GRAY'S

SCHOOL AND FIELD BOOK

OF

BOTANY.

CONSISTING OF

"LESSONS IN BOTANY," AND "FIELD, FOREST, AND GARDEN BOTANY,"

BOUND IN ONE VOLUME.

BY ASA GRAY,
FISHER PROFESSOR OF NATURAL HISTORY IN HARVARD UNIVERSITY.

IVISON, BLAKEMAN & COMPANY,
PUBLISHERS,
NEW YORK AND CHICAGO.

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PUBLISHERS' PREFACE

TO

GRAY'S SCHOOL AND FIELD BOOK OF BOTANY

THIS work consists of the "LESSONS IN BOTANY" and the "FIELD, FOREST AND GARDEN BOTANY," bound together in *one complete volume*, forming a most popular and comprehensive SCHOOL BOTANY, adapted to beginners and advanced classes, to Agricultural Colleges and Schools, as well as to all other grades in which the science is taught; it is also adapted for use as a hand-book to assist in analyzing plants and flowers in field study of botany, either by classes or individuals.

The book is intended to furnish Botanical Classes and beginners with an easier introduction to the Plants of this country, and a much more comprehensive work, than is the MANUAL.

Beginning with the *first principles*, it progresses by easy stages until the student, who is at all diligent, is enabled to master the intricacies of the science.

It is a *Grammar* and *Dictionary* of Botany, and comprises the common Herbs, Shrubs, and Trees of the Southern as well as the Northern and Middle States, including the commonly cultivated, as well as the native species in *fields*, *gardens*, *pleasure-grounds*, or *house culture*, and even the *conservatory plants* ordinarily met with.

This work supplies a great *desideratum* to the Botanist and Botanical Teacher, there being no similar class-book published in this country.

GRAY'S

LESSONS IN BOTANY

AND

VEGETABLE PHYSIOLOGY,

ILLUSTRATED BY OVER 360 WOOD ENGRAVINGS, FROM ORIGINAL DRAWINGS, BY ISAAC SPRAGUE.

TO WHICH IS ADDED A COPIOUS

GLOSSARY,

OR

DICTIONARY OF BOTANICAL TERMS.

By ASA GRAY,

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PREFACE.

THIS book is intended for the use of beginners, and for classes in the common and higher schools, — in which the elements of Botany, one of the most generally interesting of the Natural Sciences, surely ought to be taught, and to be taught correctly, as far as the instruction proceeds. While these Lessons are made as plain and simple as they well can be, all the subjects treated of have been carried far enough to make the book a genuine Grammar of Botany and Vegetable Physiology, and a sufficient introduction to those works in which the plants of a country — especially of our own — are described.

Accordingly, as respects the principles of Botany (including Vegetable Physiology), this work is complete in itself, as a school-book for younger classes, and even for the students of our higher seminaries. For it comprises a pretty full account of the structure, organs, growth, and reproduction of plants, and of their important uses in the scheme of creation, — subjects which certainly ought to be as generally understood by all educated people as the elements of Natural Philosophy or Astronomy are; and which are quite as easy to be learned.

The book is also intended to serve as an introduction to the author's *Manual of the Botany of the Northern United States* (or to any similar work describing the plants of other districts), and to be to it what a grammar and a dictionary are to a classical author. It consequently contains many terms and details which there is no necessity for young students perfectly to understand in the first instance, and still less to commit to memory, but which they will need to refer to as occasions arise, when they come to analyze flowers, and ascertain the names of our wild plants.

To make the book complete in this respect, a full *Glossary, or Dictionary of Terms used in describing Plants*, is added to the volume. This contains very many words which are not used in the *Manual of Botany;* but as they occur in common botanical works, it was thought best to introduce and explain them. All the words in the Glossary which seemed to require it are accented.

It is by no means indispensable for students to go through the volume before commencing with the analysis of plants. When the proper season for botanizing arrives, and when the first twelve Lessons have been gone over, they may take up Lesson XXVIII. and the following ones, and proceed to study the various wild plants they find in blossom, in the manner illustrated in Lesson XXX., &c., — referring to the Glossary, and thence to the pages of the Lessons, as directed, for explanations of the various distinctions and terms they meet with. Their first essays will necessarily be rather tedious, if not difficult; but each successful attempt smooths the way for the next, and soon these technical terms and distinctions will become nearly as familiar as those of ordinary language.

Students who, having mastered this elementary work, wish to extend their acquaintance with Vegetable Anatomy and Physiology, and to consider higher questions about the structure and classification of plants, will be prepared to take up the author's *Botanical Text-Book*, an *Introduction to Structural Botany*, or other more detailed treatises.

No care and expense have been spared upon the illustrations of this volume; which, with one or two exceptions, are all original. They were drawn from nature by Mr. Sprague, the most accurate of living botanical artists, and have been as freely introduced as the size to which it was needful to restrict the volume would warrant.

To append a set of questions to the foot of each page, although not unusual in school-books, seems like a reflection upon the competency or the faithfulness of teachers, who surely ought to have mastered the lesson before they undertake to teach it; nor ought facilities to be afforded for teaching, any more than learning, lessons by rote. A full *analysis of the contents* of the Lessons, however, is very convenient and advantageous. Such an Analysis is here given, in place of the ordinary table of contents. This will direct the teacher and the learner at once to the leading ideas and important points of each Lesson, and serve as a basis to ground proper questions on, if such should be needed.

ASA GRAY

HARVARD UNIVERSITY, CAMBRIDGE,
January 1, 1857.

*** Revised August, 1868, and alterations made adapting it to the new edition of *Manual*, and to *Field, Forest, and Garden Botany*, to which this work is the proper introduction and companion.

A. G.

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8. Botany, how defined. 9. Physiology, and Physiological Botany, what they relate to. 10. Systematic Botany, what it relates to: a Flora, what it is 11. Geographical Botany, Fossil Botany, &c., what they relate to.

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ing. 434. What the living parts of a tree are; their annual renewal. 435. Cambium-layer or zone of growth in the stem; connected with, 436. new rootlets below, and new shoots, buds, and leaves above. 437. Structure of a leaf: its two parts, the woody and the cellular, or, 438. the pulp; this contains the green matter, or Chlorophyll. 439, 440. Arrangement of the cells of green pulp in the leaf, and structure of its epidermis or skin. 441. Upper side only endures the sunshine. 442. Evaporation or exhalation of moisture from the leaves. 443. Stomates or Breathing-pores, their structure and use. 444. Their numbers.

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FIRST LESSONS

IN

BOTANY AND VEGETABLE PHYSIOLOGY.

LESSON 1.

BOTANY AS A BRANCH OF NATURAL HISTORY.

1. THE subjects of Natural History are, the earth itself and the beings that live upon it.

2. **The Inorganic World, or Mineral Kingdom.** The earth itself, with the air that surrounds it, and all things naturally belonging to them which are destitute of life, make up the mineral kingdom, or inorganic world. These are called *inorganic*, or unorganized, because they are not composed of *organs*, that is, of parts which answer to one another, and make up a whole, such as is a horse, a bird, or a plant. They were formed, but they did not grow, nor proceed from previous bodies like themselves, nor have they the power of producing other similar bodies, that is, of reproducing their kind. On the other hand, the various living things, or those which have possessed life, compose

3. **The Organic World,** — the world of organized beings. These consist of *organs;* of parts which go to make up an *individual*, a *being*. And each individual owes its existence to a preceding one like itself, that is, to a parent. It was not merely formed, but *produced*. At first small and imperfect, it grows and develops by powers of its own; it attains maturity, becomes old, and finally dies. It was formed of inorganic or mineral matter, that is, of earth and air, indeed; but only of this matter under the influence of life: and after life departs, sooner or later, it is decomposed into earth and air again.

4. The organic world consists of two kinds of beings; namely, 1. *Plants* or *Vegetables*, which make up what is called the *Vegetable Kingdom;* and, 2. *Animals*, which compose the *Animal Kingdom.*

5. **The Differences between Plants and Animals** seem at first sight so obvious and so great, that it would appear more natural to inquire how they resemble rather than how they differ from each other. What likeness does the cow bear to the grass it feeds upon? The one moves freely from place to place, in obedience to its own will, as its wants or convenience require: the other is fixed to the spot of earth where it grew, manifests no will, and makes no movements that are apparent to ordinary observation. The one takes its food into an internal cavity (the stomach), from which it is absorbed into the system: the other absorbs its food directly by its surface, by its roots, leaves, &c. Both possess organs; but the limbs or members of the animal do not at all resemble the roots, leaves, blossoms, &c. of the plant. All these distinctions, however, gradually disappear, as we come to the lower kinds of plants and the lower animals. Many animals (such as barnacles, coral-animals, and polyps) are fixed to some support as completely as the plant is to the soil; while many plants are not fixed, and some move from place to place by powers of their own. All animals move some of their parts freely; yet in the extent and rapidity of the motion many of them are surpassed by the common Sensitive Plant, by the Venus's Fly-trap, and by some other vegetables; while whole tribes of aquatic plants are so freely and briskly locomotive, that they have until lately been taken for animals. It is among these microscopic tribes that the animal and vegetable kingdoms most nearly approach each other, — so nearly, that it is still uncertain where to draw the line between them.

6. Since the difficulty of distinguishing between animals and plants occurs only, or mainly, in those forms which from their minuteness are beyond ordinary observation, we need not further concern ourselves with the question here. One, and probably the most absolute, difference, however, ought to be mentioned at the outset, because it enables us to see what plants are made for. It is this: —

7. Vegetables are nourished by the mineral kingdom, that is, by the ground and the air, which supply all they need, and which they are adapted to live upon; while animals are entirely nourished by vegetables. The great use of plants therefore is, to take portions of

LESSON II.

THE GROWTH OF THE PLANT FROM THE SEED.

12. **The Course of Vegetation.** We see plants growing from the seed in spring-time, and gradually developing their parts: at length they blossom, bear fruit, and produce seeds like those from which they grew. Shall we commence the study of the plant with the full-grown herb or tree, adorned with flowers or laden with fruit? Or shall we commence with the seedling just rising from the ground? On the whole, we may get a clearer idea of the whole life and structure of plants if we begin at the beginning, that is, with the plantlet springing from the seed, and follow it throughout its course of growth. This also agrees best with the season in which the study of Botany is generally commenced, namely, in the spring of the year, when the growth of plants from the seed can hardly fail to attract attention. Indeed, it is this springing forth of vegetation from seeds and buds, after the rigors of our long winter,—clothing the earth's surface almost at once with a mantle of freshest verdure,—which gives to spring its greatest charm. Even the dullest beholder, the least observant of Nature at other seasons, can then hardly fail to ask: What are plants? How do they live and grow? What do they live upon? What is the object and use of vegetation in general, and of its particular and wonderfully various forms? These questions it is the object of the present Lessons to answer, as far as possible, in a simple way.

13. A reflecting as well as observing person, noticing the resemblances between one plant and another, might go on to inquire whether plants, with all their manifold diversities of form and appearance, are not all constructed on one and the same general plan. It will become apparent, as we proceed, that this is the case;—that one common plan may be discerned, which each particular plant, whether herb, shrub, or tree, has followed much more closely than would at first view be supposed. The differences, wide as they are, are merely incidental. What is true in a general way of any ordinary vegetable, will be found to be true of all, only with great variation in the details. In the same language, though in varied phrase, the hundred thousand kinds of plants repeat the same

story, — are the living witnesses and illustrations of one and the same plan of Creative Wisdom in the vegetable world. So that the study of any one plant, traced from the seed it springs from round to the seeds it produces, would illustrate the whole subject of vegetable life and growth. It matters little, therefore, what particular plant we begin with.

14. **The Germinating Plantlet.** Take for example a seedling Maple. Sugar Maples may be found in abundance in many places, starting from the seed (i. e. *germinating*) in early spring, and Red Maples at the beginning of summer, shortly after the fruits of the season have ripened and fallen to the ground. A pair of narrow green leaves raised on a tiny stem make up the whole plant at its first appearance (Fig. 4). Soon a root appears at the lower end of this stemlet; then a little bud at its upper end, between the pair of leaves, which soon grows into a second joint or stem bearing another pair of leaves, resembling the ordinary leaves of the Red Maple, which the first did not. Figures 5 and 6 represent these steps in the growth.

15. Was this plantlet formed in the seed at the time of germination, something as the chick is formed in the egg during the process of incubation? Or did it exist before in the seed, ready formed? To decide this question, we have only to inspect a sound seed, which in this instance requires no microscope, nor any other instrument than a sharp knife, by which the coats of the seed (previously soaked in water, if dry) may be laid open. We find within the seed, in this case, the little plantlet ready formed, and nothing else (Fig. 2); — namely, a pair of leaves like those of the earliest seedling (Fig. 4), only smaller, borne on a stemlet just like that of the seedling, only much shorter, and all snugly coiled up within the protecting seed-coat. The plant then exists beforehand in the seed, in miniature. It was not formed, but only devel-

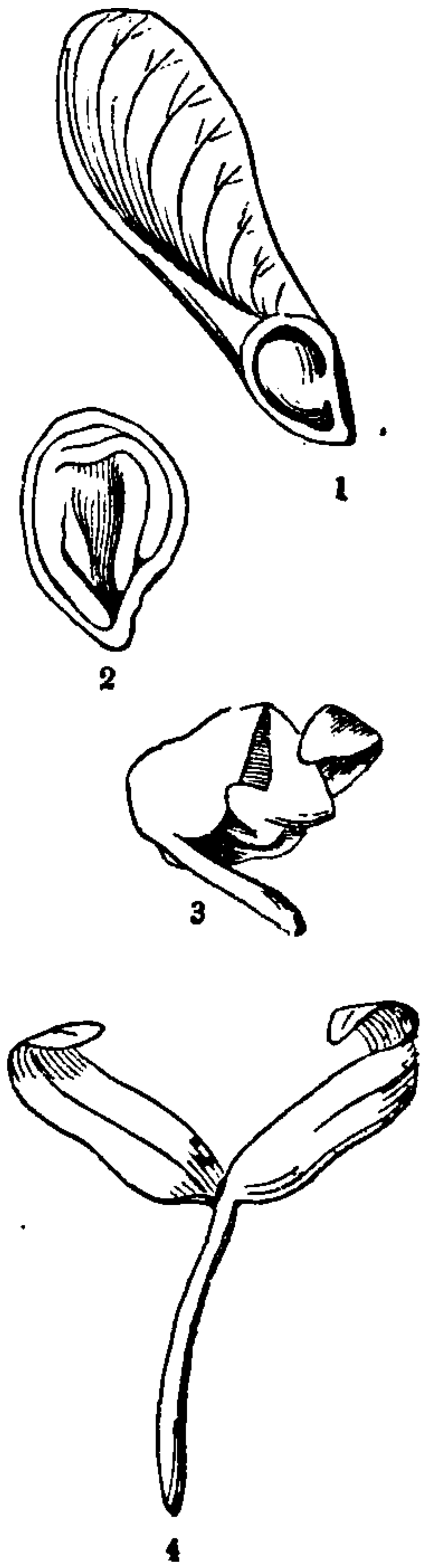
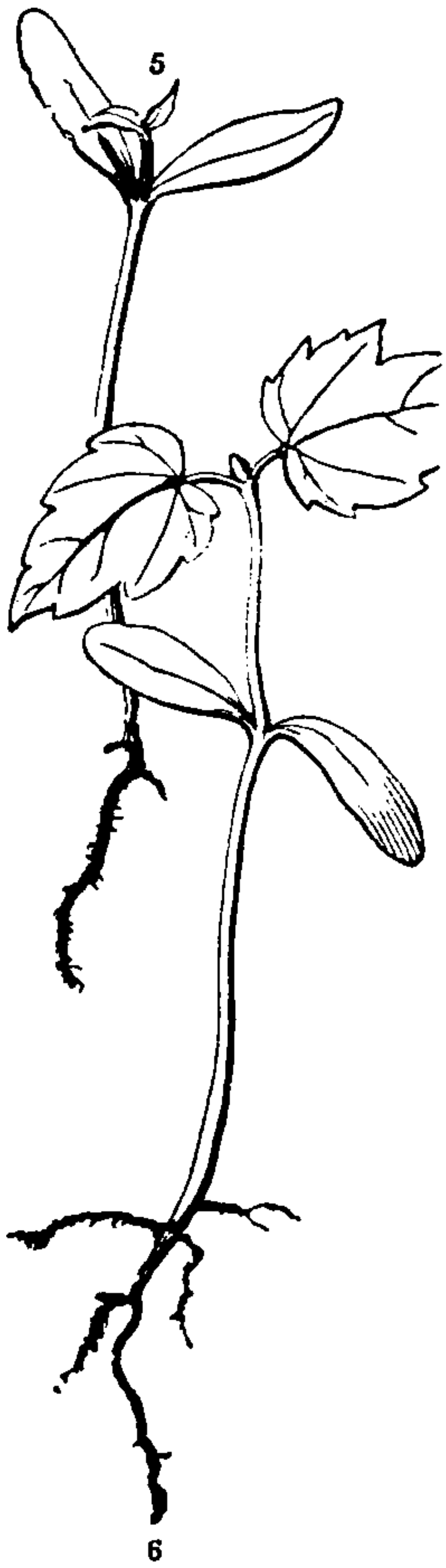


FIG. 1. A winged fruit of Red Maple, with the seed-bearing portion cut open, to show the seed. 2. This seed cut open to show the embryo plantlet within, enlarged. 3. The embryo taken out whole, and partly unfolded. 4. The same after it has begun to grow; of the natural size.

oped, in germination; when it had merely to unfold and grow,— to elongate its rudimentary stem, which takes at the same time an upright position, so as to bring the leaf-bearing end into the light and air, where the two leaves expand; while from the opposite end, now pushed farther downwards into the soil, the root begins to grow. All this is true in the main of all plants that spring from real seeds, although with great diversity in the particulars. At least, there is hardly an exception to the fact, that *the plantlet exists ready formed in the seed*, in some shape or other.

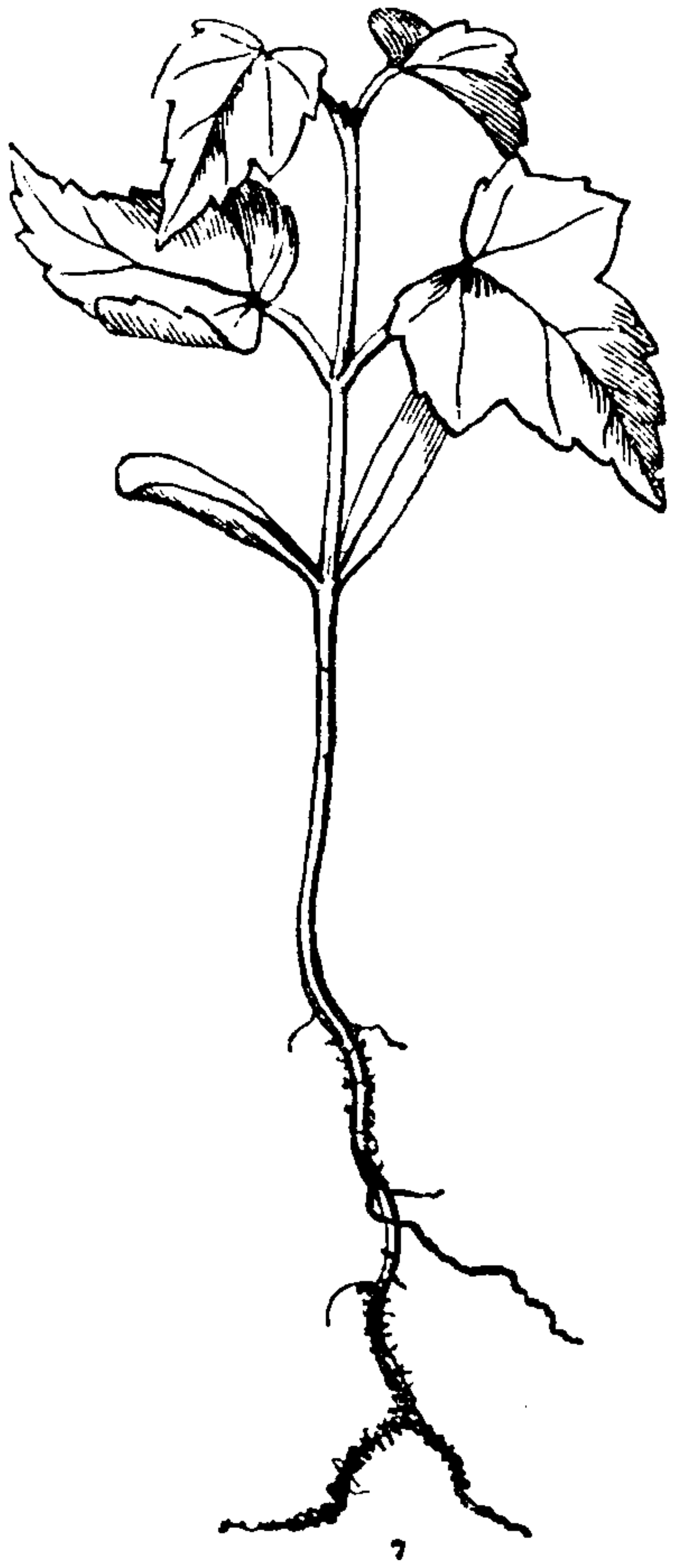


16. The rudimentary plantlet contained in the seed is called an *Embryo*. Its little stem is named the *Radicle*, because it was supposed to be the root, when the difference between the root and stem was not so well known as now. It were better to name it the *Caulicle* (i. e. little stem); but it is not expedient to change old names. The seed-leaves it bears on its summit (here two in number) are technically called *Cotylèdons*. The little bud of undeveloped leaves which is to be found between the cotyledons before germination in many cases (as in the Pea, Bean, Fig. 17, &c.), has been named the *Plumule*.

17. In the Maple (Fig. 4), as also in the Morning-Glory (Fig. 28), and the like, this bud, or plumule, is not seen for some days after the seed-leaves are expanded. But soon it appears, in the Maple as a pair of minute leaves (Fig. 5), erelong raised on a stalk which carries them up to some distance above the cotyledons. The plantlet (Fig. 6) now consists, above ground, of two pairs of leaves, viz.: 1. the cotyledons or seed-leaves, borne on the summit of the original stemlet (the radicle); and 2. a pair of ordinary leaves, raised on a second joint of stem which has grown from the top of the first. Later, a third pair of leaves is formed, and raised on a third joint of stem, proceeding from the summit of the second (Fig. 7), just as that did from the first; and so on, until the germinating plantlet becomes a tree.

FIG. 5. Germinating Red Maple, which has produced its root beneath, and is developing a second pair of leaves above. 6. Same, further advanced.

18. So the youngest seedling, and even the embryo in the seed, is already an epitome of the herb or tree. It has a stem, from the lower end of which it strikes root; and it has leaves. The tree itself in its whole vegetation has nothing more in kind. To become a tree, the plantlet has only to repeat itself upwardly by producing more similar parts, — that is, new portions of stem, with new and larger leaves, in succession, — while beneath, it pushes its root deeper and deeper into the soil.



19. **The Opposite Growth of Root and Stem** began at the beginning of germination, and it continues through the whole life of the plant. While yet buried in the soil, and perhaps in total darkness, as soon as it begins to grow, the stem end of the embryo points towards the light, — curving or turning quite round if it happens to lie in some other direction, — and stretches upwards into the free air and sunshine; while the root end as uniformly avoids the light, bends in the opposite direction to do so if necessary, and ever seeks to bury itself more and more in the earth's bosom. How the plantlet makes these movements we cannot explain. But the object of this instinct is obvious. It places the plant from the first in the proper position, with its roots in the moist soil, from which they are to absorb nourishment, and its leaves in the light and air, where alone they can fulfil their office of digesting what the roots absorb.

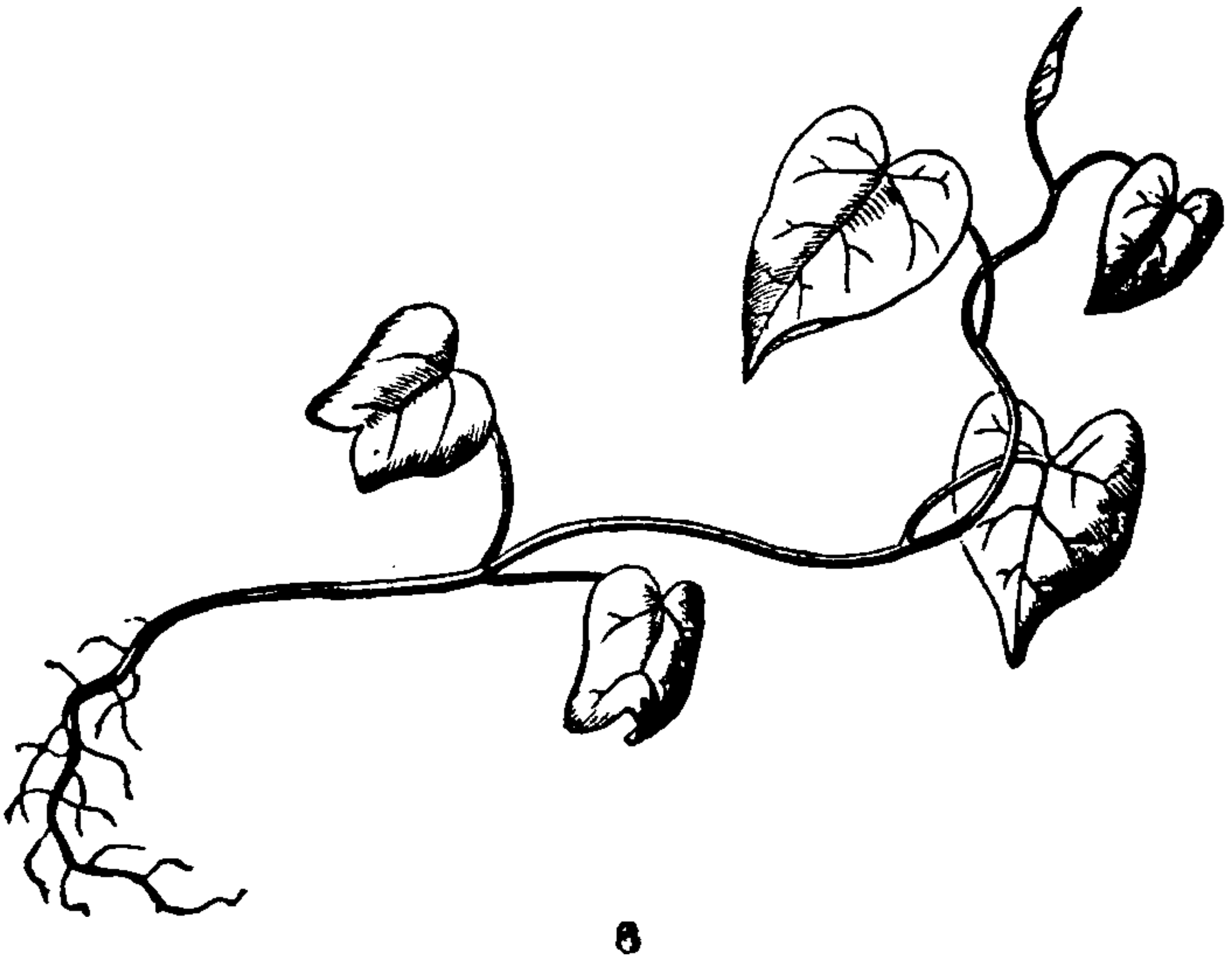
20. So the seedling plantlet finds itself provided with all the *organs of vegetation* that even the oldest plant possesses, — namely, root, stem, and leaves; and has these placed in the situation where each is to act, — the root in the soil, the foliage in the light and air. Thus established, the plantlet has only to set about its proper work.

21. **The different Mode of Growth of Root and Stem** may also be here mentioned. Each grows, not only in a different direction, but in a different way. The stem grows by producing a set of joints, each from

FIG. 7. Germinating Red Maple, further developed.

the summit of its predecessor; and each joint elongates throughout every part, until it reaches its full length. The root is not composed of joints, and it lengthens only at the end. The stem in the embryo (viz. the radicle) has a certain length to begin with. In the pumpkin-seed, for instance (Fig. 9), it is less than an eighth of an inch long: but it grows in a few days to the length of one or two inches (Fig. 10), or still more, if the seed were deeper covered by the soil. It is by this elongation that the seed-leaves are raised out of the soil, so as to expand in the light and air. The length they acquire varies with the depth of the covering. When large and strong seeds are too deeply buried, the stemlet sometimes grows to the length of several inches in the endeavor to bring the seed-leaves to the surface. The lengthening of the succeeding joints of the stem serves to separate the leaves, or pairs of leaves, from one another, and to expose them more fully to the light.

22. The root, on the other hand, begins by a new formation at the base of the embryo stem; and it continues to increase in length solely by additions to the extremity, the parts once formed scarcely elongating at all afterwards. This mode of growth is well adapted to the circumstances in which roots are placed, leaving every part undisturbed in the soil where it was formed, while the ever-advancing points readily insinuate themselves into the crevices or looser portions of the soil, or pass around the surface of solid obstacles.



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LESSON III.

GROWTH OF THE PLANT FROM THE SEED.—*Continued.*

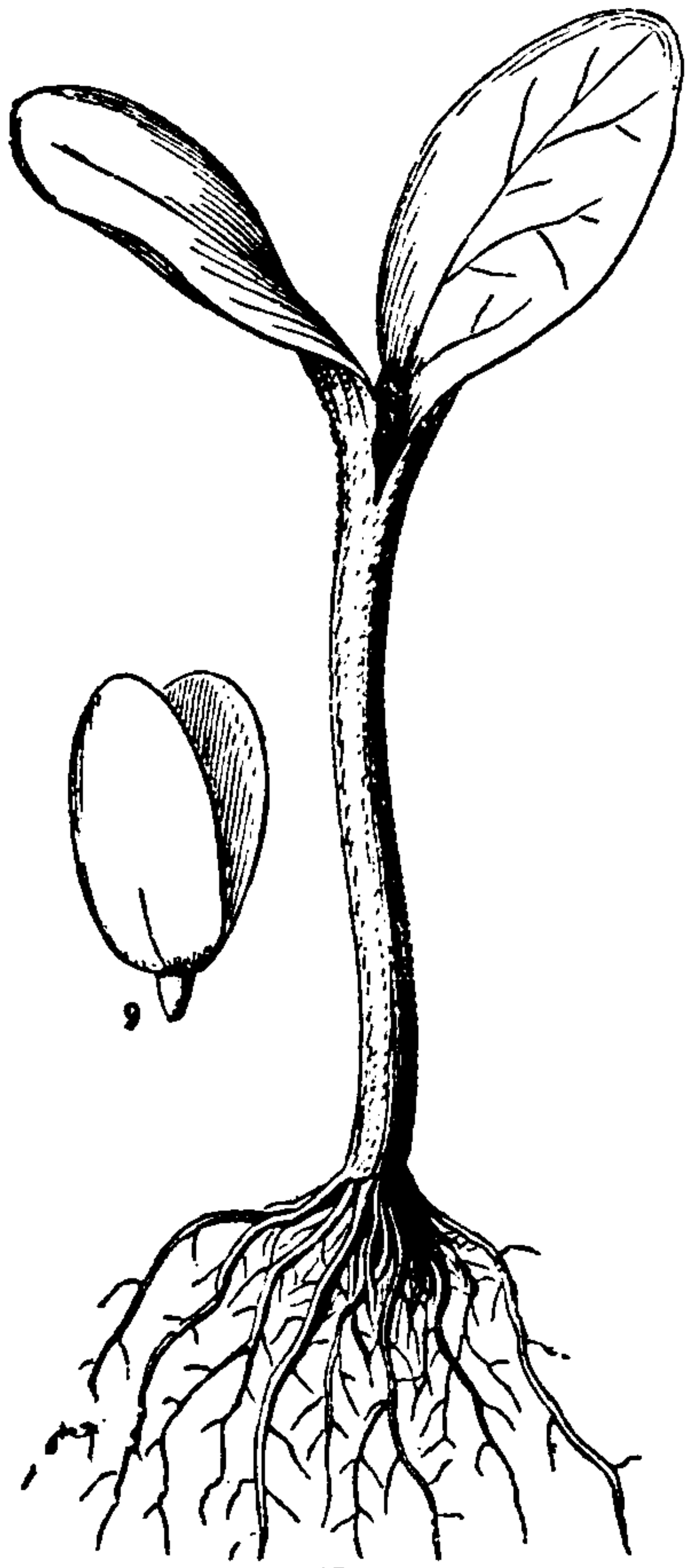
23. So a plant consists of two parts, growing in a different manner, as well as in opposite directions. One part, the root, grows downwards into the soil: it may, therefore, be called the *descending axis.* The other grows upwards into the light and air: it may be called the *ascending axis.* The root grows on continuously from the extremity, and so does not consist of joints, nor does it bear leaves, or anything of the kind. The stem grows by a succession of joints, each bearing one or more leaves on its summit. Root on the one hand, and stem with its foliage on the other, make up the whole plantlet as it springs from the seed; and the full-grown herb, shrub, or tree has nothing more in kind,—only more in size and number. Before we trace the plantlet into the herb or tree, some other cases of the growth of the plantlet from the seed should be studied, that we may observe how the same plan is worked out under a variety of forms, with certain differences in the details. The materials for this study are always at hand. We have only to notice what takes place all around us in spring, or to plant some common seeds in pots, keep them warm and moist, and watch their germination.

24. **The Germinating Plantlet feeds on Nourishment provided beforehand.** The embryo so snugly ensconced in the seed of the Maple (Fig. 2, 3, 4) has from the first a miniature stem, and a pair of leaves already green, or which become green as soon as brought to the light. It has only to form a root by which to fix itself to the ground, when it becomes a perfect though diminutive vegetable, capable of providing for itself. This root can be formed only out of proper material: neither water nor anything else which the plantlet is imbibing from the earth will answer the purpose. The proper material is nourishing matter, or prepared food, more or less of which is always provided by the parent plant, and stored up in the seed, either *in* the embryo itself, or *around* it. In the Maple, this nourishment is stored up in the thickish cotyledons, or seed-leaves. And there is barely enough of it to make the beginning of a root, and to provide for the lengthening of the stemlet so as to bring up the unfolding seed-leaves where they may expand to the light of day. But when this is done,

the tiny plant is already able to shift for itself; — that is, to live and continue its growth on what it now takes from the soil and from the air, and *elaborates into nourishment* in its two green leaves, under the influence of the light of the sun.

