* C is the chemical symbol for charcoal (carbon).
† O is the chemical symbol for oxygen.

CHAPTER XVI.

ON THE NUMBERS OF THE PARTS OF PLANTS.

273. THE numbers of the parts of plants are various.*

274. But in no case is this more manifest than in the stamens, where we have from one to many.

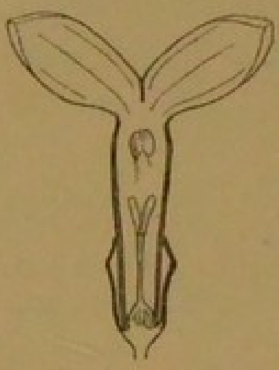

Fig. 291.

Fig. 292.

The Mare's-tail (*Hippuris*) has one stamen; the Speedwell (*Veronica*) *Fig*. 193, and Lilac (*Syringa*) *Fig*. 291, two; the Crocus, Iris (*Figs*. 292, 293), and Oat (*Avena*) three; the Teasel (*Dipsacus*), Goose-grass or Bedstraw (*Galium*), Plantain (*Plantago*), and Lady's Mantle

Fig. 291.—Lilac (*Syringa*), half the flower.
Fig. 292.—Flower-de-luce (*Iris*).

* A set number prevails in certain classes of plants, as the number two in Cryptogams, the number three in Endogens, and the numbers four or five in Exogens. So set numbers prevail in other kingdoms of nature; thus, among chemical elements there are set numbers, for the number eight characterizes oxygen, the number six carbon, and so on. There is also a curious play upon numbers in the animal kingdom: thus, the Rhinoceros has one horn (an odd number), and three digits, or toes (an odd number); the Ox has two well-developed digits (and two which are rudimentary, an even number), and two horns. This play upon numbers is also discoverable in the vegetable kingdom, as is shown by the note to Prop. 233; these considerations it was which tempted an ancient philosopher to consider creation as little more than a play upon numbers.

(*Alchemilla*) *Fig.* 158, four; the Borage (*Borago*) *Fig.* 180, Primrose (*Primula*), Bindweed (*Calystegia*) *Fig.* 294, Henbane (*Hyoscyamus*), and Nightshade (*Solanum*), five; the Snow-drop (*Galanthus*), Daffodil (*Narcissus*), Fritillary (*Fritillaria*), *Figs.* 174, 295, Tulip (*Tulipa*), and Hyacinth (*Hyacinthus*), six; the European Chickweed Wintergreen (*Trientalis*) and Horse-chestnut (*Æsculus*) have seven; the Evening-Primrose (*Œnothera*), Willow-herb (*Epilobium*), Heath

Fig. 293.

Fig. 294.

(*Erica*), *Fig.* 296, and *Fuchsia* (*Fig.* 159), have eight; the Flowering-rush (*Butomus*), *Fig.* 297, has nine; the Strawberry-tree (*Arbutus*), Saxifrage (*Saxifraga*), Pink (*Dianthus*), *Fig.* 300, Stonecrop (*Sedum*), *Fig.* 160, and Wood-sorrel (*Oxalis*), *Fig.* 268, have ten; and so on.

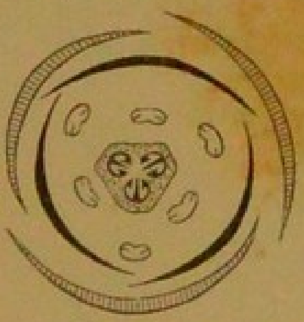

Fig. 295.

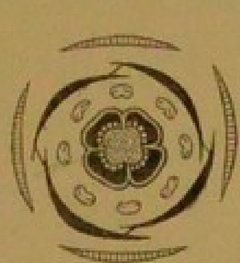

Fig. 296.

275. Yet these numbers result usually from the repetition of a number which pervades the other parts of the plant.

Fig. 293.—Diagram of the Iris.
Fig. 294.—Bindweed (*Calystegia sepium*).
Fig. 295.—Diagram of the Fritillary (*Fritillaria*).
Fig. 296.—Diagram of the Heath (*Erica*).

276. Thus, where we have six stamens in a flower, we usually have three petals, three sepals, and three carpels, in which case the six stamens result from two rows of three (*Fig.* 295).