25. In most ordinary plants, a larger portion of nourishment is provided beforehand in the seed; and the plantlet consequently is not so early or so entirely left to its own resources. Let us examin a number of cases, selected from very common plants. Sometimes as has just been stated, we find this

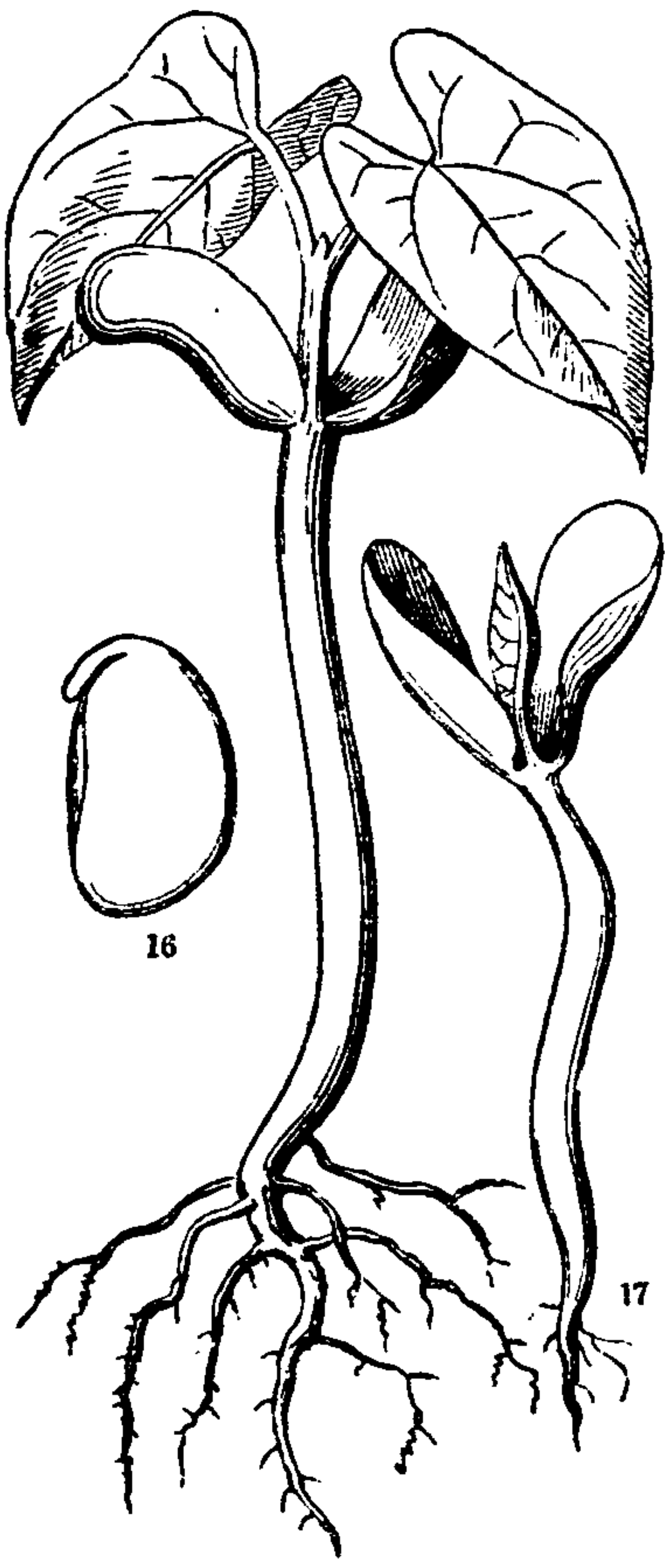
26. **Deposit of Food in the Embryo itself.** And we may observe it in every gradation as to quantity, from the Maple of our first illustration, where there is very little, up to the Pea and the Horsechestnut, where there is as much as there possibly can be. If we strip off the coats from the large and flat seed of a Squash or Pumpkin, we find nothing but the embryo within (Fig. 9); and almost the whole bulk of this consists of the two seed-leaves. That these contain a good supply of nourishing matter, is evident from their sweet taste and from their thickness, although there is not enough to obscure their leaf-like appearance. It is by feeding on this supply of nourishment that the germinating Squash or Pumpkin (Fig. 10) grows so rapidly and so vigorously from the seed, — lengthening its stemlet to more than twenty times the length it had in the seed, and thickening it in proportion, — sending out at once a number of roots from its lower end, and soon developing the plumule (16) from its upper end into a third leaf: meanwhile the two cotyledons, relieved from the nourishment with which their tissue was gorged, have expanded into useful green leaves.



27. For a stronger instance, take next the seed of a Plum or Peach, or an Almond, or an Apple-seed (Fig. 11, 12), which shows

FIG. 9. Embryo of a Pumpkin, of the natural size; the cotyledons a little opened
10. The same, when it has germinated.

they were so gorged and, as it were, misshapen, that they became quite unfitted to perform the office of foliage. This office is accordingly first performed by the succeeding pair of leaves, those of the plumule (Fig. 17, 18), which is put into rapid growth by the abundant nourishment contained in the large and thick seed-leaves. The latter, having fulfilled this office, soon wither and fall away.



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29. This is carried a step farther in the Pea (Fig. 19, 20), a near relative of the Bean, and in the Oak (Fig. 21, 22), a near relative of the Beech. The difference in these and many other similar cases is this. The cotyledons, which make up nearly the whole bulk of the seed are excessively thickened, so as to become nearly hemispherical in shape. They have lost all likeness to leaves, and all power of ever fulfilling the office of leaves. Accordingly in germination they remain unchanged within the husk or coats of the seed, never growing themselves, but supplying abundant nourishment to the plumule (the bud for the forming stem) between them. This pushes forth from the seed, shoots upward, and gives rise

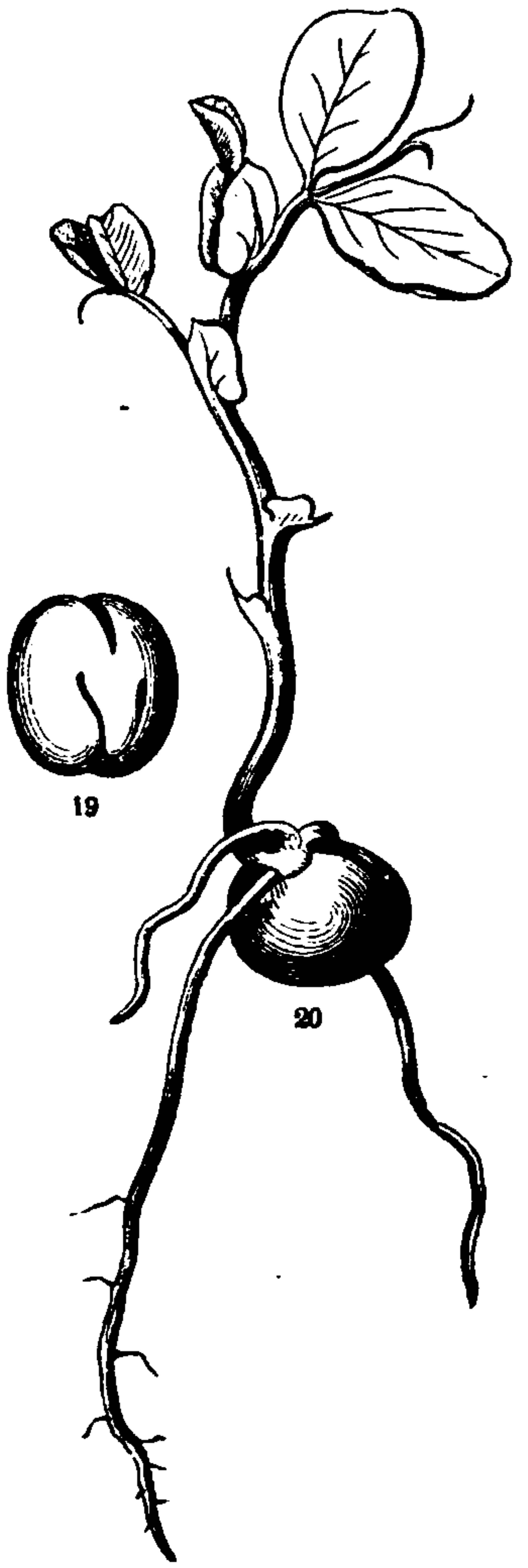

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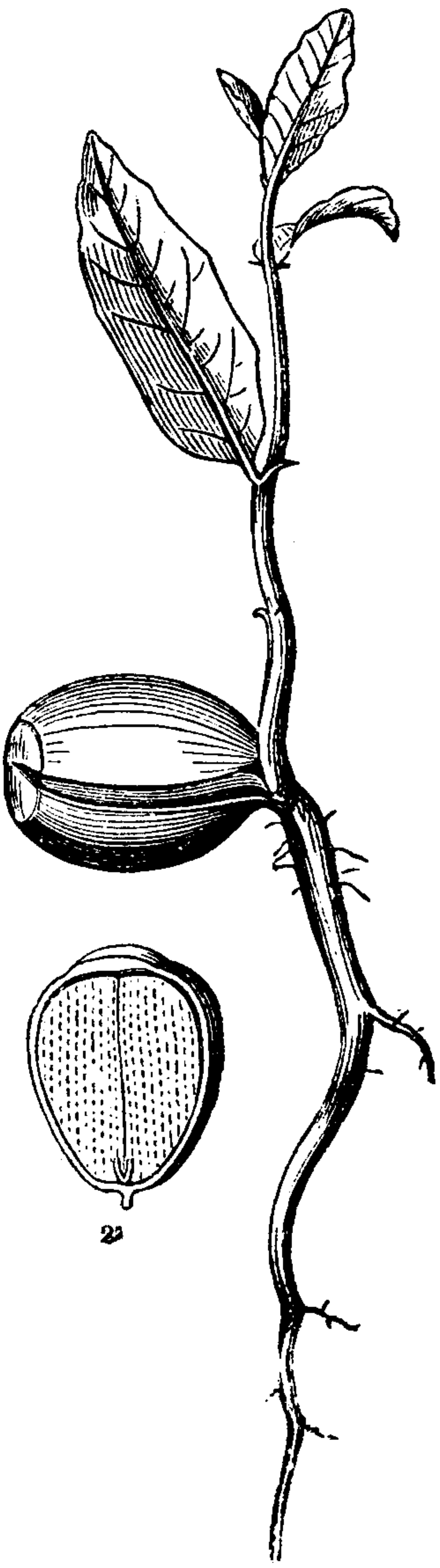
FIG. 16. A Bean: the embryo, from which seed-coats have been removed: the small stem is seen above, bent down upon the edge of the thick cotyledons. 17. The same in early germination; the plumule growing from between the two seed-leaves. 18. The germination more advanced, the two leaves of the plumule unfolded, and raised on a short joint of stem.

FIG. 19. A Pea: the embryo, with the seed-coats taken off. 20. A Pea in germination.

to the first leaves that appear. In most cases of the sort, the radicle, or short original stemlet of the embryo below the cotyledons (which is plainly shown in the Pea, Fig. 19), lengthens very little, or not at all; and so the cotyledons remain under ground, if the seed was covered by the soil, as every one knows to be the case with Peas. In these (Fig. 20), as also in the Oak (Fig. 22), the leaves of the first one or two joints are imperfect, and mere small scales; but genuine leaves immediately follow. The Horsechestnut and Buckeye (Fig. 23, 24) furnish another instance of the same sort. These trees are nearly related to the Maple; but while the seed-leaves of the Maple show themselves to be leaves, even in the seed (as we have already seen), and when they germinate fulfil the office of ordinary leaves, those of the Buckeye and of the Horsechestnut (Fig. 23), would never be suspected to be the same organs. Yet they are so, only in another shape, — exceedingly thickened by the accumulation of a great quantity of starch and other nourishing matter in their substance; and besides, their contiguous faces stick together more or less firmly, so that they never open. But the stalks of these seed-leaves grow, and, as they lengthen, push the radicle and the pumule out of the seed, when the former develops downwardly the root, the latter upwardly the leafy stem and all it bears (Fig. 24).



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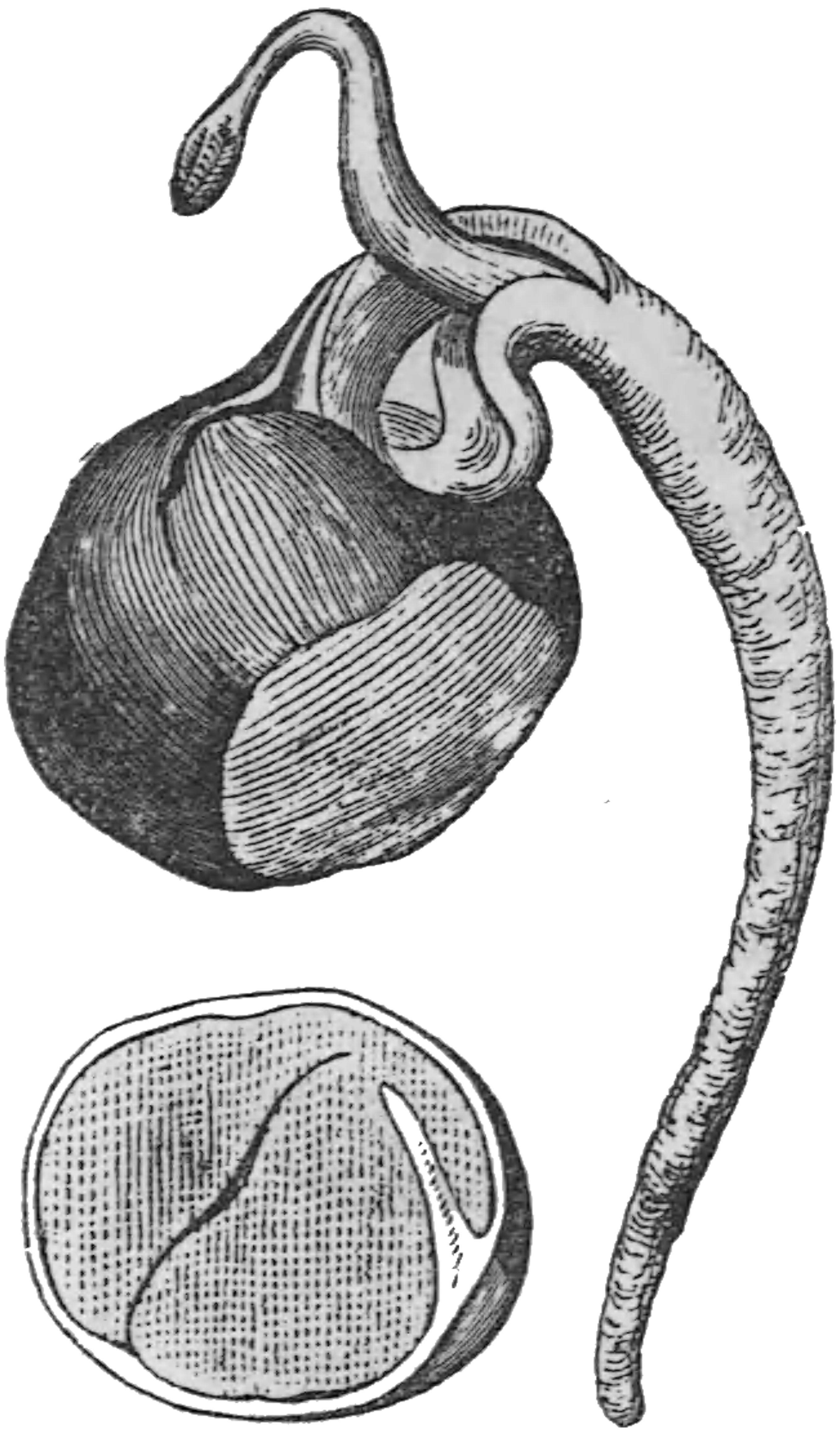
30. **Deposit of Food outside of the Embryo.** Very often the nourishment provided for the seedling plantlet is laid up, not *in* the embryo itself, but *around* it. A good instance to begin with is furnished by the common Morning-Glory, or Convolvulus. The embryo, taken out of the seed and straightened, is shown in Fig. 26. It consists of a short stemlet and of a pair of very thin and delicate green leaves, having no stock of nourishment in them for sustaining the

FIG. 21. An acorn divided lengthwise. 22. The germinating Oak.

earliest growth. On cutting open the seed, however, we find this embryo (considerably crumpled or folded together, so as to occupy less space, Fig. 25) to be surrounded by a mass of rich, mucilaginous matter (becoming rather hard and solid when dry), which forms the principal bulk of the seed. Upon this stock the embryo feeds in germination; the seed-leaves absorbing it into their tissue as it is rendered soluble (through certain chemical changes) and dissolved by the water which the germinating seed imbibes from the moist soil. Having by this aid lengthened its radicle into a stem of considerable length, and formed the beginning of a root at its lower end, already imbedded in the soil (Fig. 27), the cotyledons now disengage themselves from the seed-coats, and expand in the light as the first pair of leaves (Fig. 28). These immediately begin to elaborate, under the sun's influence, what the root imbibes from the soil, and the new nourishment so produced is used, partly to increase the size of the little stem, root, and leaves already existing, and partly to produce a second joint of stem with its leaf (Fig. 29), then a third with its leaf (Fig. 8); and so on.



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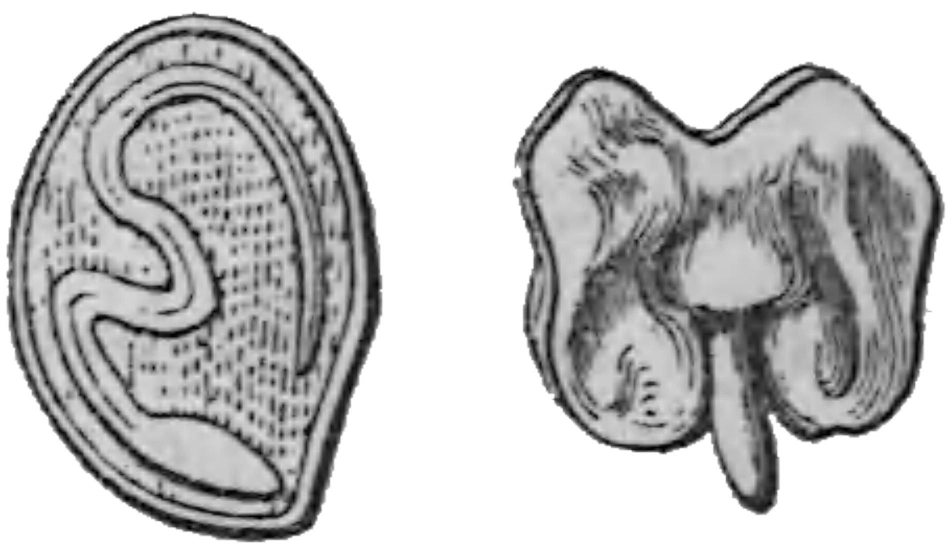

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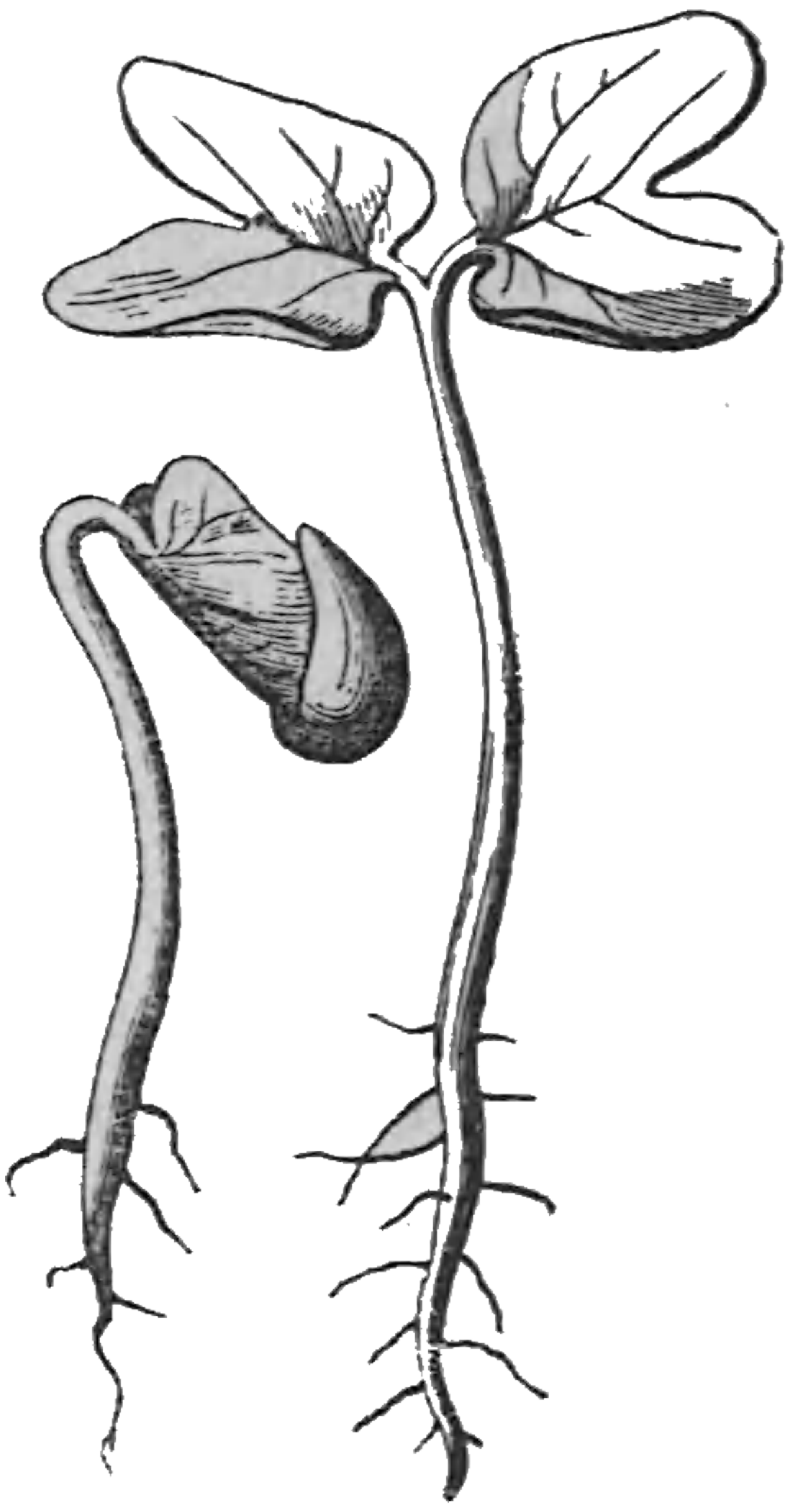


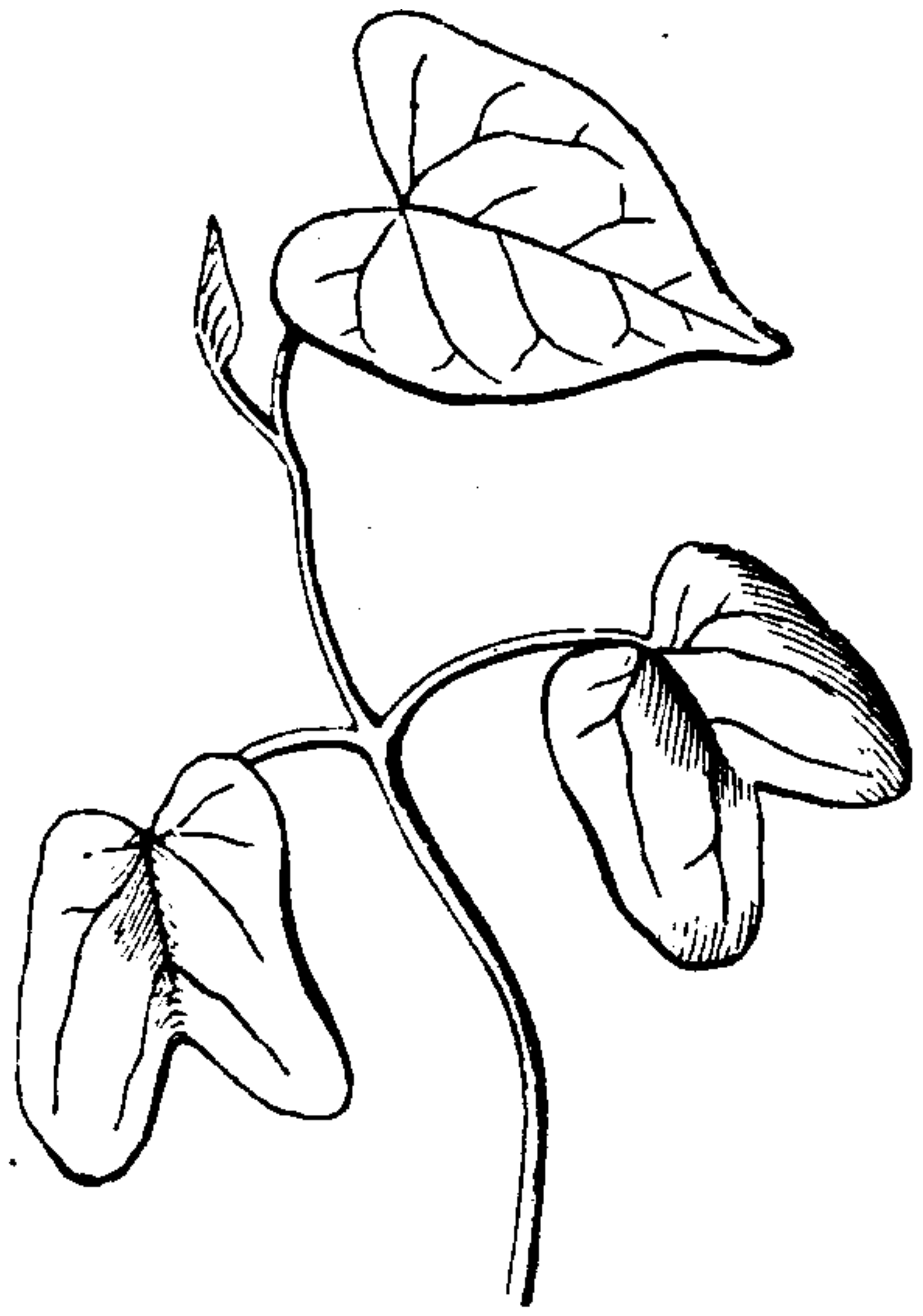
27 28

31. This maternal store of food, deposited in the seed along with the embryo (but not in its substance), the old botanists likened to

FIG. 23. Buckeye: a seed divided. 24. A similar seed in gemination.

FIG. 25. Seed and embryo of Morning-Glory, cut across. 26. Embryo of the same, detached and straightened. 27. Germinating Morning-Glory. 28. The same further advanced; its two thin seed-leaves expanded.

the *albumen*, or white of the egg, which encloses the yolk, and therefore gave it the same name,— the *albumen* of the seed,— a name which it still retains. Food of this sort for the plant is also food for animals, or for man; and it is this albumen, the floury part of the seed, which forms the principal bulk of such important grains as those of Indian Corn (Fig. 38 – 40), Wheat, Rice, Buckwheat, and of the seed of Four-o'clock, (Fig. 36, 37), and the like. In all these last-named cases, it may be observed that the embryo is not enclosed in the albumen, but placed on one side of it, yet in close contact with it, so that the embryo may absorb readily from it the nourishment it requires when it begins to grow. Sometimes the embryo is coiled around the outside, in the form of a ring, as in the Purslane and the Four-o'clock (Fig. 36, 37); sometimes it is coiled within the albumen, as in the Potato (Fig. 34, 35); sometimes it is straight in the centre of the albumen, occupying nearly its whole length, as in the Barberry (Fig. 32, 33), or much smaller and near one end, as in the Iris (Fig. 43); or sometimes so minute, in the midst of the albumen, that it needs a magnifying-glass to find it, as in the But-



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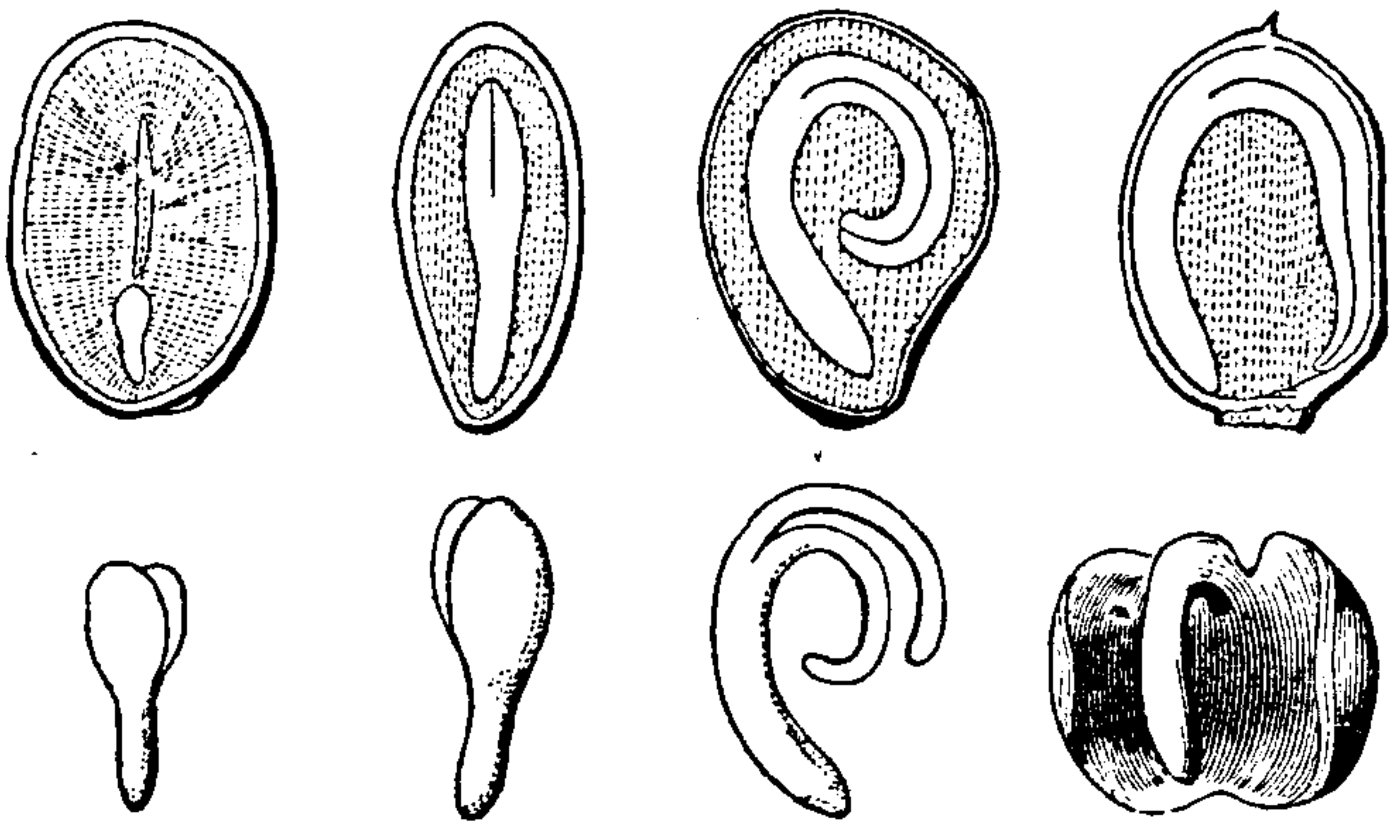

30 32 34 36

31 33 35 37

FIG. 29. Germination of the Morning Glory more advanced: the upper part only; showing the leafy cotyledons, the second joint of stem with its leaf, and the third with its leaf just developing.

FIG. 30. Section of a seed of a Peony, showing a very small embryo in the albumen, near one end. 31. This embryo detached, and more magnified.

FIG. 32. Section of a seed of Barberry, showing the straight embryo in the middle of the albumen. 33. Its embryo detached.

FIG. 34. Section of a Potato-seed, showing the embryo coiled in the albumen. 35. Its embryo detached.

FIG. 36. Section of the seed of Four-o'clock, showing the embryo coiled round the outside of the albumen. 37. Its embryo detached.

tercup or the Columbine, and in the Peony (Fig. 30, 31), where, however, it is large enough to be distinguished by the naked eye. Nothing is more curious than the various shapes and positions of the embryo in the seed, nor more interesting than to watch its development in germination. One point is still to be noticed, since the botanist considers it of much importance, namely: —

32. **The Kinds of Embryo as to the Number of Cotyledons.** In all the figures, it is easy to see that the embryo, however various in shape, is constructed on one and the same plan; — it consists of a radicle or stemlet, with a pair of cotyledons on its summit. Botanists therefore call it *dicotyledonous*, — an inconveniently long word to express the fact that the embryo has two cotyledons or seed-leaves. In many cases (as in the Buttercup), the cotyledons are indeed so minute, that they are discerned only by the nick in the upper end of the little embryo; yet in germination they grow into a pair of seed-leaves, just as in other cases where they are plain to be seen, as leaves, in the seed. But in Indian Corn (Fig. 40), in Wheat, the Onion, the Iris (Fig. 43), &c., it is well known that only one leaf appears at first from the sprouting seed: in these the embryo has only one cotyledon, and it is therefore termed by the botanists *monocotyledonous;* — an extremely long word, like the other, of Greek derivation, which means *one-cotyledoned.* The rudiments of one or more other leaves are, indeed, commonly present in this sort of embryo, as is plain to see in Indian Corn (Fig. 38 – 40), but they form a bud situated above or within the cotyledon, and enclosed by it more or less completely; so that they evidently belong to the plumule (16); and these leaves appear in the seedling plantlet, each from within its predecessor, and therefore originating higher up on the forming stem (Fig. 42, 44). This will readily be understood from the accompanying figures, with their explanation, which the student may without difficulty verify for him-

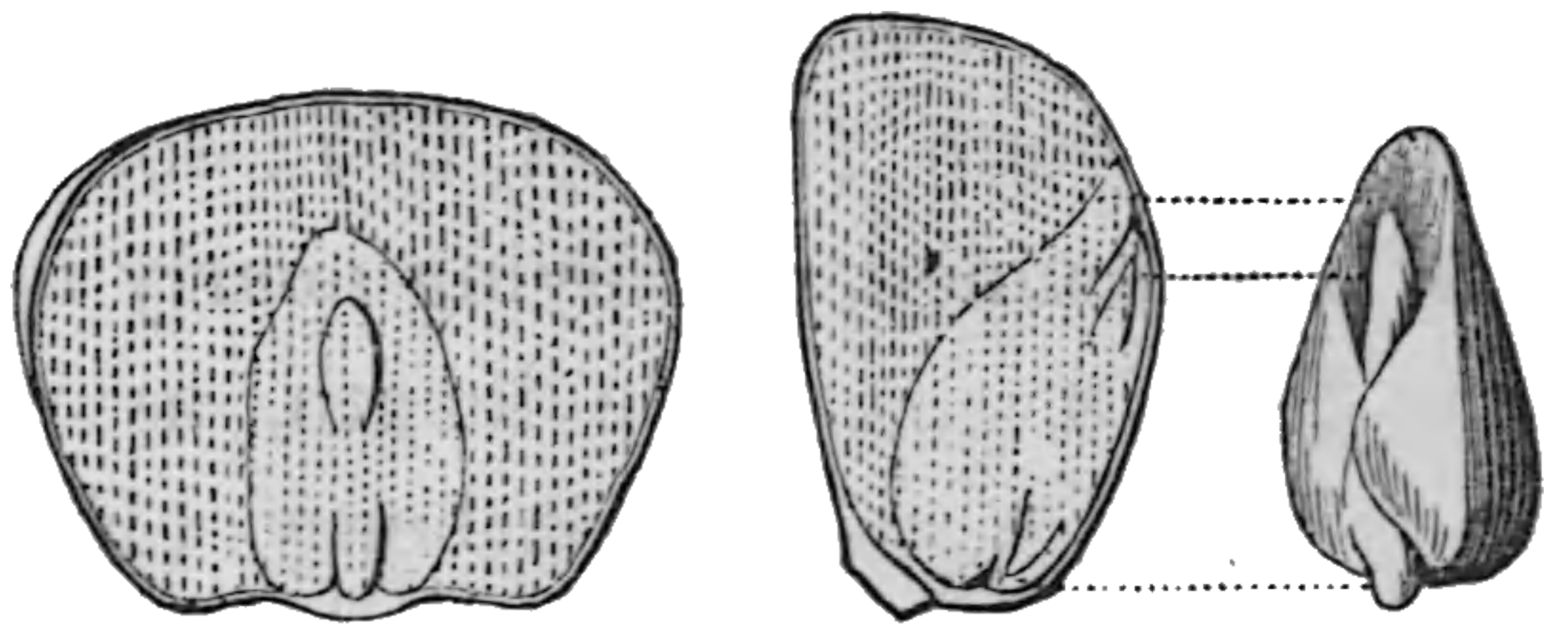

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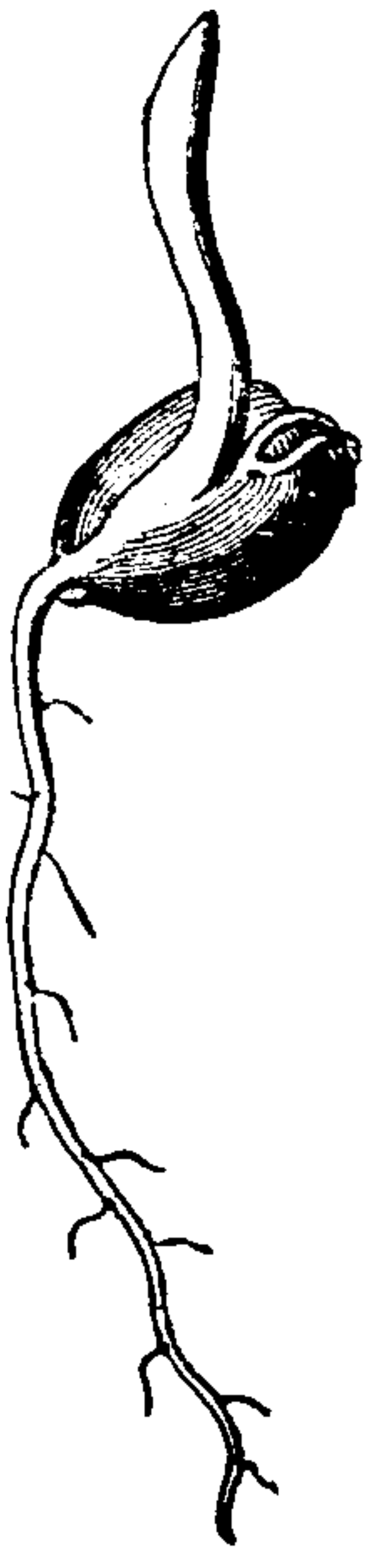
FIG. 38. A grain of Indian Corn, flatwise, cut away a little, so as to show the embryo, lying on the albumen, which makes the principal bulk of the seed.

FIG. 39. Another grain of Corn, cut through the middle in the opposite direction, dividing the embryo through its thick cotyledon and its plumule, the latter consisting of two leaves, one enclosing the other.

FIG. 40. The embryo of Corn, taken out whole: the thick mass is the cotyledon; the narrow body partly enclosed by it is the plumule; the little projection at its base is the very short radicle enclosed in the sheathing base of the first leaf of the plumule.

self, and should do so, by examining grains of Indian Corn, soaked in water, before and also during germination. In the Onion, Lily, and the Iris (Fig. 43), the monocotyledonous embryo is simpler, consisting apparently of a simple oblong or cylindrical body, in which no distinction of parts is visible: the lower end is *radicle*, and from it grows the root; the rest is a *cotyledon*, which has wrapped up in it a minute *plumule*, or bud, that shows itself when the seeds sprout in germination. The first leaf which appears above ground in all these cases is not the cotyledon. In all seeds with one cotyledon to the embryo, this remains in the seed, or at least its upper part, while its lengthening base comes out, so as to extricate the plumule, which shoots upward, and develops the first leaves of the plantlet. These appear one above or within the other in succession, — as is shown in Fig. 42 and Fig. 44, — the first commonly in the form of a little scale or imperfect leaf; the second or third and the following ones as the real, ordinary leaves of the plant. Meanwhile, from the root end of the embryo, a root (Fig. 41, 44), or soon a whole cluster of roots (Fig. 42), makes its appearance.



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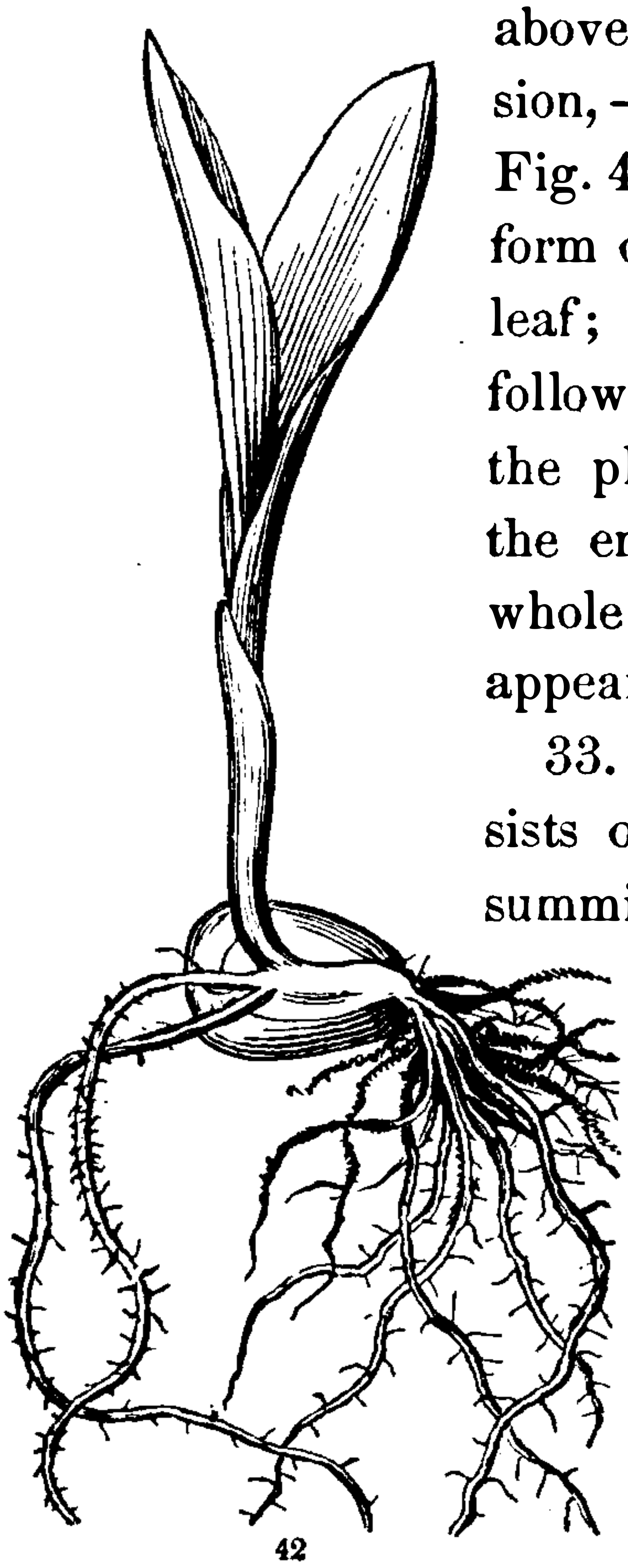
33. In Pines, and the like, the embryo consists of a radicle or stemlet, bearing on its summit three or four, or often from five to ten slender cotyledons, arranged in a circle (Fig. 45), and expanding at once into a circle of as many green leaves in germination (Fig. 46). Such embryos are said to be *polycotyledonous*, that is, as the word denotes, many-cotyledoned.



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34. **Plan of Vegetation.** The student who has understandingly followed the growth of the embryo in the seed into the seedling plantlet, — composed of a root, and a stem of two or three joints, each bearing a

FIG. 41. Grain of Indian Corn in germination.
FIG. 42. The same, further advanced.

leaf, or a pair (rarely a circle) of leaves, — will have gained a correct idea of the plan of vegetation in general, and have laid a good foundation for a knowledge of the whole structure and physiology of plants. For the plant goes on to grow in the same way throughout, by mere repetitions of what the early germinating plantlet displays to view, — of what was contained, in miniature or in rudiment, in the seed itself. So far as vegetation is concerned (leaving out of view for the present the flower and fruit), the full-grown leafy herb or tree, of whatever size, has nothing, and does nothing, which the seedling plantlet does not have and do. The whole mass of stem or trunk and foliage of the complete plant, even of the largest forest-tree, is composed of a succession or multiplication of similar parts, — one arising from the summit of another, — each, so to say, the offspring of the preceding and the parent of the next.

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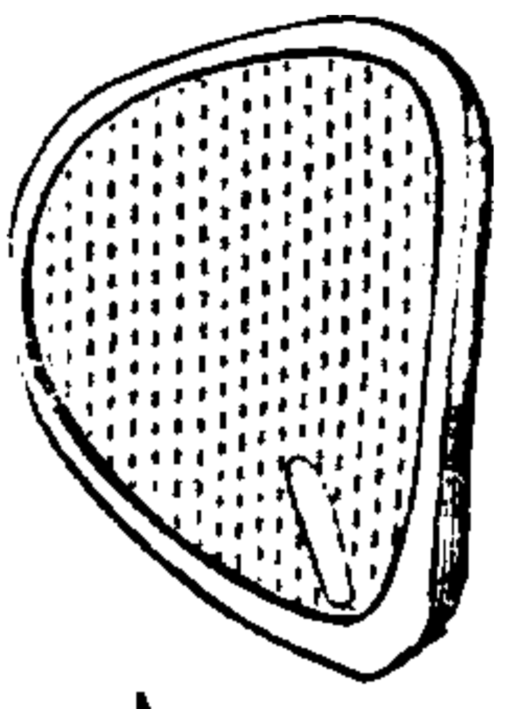

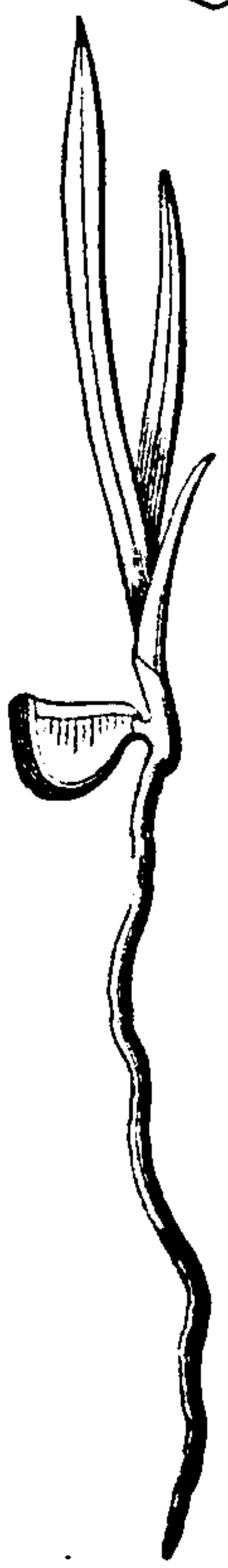

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35. In the same way that the earliest portions of the seedling stem, with the leaves they bear, are successively produced, so, joint by joint in direct succession, a single, simple, leafy stem is developed and carried up. Of such a simple leafy stem many a plant consists (before flowering, at least), — many herbs, such as Sugar-Cane, Indian Corn, the Lily, the tall Banana, the Yucca, &c.; and among trees the Palms and the Cycas (wrongly called Sago Palm) exhibit the same simplicity, their stems, of whatever age, being unbranched columns (Fig. 47). (Growth in diameter is of course to be considered, as well as growth in length. That, and the question *how* growth of any kind takes place, we will consider hereafter.) But more commonly, as soon as the plant has produced a main stem of a certain length, and displayed a certain amount of foliage, it begins to

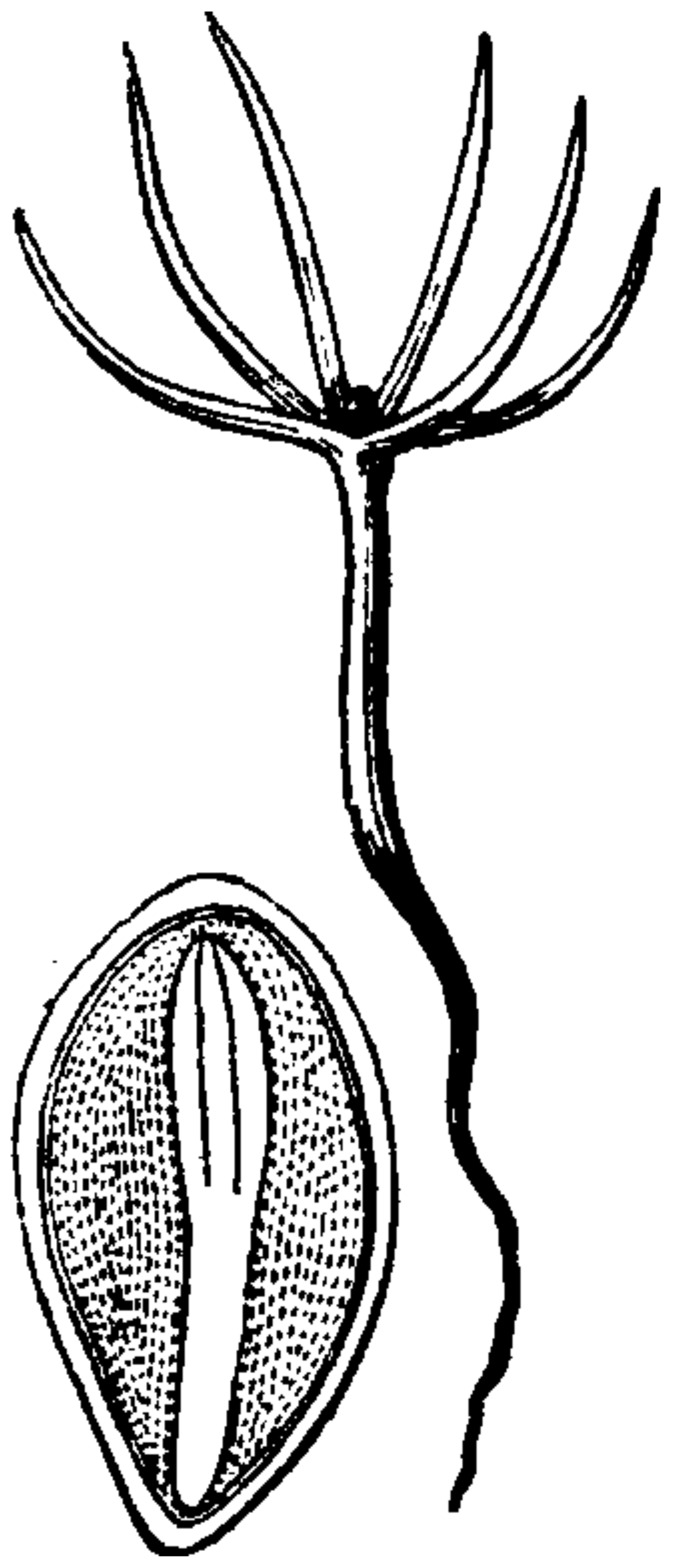

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FIG. 43. Section of a seed of the Iris, or Flower-de-Luce, showing its small embryo in the albumen, near the bottom.

FIG. 44. Germinating plantlet of the Iris.

FIG. 45. Section of a seed of a Pine, with its embryo of several cotyledons. 46. Early seedling Pine, with its stemlet, displaying its six seed-leaves.

LESSON IV.

THE GROWTH OF PLANTS FROM BUDS AND BRANCHES.

37. We have seen how the plant grows so as to produce a root, and a simple stem with its foliage. Both the root and stem, however, generally branch.

38. The branches of the root arise without any particular order. There is no telling beforehand from what part of a main root they will spring. But the branches of the stem, except in some extraordinary cases, regularly arise from a particular place. Branches or shoots in their undeveloped state are

39. **Buds.** These regularly appear in the *axils* of the leaves,—that is, in the angle formed by the leaf with the stem on the upper side; and as leaves are symmetrically arranged on the stem, the buds, and the branches into which the buds grow, necessarily partake of this symmetry.

40. We do not confine the name of bud to the scaly winter-buds which are so conspicuous on most of our shrubs and trees in winter and spring. It belongs as well to the forming branch of any herb, at its first appearance in the axil of a leaf. In growing, buds lengthen into branches, just as the original stem did from the plumule of the embryo (16) when the seed germinated. Only, while the original stem is implanted in the ground by its root, the branch is implanted on the stem. Branches, therefore, are repetitions of the main stem. They consist of the same parts,—namely, joints of stem and leaves,—growing in the same way. And in the axils of their leaves another crop of buds is naturally produced, giving rise to another generation of branches, which may in turn produce still another generation; and so on,—until the tiny and simple seedling develops into a tall and spreading herb or shrub; or into a massive tree, with its hundreds of annually increasing branches, and its thousands, perhaps millions, of leaves.

41. The herb and the tree grow in the same way. The difference is only in size and duration.

An *Herb* dies altogether, or dies down to the ground, after it has ripened its fruit, or at the approach of winter.

An *annual herb* flowers in the first year, and dies, root and all, after ripening its seed: Mustard, Peppergrass, Buckwheat, &c., are examples.

A *biennial herb* — such as the Turnip, Carrot, Beet, and Cabbage — grows the first season without blossoming, survives the winter, flowers after that, and dies, root and all, when it has ripened its seed.

A *perennial herb* lives and blossoms year after year, but dies down to the ground, or near it, annually, — not, however, quite down to the root: for a portion of the stem, with its buds, still survives; and from these buds the shoots of the following year arise.

A *Shrub* is a perennial plant, with woody stems which continue alive and grow year after year.

A *Tree* differs from a shrub only in its greater size.

42. **The Terminal Bud.** There are herbs, shrubs, and trees which do not branch, as we have already seen (35); but whose stems, even when they live for many years, rise as a simple shaft (Fig. 47). These plants grow by the continued evolution of a bud which crowns the summit of the stem, and which is therefore called the *terminal bud.* This bud is very conspicuous in many branching plants also; as on all the stems or shoots of Maples (Fig. 53), Horsechestnuts (Fig. 48), or Hickories (Fig. 49), of a year old. When they grow, they merely prolong the shoot or stem on which they rest. On these same shoots, however, other buds are to be seen, regularly arranged down their sides. We find them situated just over broad, flattened places, which are the scars left by the fall of the leaf-stalk the autumn previous. Before the fall of the leaf, they would have been seen to occupy their *axils* (39): so they are named

43 **Axillary Buds.** They were formed in these trees early in the summer. Occasionally they grow at the time into branches: at least, some of them are pretty sure to do so, in case the growing terminal bud at the end of the shoot is injured or destroyed. Otherwise they lie dormant until the spring. In many trees or shrubs (such for example as the Sumach and Honey-Locust) these axillary buds do not show themselves until spring; but if

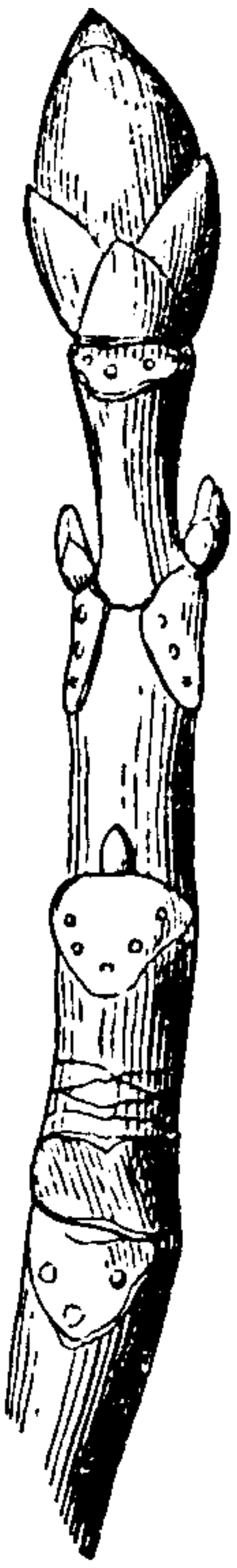
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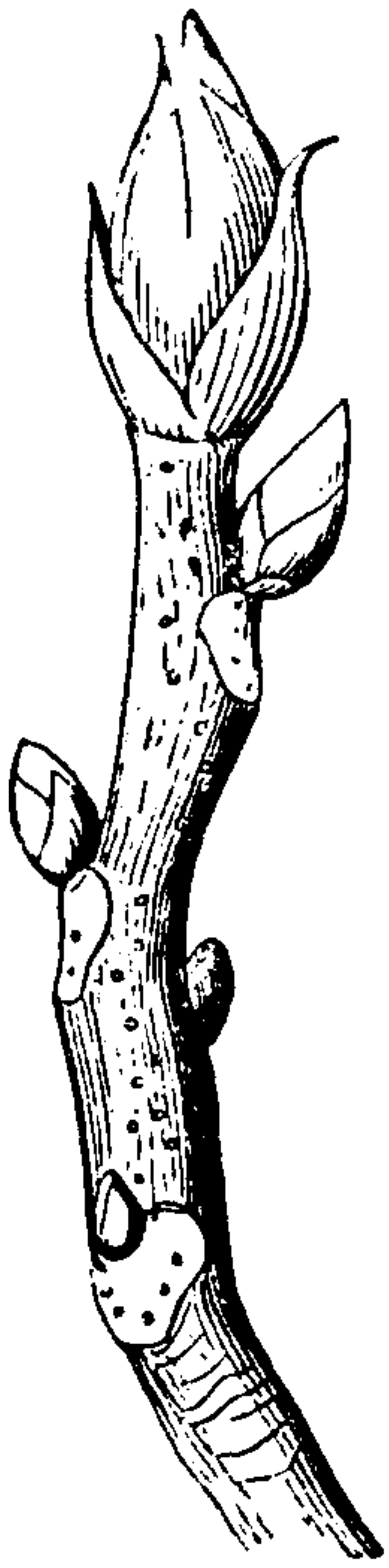
FIG. 48. Shoot of Horsechestnut, of one year's growth, taken in autumn after the leaves have fallen.

searched for, they may be detected, though of small size, hidden under the bark. Sometimes, although early formed, they are concealed all summer long under the base of the leaf-stalk, hollowed out into a sort of inverted cup, like a candle-extinguisher, to cover them; as in the Locust, the Yellow-wood, or more strikingly in the Button-wood or Plane-tree (Fig. 50).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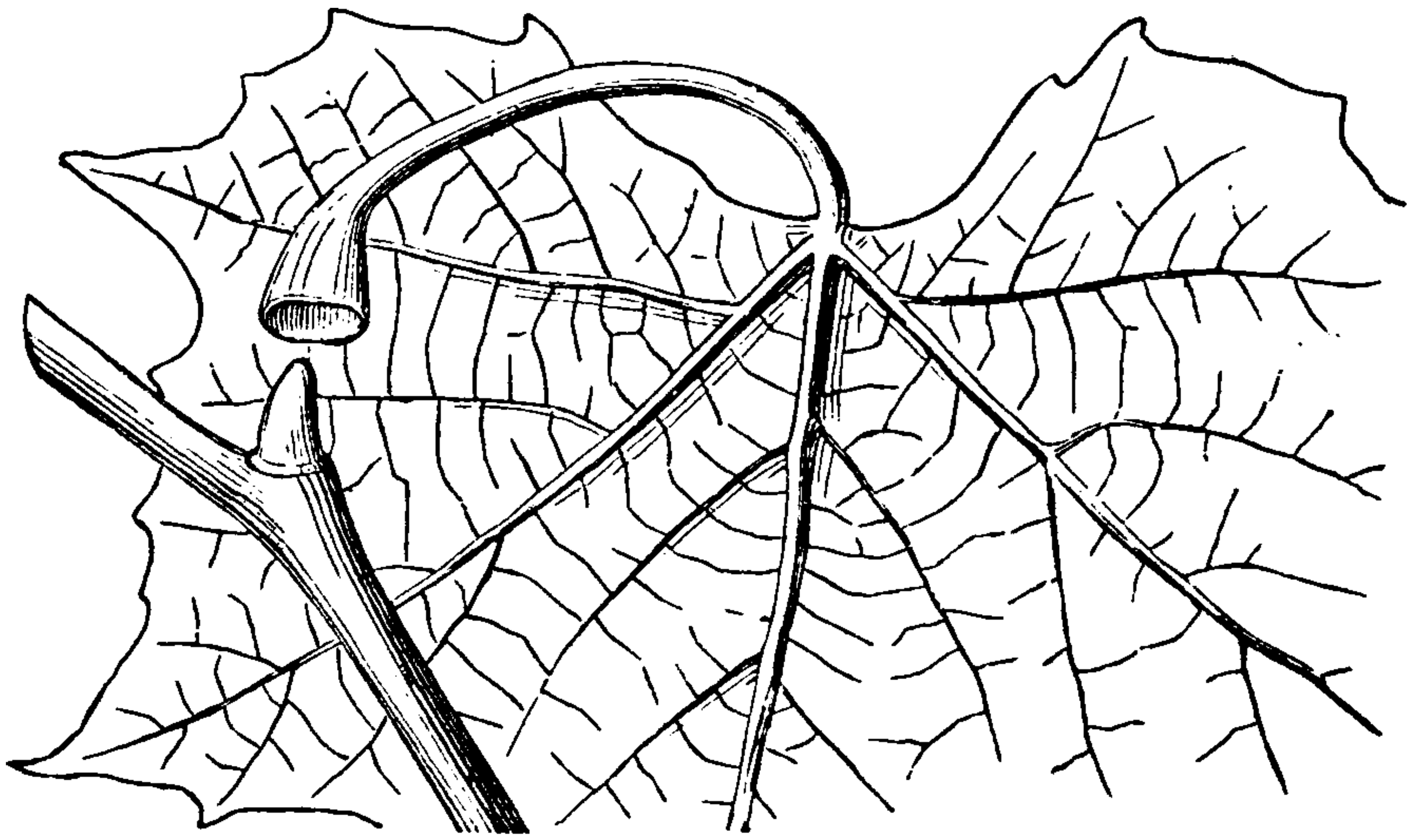
44. Such large and conspicuous buds as those of the Horsechestnut, Hickory, and the like, are *scaly;* the scales being a kind of imperfect leaves. The use of the bud-scales is obvious; namely, to protect the tender young parts beneath. To do this more effectually, they are often coated on the outside with a varnish which is impervious to wet, while within they, or the parts they enclose, are thickly clothed with down or wool; not really to keep out the cold of winter, which will of course penetrate the bud in time, but to shield the interior against sudden changes from warm to cold, or from cold to warm, which are equally injurious. Scaly buds commonly belong, as would be expected, to trees and shrubs of northern climates; while *naked* buds are usual in tropical regions, as well as in herbs everywhere which branch during the summer's growth and do not endure the winter.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45. But *naked buds*, or nearly naked, also occur in several of our own trees and shrubs; sometimes pretty large ones, as those of Hob-

FIG. 49. Annual shoot of the Shagbark Hickory.
FIG. 50. Bud and leaf of the ButtonWood, or American Plane-tree.

blebush (while those of the nearly-related Snowball or High Bush-Cranberry are scaly); but more commonly, when naked buds occur in trees and shrubs of our climate, they are small, and sunk in the bark, as in the Sumac; or even partly buried in the wood until they begin to grow, as in the Honey-Locust.

46. **Vigor of Vegetation from Buds.** Large and strong buds, like those of the Horsechestnut, Hickory, and the like, on inspection will be found to contain several leaves, or pairs of leaves, ready formed, folded and packed away in small compass, just as the seed-leaves are packed away in the seed: they even contain all the blossoms of the ensuing season, plainly visible as small buds. And the stems upon which these buds rest are filled with abundant nourishment, which was deposited the summer before in the wood or in the bark. Under the surface of the soil, or on it, covered with the fallen leaves of autumn, we may find similar strong buds of our perennial herbs, in great variety; while beneath are thick roots, rootstocks, or tubers, charged with a great store of nourishment for their use. As we regard these, we shall readily perceive how it is that vegetation shoots forth so vigorously in the spring of the year, and clothes the bare and lately frozen surface of the soil, as well as the naked boughs of trees, almost at once with a covering of the freshest green, and often with brilliant blossoms. Everything was prepared, and even formed, beforehand: the short joints of stem in the bud have only to lengthen, and to separate the leaves from each other so that they may unfold and grow. Only a small part of the vegetation of the season comes directly from the seed, and none of the earliest vernal vegetation. This is all from buds which have lived through the winter.

47. This growth from buds, in manifold variety, is as interesting a subject of study as the growth of the plantlet from the seed, and is still easier to observe. We have only room here to sketch the general plan; earnestly recommending the student to examine attentively their mode of growth in all the common trees and shrubs, when they shoot forth in spring. The growth of the terminal bud prolongs the stem or branch: the growth of axillary buds produces branches.

48. **The Arrangement of Branches** is accordingly the same as of axillary buds; and the arrangement of these buds is the same as that of the leaves. Now leaves are arranged in two principal ways: they are either *opposite* or *alternate.* Leaves are *opposite* when

there are two borne on the same joint of stem, as in the Horse-chestnut, Maple (Fig. 7), Honeysuckle (Fig. 132), Lilac, &c.; the two leaves in such cases being always *opposite* each other, that is, on exactly opposite sides of the stem. Here of course the buds in their axils are opposite, as we observe in Fig. 48, where the leaves have fallen, but their place is shown by the scars. And the branches into which the buds grow are likewise opposite each other in pairs.

49. Leaves are *alternate* when there is only one from each joint of stem, as in the Oak (Fig. 22), Lime-tree, Poplar, Buttonwood (Fig. 50), Morning-Glory (Fig. 8), — not counting the seed-leaves, which of course are opposite, there being a pair of them; also in Indian Corn (Fig. 42), and Iris (Fig. 44). Consequently the axillary buds are also alternate, as in Hickory (Fig. 49); and the branches they form alternate, — making a different kind of spray from the other mode, — one branch shooting on the one side of the stem and the next on some other. For in the alternate arrangement no leaf is on the same side of the stem as the one next above or next below it.

50. Branches, therefore, are arranged with symmetry; and the mode of branching of the whole tree may be foretold by a glance at the arrangement of the leaves on the seedling or stem of the first year. This arrangement of the branches according to that of the leaves is always plainly to be recognized; but the symmetry of branches is rarely complete. This is owing to several causes; mainly to one, viz.: —

51. It never happens that all the buds grow. If they did, there would be as many branches in any year as there were leaves the year before. And of those which do begin to grow, a large portion perish, sooner or later, for want of nourishment or for want of light. Those which first begin to grow have an advantage, which they are apt to keep, taking to themselves the nourishment of the stem, and starving the weaker buds.

52. In the Horsechestnut (Fig. 48), Hickory (Fig. 49), Magnolia, and most other trees with large scaly buds, the terminal bud is the strongest, and has the advantage in growth, and next in strength are the upper axillary buds: while the former continues the shoot of the last year, some of the latter give rise to branches, while the rest fail to grow. In the Lilac also, the upper axillary buds are stronger than the lower; but the terminal bud rarely

appears at all; in its place the uppermost pair of axillary buds grow, and so each stem branches every year into two; making a repeatedly two-forked ramification.

53. In these and many similar trees and shrubs, most of the shoots make a *definite annual growth*. That is, each shoot of the season develops rapidly from a strong bud in spring,—a bud which generally contains, already formed in miniature, all or a great part of the leaves and joints of stem it is to produce,—makes its whole growth in length in the course of a few weeks, or sometimes even in a few days, and then forms and ripens its buds for the next year's similar rapid growth.

54. On the other hand, the Locust, Honey-Locust, Sumac, and, among smaller plants, the Rose and Raspberry, make an *indefinite annual growth*. That is, their stems grow on all summer long, until stopped by the frosts of autumn or some other cause; consequently they form and ripen no terminal bud protected by scales, and the upper axillary buds are produced so late in the season that they have no time to mature, nor has the wood time to solidify and ripen. Such stems therefore commonly die at the top in winter, or at least all their upper buds are small and feeble; and the growth of the succeeding year takes place mainly from the lower axillary buds, which are more mature. Most of our perennial herbs grow in this way, their stems dying down to the ground every year: the part beneath, however, is charged with vigorous buds, well protected by the kindly covering of earth, ready for the next year's vegetation.

55. In these last-mentioned cases there is, of course, no single main stem, continued year after year in a direct line, but the trunk is soon lost in the branches; and when they grow into trees, these commonly have rounded or spreading tops. Of such trees with *deliquescent* stems,—that is, with the trunk dissolved, as it were, into the successively divided branches, the common American Elm (Fig. 54) furnishes a good illustration.

56. On the other hand, the main stem of Pines and Spruces, as it begins in the seedling, unless destroyed by some injury, is carried on in a direct line throughout the whole growth of the tree, by the development year after year of a terminal bud: this forms a single, uninterrupted shaft,—an *excurrent* trunk, which can never be confounded with the branches that proceed from it. Of such *spiry* or *spire-shaped* trees, the Firs or Spruces are the most perfect and

familiar illustrations (Fig. 54); but some other trees with strong terminal buds exhibit the same character for a certain time, and in a less marked degree.