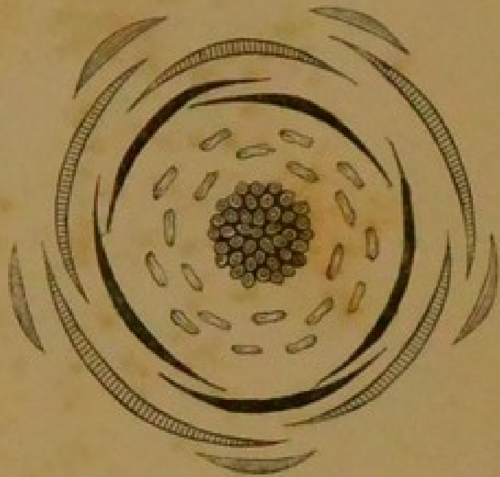

Fig. 299.

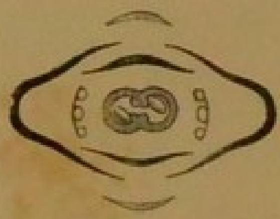

Fig. 297.

Fig. 298.

In the *Dielytra* we have six stamens, and have two sepals, four (twice two) petals, and two carpels; here the number which pervades the flower is two (*Fig.* 298).

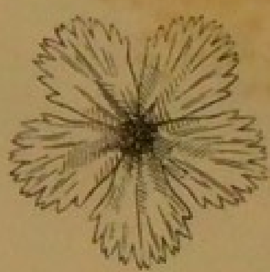

Fig. 300.

277. Also, if we have eight stamens, we usually have four

Fig. 297.—Flowering Rush (*Butomus umbellatus*).
Fig. 298.—Diagram of the *Dielytra Spectabalis*.
Fig. 299.—Diagram of the Strawberry (*Fragaria*).
Fig. 300.—Pink (*Dianthus*).

parts to the other floral whorls, and the eight result from the presence of two staminal whorls (*Fig.* 296).

278. If we have ten stamens, we usually have five parts in the other floral whorls; hence the ten result from there being two staminal whorls (*Figs.* 160, 300).

279. In like manner, when we have nine stamens, there are usually three parts to the other whorls, and the nine result from there being three whorls to the andræceum (*Fig.* 297).

280. The same principle holds good throughout, regardless of how far it may be extended; thus, if we have twenty stamens (four times five), there are usually five parts to the other floral verticils (*Fig.* 299).

281. There are not, then, so many distinct numbers as might be supposed.

282. And when we consider that the floral verticils result from juxtaposed metamorphosed leaves, which have a rhythmical arrangement, and that all arrangements of phyllous members are mere modifications of one principle of development (see Props. 238, 239), we find that all these numbers result from one principle or order of generation, which is so modified as to give rise to the numbers now reviewed.

CHAPTER XVII.

ON THE UNITY DEDUCED FROM THE COLOURS OF PLANTS.

283. There is also a unity in the colours of plants.

284. For although the variety of tints and shades of colour discoverable in vegetable nature are almost endless, yet (in accordance with the physical laws of colour) all are tertiary, secondary, or primary colours, or their hues, tints, or tones.

285. Nevertheless, all these colours result from three—viz., Blue, Red, and Yellow.

286. And these three have their origin in light.

287. In a chemical point of view a unity may also be traced.

288. Modern chemistry has shown that only two chemical principles exist in plants, in order to the production of all colours.

289. That one principle is the basis of White and Yellow, and that the other is the foundation of all other colours.

290. Also, that these substances, when acted upon by certain varying proportions of acid and ammonia (both of which exist in plants), pass through all the colours found in vegetable nature.

This can be tried thus: let a coloured portion of a plant (the inflorescence of a dark red Dahlia, for example) be immersed in spirits of wine, by which operation, if sufficiently long continued, the colouring matter of the flowers will be imparted to the spirit; add to this spirit a little acid ($S\ O_3$), and then ammonia, and the colour will change and pass through the series presented by the inflorescence of the Hydrangea (*Hydrangea hortensis*).

291. Then, although we have tints without number in vegetable structures, yet the physical conditions necessary for

their production are brought about by these two chemical agents.

The appearance of colour results from certain physical actions upon the rays of light, by which some portion of these rays are absorbed, or destroyed, by the body appearing coloured; and another portion is reflected to the retina of the eye of the spectator. There is no colour inherent in any body.

CHAPTER XVIII.

ON THE UNITY DEDUCED FROM THE POETIC AND ARTISTIC PHASES OF PLANTS.

292. VEGETABLE nature may be viewed in another light, in order to trace out, yet farther, the extent of that unity which is discoverable amidst the vast variety of vegetable objects,—and this is, a poetic and artistic, or ornamental light.

293. Plants speak in a thousand poetic strains, yet in all there is a vast concord, for all speak of God.

In other words, it may be said that the poetic face of nature, which so cheers and soothes, is God; or rather, that when we behold the vegetable creation, we behold the works of God, and we perceive the Most High speaking to us by his works. This is the poetry of Nature.