57. **Latent Buds.** Some of the axillary buds grow the following year into branches; but a larger number do not (51). These do not necessarily die. Often they survive in a latent state for some years, visible on the surface of the branch, or are smaller and concealed under the bark, resting on the surface of the wood: and when at any time the other buds or branches happen to be killed, these older latent buds grow to supply their place; — as is often seen when the foliage and young shoots of a tree are destroyed by insects. The new shoots seen springing directly out of large stems may sometimes originate from such latent buds, which have preserved their life for years. But commonly these arise from

58. **Adventitious Buds.** These are buds which certain shrubs and trees produce anywhere on the surface of the wood, especially where it has been injured. They give rise to the slender twigs which often feather so beautifully the sides of great branches or trunks of our American Elms. They sometimes form on the root, which naturally is destitute of buds; and they are sure to appear on the trunks and roots of Willows, Poplars, and Chestnuts, when these are wounded or mutilated. Indeed Osier-Willows are *pollarded*, or cut off, from time to time, by the cultivator, for the purpose of producing a crop of slender adventitious twigs, suitable for basket-work. Such branches, being altogether irregular, of course interfere with the natural symmetry of the tree (50). Another cause of irregularity, in certain trees and shrubs, is the formation of what are called

59. **Accessory or Supernumerary Buds.** There are cases where two, three, or more buds spring from the axil of a leaf, instead of the single one which is ordinarily found there. Sometimes they are placed one over the other, as in the Aristolochia or Pipe-Vine, and in the Tartarian Honeysuckle (Fig. 51); also in the Honey-Locust, and in the Walnut and Butternut (Fig. 52), where the upper supernumerary bud is a good way out of the axil and above the others. And this is here stronger

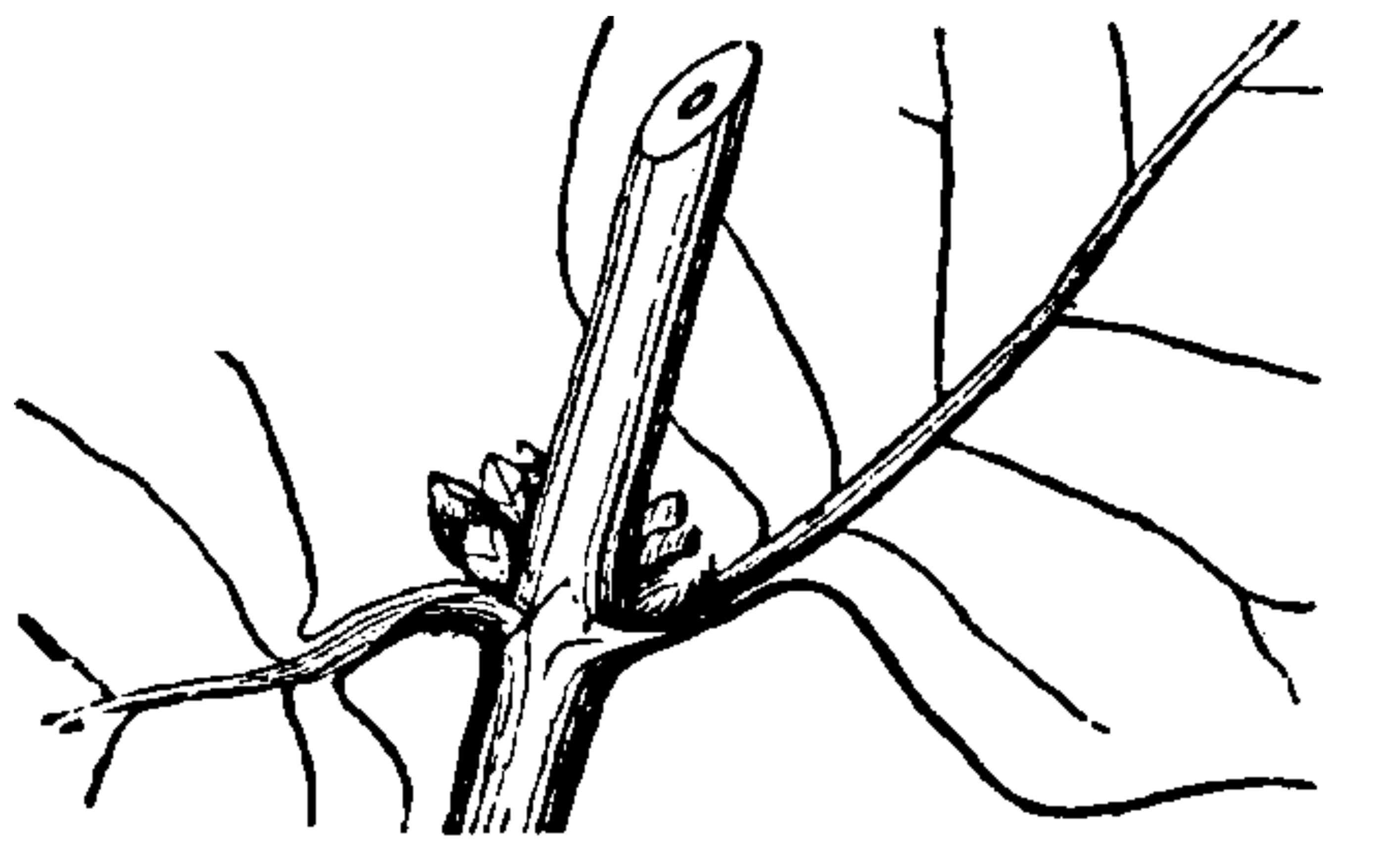

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FIG. 51. Tartarian Honeysuckle, with three accessory buds in one axil.

side-buds of the Red-Maple, or when they are undeveloped blossoms. These we shall have to consider hereafter.

Figure 54 represents a spreading-topped tree (American Elm), the stem dividing off into branches; and some spiry trees (Spruces on the right hand, and two of the Arbor-Vitæ on the left) with excurrent stems.

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LESSON V.

MORPHOLOGY (i.e. VARIOUS SORTS AND FORMS) OF ROOTS.

61. **Morphology**, as the name (derived from two Greek words) denotes, is the doctrine of forms. In treating of forms in plants, the botanist is not confined to an enumeration or description of the shapes or sorts that occur, — which would be a dull and tedious business, — but he endeavors to bring to view *the relations between one form and another;* and this is an interesting study.

62. Botanists give particular names to all the parts of plants, and also particular terms to express their principal varieties in form. They use these terms with great precision and advantage in describing the species or kinds of plants. They must therefore be defined and explained in our books. But it would be a great waste of time

for the young student to learn them by rote. The student should rather consider the connection between one form and another; and notice how the one simple plan of the plant, as it has already been illustrated, is worked out in the greatest variety of ways, through the manifold diversity of forms which each of its three organs of vegetation — root, stem, and leaf — is made to assume.

63. This we are now ready to do. That is, having obtained a general idea of vegetation, by tracing the plant from the seed and the bud into the herb, shrub, or tree, we proceed to contemplate the principal forms under which these three organs occur in different plants, or in different parts of the same plant; or, in other words, to study the *morphology* of the root, stem, and leaves.

64. Of these three organs, the root is the simplest and the least varied in its modifications. Still it exhibits some widely different kinds. Going back to the beginning, we commence with

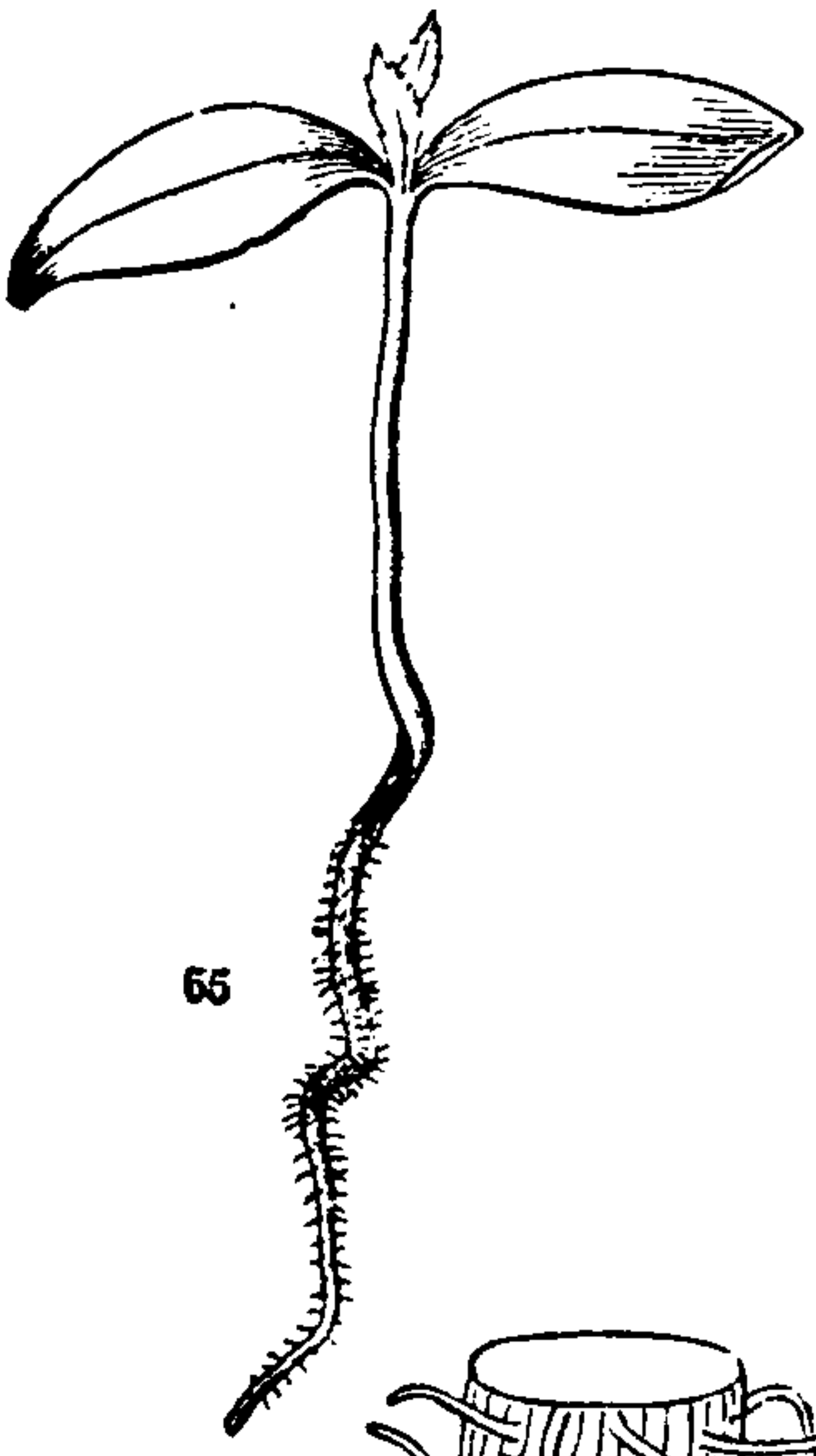
65. **The simple Primary Root,** which most plants send down from the root-end of the embryo as it grows from the seed; as we have seen in the Maple (Fig 5 – 7), Morning-Glory (Fig. 8 and 28), Beech (Fig. 14, 15), Oak and Buckeye (Fig. 22 – 24), &c. This, if it goes on to grow, makes a *main* or *tap* root, from which side-branches here and there proceed. Some plants keep this main root throughout their whole life, and send off only small side branches; as in the Carrot (Fig. 58) and Radish (Fig. 59): and in some trees, like the Oak, it takes the lead of the side-branches for many years, unless accidentally injured, as a strong tap-root. But commonly the main root divides off very soon, and is lost in the branches. We have already seen, also, that there may be at the beginning

66. **Multiple Primary Roots.** We have noticed them in the Pumpkin (Fig. 10), in the Pea (Fig. 20), and in Indian Corn (Fig. 42). That is, several roots have started all at once, or nearly so, from the seedling stem, and formed a bundle or cluster (a *fascicled* root, as it is called), in place of one main root. The Bean, as we observe in Fig. 18, begins with a main root, but some of its branches soon overtake it, and a cluster of roots is formed.

67. **Absorption of Moisture by Roots.** The branches of roots as they grow commonly branch again and again, into smaller roots or *rootlets;* in this way very much increasing the surface by which the plant connects itself with the earth, and absorbs moisture from it. The whole surface of the root absorbs, so long as it is fresh and new; and the newer the roots and rootlets are, the more freely do they

imbibe. Accordingly, as long as the plant grows above ground, and expands fresh foliage, from which moisture much of the time largely escapes into the air, so long it continues to extend and multiply its roots in the soil beneath, renewing and increasing the fresh surface for absorbing moisture, in proportion to the demand from above. And when growth ceases above ground, and the leaves die and fall, or no longer act, then the roots generally stop growing, and their soft and tender tips harden. From this period, therefore, until growth begins anew the next spring, is the best time for transplanting; especially for trees and shrubs, and herbs so large that they cannot well be removed without injuring the roots very mnch.

68. We see, on considering a moment, that an herb or a tree consists of two great surfaces, with a narrow part or trunk between them, — one surface spread out in the air, and the other in the soil. These two surfaces bear a certain proportion to each other; and the upper draws largely on the lower for moisture. Now, when the leaves fall from the tree in autumn, the vast surface exposed to the air is reduced to a very small part of what it was before; and the remainder, being covered with a firm bark, cannot lose much by evaporation. In common herbs the whole surface above ground perishes in autumn; and many of the rootlets die at the same time, or soon afterwards. So that the living vegetable is reduced for the time to the smallest compass, — to the thousandth or hundred-thousandth part of what it was shortly before, — and what remains alive rests in a dormant state, and may now be transplanted without much danger of harm. If any should doubt whether there is so great a difference between the summer and the winter size of plants, let them compare a lily-bulb with the full-grown Lily, or calculate the surface of foliage which



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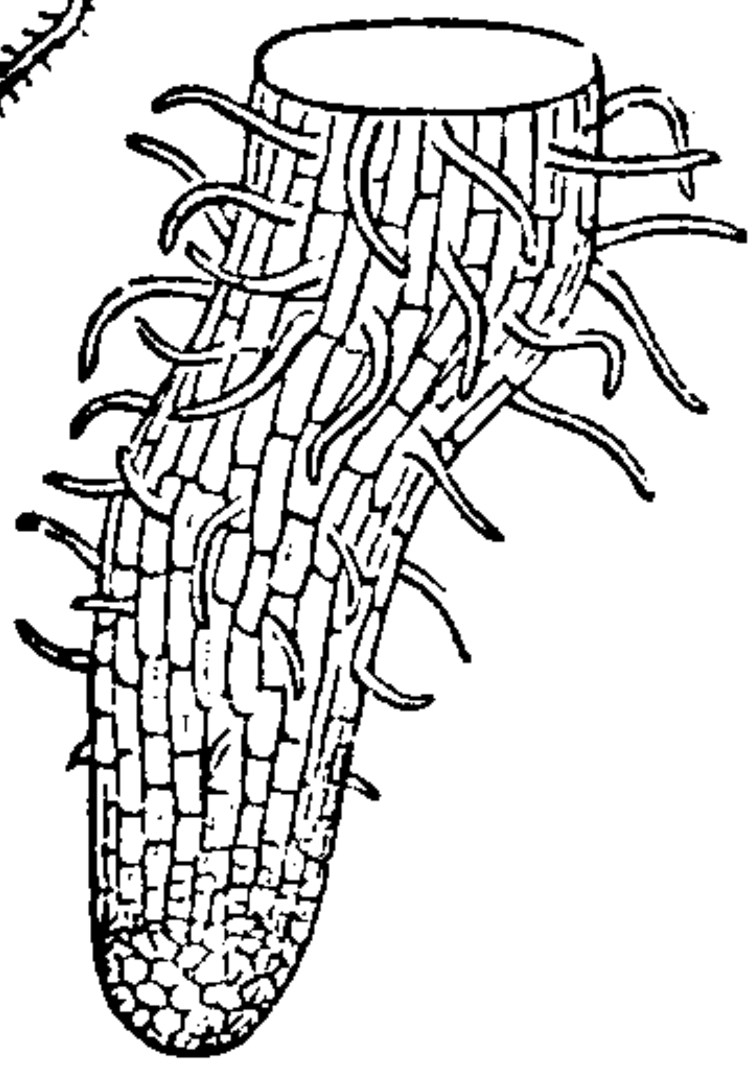

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FIG. 55. Seedling Maple, of the natural size, showing the root-hairs. 56. A bit of the end of the root magnified.

a tree exposes to the air, as compared with the surface of its twigs.

69. The absorbing surface of roots is very much greater than it appears to be, on account of the root-hairs, or slender fibrils, which abound on the fresh and new parts of roots. These may be seen with an ordinary magnifying-glass, or even by the naked eye in many cases; as in the root of a seedling Maple (Fig. 55), where the surface is thickly clothed with them. They are not rootlets of a smaller sort; but, when more magnified, are seen to be mere elongations of the surface of the root into slender tubes, which through their very delicate walls imbibe moisture from the soil with great avidity. They are commonly much longer than those shown in Fig. 56, which represents only the very tip of a root moderately magnified. Small as they are individually, yet the whole amount of absorbing surface added to the rootlets by the countless numbers of these tiny tubes is very great.

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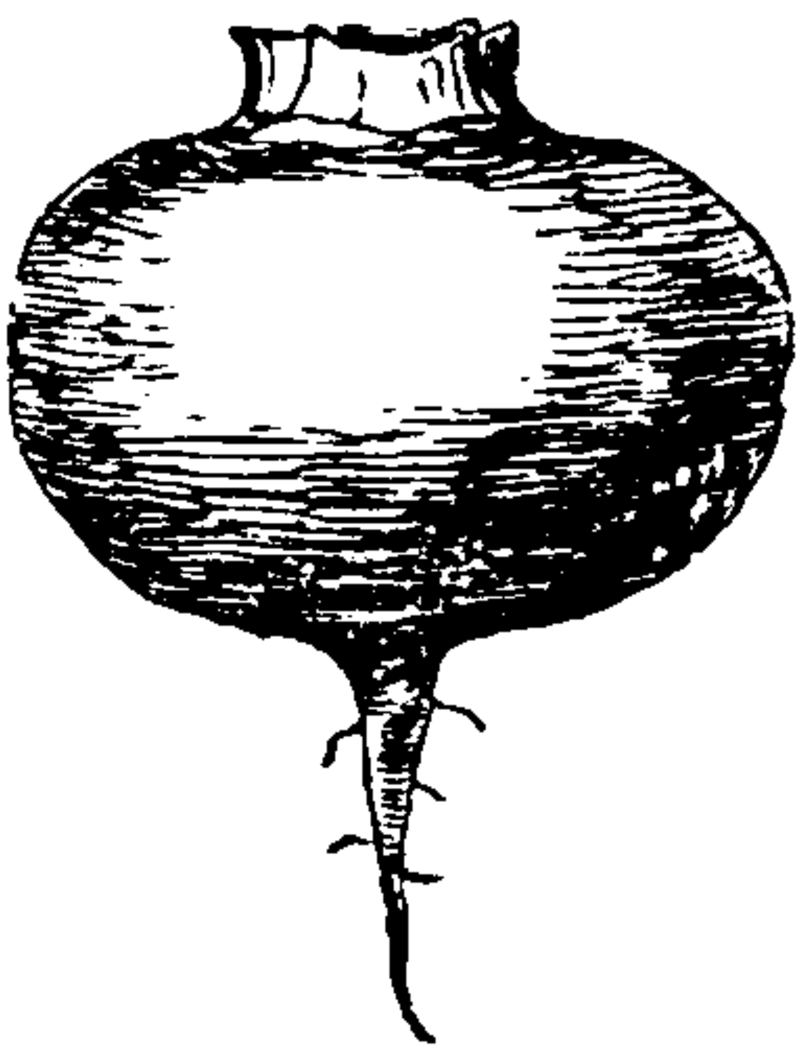

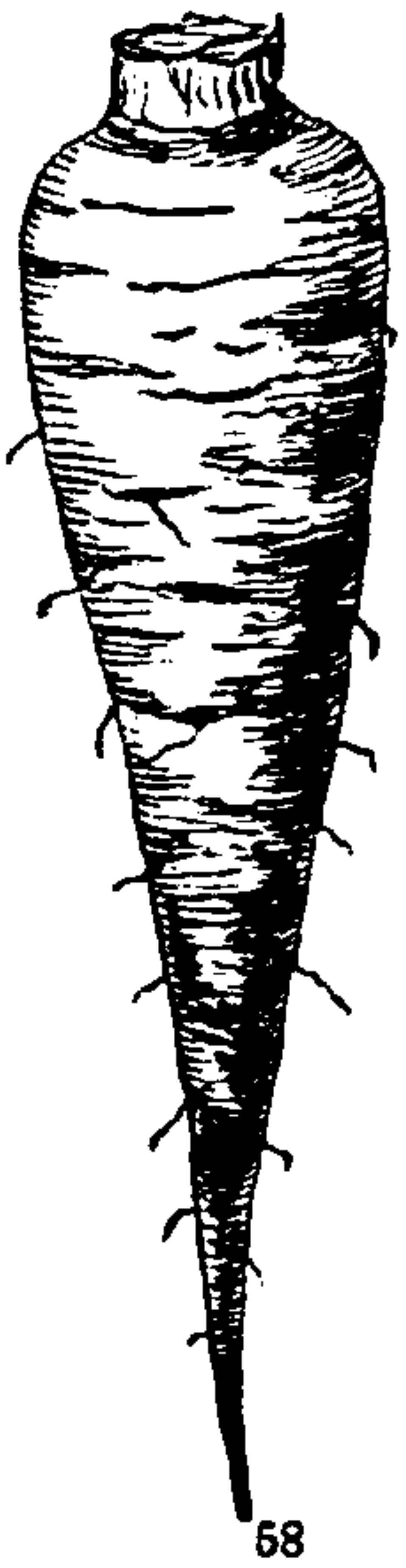

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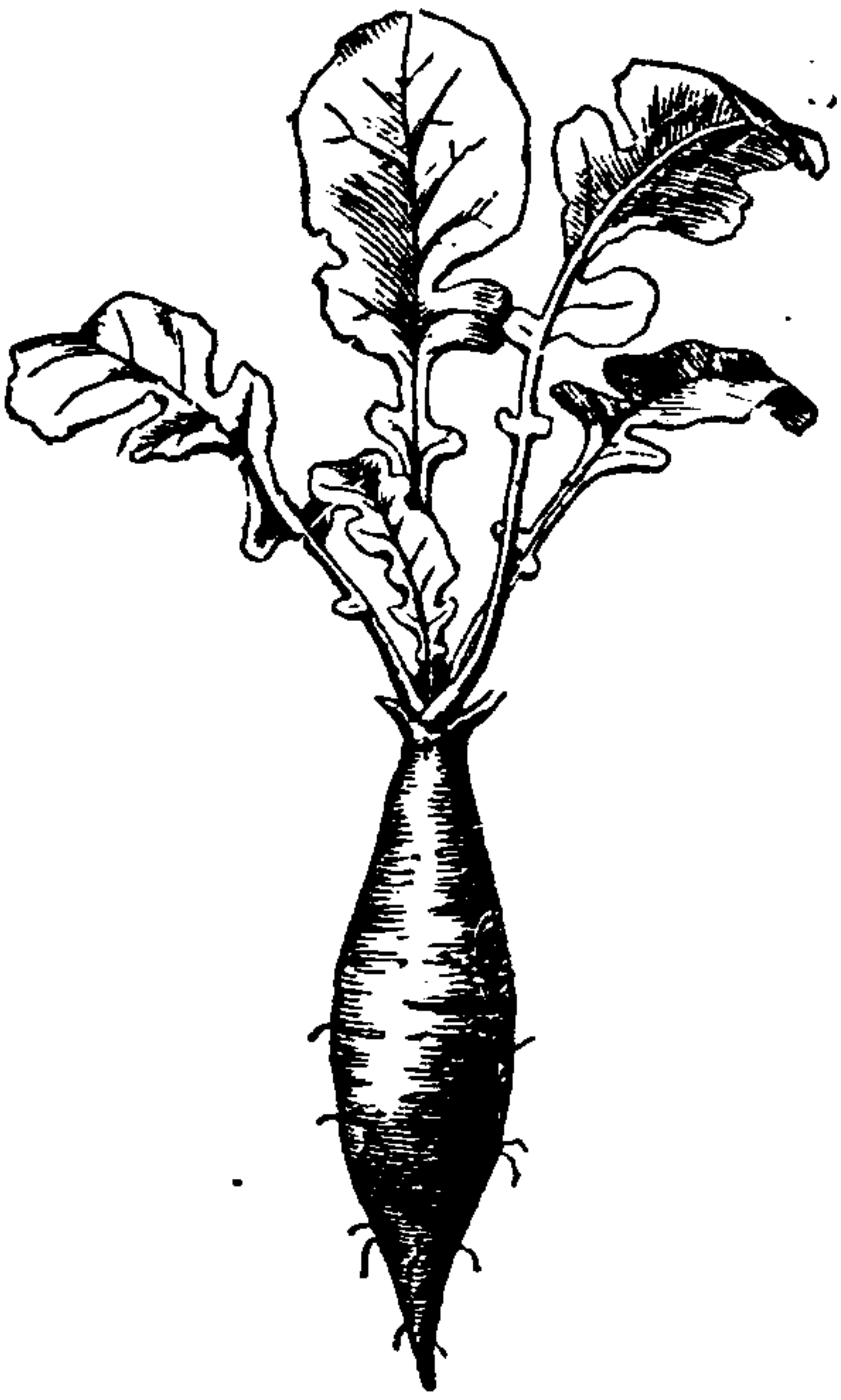

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70. Roots intended mainly for absorbing branch freely, and are slender or thread-like. When the root is principally of this character it is said to be *fibrous;* as in Indian Corn (Fig. 42), and other grain, and to some extent in all annual plants (41).

71. **The Root as a Storehouse of Food** In biennial and many perennial herbs (41), the root answers an additional purpose. In the course of the season it becomes a storehouse of nourishment, and enlarges or thickens as it receives the accumulation. Such roots are said to be *fleshy;* and different names are applied to them according to

FIG. 57 58, 59. Forms of fleshy or thickened roots.

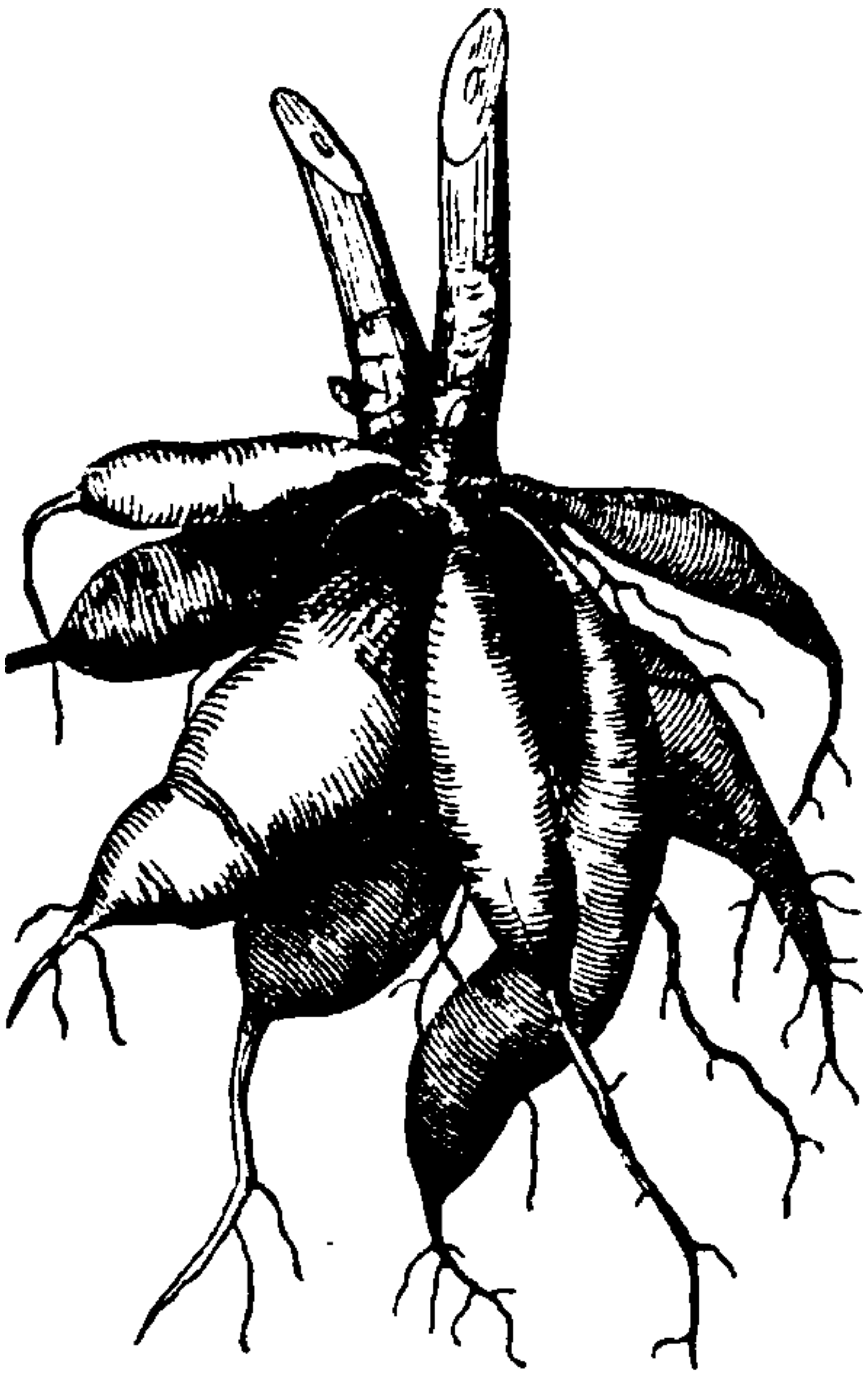
their shapes. We may divide them all into two kinds; 1st, those consisting of one main root, and 2d, those without any main root.

72. The first are merely different shapes of the *tap-root*; which is

Conical, when it thickens most at the crown, or where it joins the stem, and tapers regularly downwards to a point, as in the Common Beet, the Parsnip, and Carrot (Fig. 58):

Turnip-shaped or *napiform*, when greatly thickened above; but abruptly becoming slender below; as the Turnip (Fig. 57): and,

Spindle-shaped, or *fusiform*, when thickest in the middle and tapering to both ends; as the common Radish (Fig. 59).



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73. In the second kind, where there is no main root, the store of nourishing matter may be distributed throughout the branches or cluster of roots generally, or it may be accumulated in some of them, as we see in the *tuberous* roots of the Sweet Potato, the common Peony, and the Dahlia (Fig. 60).

74. All but the last of these illustrations are taken from *biennial* plants. These grow with a large tuft of leaves next the ground, and accumulate nourishment all the first summer, and store up all they produce beyond what is wanted at the time in their great root, which lives over the winter. We know very well what use man and other animals make of this store of food, in the form of starch, sugar, jelly, and the like. From the second year's growth we may learn what use the plant itself makes of it. The new shoots then feed upon it, and use it to form with great rapidity branches, flower-stalks, blossoms, fruit, and seed; and, having used it up, the whole plant dies when the seeds have ripened.

75. In the same way the nourishment contained in the separate tuberous roots of the Sweet Potato and the Dahlia (Fig 60) is fed upon in the spring by the buds of the stem they belong to; and as they are emptied of their contents, they likewise die and decay. But meanwhile similar stores of nourishment, produced by the second year's vegetation, are deposited in new roots, which live through the

FIG. 60. Clustered tuberous roots of the Dahlia, with the bottom of the stem they belong to.

next winter, and sustain the third spring's growth, and so on; — these plants being *perennial* (41), or lasting year after year, though each particular root lives little more than one year.

76. Many things which commonly pass for roots are not really roots at all. Common potatoes are tuberous parts of stems, while sweet potatoes are roots, like those of the Dahlia (Fig. 60). The difference between them will more plainly appear in the next Lesson.

77. **Secondary Roots.** So far we have considered only the original or primary root, — that which proceeded from the lower end of the first joint of stem in the plantlet springing from the seed, — and its subdivisions. We may now remark, that any other part of the stem will produce roots just as well, whenever favorably situated for it; that is, when covered by the soil, which provides the darkness and the moisture which is congenial to them. For these *secondary* roots, as they may be called, partake of the ordinary disposition of the organ: they avoid the light, and seek to bury themselves in the ground. In Indian Corn we see roots early striking from the second and the succeeding joints of stem under ground, more abundantly than from the first joint (Fig. 42). And all stems that keep up a connection with the soil — such as those which creep along on or beneath its surface — are sure to strike root from almost every joint. So will most branches when bent to the ground, and covered with the soil: and even cuttings from the branches of most plants can be made to do so, if properly managed. Propagation by buds depends upon this. That is, a piece of a plant which has stem and leaves, either developed or in the bud, may be made to produce roots, and so become an independent plant.

78. In many plants the disposition to strike root is so strong, that they even will spring from the stem above ground. In Indian Corn, for example, it is well known that roots grow, not only from all those joints round which the earth is heaped in hoeing, but also from those several inches above the soil: and other plants produce them from stems or branches high in the air. Such roots are called

79. **Aerial Roots.** All the most striking examples of these are met with, as we might expect, in warmer and damper climates than ours, and especially in deep forests which shut out much of the light; this being unfavorable to roots. The Mangrove of tropical shores, which occurs on our own southern borders; the Sugar Cane, from which roots strike just as in Indian Corn, only from higher up the stem; the Pandanus, called Screw Pine (not from its resemblance to a

Pine-tree, but because it is like a Pine-apple plant); and the famous Banyan of India, and some other Fig-trees, furnish the most remarkable examples of roots, which strike from the stem or the branches in the open air, and at length reach the ground, and bury themselves, when they act in the same manner as ordinary roots.

80. Some of our own common plants, however, produce small *aerial rootlets;* not for absorbing nourishment, but for climbing. By these rootlets, that shoot out abundantly from the side of the stems and branches, the Trumpet Creeper, the Ivy of Europe, and our Poison Rhus, — here called Poison Ivy, — fasten themselves firmly to walls, or the trunks of trees, often ascending to a great height. Here roots serve the same purpose that tendrils do in the Grape-Vine and Virginia Creeper. Another form, and the most aerial of all roots, since they never reach the ground, are those of

81. **Epiphytes, or Air-Plants.** These are called by the first name (which means growing on plants), because they are generally found upon the trunks and branches of trees; — not that they draw any nourishment from them, for their roots merely adhere to the bark, and they flourish just as well upon dead wood or any other convenient support. They are called *air-plants* because they really live altogether upon what they get from the air, as they have no connection with the soil. Hundreds of air-plants grow all around us without attracting any attention, because they are small or humble. Such are the Lichens and Mosses that abound on the trunks or boughs of trees, especially on the shaded side, and on old walls, fences, or rocks, from which they obtain no nourishment. But this name is commonly applied only to the larger, flower-bearing plants which live in this way. These belong to warm and damp parts of the world, where there is always plenty of moisture in the air. The greater part belong to the Orchis family and to the Pine-Apple family; and among them are some of the handsomest flowers known. We have two or three flowering air-plants in the Southern States, though they are not showy ones. One of them is an Epidendrum growing on the boughs of the Great-flowered Magnolia: another is the Long-Moss, or Black Moss, so called, — although it is no Moss at all, — which hangs from the branches of Oaks and Pines in all the warm parts of the Southern States. (Fig 61 represents both of these. The upper is the Epidendrum conopseum; the lower, the Black Moss, Tillandsia usneoides.)

82. **Parasitic Plants** exhibit roots under yet another remarkable

LESSON VI.

MORPHOLOGY OF STEMS AND BRANCHES.

83. THE growth of the stem in length, and the formation o branches, have been considered already. Their growth in thickness we may study to more advantage in a later Lesson. The very various forms which they assume will now occupy our attention,— beginning with

84. **The Forms of Stems and Branches above ground.** The principal differences as regards size and duration have been mentioned before (41); namely, the obvious distinction of plants into herbs, shrubs, and trees, which depends upon the duration and size of the stem. The stem is accordingly

Herbaceous, when it dies down to the ground every year, or after blossoming.

Suffrutescent, when the bottom of the stem above the soil is a little woody, and inclined to live from year to year.

Suffruticose, when low stems are decidedly woody below, but herbaceous above.

Fruticose, or *shrubby*, when woody, living from year to year, and of considerable size,— not, however, more than three or four times the height of a man.

Arborescent, when tree-like in appearance, or approaching a tree in size.

Arboreous, when forming a proper tree trunk.

85. When the stem or branches rise above ground and are apparent to view, the plant is said to be *caulescent* (that is, to have a *caulis* or true stem). When there is no evident stem above ground, but only leaves or leaf-stalks and flower-stalks, the plant is said to be *acaulescent*, i. e. *stemless*, as in the Crocus, Bloodroot, common Violets, &c., and in the Beet, Carrot, and Radish (Fig. 59), for the first season. There is a stem, however, in all such cases, only it remains on or beneath the ground, and is sometimes very short. Of course leaves and flowers do not arise from the root. These concealed sorts of stem we will presently study.

86. The direction taken by stems, &c., or their mode of growth,

gives rise to several terms, which may be briefly mentioned: — such as

Diffuse, when loosely spreading in all directions.

Declined, when turned or bending over to one side.

Decumbent, reclining on the ground, as if too weak to stand.

Assurgent or *ascending*, when rising obliquely upwards.

Procumbent or *prostrate*, lying flat on the ground from the first.

Creeping, or *repent*, when prostrate stems on or just beneath the ground strike root as they grow; as does the White Clover, the little Partridge-berry, &c.

Climbing, or *scandent*, when stems rise by clinging to other objects for support, — whether by *tendrils*, as do the Pea, Grape-Vine, and Virginia Creeper (Fig. 62); by their twisting leaf-stalks, as the Virgin's Bower; or by rootlets, like the Ivy, Poison Ivy, and Trumpet Creeper (80).

Twining, or *voluble*, when stems rise by coiling themselves spirally around other stems or supports; like the Morning-Glory and the Bean.

87. Certain forms of stems have received distinct names. The jointed stem of Grasses and Sedges is called by botanists a *culm*; and the peculiar scaly trunk of Palms and the like (Fig. 47) is sometimes called a *caudex*. A few forms of branches the gardener distinguishes by particular names; and they are interesting from their serving for the natural propagation of plants from buds, and for suggesting ways by which we artificially multiply plants that would not propagate themselves without the gardener's aid. These are *suckers*, *offsets*, *stolons*, and *runners*.

88. **Suckers** are ascending branches rising from stems under ground, such as are produced so abundantly by the Rose, Raspberry, and other plants said to multiply "by the root." If we uncover them, we see at once the great difference between these subterranean branches and real roots. They are only creeping branches under ground. Remarking how the upright shoots from these branches become separate plants, simply by the dying off of the connecting under-ground stems, the gardener expedites the result by cutting them through with his spade. That is, he propagates the plant "by division."

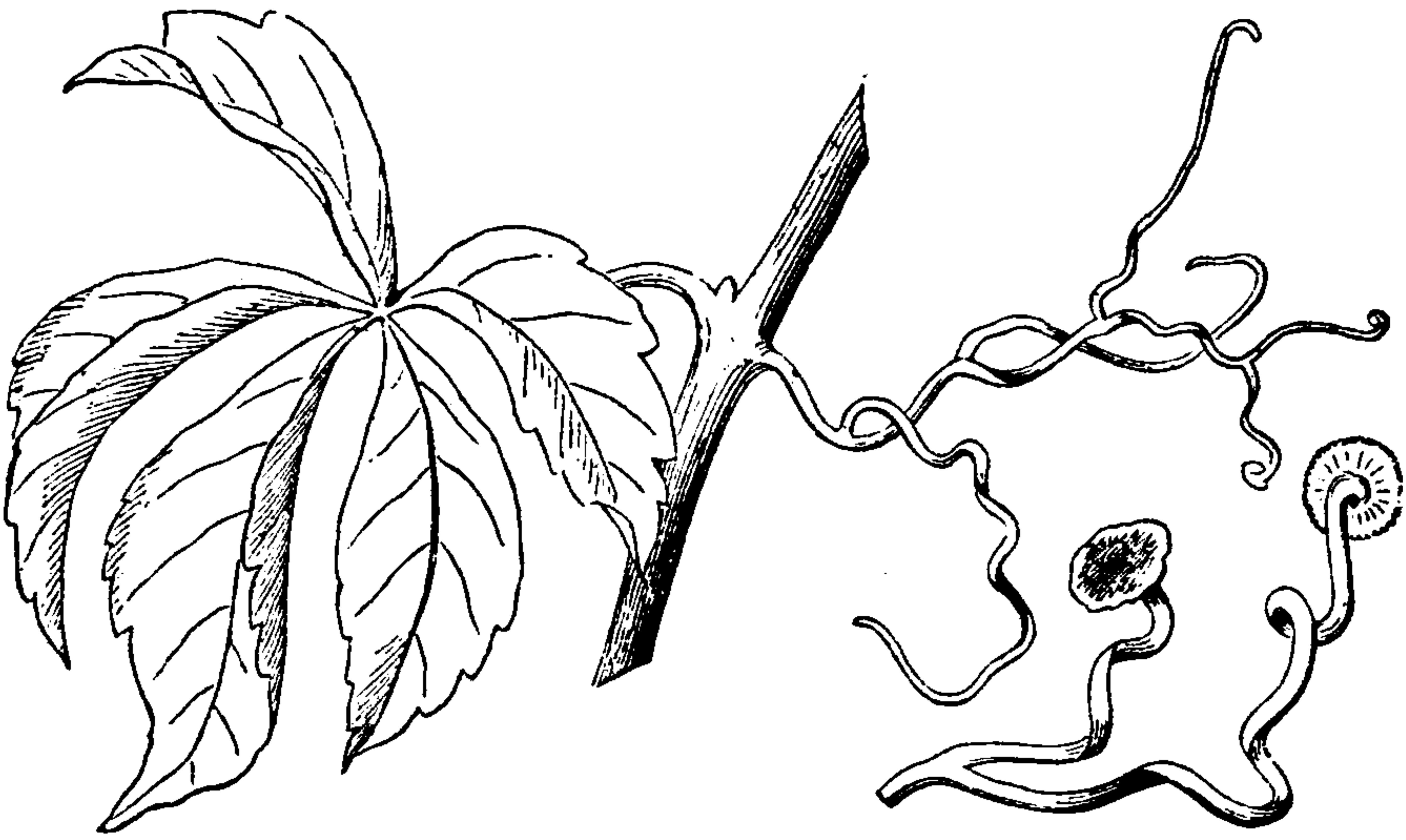
89. **Stolons** are trailing or reclining branches above ground, which strike root where they touch the soil, and then send up a vigorous shoot, which has roots of its own, and becomes an independent plant when the connecting part dies, as it does after a while. The Currant

and the Gooseberry naturally multiply in this way, as well as by suckers (which we see are just the same thing, only the connecting part is concealed under ground). They must have suggested the operation of *layering*, or bending down and covering with earth branches which do not naturally make stolons; and after they have taken root, as they almost always will, the gardener cuts through the connecting stem, and so converts a rooting branch into a separate plant.

90. **Offsets,** like those of the Houseleek, are only short stolons, with a crown of leaves at the end.

91. **Runners,** of which the Strawberry presents the most familiar example, are a long and slender, tendril-like, leafless form of creeping branches. Each runner, after having grown to its full length, strikes root from the tip, and fixes it to the ground, then forms a bud there, which develops into a tuft of leaves, and so gives rise to a new plant, which sends out new runners to act in the same way. In this manner a single Strawberry plant will spread over a large space, or produce a great number of plants, in the course of the summer; — all connected at first by the slender runners; but these die in the following winter, if not before, and leave the plants as so many separate individuals.

92. **Tendrils** are branches of a very slender sort, like runners, not destined like them for propagation, and therefore always destitute



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of buds or leaves, but intended for climbing. Those of the Grape-Vine, of the Virginia Creeper (Fig. 62), and of the Cucumber and

FIG. 62. Piece of the stem of Virginia Creeper, bearing a leaf and a tendril. 63. Tips of a tendril, about the natural size, showing the disks by which they hold fast to walls, &c.

Squash tribe are familiar illustrations. The tendril commonly grows straight and outstretched until it reaches some neighboring support, such as a stem, when its apex hooks around it to secure a hold; then the whole tendril shortens itself by coiling up spirally, and so draws the shoot of the growing plant nearer to the supporting object. When the Virginia Creeper climbs the side of a building or the smooth bark of a tree, which the tendrils cannot lay hold of in the usual way, their tips expand into a flat disk or sucker (Fig. 62, 63), which adheres very firmly to the wall or bark, enabling the plant to climb over and cover such a surface, as readily as the Ivy does by means of its sucker-like little rootlets. The same result is effected by different organs, in the one case by branches in the form of tendrils; in the other, by roots.

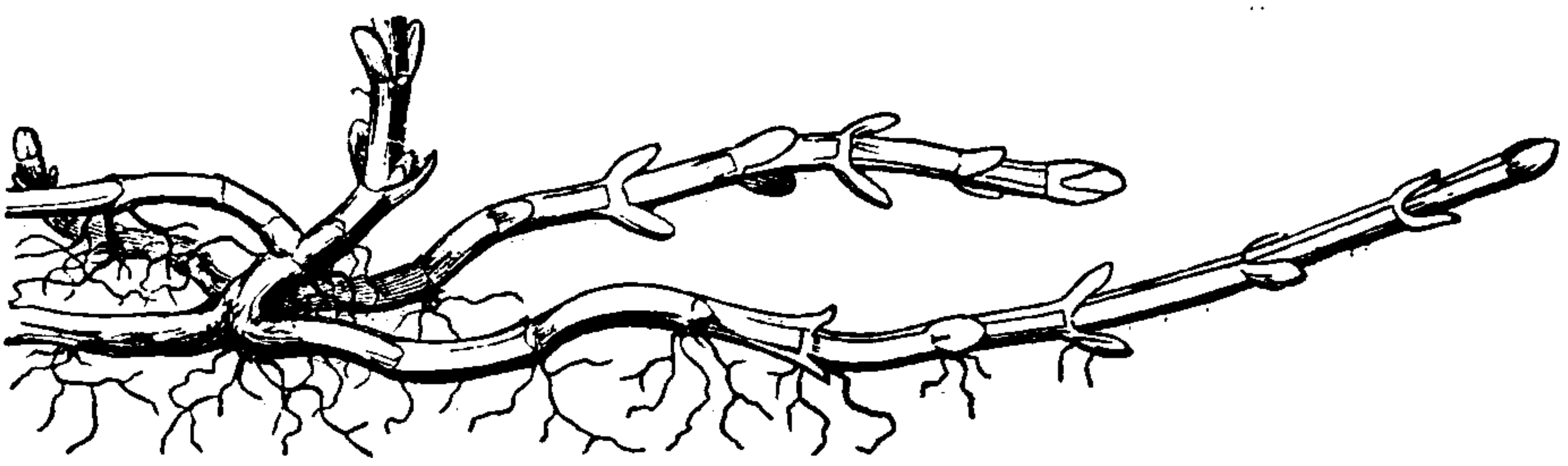
93. Tendrils, however, are not always branches; some are leaves, or parts of leaves, as those of the Pea (Fig. 20). Their nature in each case is to be learned from their position, whether it be that of a leaf or of a branch. In the same way

94. **Spines or Thorns** sometimes represent leaves, as in the Barberry, where their nature is shown by their situation *outside* of an axillary bud or branch. In other words, here they have a bud in their axil, and are therefore leaves; so we shall have to mention them in another place. Most commonly spines are stunted and hardened branches, arising from the axils of leaves, as in the Hawthorn and Pear. A neglected Pear-tree or Plum-tree shows every gradation between ordinary branches and thorns. Thorns sometimes branch, their branches partaking of the same spiny character: in this way those on the trunks of Honey-Locust trees (produced from adventitious buds, 58) become exceedingly complicated and horrid. The thorns on young shoots of the Honey-Locust may appear somewhat puzzling at first view; for they are situated some distance above the axil of the leaf. Here the thorn comes from the uppermost of several supernumerary buds (59). *Prickles*, such as those of the Rose and Blackberry, must not be confounded with thorns: these have not the nature of branches, and have no connection with the wood; but are only growths of the bark. When we strip off the bark, the prickles go with it.

95. Still stranger forms of stems and branches than any of these are met with in some tribes of plants, such as Cactuses (Fig. 76). These will be more readily understood after we have considered some of the commoner forms of

96. **Subterranean Stems and Branches.** These are very numerous and various; but they are commonly overlooked, or else confounded with roots. From their situation they are out of the sight of the superficial observer: but if sought for and examined, they will well repay the student's attention. For the vegetation that is carried on under ground is hardly less varied, and no less interesting and important, than that which meets our view above ground. All their forms may be referred to four principal kinds; namely, the *Rhizoma* or *Rootstock*, the *Tuber*, the *Corm*, and the *Bulb.*

97. **The Rootstock, or Rhizoma,** in its simplest form, is merely a creeping stem or branch (86) growing beneath the surface of the soil, or partly covered by it. Of this kind are the so-called *creeping*, *running*, or *scaly roots*, such as those by which the Mint (Fig. 64), the Scotch Rose, the Couch-grass or Quick-grass, and many other plants, spread so rapidly and widely, "by the root," as it is said.



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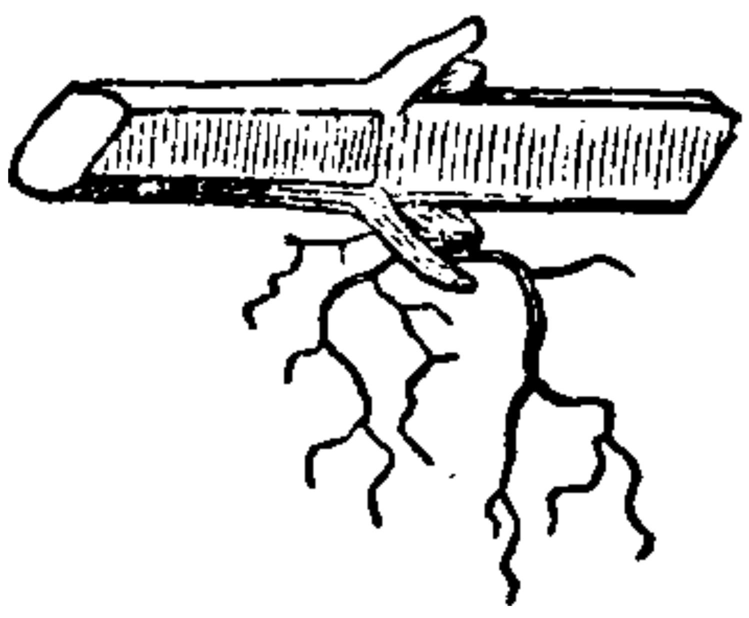
That these are really *stems*, and not roots, is evident from the way in which they grow; from their consisting of a succession of joints; and from the leaves which they bear on each joint (or *node*, as the botanist calls the place from which leaves arise), in the form of small scales, just like the lowest ones on the upright stem next the ground. Like other stems, they also produce buds in the axils of these scales, showing the scales to be leaves; whereas real roots bear neither leaves nor axillary buds. Placed, as they are, in the damp and dark soil, such stems naturally produce roots, just as the creeping stem does where it lies on the surface of the ground; but the whole appearance of these roots, their downward growth, and their mode of branching, are very different from that of the subterranean stem they spring from.

98. It is easy to see why plants with these running rootstocks take such rapid and wide possession of the soil,—often becoming great pests to farmers,—and why they are so hard to get rid of. They are

FIG. 64. Rootstocks, or creeping subterranean branches, of the Peppermint.

always perennials (41); the subterranean shoots live over the first winter, if not longer, and are provided with vigorous buds at every joint. Some of these buds grow in spring into upright stems, bearing foliage, to elaborate the plant's crude food into nourishment, and at length produce blossoms for reproduction by seed; while many others, fed by nourishment supplied from above, form a new generation of subterranean shoots; and this is repeated over and over in the course of the season or in succeeding years. Meanwhile as the subterranean shoots increase in number, the older ones, connecting the series of generations into one body, die off year by year, liberating the already rooted side-branches as so many separate plants; and so on indefinitely. Cutting these running rootstocks into pieces, therefore, by the hoe or the plough, far from destroying the plant, only accelerates the propagation; it converts one many-branched plant into a great number of separate individuals. Even if you divide the shoots into as many pieces as there are joints of stem, each piece (Fig. 65) is already a plantlet, with its roots and with a bud in the axil of its scale-like leaf (either latent or apparent), and having prepared nourishment enough in the bit of stem to develop this bud into a leafy stem; and so a single plant is all the more speedily converted into a multitude. Such plants as the Quick-grass accordingly realize the fable of the Hydra; as fast as one of its many branches is cut off, twice as many, or more, spring up in its stead. Whereas, when the subterranean parts are only roots, cutting away the stem completely destroys the plant, except in the rather rare cases where the root produces adventitious buds (58).



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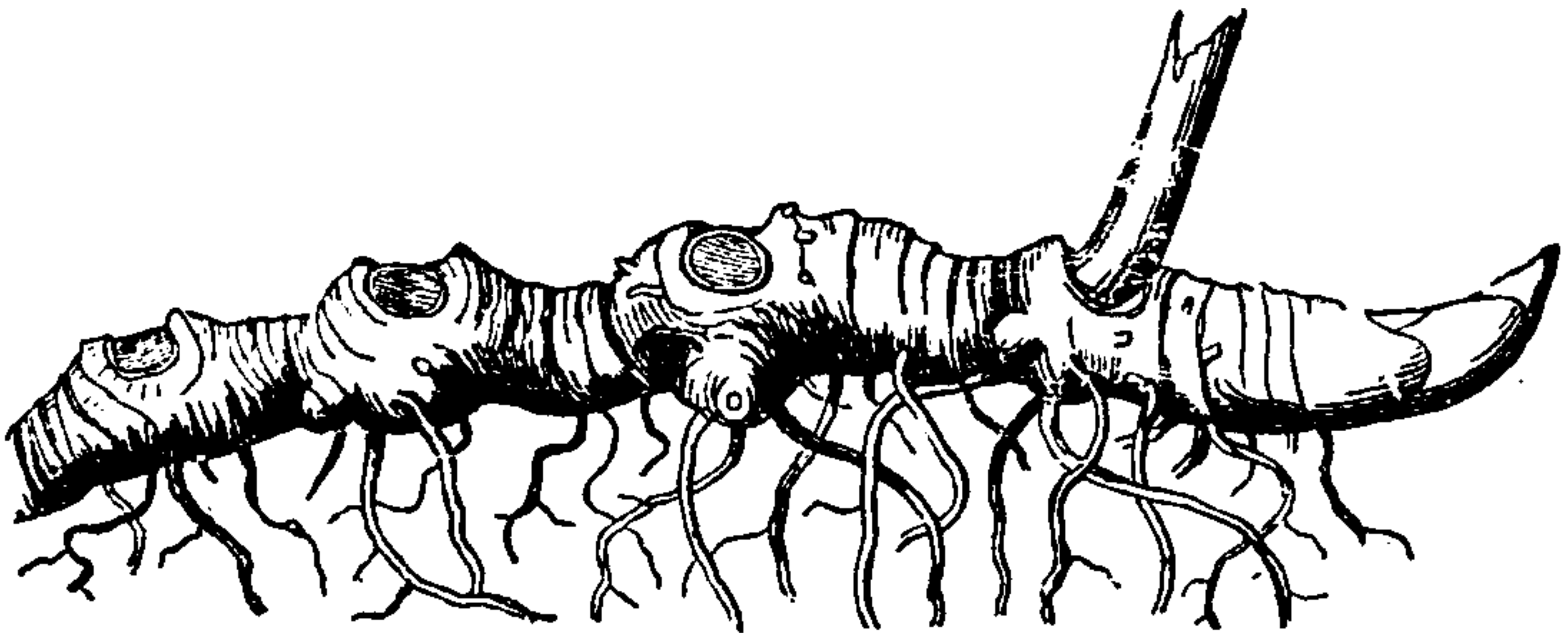
99. The more nourishment rootstocks contain, the more readily do separate portions, furnished with buds, become independent plants. It is to such underground stems, thickened with a large amount of starch, or some similar nourishing matter stored up in their tissue, that the name of *rhizoma* or rootstock is commonly applied; — such, for example, as those of the Sweet Flag or Calamus, of Ginger, of Iris or Flower-de-luce (Fig. 133), and of the Solomon's Seal (Fig. 66).

100. The rootstocks of the common sorts of Iris of the gardens usually lie on the surface of the ground, partly uncovered; and they bear real leaves (Fig. 133), which closely overlap each other;

FIG. 65. A piece of the running rootstock of the Peppermint, with its node or joint, and an axillary bud ready to grow.

the joints (i. e. the *internodes*, or spaces between each leaf) being very short. As the leaves die, year by year, and decay, a scar left in the form of a ring marks the place where each leaf was attached. Instead of leaves, rootstocks buried under ground commonly bear scales, like those of the Mint (Fig. 64), which are imperfect leaves.



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101. Some rootstocks are marked with large round scars of a different sort, like those of the Solomon's Seal (Fig. 66), which gave this name to the plant, from their looking something like the impression of a seal upon wax. Here the rootstock sends up every spring an herbaceous stalk or stem, which bears the foliage and flowers, and dies in autumn; and the *seal* is the circular scar left by the death and separation of the dead stalk from the living rootstock. As but one of these is formed each year, they mark the limits of a year's growth. The bud at the end of the rootstock in the figure, which was taken in summer, will grow the next spring into the stalk of the season, which, dying in autumn, will leave a similar scar, while another bud will be formed farther on, crowning the ever-advancing summit or growing end of the stem.

102. As each year's growth of stem, in all these cases, makes its own roots, it soon becomes independent of the older parts. And after a certain age, a portion dies off behind, every year, about as fast as it increases at the growing end; — death following life with equal and certain step, with only a narrow interval between. In vigorous plants of Solomon's Seal or Iris, the living rootstock is several inches or a foot in length; while in the short rootstock of

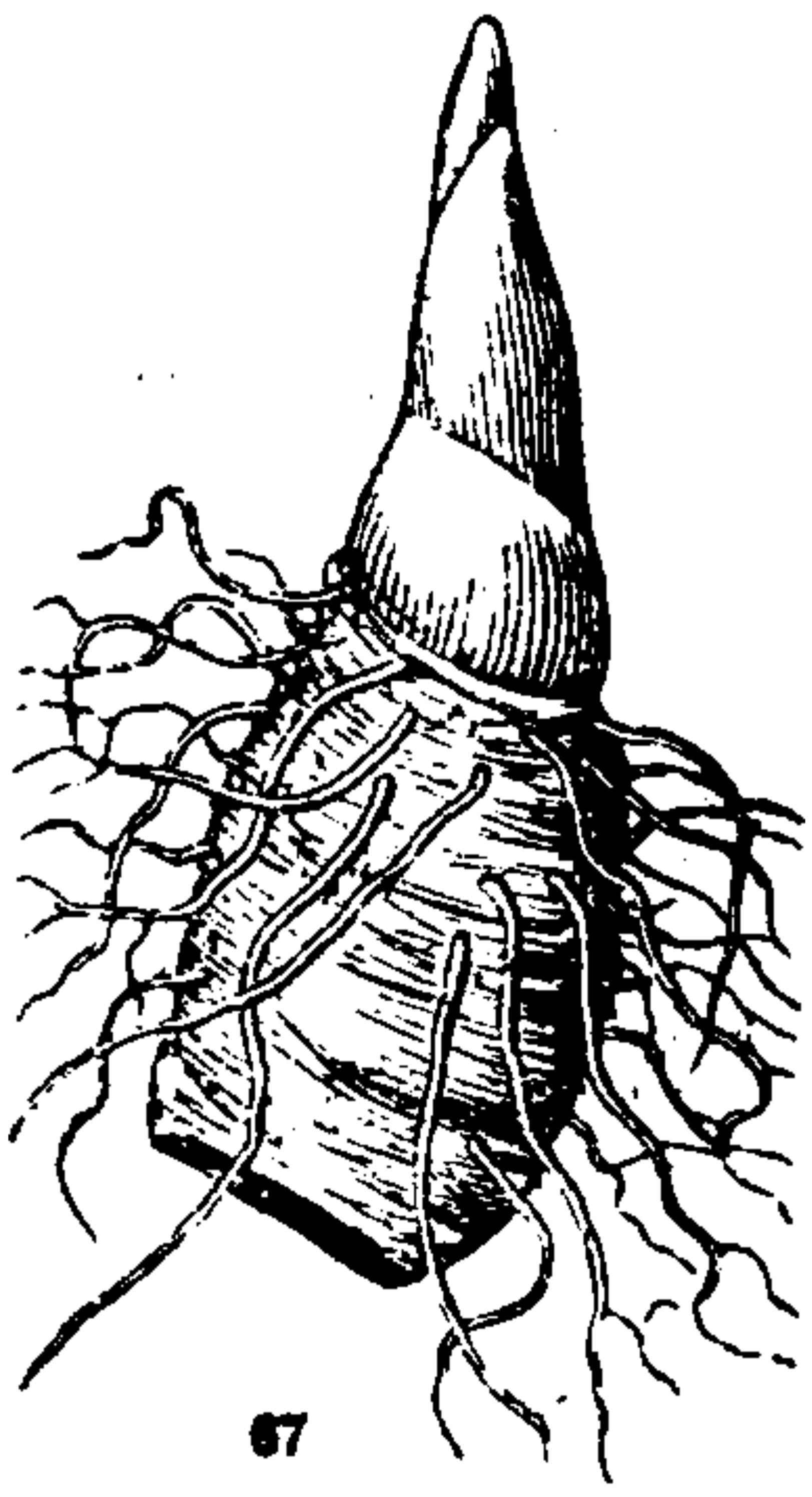

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FIG. 66. Rootstock of Solomon's Seal, with the bottom of the stalk of the season, and the bud for the next year's growth.

FIG. 67. The very short rootstock and bud of a Trillium or Birthroot.

phology of the branches, — that is, in the different forms they appear under, and the purposes they serve. The Potato-plant has three principal forms of branches: — 1. Those that bear ordinary leaves, expanded in the air, to digest what they gather from it and what the roots gather from the soil, and convert it into nourishment. 2. After a while a second set of branches at the summit of the plant bear flowers, which form fruit and seed out of a portion of the nourishment which the leaves have prepared. 3. But a larger part of this nourishment, while in a liquid state, is carried down the stem, into a third sort of branches under ground, and accumulated in the form of starch at their extremities, which become tubers, or depositories of prepared solid food; — just as in the Turnip, Carrot, Dahlia, &c. (Fig. 57 – 60), it is deposited in the root. The use of the store of food is obvious enough. In the autumn the whole plant dies, except the seeds (if it formed them) and the tubers; and the latter are left disconnected in the ground. Just as that small portion of nourishing matter which is deposited in the seed (3, and Fig. 34) feeds the embryo when it germinates, so the much larger portion deposited in the tuber nourishes its buds, or eyes, when they likewise grow, the next spring, into new plants. And the great supply enables them to shoot with a greater vigor at the beginning, and to produce a greater amount of vegetation than the seedling plant could do in the same space of time; which vegetation in turn may prepare and store up, in the course of a few weeks or months, the largest quantity of solid nourishing material, in a form most available for food. Taking advantage of this, man has transported the Potato from the cool Andes of South America to other cool climates, and makes it yield him a copious supply of food, especially in countries where the season is too short, or the summer's heat too little, for profitably cultivating the principal grain-plants.

105. All the sorts of subterranean stems or branches distinguished by botanists pass into one another by gradations. We have seen how nearly related the tuber is to the rootstock, and there are many cases in which it is difficult to say which is the proper name to use. So likewise,

106. **The Corm, or Solid Bulb,** like that of the Indian Turnip and the Crocus (Fig. 71), is just a very short and thick rootstock; as will be seen by comparing Fig. 71 with Fig. 67. Indeed, it grows so very little in length, that it is often much broader than long, as in the Indian Turnip, and the Cyclamen of our greenhouses. Corms

are usually upright, producing buds on their upper surface and roots from the lower. But (as we see in the Crocus here figured) buds may shoot from just above any of the faint cross lines or rings, which are the scars left by the death and decay of the sheathing bases of former leaves. That is, these are axillary buds. In these extraordinary (just as in ordinary) stems, the buds are either axillary or terminal. The whole mode of growth is just the same, only the corm does not increase in length faster than it does in thickness. After a few years some of the buds grow into new corms at the expense of the old one; the young ones taking the nourishment from the parent, and storing up a large part of it in their own tissue. When exhausted in this way, as well as by flowering, the old corm dies, and its shrivelled and decaying remains may be found at the side of or beneath the present generation, as we see in the Crocus (Fig. 71).

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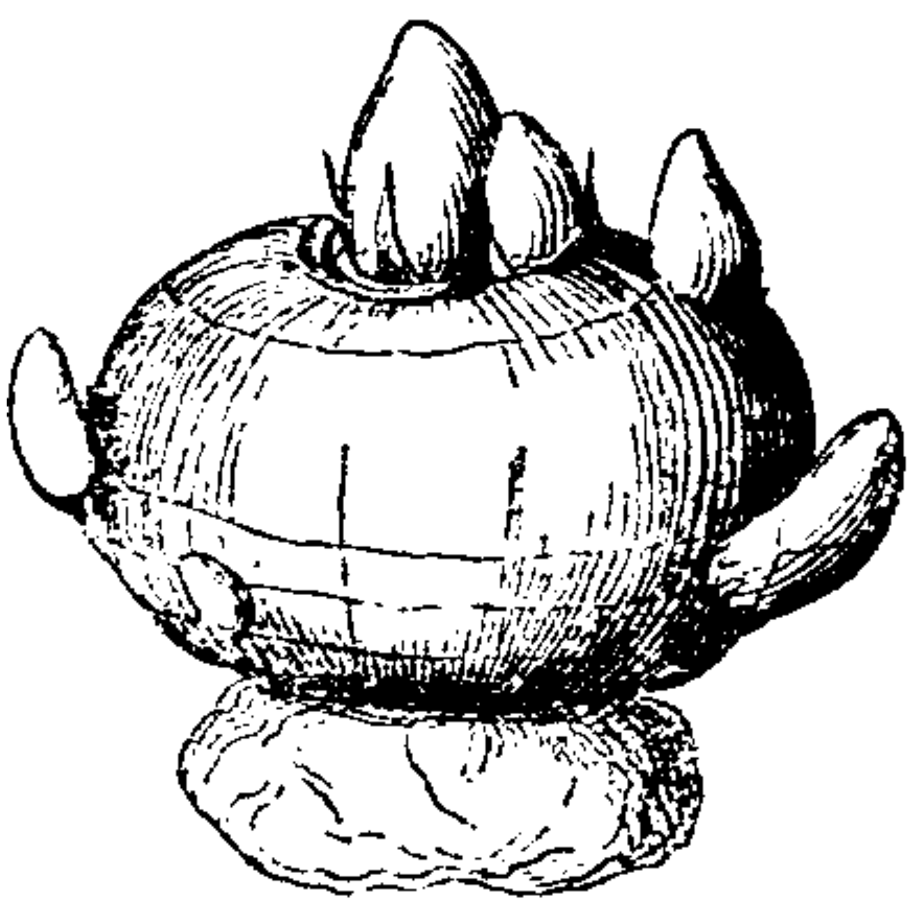

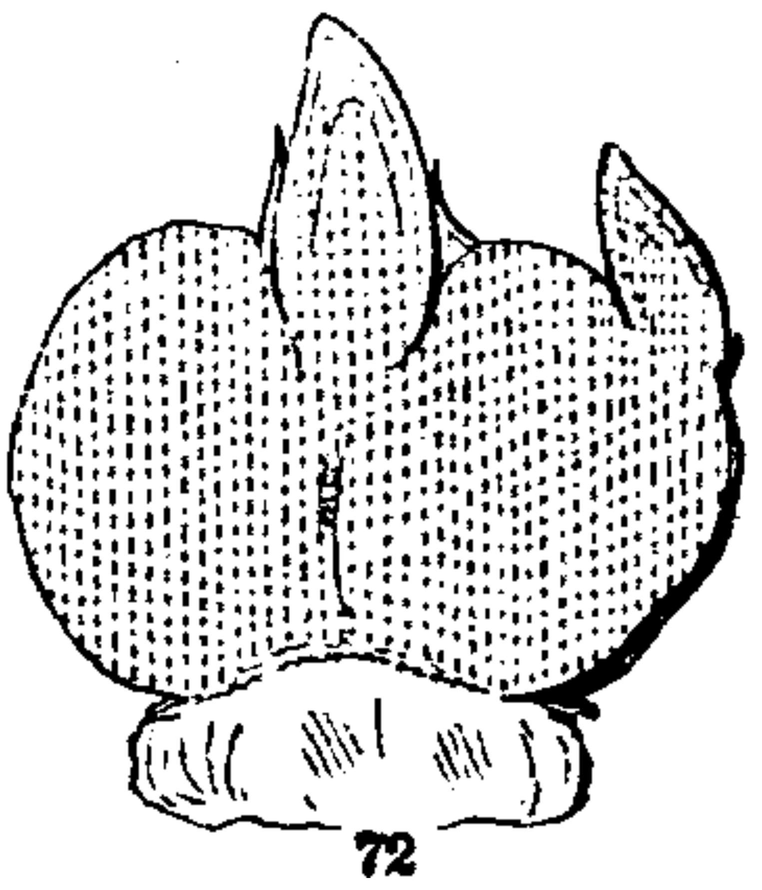

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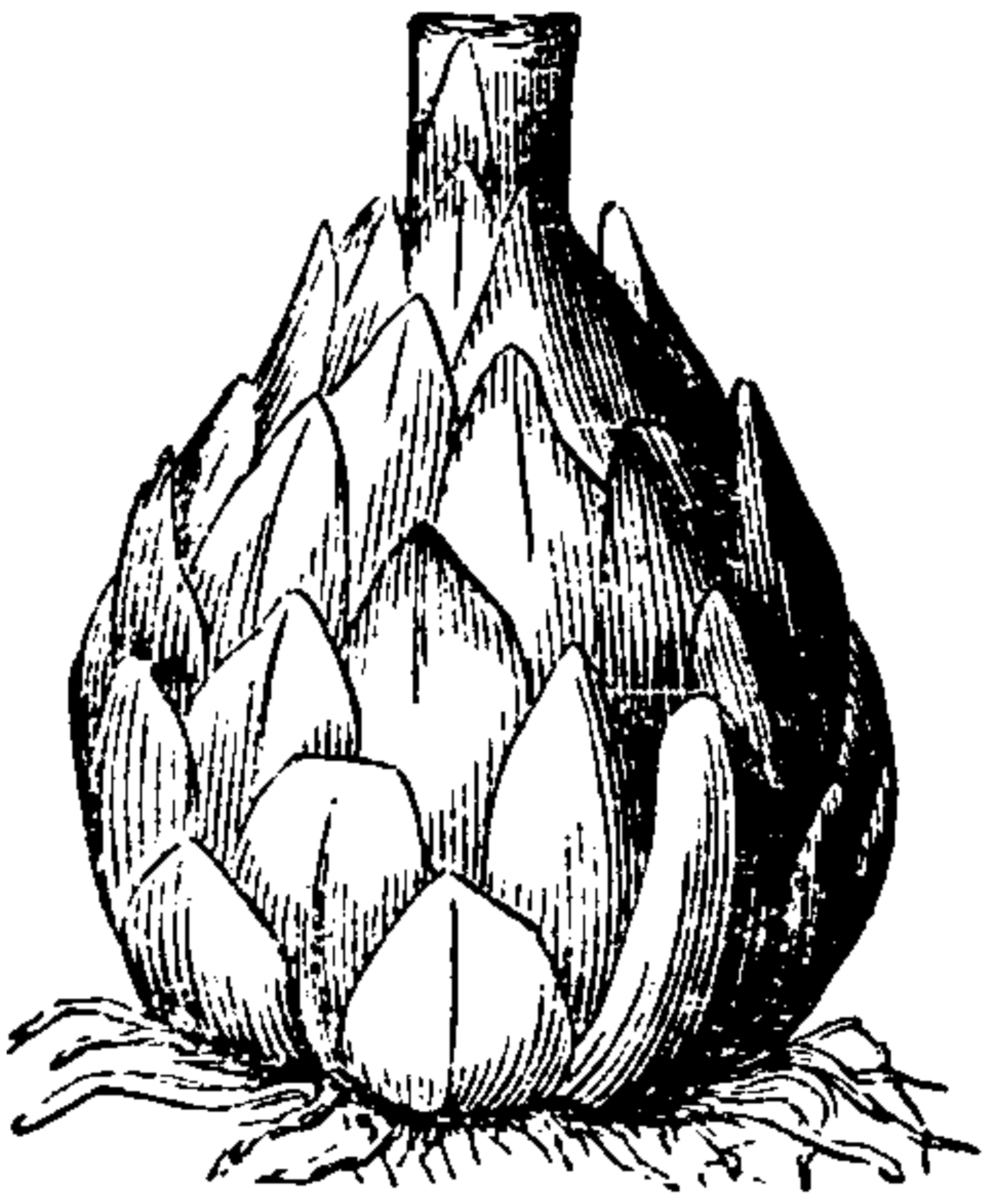
107. The corm of a Crocus is commonly covered with a thin and dry, scaly or fibrous husk, consisting of the dead remains of the bases of former leaves. When this husk consists of many scales, there is scarcely any distinction left between the corm and

108. **The Bulb.** This is an extremely short subterranean stem, usually much broader than high, producing roots from underneath, and covered with leaves or the bases of leaves, in the form of thickened scales. It is, therefore, the same as a corm, or solid bulb, only it bears an abundance of leaves or scales, which make up the greater part of its bulk. Or we may regard it as a bud, with thick and fleshy scales. Compare a Lily-bulb (Fig. 73) with the strong scaly buds of the Hickory and Horsechestnut (Fig. 48 and 49), and the resemblance will be apparent enough.