294. In an artistic point of view, we discover, amidst the vast numbers of plants which creation presents, an infinity of ornaments.*

295. Yet, amidst all the ornaments of vegetable nature, we discover but a few typical varieties.

296. Thus, we have flowers which, by the exquisite forms and colours of their parts, and the beautiful arrangement of their members, create within us, upon beholding them, feelings of high joy.

297. We have also those which, by the eccentric disposition of their members, together with their quaint abnormal forms, strike us as grotesque.

* There are certain ornamental and geometrical forms which may be found amidst all creation; thus, we may take an hexagon, with radii proceeding from the centre to its angles: we have it in the top view of the flower buds of most Endogens, we have it in many crystals, and we have it in animals, as in the Spoonbill Sturgeon (*Polyodon spatula*), in its osseous dermo-skeleton. See also a transverse section of a tooth of *Orycteropus*, and section of the bark of the Ivory-nut (*Phytelephus macrocarpa*).

298. And we have those which, by their livid hues and lifeless aspects, are repugnant to our feelings.

299. Nevertheless, there is a unity in the artistic effects of plants, for monotony is inimical to all, and variety makes all more beauteous; hence these three principles, by their diversity, furnish those conditions required by our nature, in order to the perfecting within us the highest feelings of delight.

CHAPTER XIX.

ON THE UNITY DEDUCED FROM THE VITAL FORCE OF PLANTS.

300. It has been shown that all vegetable organs are developed upon the same principle, that all are protruded in the same arrangements, and that throughout all plants, and all parts of the varied plants, there is a oneness of operation; this enables us to determine the nature of the operations of the vital force.

301. For although the vital force is that hidden energy which causes the parts of vegetable structures to enlarge, and the plant generally to grow, yet we can determine the nature of the cause operating, or rather, the rules by which it operates, from the effects produced.

302. Thus, as all growth is the result of the operations of the vital force, and there subsists between the varied members of all plants a strong unity, both in the nature of the organs produced and in the mode of their development, an obvious oneness must also exist between those modified principles of vitality which so operate as to produce the diversified plants.

Thus, as the members of all plants radiate from a common centre, we infer that the vital force which actuates them to develop in all cases operates in a similar manner. Also, as there are but two principles of growth, the definite and the indefinite, and as there is no strong difference even between these, we make the following deduction,—that the vital developing energy of all plants is similar.

303. There is, then, unity in the varied vital principles which give life to all plants, just as there is unity in the modes of development of the varied vegetable organs.

For this reason it would be better, and probably more correct, to say that all plants result from various modifications of one vital principle, than that all result from different vital forces, which are analogous to each other.

CHAPTER XX.

ON THE UNITY TRACEABLE BETWEEN ALL PLANTS FROM GENERAL CONSIDERATIONS.

304. THE analogy between the parts of plants and between plants as a whole may be further seen.

305. Thus a cell may be regarded as a perfect individual, and all plants as compound individuals, being aggregations of cells.

The protococcus is an exception, as it consists of one cell only.

306. For a cell is capable of independent existence and isolated life, as is proved by the protococcus.

307. A leaf may also be regarded as an individual, and all phyllophorous plants as compound organisms, being aggregations of leaves.

308. For a leaf is capable of aërating the sap, and assimilating it to the nature of the plant, and of producing wood, hence roots (for roots are but downward prolongations of the woody system).

A unifoliar phyton is little more than a leaf with the wood and other matters which it has formed.

309. A bud may also be regarded as an individual, and all plants as aggregations of buds.

310. For a bud develops wood which may form roots; also a bud is capable of independent existence, as is shown by a bulb, and by the bulbels of the bulbiferous Lily.

311. And a branch may be regarded as an individual, and all ramified plants as consisting of a series of distinct organisms, which exist in the form of branches.

312. Thus a branch of one year old, with the woody matter which it has passed into that axis of the parent by which it

has been generated, is exactly equal to an entire plant of the same age; and a branch is capable of independent existence, as is shown by "cuttings."

313. A phyton, whether unifoliar, bifoliar, or polyfoliar, may also be regarded as an individual, and all leaf-producing axes as aggregations of phytons.

314. For all leaf-bearing axes are merely repetitions, or aggregations of these units, and phytons have, for the most part, the power of isolated existence.

The vine is now "struck" by employing one node only; "cuttings," however, usually have two or more.

315. These facts not only establish the existence of a unity between all the parts of a plant, but also the existence of a concord between the members of all plants, and between plants themselves.

THE END.

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