109. Bulbs serve the same purpose as tubers, rootstocks, or corms. The main difference is, that in these the store of food for future growth is deposited in the stem; while in the bulb, the greater part is deposited in the bases of the leaves, changing them into thick scales, which closely overlap or enclose one another, because the stem does not elongate enough to separate them. That the scales

FIG. 71. Corm or solid bulb of a Crocus. 72. The same, cut through lengthwise.

of the bulb are the bases of leaves may be seen at once by following any of the ground-leaves (root-leaves as they are incorrectly called) down to their origin in the bulb. Fig. 75 represents one of them from the White Lily; the thickened base, which makes a scale, being cut off below, to show its thickness. After having lasted its time and served its purpose as foliage, the green leaf dies, down to the thickened base, which remains as a scale of the bulb. And year after year, as the bulb grows from the centre, to produce the vegetation and the flowers of the season, the outer scales yield up their store of nourishment for the purpose, and perish.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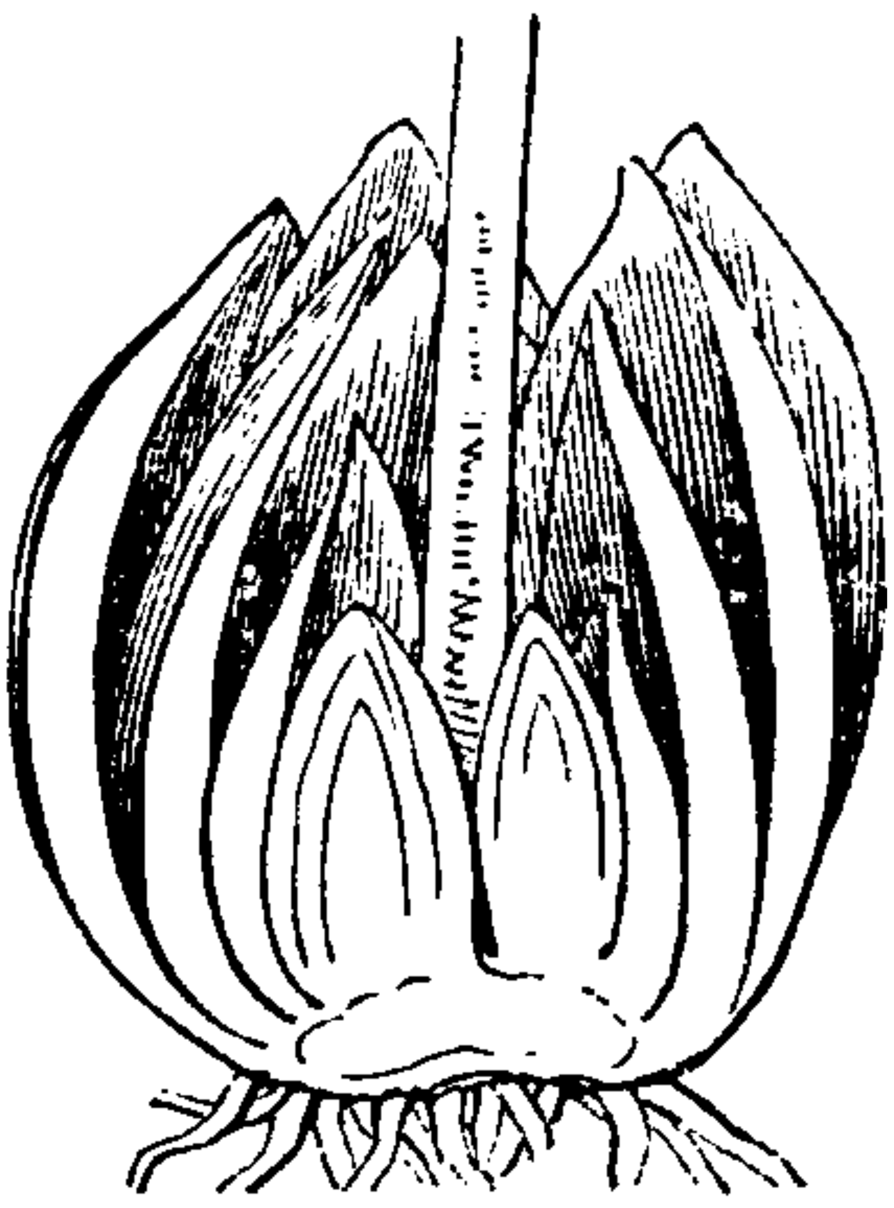
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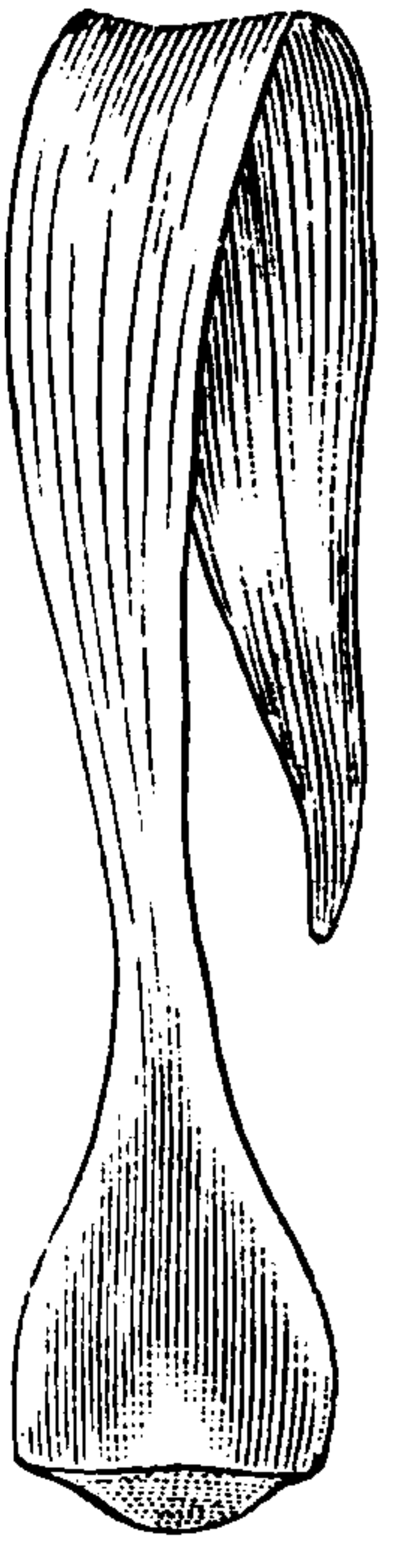
110. Each scale, being a leaf, may have a bud in its axil. Some of these buds grow into leafy and flowering stems above ground: others grow into new bulbs, feeding on the parent, and at length destroying it, in the same way that corms do, as just described (106).

111. When the scales are broad and enwrap all that is within so as to form a succession of coats, one over another, the bulb is said to be *tunicated* or *coated.* The Tulip, Hyacinth, Leek, and Onion afford such familiar examples of coated bulbs that no figure is needed. When the scales are narrow and separate, as in the Lily (Fig. 73), the bulb is said to be *scaly.*

112. **Bulblets** are small bulbs formed above ground on some plants; as in the axils of the leaves of the common bulbiferous Lily of the gardens, and often in the flower-clusters of the Leek and Onion. They are plainly nothing but bulbs with thickened scales. They never grow into branches, but detach themselves when full grown, and fall to the ground, to take root there and form new plants.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113. From the few illustrations already given, attentive students

FIG. 73. Bulb of the Meadow or Canada Lily. 74. The same, cut through lengthwise.

FIG. 75. A lower leaf of White Lily, with its base under ground thickened into a bulb-scale.

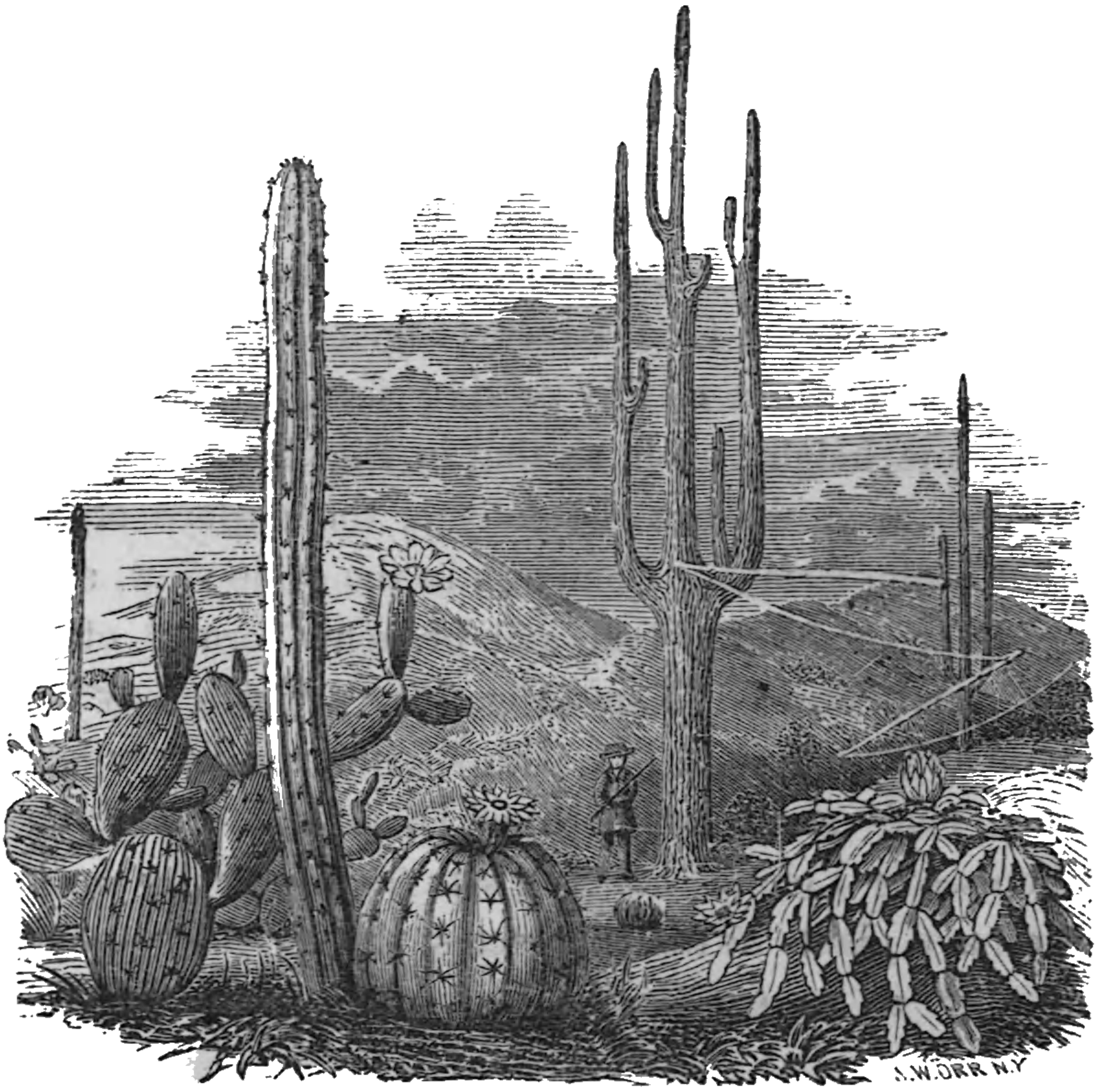
can hardly fail to obtain a good idea of what is meant by *morphology* in Botany; and they will be able to apply its simple principles for themselves to all forms of vegetation. They will find it very interesting to identify all these various subterranean forms with the common plan of vegetation above ground. There is the same structure, and the same mode of growth in reality, however different in appearance, and however changed the form, to suit particular conditions, or to accomplish particular ends. It is plain to see, already, that the plant is constructed *according to a plan,* — a very simple one, — which is exhibited by all vegetables, by the extraordinary no less than by the ordinary kinds; and that the same organ may appear under a great many different shapes, and fulfil very different offices.

114. These extraordinary shapes are not confined to subterranean vegetation. They are all repeated in various sorts of *fleshy plants;* in the Houseleek, Aloe, Agave (Fig. 82), and in the many and strange shapes which the Cactus family exhibit (Fig. 76); shapes which imitate rootstocks, tubers, corms, &c. above ground. All these we may regard as

115. **Consolidated Forms of Vegetation.** While ordinary plants are constructed on the plan of great spread of surface (131), these are formed on the plan of the least possible amount of surface in proportion to their bulk. The Cereus genus of Cactuses, for example, consisting of solid columnar trunks (Fig. 76, *b*), may be likened to rootstocks. A green rind serves the purpose of foliage; but the surface is as nothing compared with an ordinary leafy plant of the same bulk. Compare, for instance, the largest Cactus known, the Giant Cereus of the Gila River (Fig. 76, in the background), which rises to the height of fifty or sixty feet, with a common leafy tree of the same height, such as that in Fig. 54, and estimate how vastly greater, even without the foliage, the surface of the latte is than that of the former. Compare, in the same view, an Opunti or Prickly-Pear Cactus, its stem and branches formed of a succession of thick and flattened joints (Fig. 76, *a*), which may be likened to tubers, or an Epiphyllum (*d*), with shorter and flatter joints, with an ordinary leafy shrub or herb of equal size. And finally, in Melon-Cactuses or Echinocactus (*c*), with their globular or bulb-like shapes, we have plants in the compactest shape; their spherical figure being such as to expose the least possible amount of its bulk to the air.

116. These *consolidated plants* are evidently adapted and designed

for very *dry regions ;* and in such only are they found. Similarly, bulbous and corm-bearing plants, and the like, are examples of a form of vegetation which in the growing season may expand a large surface to the air and light, while during the period of rest the living vegetable is reduced to a globe, or solid form of the least possible surface; and this is protected by its outer coats of dead and dry scales, as well as by its situation under ground. Such plants exhibit another and very similar adaptation to a season of drought. And they mainly belong to countries (such as Southern Africa, and parts of the interior of Oregon and California) which have a long hot season during which little or no rain falls, when, their stalks and foliage above and their roots beneath being early cut off by drought, the plants rest securely in their compact bulbs, filled with nourishment, and retaining their moisture with great tenacity, until the rainy season comes round. Then they shoot forth leaves and flowers with wonderful rapidity, and what was perhaps a desert of arid sand becomes green with foliage and gay with blossoms, almost in a day. This will be more perfectly understood when the nature and use of foliage have been more fully considered. (Fig 76. represents several forms of Cactus vegetation.)



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LESSON VII.

MORPHOLOGY OF LEAVES.

117. In describing the subterranean forms of the stem, we have been led to notice already some of the remarkable forms under which leaves occur; namely, as *scales*, sometimes small and thin, as those of the rootstocks of the Quick-grass, or the Mint (Fig. 64), sometimes large and thick, as those of bulbs (Fig. 73 – 75), where they are commonly larger than the stem they belong to. We have seen, too, in the second Lesson, the seed-leaves (or cotyledons) in forms as unlike foliage as possible; and in the third Lesson we have spoken of bud-scales as a sort of leaves. So that the botanist recognizes the leaf under other forms than that of foliage.

118. We may call foliage the *natural form* of leaves, and look upon the other sorts as *special forms*, — as *transformed* leaves: by this term meaning only that what would have been ordinary leaves under other circumstances (as, for instance, those on shoots of Mint, Fig. 64, had these grown upright in the air, instead of creeping under ground) are developed in special forms to serve some particular purpose. For the Great Author of Nature, having designed plants upon one simple plan, just adapts this plan to all cases. So, whenever any special purpose is to be accomplished, no new instruments or organs are created for it, but one of the three general organs of the vegetable, *root*, *stem*, or *leaf*, is made to serve the purpose, and is adapted to it by taking some peculiar form.

119. It is the study of the varied forms under this view that constitutes *Morphology* (61), and gives to this part of Botany such great interest. We have already seen stems and roots under a great variety of forms. But leaves appear under more various and widely different forms, and answer a greater variety of purposes, than do both the other organs of the plant put together. We have to consider, then, *leaves as foliage*, and *leaves as something else than foliage*. As we have just been noticing cases of leaves that are not foliage, we may consider these first, and enumerate the principal kinds.

120. **Leaves as Depositories of Food.** Of these we have had plenty of instances in the seed-leaves, such as those of the Almond, Apple-

seed (Fig. 11), Beech (Fig. 13 – 15), the Bean and Pea (Fig. 16 – 20), the Oak (Fig. 21, 22), and Horsechestnut (Fig. 23, 24); where the food upon which the plantlet feeds when it springs from the seed is stored up in its cotyledons or first leaves. And we have noticed how very unlike foliage such leaves are. Yet in some cases, as in the Pumpkin (Fig. 10), they actually grow into green leaves as they get rid of their burden.


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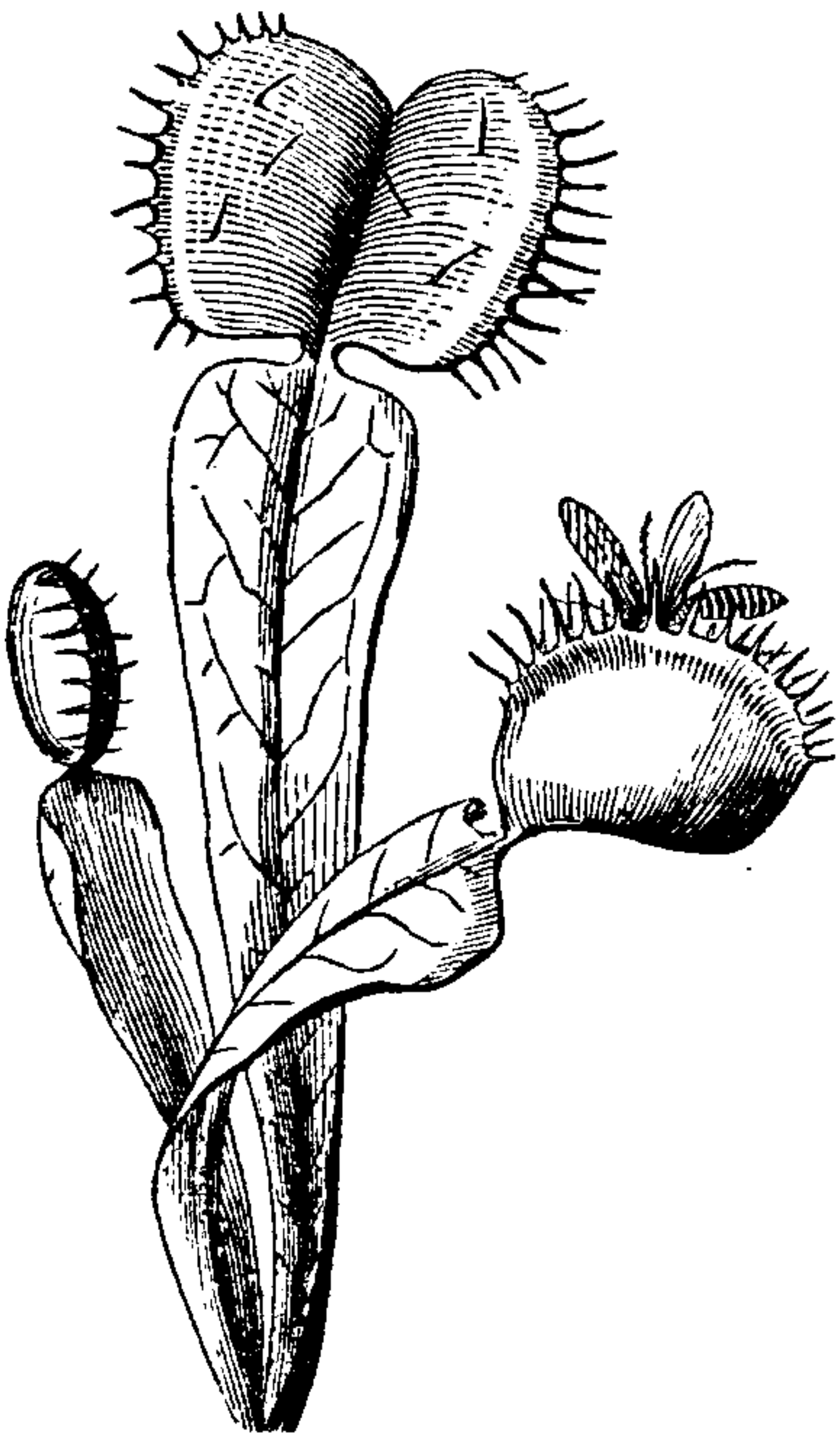
121. **Bulb-Scales** (Fig. 73 – 75) offer another instance, which we were considering at the close of the last Lesson. Here a part of the nourishment prepared in the foliage of one year is stored up in the scales, or subterranean thickened leaves, for the early growth and flowering of the next year; and this enables the flowers to appear before the leaves, or as soon as they do; as in Hyacinths, Snowdrops, and many bulbous plants.

122. **Leaves as Bud-scales, &c.** True to its nature, the stem produces leaves even under ground, where they cannot serve as foliage, and where often, as on rootstocks and tubers (97 – 103), they are not of any use that we know of. In such cases they usually appear as thin scales. So the first leaves of the stems of herbs, as they sprout from the ground, are generally mere scales, such as those of an Asparagus shoot; and such are the first leaves on the stem of the seedling Oak (Fig. 22) and the Pea (Fig. 20). Similar scales, however, often serve an important purpose; as when they form the covering of buds, where they protect the tender parts within (44). That bud-scales are

FIG. 77. Leaves of a developing bud of the Low Sweet Buckeye (*Æsculus parviflora*), showing a nearly complete set of gradations from a scale to a compound leaf of five leaflets.

126. **Leaves as Fly-traps.** Insects are caught in another way, and more expertly, by the most extraordinary of all the plants of this country, the Dionæa or Venus's Fly-trap, which grows in the sandy bogs around Wilmington, North Carolina. Here (Fig. 81) each leaf bears at its summit an appendage which opens and shuts, in shape something like a steel trap, and operating much like one. For when open, as it commonly is when the sun shines, no sooner does a fly alight on its surface, and brush against any one of the several long bristles that grow there, than the trap suddenly closes, often capturing the intruder, pressing it all the harder for its struggles, and commonly depriving it of life. If the fly escapes, the trap soon slowly opens, and is ready for another capture. When retained, the insect is after a time moistened by a secretion from minute glands of the inner surface, and is apparently digested! How such and various other movements are made by plants, — some as quick as in this case, others very slow, but equally wonderful, — must be considered in a future Lesson.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127. **Leaves serving both Ordinary and Special Purposes.** Let us now remark, that the same leaf frequently answers its general purpose, as foliage, and some special purpose besides. For example, in the Dionæa, the lower part of the leaf, and probably the whole of it, acts as foliage, while the appendage serves its mysterious purpose as a fly-catcher. In the Pea and Vetch (Fig. 20, 127), the lower part of the leaf is foliage, the upper a tendril. In the Pitcher-plants of the Indian Archipelago (Nepenthes, Fig. 80) which are not rare in conservatories, the lower part of the leaf is expanded and acts as foliage;

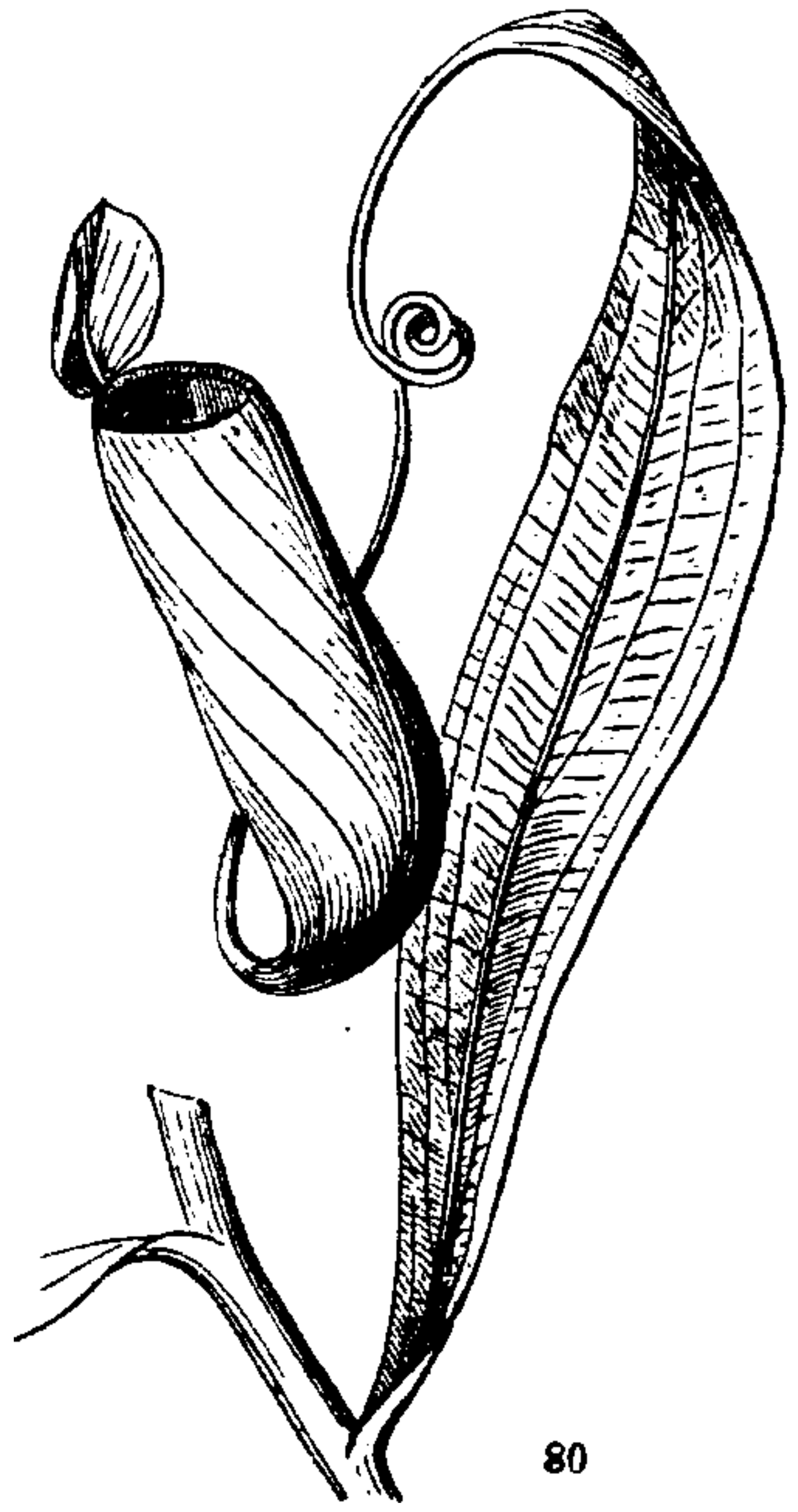
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FIG. 80. Leaf of Nepenthes: leaf, tendril, and pitcher combined.

FIG. 81. Leaves of Dionæa; the trap in one of them open, in the others closed.

farther on, it is contracted into a tendril, enabling the plant to climb; the end of this tendril is then expanded into a pitcher, of five or six inches in length, and on the end of this is a lid, which exactly closes the mouth of the pitcher until after it is full grown, when the lid opens by a hinge! But the whole is only one leaf.

128. So in the root-leaves of the Tulip or the Lily (Fig. 75), while the green leaf is preparing nourishment throughout the growing season, its base under ground is thickened into a reservoir for storing up a good part of the nourishment for next year's use.

129. Finally, the whole leaf often serves both as foliage, to prepare nourishment, and as a depository to store it up. This takes place in all flesby-leaved plants, such as the Houseleek, the Ice-plant, and various sorts of Mesembryanthemum, in the Live-for-ever of the gardens to some extent, and very strikingly in the Aloe, and in the Century-plant. In the latter it is only the green surface of these large and thick leaves (of three to five feet in length on a strong plant, and often three to six inches thick near the base) which acts as foliage; the whole interior is white, like the interior of a potato, and almost as heavily loaded with starch and other nourishing matter. (Fig. 82 represents a young Century-plant, Agave Americana.)

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LESSON VIII.

MORPHOLOGY OF LEAVES AS FOLIAGE.

130. HAVING in the last Lesson glanced at some of the special or extraordinary forms and uses of leaves, we now return to leaves in their ordinary condition, namely, as foliage. We regard this as the natural state of leaves. For although they may be turned to account in other and very various ways, as we have just seen, still their proper office in vegetation is to serve as foliage. In this view we may regard

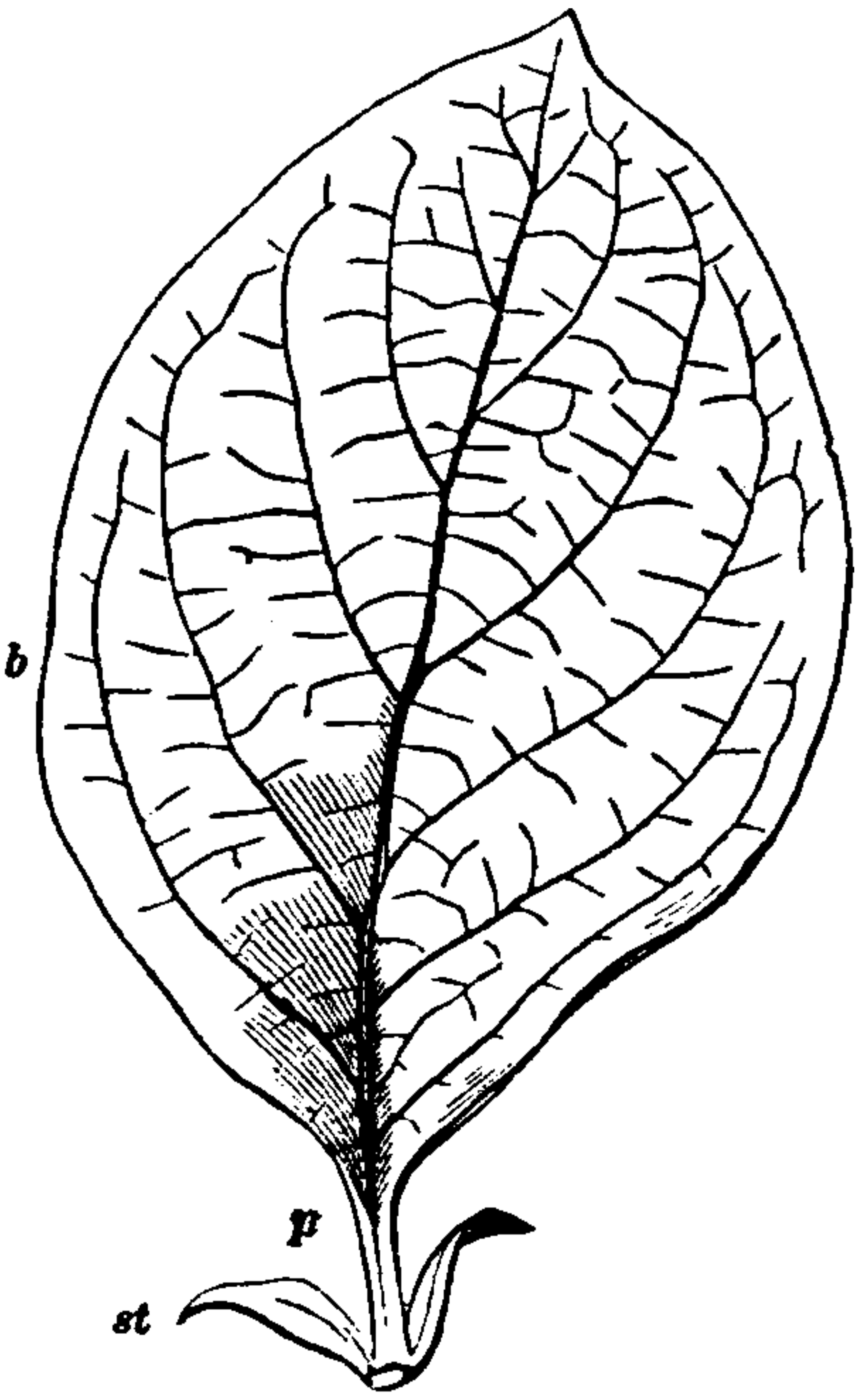
131. **Leaves as a Contrivance for Increasing the Surface** of that large part of the plant which is exposed to the light and the air. This is shown by their expanded form, and ordinarily slight thickness in comparison with their length and breath. While a Melon-Cactus (115, Fig. 76) is a striking example of a plant with the least possible amount of surface for its bulk, a repeatedly branching leafy herb or tree presents the largest possible extent of surface to the air. The actual amount of surface presented by a tree in full leaf is much larger than one would be apt to suppose. Thus, the Washington Elm at Cambridge — a tree of no extraordinary size — was some years ago estimated to produce a crop of seven millions of leaves, exposing a surface of 200,000 square feet, or about five acres, of foliage.

132. What is done by the foliage we shall have to explain in another place. Under the present head we are to consider ordinary leaves as to their *parts* and their *shapes.*

133. **The Parts of the Leaf.** The principal part of a leaf is the blade, or expanded portion, one face of which naturally looks toward the sky, the other towards the earth. The blade is often raised on a stalk of its own, and on each side of the stalk at its base there is sometimes an appendage called a *stipule.* A complete leaf, therefore consists of a *blade* (Fig. 83, *b*), a *foot-stalk* or *leaf-stalk,* called the *petiole* (*p*), and a pair of *stipules* (*st*). See also Fig. 136.

134. It is the blade which we are now to describe. This, as being the essential and conspicuous part, we generally regard as the leaf: and it is only when we have to particularize, that we speak of the *blade,* or *lamina,* of the leaf.

135. Without here entering upon the subject of the anatomy of the leaf, we may remark, that leaves consist of two sorts of material, viz.: 1. the *green pulp*, or *parenchyma;* and 2. the *fibrous framework*, or skeleton, which extends throughout the soft green pulp and supports it, giving the leaf a strength and firmness which it would not otherwise possess. Besides, the whole surface is covered with a transparent skin, called the *epidermis*, like that which covers the surface of the shoots, &c.



136. The framework consists of *wood*, — a fibrous and tough material which runs from the stem through the leaf-stalk, when there is one, in the form of parallel threads or bundles of fibres; and in the blade these spread out in a horizontal direction, to form the *ribs* and *veins* of the leaf. The stout main branches of the framework (like those in Fig. 50) are called the *ribs*. When there is only one, as in Fig. 83, &c., or a middle one decidedly larger than the rest, it is called the *midrib*. The smaller divisions are termed *veins;* and their still smaller subdivisions, *veinlets*.

137. The latter subdivide again and again, until they become so fine that they are invisible to the naked eye. The fibres of which they are composed are hollow; forming tubes by which the sap is brought into the leaves and carried to every part. The arrangement of the framework in the blade is termed the

138. **Venation**, or mode of veining. This corresponds so completely with the general shape of the leaf, and with the kind of division when the blade is divided or lobed, that the readiest way to study and arrange the forms of leaves is first to consider their veining.

139. Various as it appears in different leaves, the veining is all reducible to two principal kinds; namely, the *parallel-veined* and the *netted-veined*.

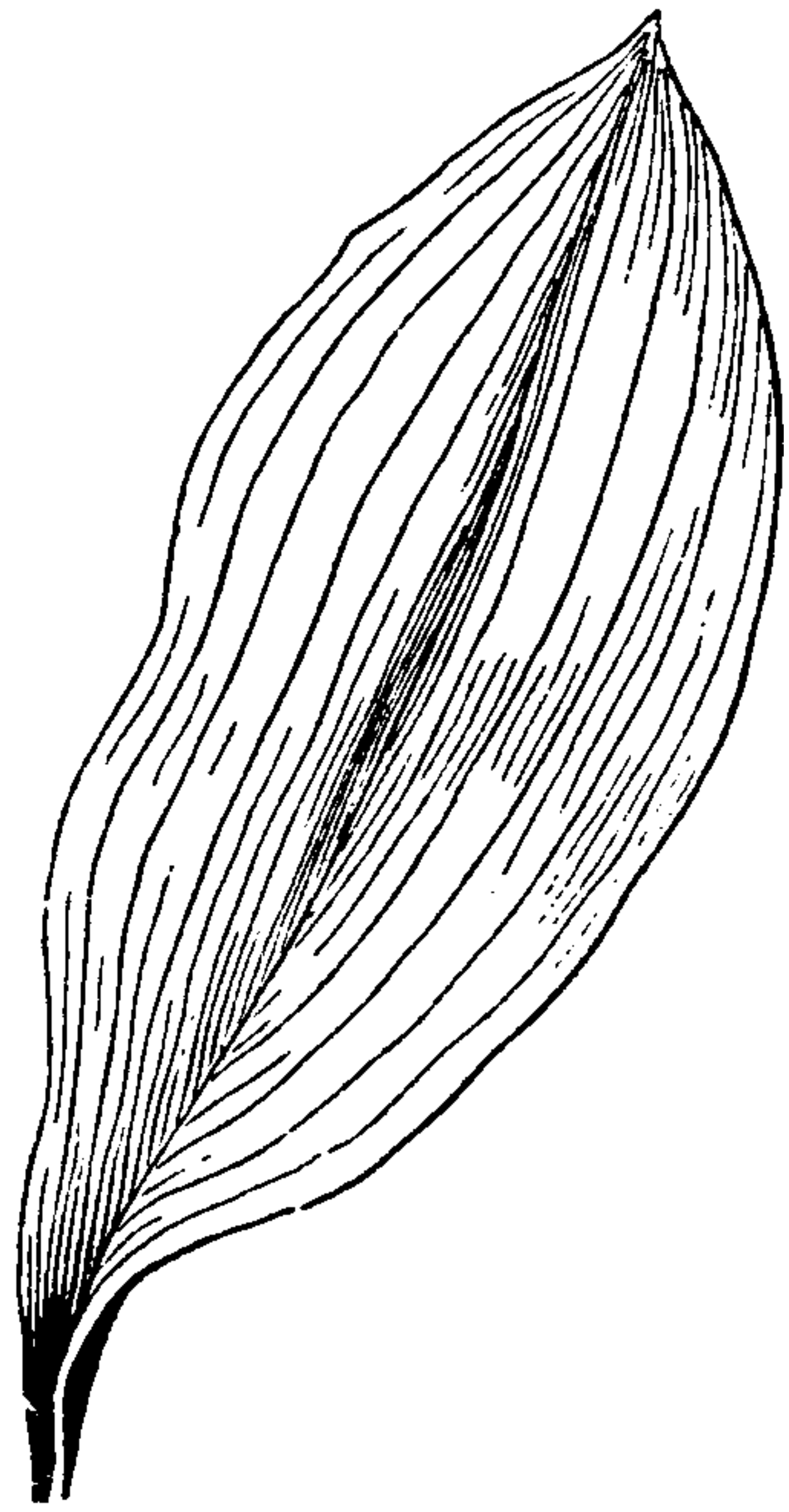
140. In *netted-veined* (also called *reticulated*) leaves, the veins branch off from the main rib or ribs, divide into finer and finer

FIG. 83. Leaf of the Quince: *b*, blade; *p*, petiole; *st*, stipules.

veinlets, and the branches unite with each other to form meshes of network. That is, they *anastomose*, as anatomists say of the veins and arteries of the body. The Quince-leaf, in Fig. 83, shows this kind of veining in a leaf with a single rib. The Maple, Basswood, and Buttonwood (Fig. 50) show it in leaves of several ribs.

141. In *parallel-veined* leaves, the whole framework consists of slender ribs or veins, which run parallel with each other, or nearly so, from the base to the point of the leaf, not dividing and sub dividing, nor forming meshes, except by very minute cross-veinlets. The leaf of any grass, or that of the Lily of the Valley (Fig. 84) will furnish a good illustration.

142. Such simple, parallel veins Linnæus, to distinguish them called *nerves*, and parallel-veined leaves are still commonly called *nerved* leaves, while those of the other kind are said to be *veined*; — terms which it is convenient to use, although these " nerves " and " veins " are all the same thing, and have no likeness to the *nerves* of animals.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143. *Netted-veined* leaves belong to plants which have a pair of seed-leaves or cotyledons, such as the Maple (Fig. 1 – 7), Beech (Fig. 15), Pea and Bean (Fig. 18, 20), and most of the illustrations in the first and second Lessons. While *parallel-veined* or *nerved* leaves belong to plants with one cotyledon or true seed-leaf; such as the Iris (Fig. 134) and Indian Corn (Fig. 42). So that a mere glance at the leaves of the tree or herb enables one to tell what the structure of the embryo is, and to refer the plant to one or the other of these two grand classes, — which is a great convenience. For generally when plants differ from each other in some one important respect, they differ correspondingly in other respects as well.

144. Parallel-veined leaves are of two sorts; one kind, and the commonest, having the ribs or nerves all running from the base to the point of the leaf, as in the examples already given; while in another kind they run from a midrib to the margin; as in the com-

FIG. 84. A (parallel-Veined) leaf of the Lily of the Valley.

mon Pickerel-weed of our ponds, in the Banana (Fig. 47), and many similar plants of warm climates.

145. Netted-veined leaves are also of two sorts, as is shown in the examples already referred to. In one case the veins all rise from a single rib (the midrib), as in Fig. 83. Such leaves are called *feather-veined* or *pinnately-veined;* both terms meaning the same thing, namely, that the veins are arranged on the sides of the rib like the plume of a feather on each side of the shaft.

146. In the other case (as in the Buttonwood, Fig. 50, Maple, &c.), the veins branch off from three, five, seven, or nine ribs, which spread from the top of the leaf-stalk, and run through the blade like the toes of a web-footed bird. Hence these are said to be *palmately* or *digitately* veined, or (since the ribs diverge like rays from a centre) *radiate-veined.*

147. Since the general outline of leaves accords with the framework or skeleton, it is plain that *feather-veined* leaves will incline to elongated shapes, or at least will be longer than broad; while in *radiate-veined* leaves more rounded forms are to be expected. A glance at the following figures shows this. Whether we consider the veins of the leaf to be adapted to the shape of the blade, or the green pulp to be moulded to the framework, is not very material. Either way, the outline of each leaf corresponds with the mode of spreading, the extent, and the relative length of the veins. Thus, in oblong or elliptical leaves of the feather-veined sort (Fig. 87, 88), the principal veins are nearly equal in length; while in ovate and heart-shaped leaves (Fig. 89, 90), those below the middle are longest; and in leaves which widen upwards (Fig. 91 – 94), the veins above the middle are longer than the others.

148. Let us pass on, without particular reference to the kind of veining, to enumerate the principal

149. **Forms of Leaves as to General Outline.** It is necessary to give names to the principal shapes, and to define them rather precisely, since they afford the easiest marks for distinguishing species. The same terms are used for all other flattened parts as well, such as the petals of the flowers; so that they make up a great part of the descriptive language of Botany. We do not mention the names of common plants which exhibit these various shapes. It will be a good exercise for young students to look them up and apply them.

150. Beginning with the narrower and proceeding to the broadest forms. a leaf is said to be

Linear (Fig. 85), when narrow, several times longer than wide, and of the same breadth throughout.

Lanceolate, or *lance-shaped*, when several times longer than wide, and tapering upwards (Fig. 86), or both upwards and downwards.

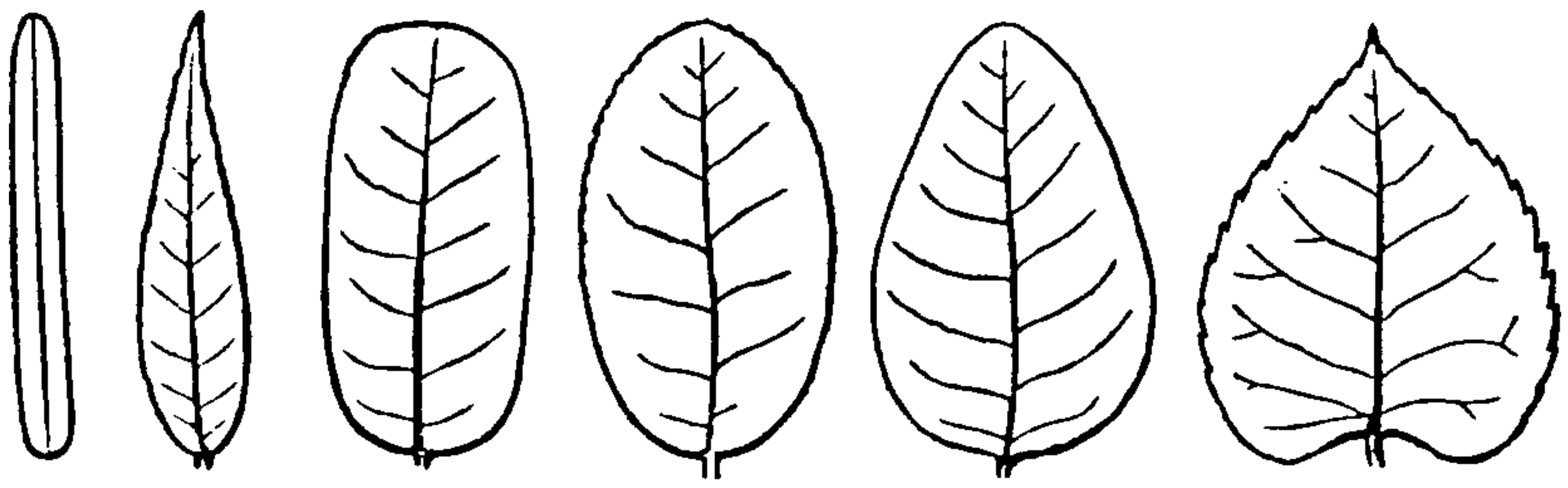
Oblong (Fig. 87), when nearly twice or thrice as long as broad.

Elliptical (Fig. 88) is oblong with a flowing outline, the two ends alike in width.

Oval is the same as broadly elliptical, or elliptical with the breadth considerably more than half the length.

Ovate (Fig. 89), when the outline is like a section of a hen's-egg lengthwise, the broader end downward.

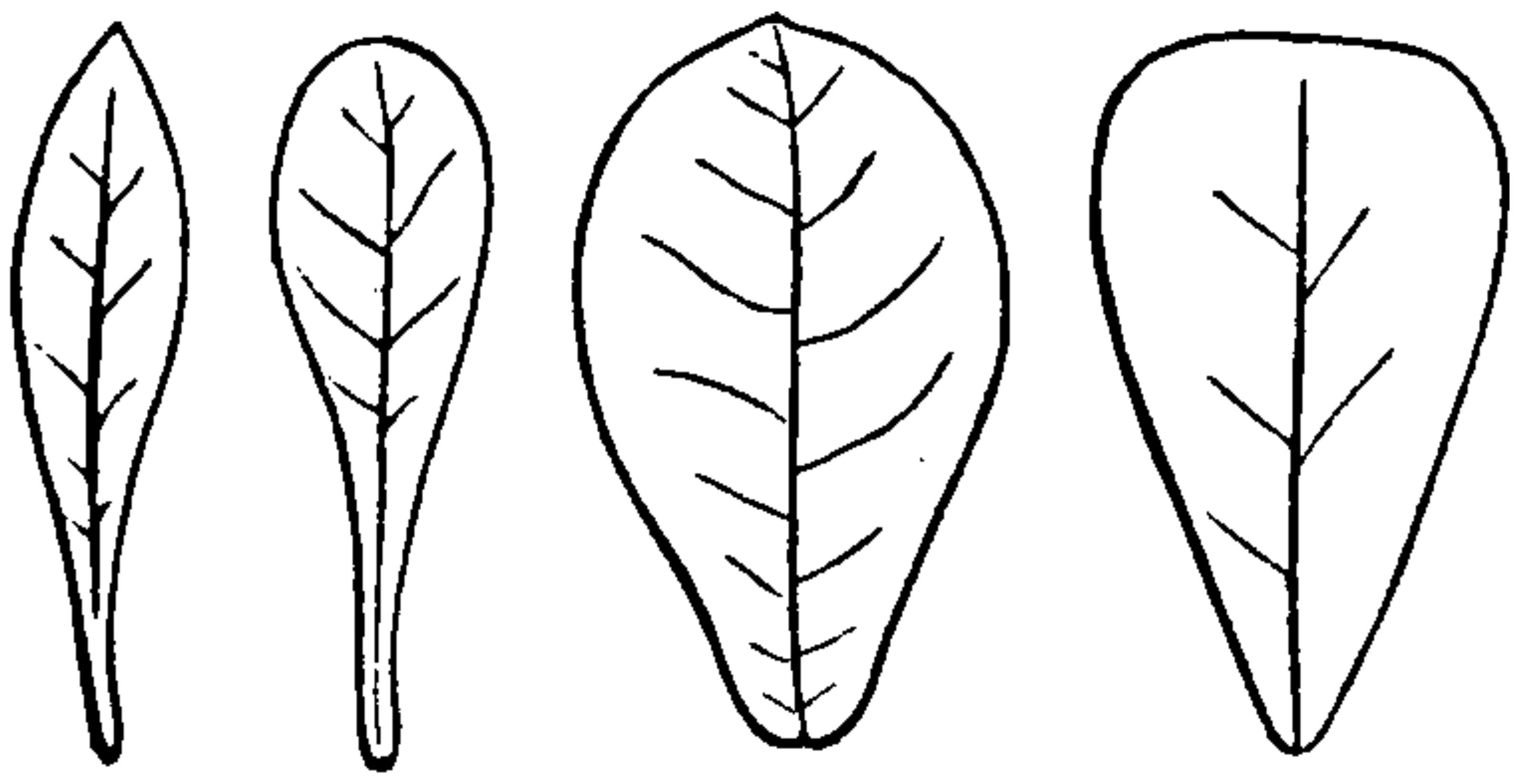
Orbicular, or *rotund* (Fig. 102), circular in outline, or nearly so.



85 86 87 88 89 90

151. When the leaf tapers towards the base, instead of upwards, it may be

Oblanceolate (Fig. 91), which is lance-shaped, with the more tapering end downwards;



91 92 93 94

Spatulate (Fig. 92), rounded above and long and narrow below, like a spatula;

Obovate (Fig. 93), or inversely ovate, that is, ovate with the narrower end down; or

Cuneate, or *cuneiform*, that is, *wedge-shaped* (Fig. 94), broad above and tapering by straight lines to an acute angle at the base.

152. **As to the Base**, its shape characterizes several forms, such as

Cordate, or *heart-shaped* (Fig. 90, 99, 8), when a leaf of an ovate form, or something like it, has the outline of its rounded base turned in (forming a notch or *sinus*) where the stalk is attached.

Reniform, or *kidney-shaped* (Fig. 100), like the last, only rounder and broader than long.

FIG. 85 – 90. Various forms of feather-veined leaves.

FIG. 91. Oblanceolate, 92. spatulate, 93. obovate, 94. wedge-shaped, feather-veined leaves.

kidney-shaped (Fig. 100) or other rounded leaf, with the margins at the base brought together and united.

153. **As to the Apex,** the following terms express the principal variations.

Acuminate, pointed, or *taper-pointed,* when the summit is more or less prolonged into a narrowed or tapering point, as in Fig. 97.

Acute, when ending in an acute angle or not prolonged point, as in Fig. 104, 98, 95, &c.

Obtuse, when with a blunt or rounded point, as in Fig. 105, 89, &c.

Truncate, with the end as if cut off square, as in Fig. 106, 94.

Retuse, with the rounded summit slightly indented, forming a very shallow notch, as in Fig. 107.

Emarginate, or *notched,* indented at the end more decidedly, as in Fig. 108.

Obcordate, that is, inversely heart-shaped, where an obovate leaf is more deeply notched at the end (Fig. 109), as in White Clover and Wood-sorrel; so as to resemble a cordate leaf (Fig. 99) inverted.

Cuspidate, tipped with a sharp and rigid point; as in Fig. 110.

Mucronate, abruptly tipped with a small and short point, like a projection of the midrib; as in Fig. 111.

Aristate, awn-pointed, and *bristle-pointed,* are terms used when this mucronate point is extended into a longer bristle-form or other slender appendage.

The first six of these terms can be applied to the lower as well as to the upper end of a leaf or other organ. The others belong to the apex only.

103 104 105 106 107 108 109 110 111

FIG. 103-111. Forms of the apex of leaves.

LESSON IX.

MORPHOLOGY OF LEAVES AS FOLIAGE.—SIMPLE AND COMPOUND LEAVES, STIPULES, ETC.

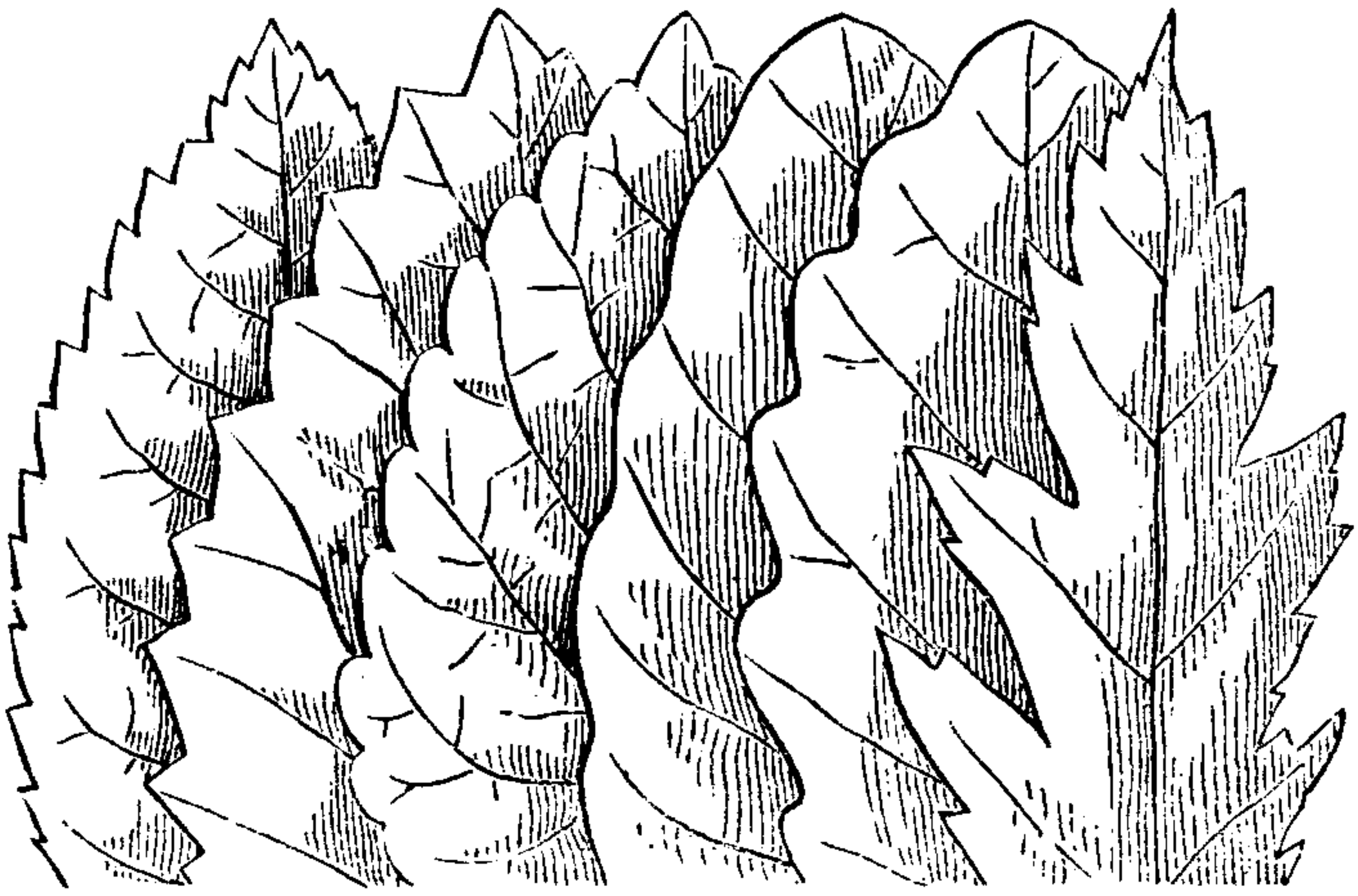
154. In the foregoing Lesson leaves have been treated of in their simplest form, namely, as consisting of a single blade. But in many cases the leaf is divided into a number of separate blades. That is,

155. **Leaves are either Simple or Compound.** They are said to be *simple*, when the blade is all of one piece: they are *compound*, when the blade consists of two or more separate pieces, borne upon a common leaf-stalk. And between these two kinds every intermediate gradation is to be met with. This will appear as we proceed to notice the principal

156. **Forms of Leaves as to particular Outline** or degree of division. In this respect, leaves are said to be

Entire, when their general outline is completely filled out, so that the margin is an even line, without any teeth or notches; as in Fig. 83, 84, 100, &c.

Serrate, or *saw-toothed*, when the margin only is cut into sharp teeth, like those of a saw, and pointing forwards; as in Fig. 112; also 90, &c.



112 113 114 115 116 117

Dentate, or *toothed*, when such teeth point outwards, instead of forwards; as in Fig. 113.

FIG. 112–117. Kinds of margin of leaves.

Crenate, or *scalloped*, when the teeth are broad and rounded; as in Fig. 114, 101.

Repand, *undulate*, or *wavy*, when the margin of the leaf forms a wavy line, bending slightly inwards and outwards in succession; as in Fig. 115.

Sinuate, when the margin is more strongly sinuous, or turned inwards and outwards, as in Fig. 116.

Incised, *cut*, or *jagged*, when the margin is cut into sharp, deep, and irregular teeth or incisions, as in Fig. 117.

157. When leaves are more deeply cut, and with a definite number of incisions, they are said, as a general term, to be *lobed;* the parts being called *lobes.* Their number is expressed by the phrase *two-lobed*, *three-lobed*, *five-lobed*, *many-lobed*, &c., as the case may be. When the depth and character of the lobing needs to be more particularly specified, — as is often the case, — the following terms are employed, viz.:

Lobed, when the incisions do not extend deeper than about half-way between the margin and the centre of the blade, if so far, and are more or less rounded; as in the leaves of the Post-Oak, Fig. 118, and the Hepatica, Fig. 122.

Cleft, when the incisions extend half-way down or more, and especially when they are sharp, as in Fig. 119, 123. And the phrases *two-cleft*, or, in the Latin form, *bifid; three-cleft*, or *trifid; four-cleft*, or *quadrifid; five-cleft*, or *quinquefid*, &c.; or *many-cleft*, in the Latin form *multifid*, — express the number of the *segments*, or portions.

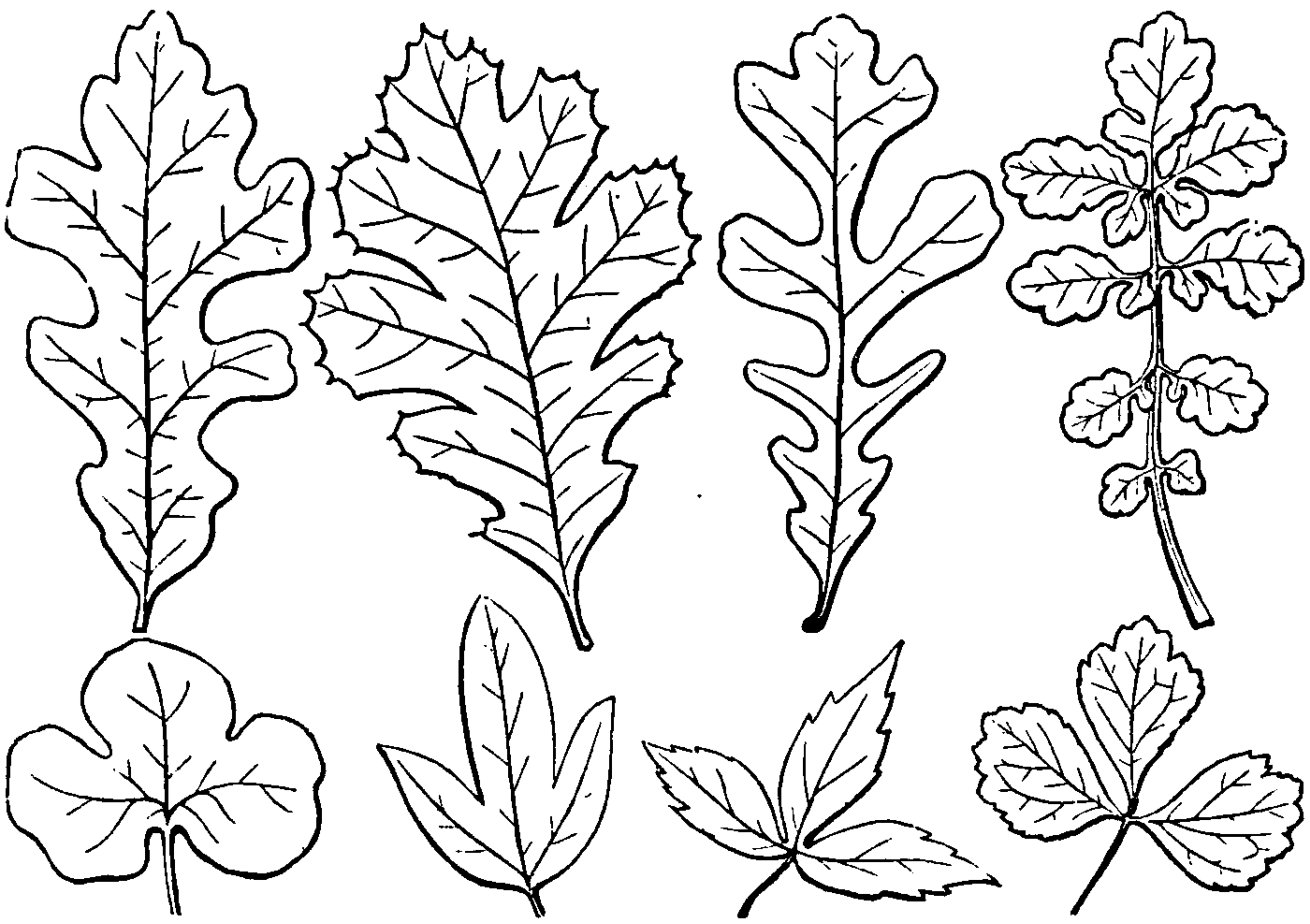
Parted, when the incisions are still deeper, but yet do not quite reach to the midrib or the base of the blade; as in Fig. 120, 124. And the terms *two-parted*, *three-parted*, &c. express the number of such divisions.

Divided, when the incisions extend quite to the midrib, as in the lower part of Fig. 121; or to the leaf-stalk, as in Fig. 125; which makes the leaf compound. Here, using the Latin form, the leaf is said to be *bisected*, *trisected* (Fig. 125), &c., to express the number of the divisions.

158. In this way the *degree* of division is described. We may likewise express the *mode* of division. The notches or incisions, being places where the green pulp of the blade has not wholly filled up the framework, correspond with the veining; as we perceive on comparing the figures 118 to 121 with figures 122 to 125. The

upper row of figures consists of *feather-veined*, or, in Latin form, *pinnately-veined* leaves (145); the lower row, of *radiate-veined* or *palmately-veined* leaves (146).

118 119 120 121



122 123 124 125

159. In the upper row the incisions all point towards the midrib, from which the main veins arise, the incisions (or *sinuses*) being between the main veins. That is, being *pinnately* veined, such leaves are *pinnately lobed* (Fig. 118), *pinnately cleft*, or *pinnatifid* (Fig. 119), *pinnately parted* (Fig. 120), or *pinnately divided* (Fig. 121), according to the depth of the incisions, as just defined.

160. In the lower row of figures, as the main veins or ribs all proceed from the base of the blade or the summit of the leaf-stalk, so the incisions all point in that direction. That is, *palmately*-veined leaves are *palmately lobed* (Fig. 122), *palmately cleft* (Fig. 123), *palmately parted* (Fig. 124), or *palmately divided* (Fig. 125). Sometimes, instead of palmately, we say *digitately* cleft, &c., which means just the same.

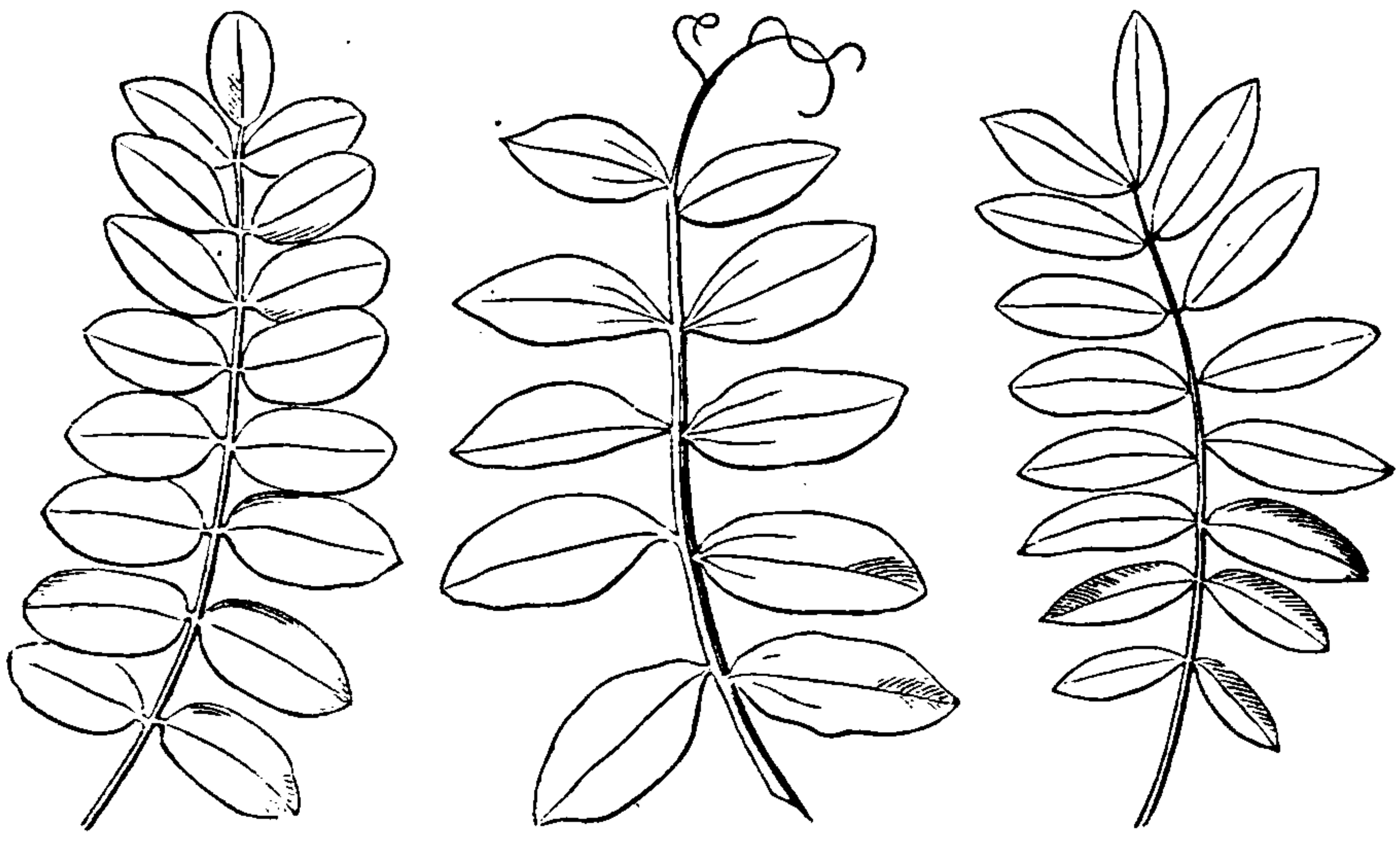
161. To be still more particular, the number of the lobes, &c. may come into the phrase. Thus, Fig. 122 is a *palmately three-lobed;* Fig. 123, a *palmately three-cleft;* Fig. 124, a *palmately three-parted;* Fig. 125, a *palmately three-divided*, or *trisected*, leaf. The

FIG. 118 - 121. Pinnately lobed, cleft, parted, and divided leaves.
FIG. 122 - 125. Palmately or digitately lobed, cleft, parted, and divided leaves.

Sugar-Maple and the Buttonwood (Fig. 50) have *palmately five-lobed leaves;* the Soft White-Maple *palmately five-parted leaves;* and so on. And in the other sort, the Post-Oak has *pinnately seven-* to *nine-lobed leaves;* the Red-Oak commonly has *pinnately seven-* to *nine-cleft leaves*, &c., &c.

162. The divisions, lobes, &c. may themselves be *entire* (without teeth or notches, 156), as in Fig. 118, 122, &c.; or *serrate* (Fig. 124), or otherwise toothed or incised (Fig. 121); or else lobed, cleft, parted, &c.: in the latter cases making *twice pinnatifid, twice palmately* or *pinnately lobed, parted,* or *divided* leaves, &c. From these illustrations, the student will perceive the plan by which the botanist, in two or three words, may describe any one of the almost endlessly diversified shapes of leaves, so as to convey a perfectly clear and definite idea of it.

163. **Compound Leaves.** These, as already stated (155), do not differ in any absolute way from the *divided* form of simple leaves. A compound leaf is one which has its blade in two or more entirely separate parts, each usually with a stalklet of its own: and the stalklet is often *jointed* (or *articulated*) with the main leaf-stalk, just as this is jointed with the stem. When this is the case, there is no



126 127 128

doubt that the leaf is compound. But when the pieces have no stalklets, and are not jointed with the main leaf-stalk, the leaf may be considered either as simple and divided, or compound, according to the circumstances.

FIG. 126. Pinnate with an odd leaflet, or odd-pinnate. 127. Pinnate with a tendril. 128. Abruptly pinnate leaf.

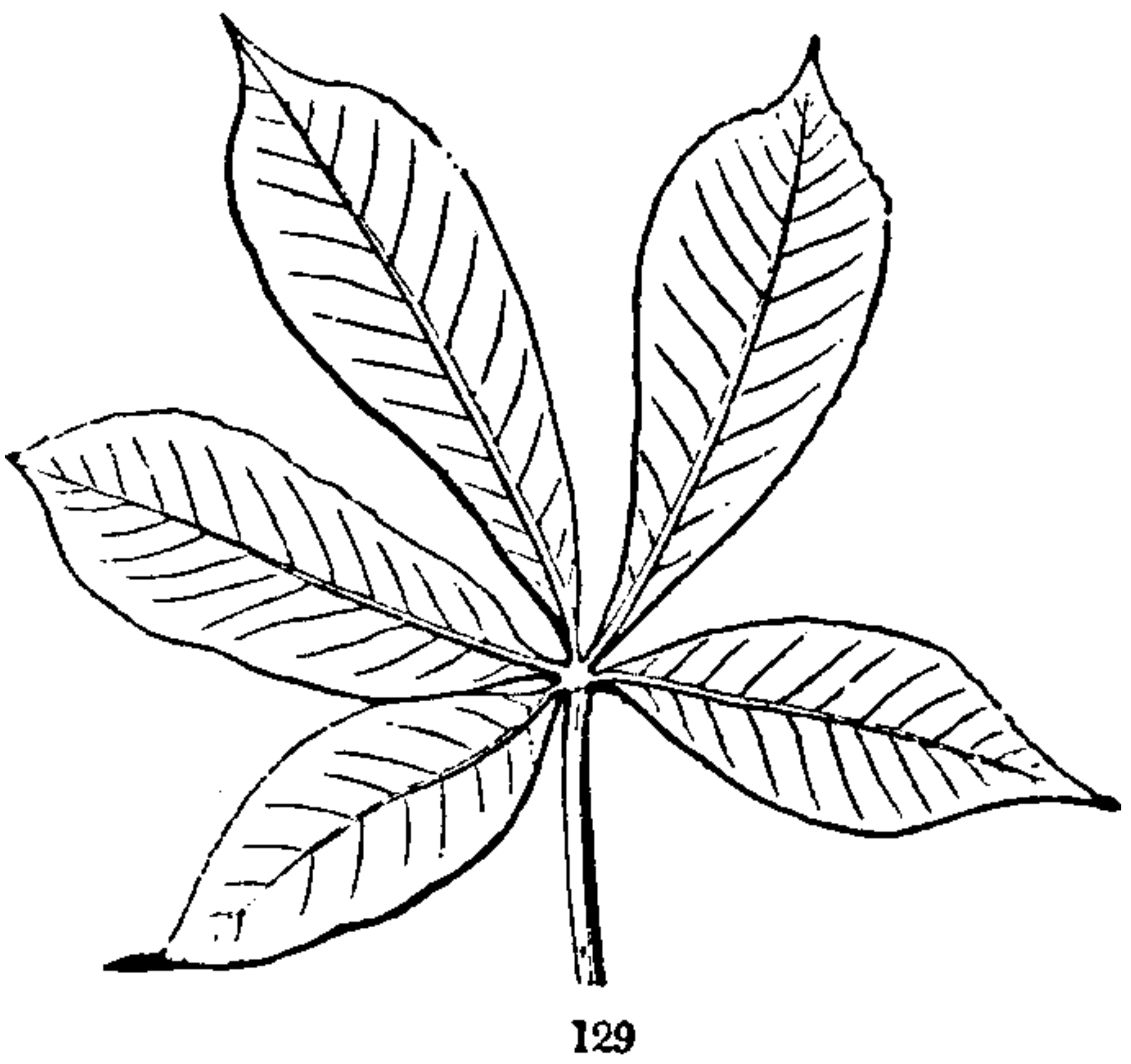
164. The separate pieces or little blades of a compound leaf are called *leaflets.*

165. Compound leaves are of two principal kinds, namely, the *pinnate* and the *palmate ;* answering to the two modes of veining in reticulated leaves (145 – 147), and to the two sorts of lobed or divided leaves (158, 159).

166. *Pinnate* leaves are those in which the leaflets are arranged on the sides of a main leaf-stalk ; as in Fig. 126 – 128. They answer to the *feather-veined* (i. e. *pinnately-veined*) simple leaf; as will be seen at once, on comparing Fig. 126 with the figures 118 to 121. The *leaflets* of the former answer to the *lobes* or *divisions* of the latter; and the continuation of the petiole, along which the leaflets are arranged, answers to the midrib of the simple leaf.

167. Three sorts of pinnate leaves are here given. Fig. 126 is *pinnate with an odd or end leaflet,* as in the Common Locust and the Ash. Fig. 127 is *pinnate with a tendril at the end,* in place of the odd leaflet, as in the Vetches and the Pea. Fig. 128 is *abruptly pinnate,* having a pair of leaflets at the end, like the rest of the leaflets ; as in the Honey-Locust.

168. *Palmate* (also named *digitate*) leaves are those in which the leaflets are all borne on the very tip of the leaf-stalk, as in the Lupine, the Common Clover (Fig. 136), the Virginia Creeper (Fig. 62), and the Horsechestnut and Buckeye (Fig. 129). They answer to the *radiate-veined* or *palmately-veined* simple leaf; as is seen by comparing Fig. 136 with the figures 122 to 125. That is, the Clover-leaf of three leaflets is the same as a palmately three-ribbed leaf cut into three separate leaflets. And such a simple five-lobed leaf as that of the Sugar-Maple, if more cut, so as to separate the parts, would produce a palmate leaf of five leaflets, like that of the Horsechestnut or Buckeye (Fig. 129).



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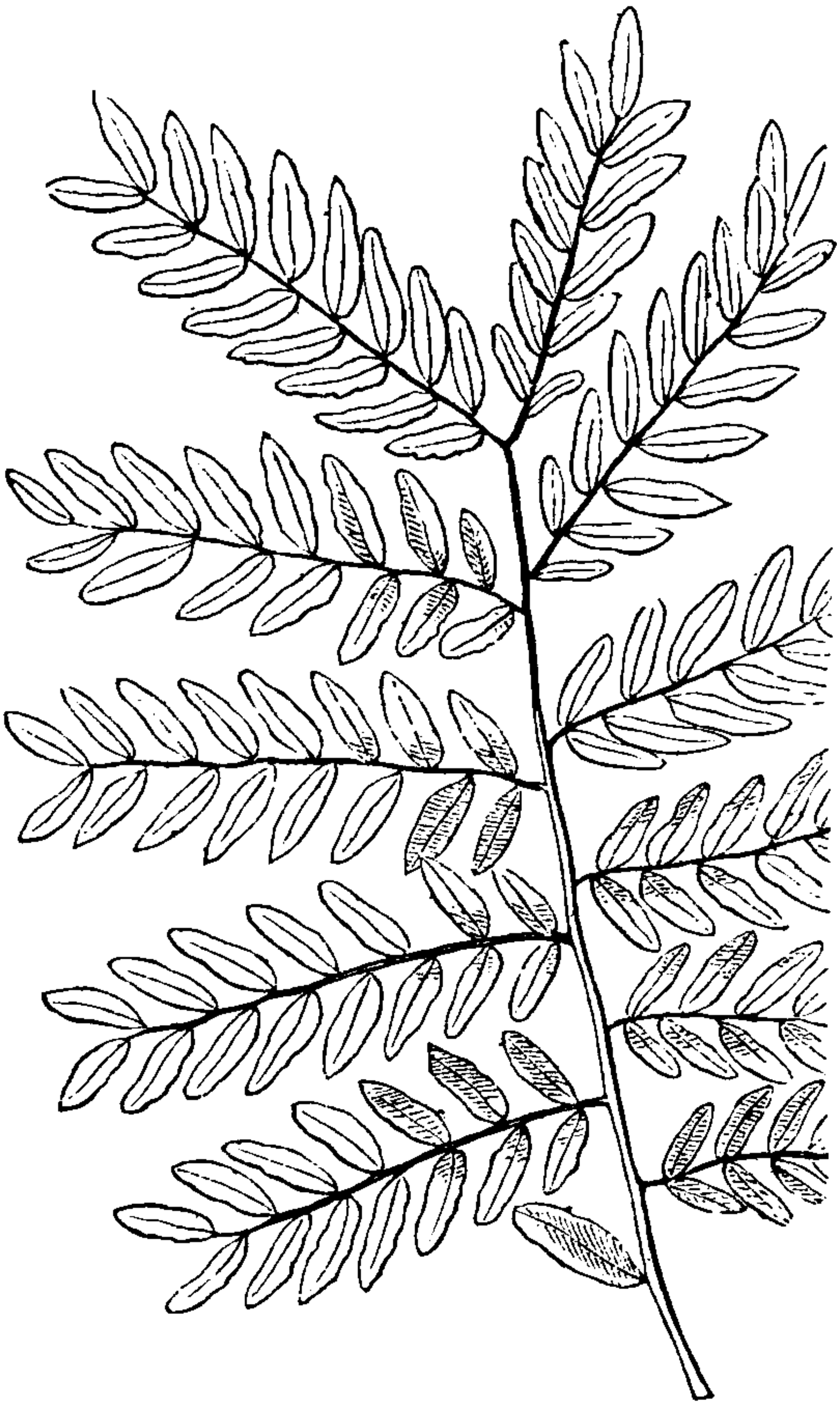
169. Either sort of compound leaf may have any number of leaflets ; though palmate leaves cannot well have a great many, since they are all crowded together on the end of the main leaf-stalk.

FIG. 129. Palmate leaf of five leaflets, of the Sweet Buckeye.

Some Lupines have nine or eleven; the Horsechestnut has seven, the Sweet Buckeye more commonly five, the Clover three. A pinnate leaf often has only seven or five leaflets, as in the Wild Bean or Groundnut; and in the Common Bean it has only three; in some rarer cases only two; in the Orange and Lemon only one! The joint at the place where the leaflet is united with the petiole alone distinguishes this last case from a simple leaf.*



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170. The leaflets of a compound leaf may be either *entire* (as in Fig. 126 – 128), or *serrate*, or lobed, cleft, parted, &c.: in fact, they may present all the variations of simple leaves, and the same terms equally apply to them.

171. When this division is carried so far as to separate what would be one leaflet into two, three, or several, the leaf becomes *doubly* or *twice compound*, either *pinnately* or *palmately*, as the case may be. For example, while some of the leaves of the Honey-Locust are *simply pinnate*, that is, *once pinnate*, as in Fig. 128, the greater part

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* When the botanist, in describing leaves, wishes to express the number o leaflets, he may use terms like these:—

Unifoliolate, for a compound leaf of a single leaflet; from the Latin *unum*, one. and *foliolum*, leaflet.

Bifoliolate, of two leaflets, from the Latin *bis*, twice, and *foliolum*, leaflet.

Trifoliolate (or *ternate*), of three leaflets, as the Clover; and so on.

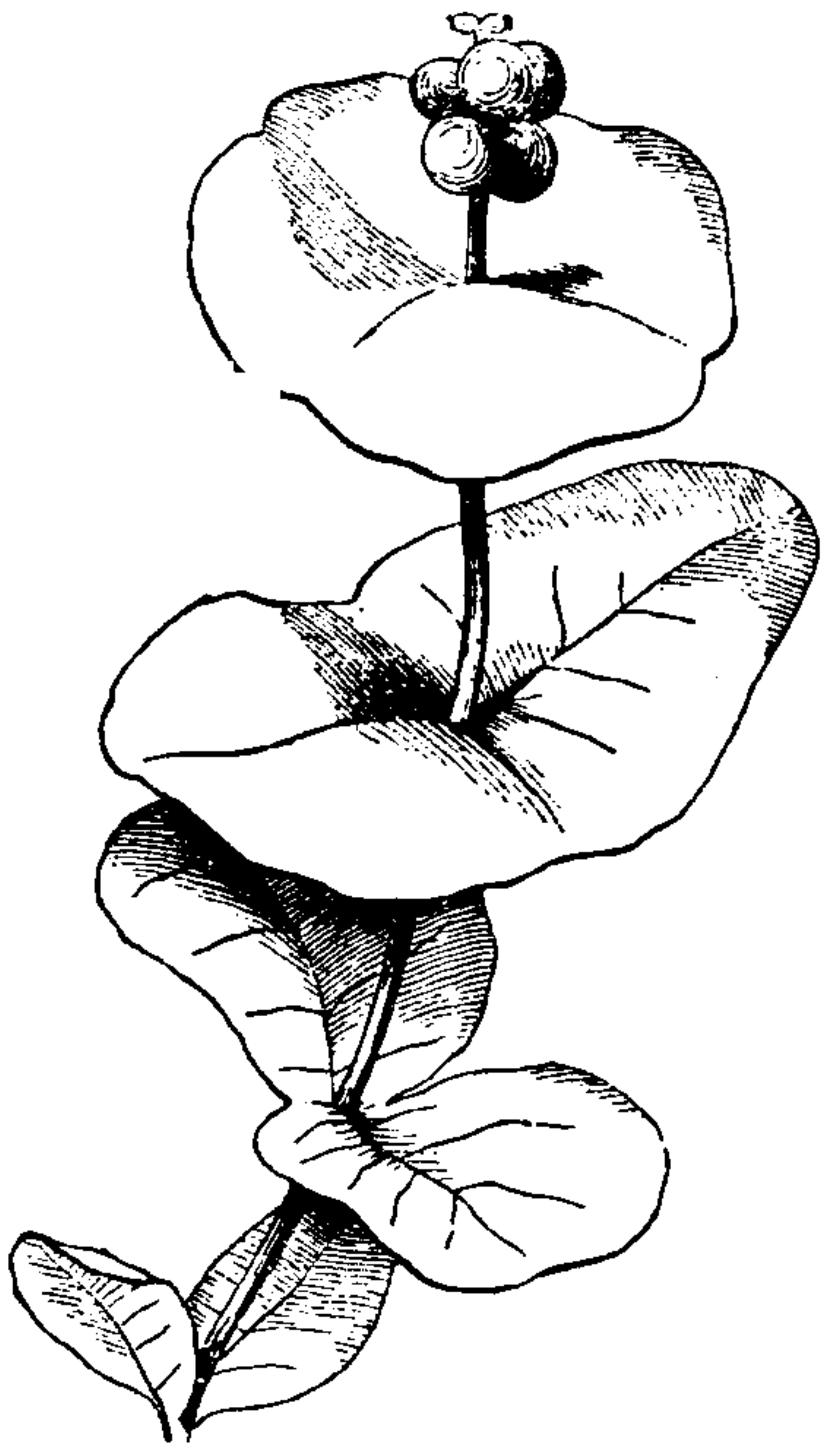
When he would express in one phrase both the number of leaflets and the way the leaf is compound, he writes:—

Palmately bifoliolate, trifoliolate, plurifoliolate (of several leaflets), &c., or else

Pinnately bi-, tri-, quadri-, or *pluri-foliolate* (that is, of two, three, four, five, or several leaflets), as the case may be.

FIG. 130. A twice-pinnate (abruptly) leaf of the Honev-Locust.

the true Honeysuckles (Fig. 132): but here it is a pair of opposite leaves, with their contiguous broad bases grown together, which makes what seems to be one round leaf, with the stem running through its centre. This is seen to be the case, by comparing together the upper and the lowest leaves of the same branch. Leaves of this sort are said to be *connate-perfoliate.*



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175. Equitant Leaves. While ordinary leaves spread horizontally, and present one face to the sky and the other to the earth, there are some that present their tip to the sky, and their faces right and left to the horizon. Among these are the *equitant* leaves of the Iris or Flower-de-Luce. On careful inspection we shall find that each leaf was formed *folded together lengthwise,* so that what would be the upper surface is within, and all grown together, except next the bottom, where each leaf covers the next younger one. It was from their straddling over each other, like a man on horseback (as is seen in the cross-section, Fig. 134), that Linnæus, with his lively fancy, called these *equitant* leaves.

176. Leaves with no distinction of Petiole and Blade. The leaves of Iris just mentioned show one form of this. The flat but narrow leaves of Jonquils, Daffodils, and the like, are other instances. *Needle-shaped* leaves, like those of the Pine (Fig. 140), Larch (Fig. 139), and Spruce, and the *awl-shaped* as well as the *scale-shaped* leaves of Junipers, Red Ce-

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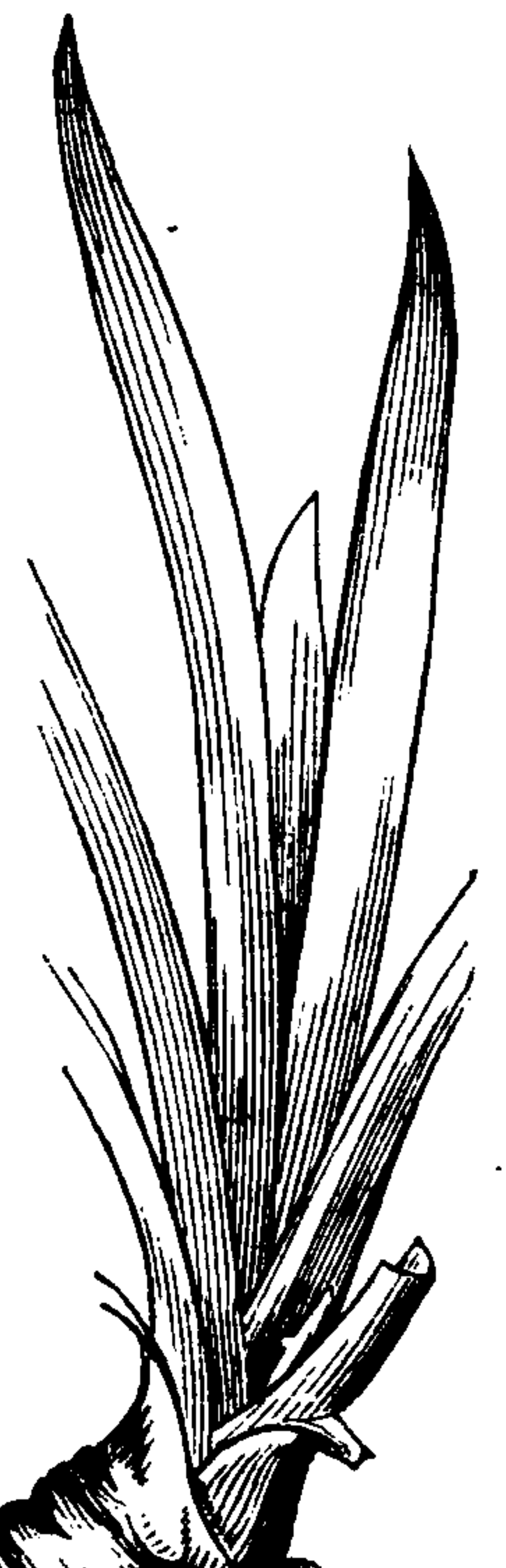

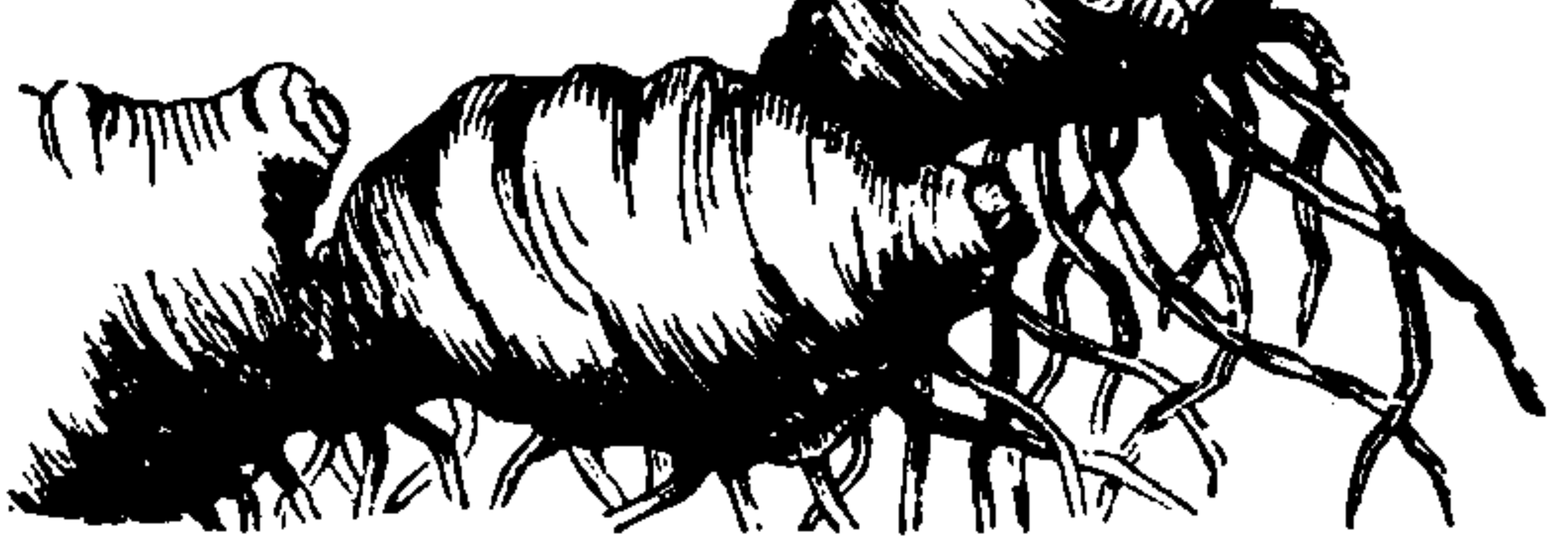

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FIG. 132. Branch of a Yellow Honeysuckle, with connate-perfoliate leaves.

FIG. 133. Rootstock and equitant leaves of Iris. 134. A section across the cluster of leaves at the bottom.

dar, and Arbor-Vitæ (Fig. 135), are different examples. These last are leaves serving for foliage, but having as little spread of surface as possible. They make up for this, however, by their immense numbers.

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177. Sometimes the *petiole* expands and flattens, and takes the place of the blade; as in numerous New Holland Acacias, some of which are now common in greenhouses. Such counterfeit blades are called *phyllodia*, — meaning leaf-like bodies. They may be known from true blades by their standing edgewise, their margins being directed upwards and downwards; while in true blades the faces look upwards and downwards; excepting in equitant leaves, as already explained, and in those which are turned edgewise by a twist, such as those of the Callistemon or Bottle-brush Flower of our greenhouses, and other Dry Myrtles of New Holland, &c.

178. **Stipules**, the pair of appendages which is found at the base of the petiole in many leaves (133), should also be considered in respect to their very varied forms and appearances. More commonly they appear like little blades, on each side of the leaf-stalk, as in the Quince (Fig. 83), and more strikingly in the Hawthorn and in the Pea. Here they remain as long as the rest of the leaf, and serve for the same purpose as the blade. Very commonly they serve for bud-scales, and fall off when the leaves expand, as in the Fig-tree, and the Magnolia (where they are large and conspicuous), or soon

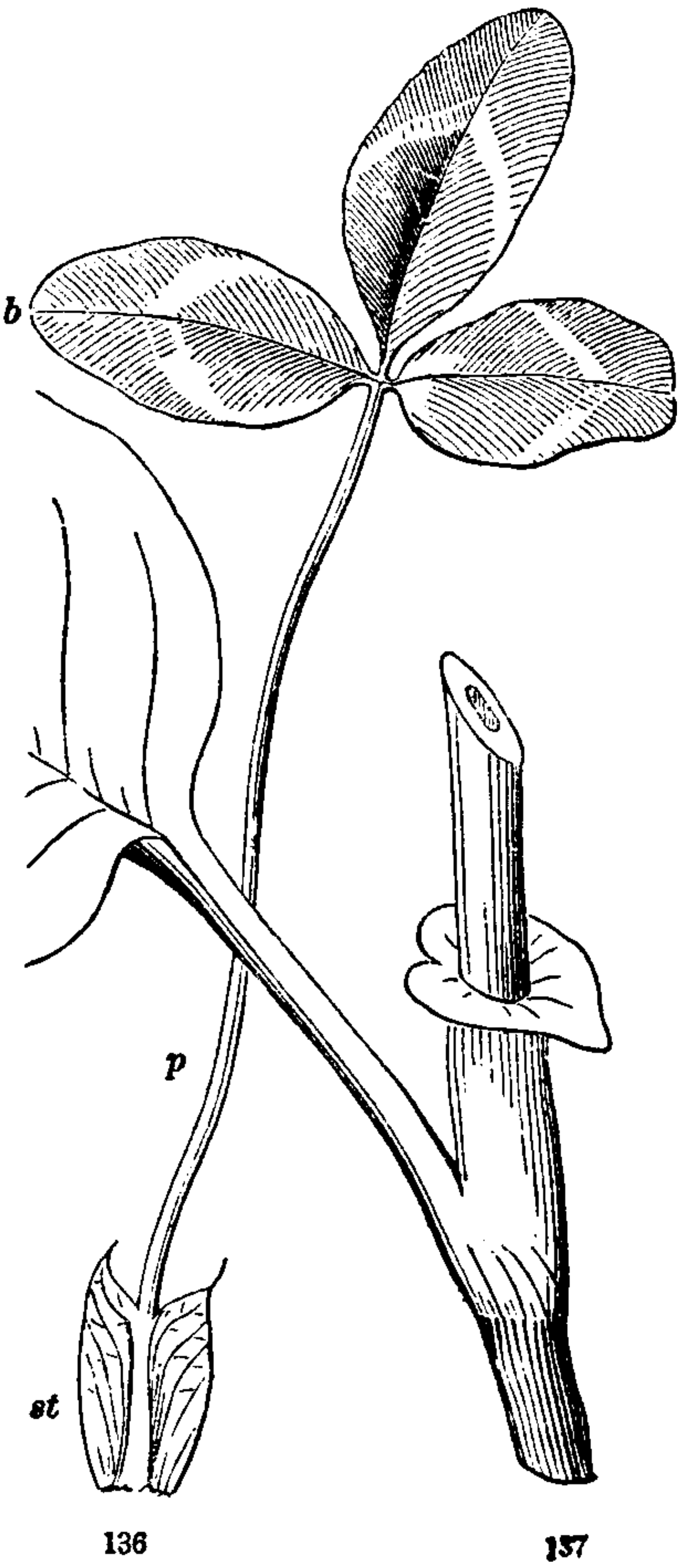

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FIG. 135. Twig of Arbor-Vitæ, with its two sorts of leaves: viz. some awl-shaped, the others scale-like; the latter on the branchlets, *a*.

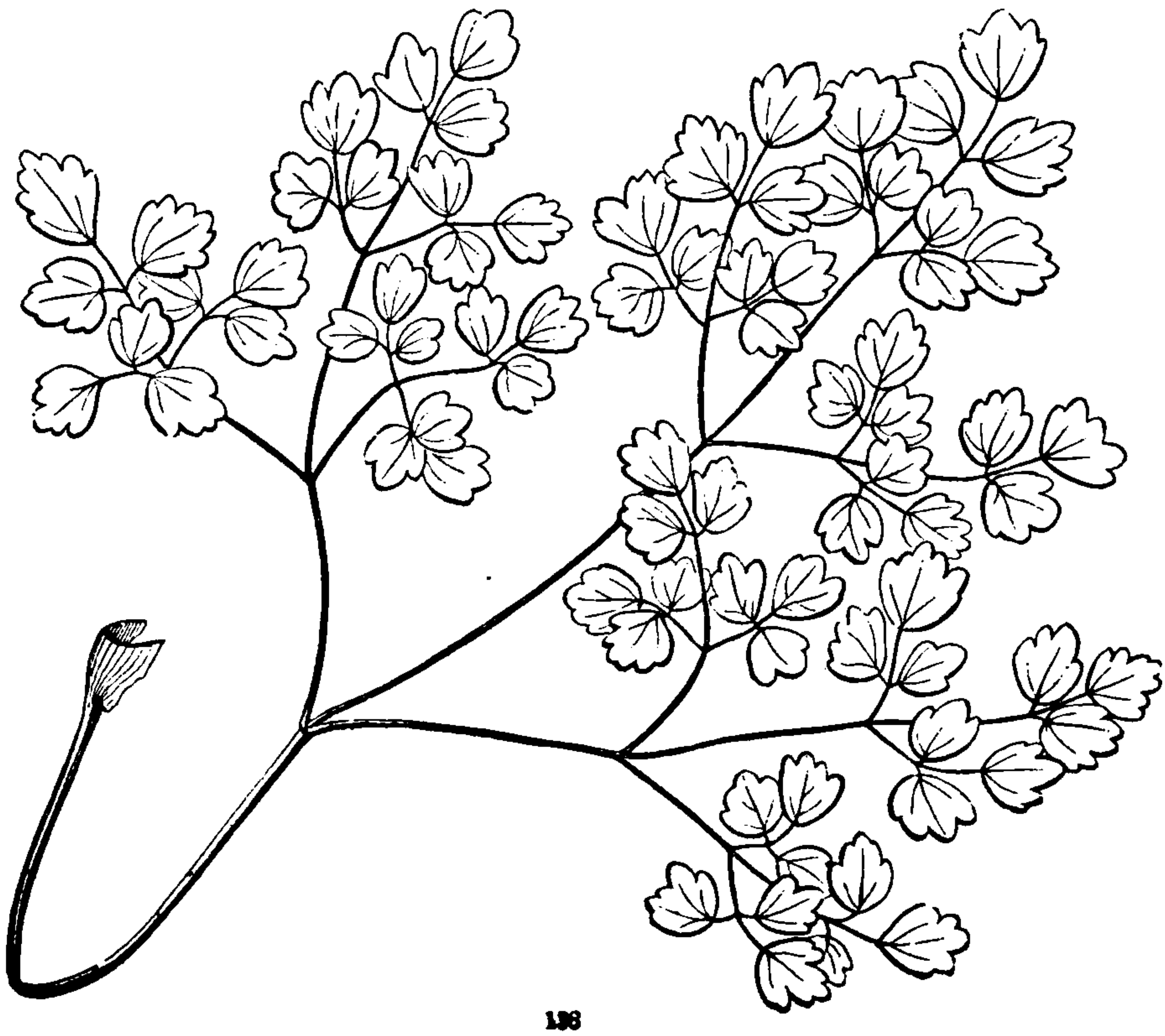
FIG. 136. Leaf of Red Clover: *st*, stipules, adhering to the base of *p*, the petiole: *b*, blade of three leaflets.

FIG. 137. Part of stem and leaf of Prince's-Feather (Polygonum orientale) with the united sheathing stipules forming a sheath.

afterwards, as in the Tulip-tree. In the Pea the stipules make a very conspicuous part of the leaf; while in the Bean they are quite small; and in the Locust they are reduced to bristles or prickles. Sometimes the stipules are separate and distinct (Fig. 83): often they are united with the base of the leaf-stalk, as in the Rose and the Clover (Fig. 136): and sometimes they grow together by both margins, so as to form a sheath around the stem, above the leaf, as in the Buttonwood, the Dock, and almost all the plants of the Polygonum Family (Fig. 137).

179. The sheaths of Grasses bear the blade on their summit, and therefore represent a form of the petiole. The small and thin appendage which is commonly found at the top of the sheath (called a *ligule*) here answers to the stipule.

FIG. 138. Ternately-decompound leaf of Meadow Rue (Thalictrum Cornuti).



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LESSON X.

THE ARRANGEMENT OF LEAVES.

180. UNDER this head we may consider, — 1. the arrangement of leaves on the stem, or what is sometimes called PHYLLOTAXY (from two Greek words meaning *leaf-order*); and 2. the ways in which they are packed together in the bud, or their VERNATION (the word meaning their spring state).

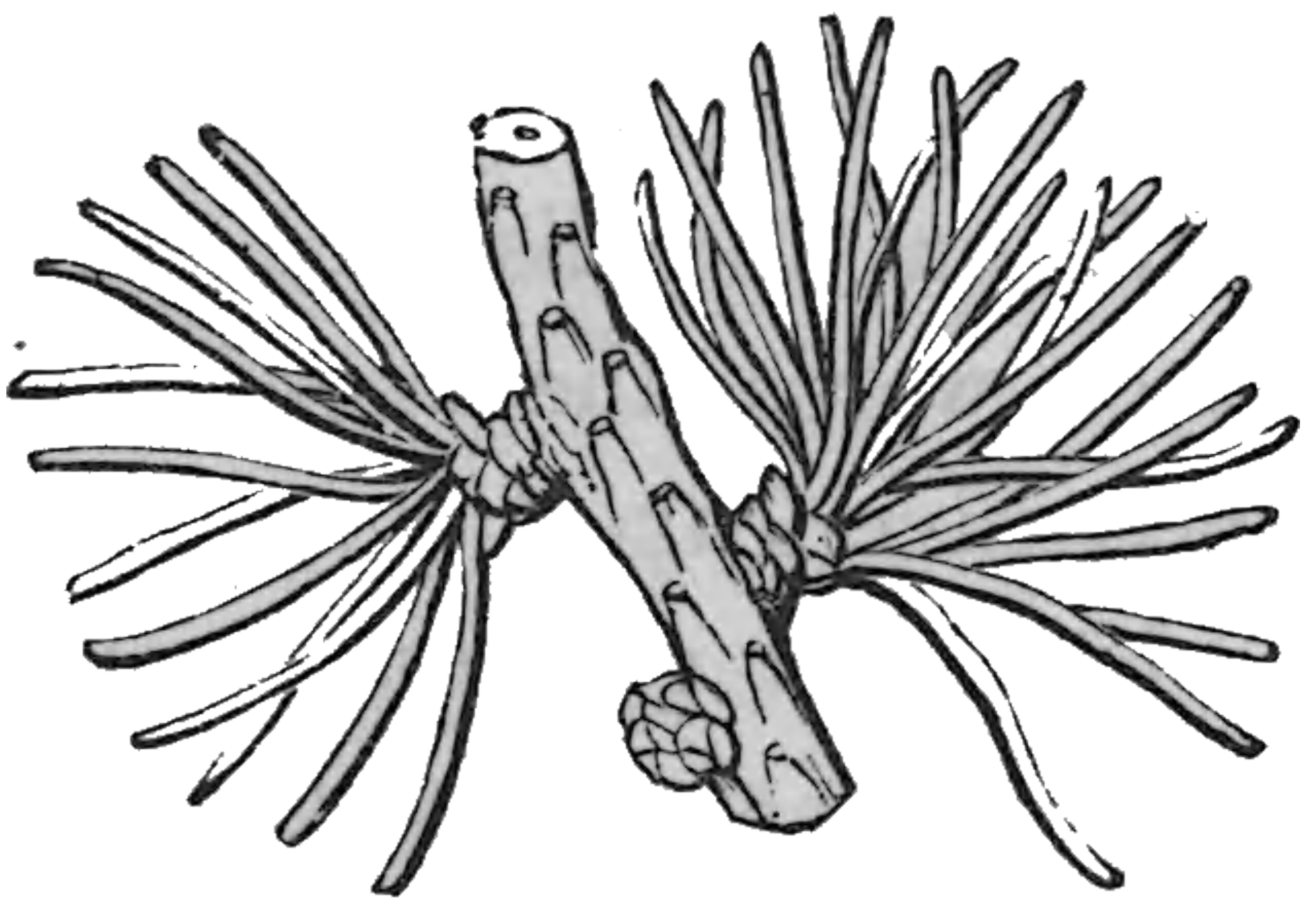
181. **Phyllotaxy.** As already explained (48, 49), leaves are arranged on the stem in two principal ways. They are either

Alternate (Fig. 131, 143), that is, one after another, only a single leaf arising from each node or joint of the stem; or

Opposite (Fig. 147), when there is a pair of leaves on each joint of the stem; one of the two leaves being in this case always situated exactly on the opposite side of the stem from the other. A third, but uncommon arrangement, may be added; namely, the

Whorled, or *verticillate* (Fig. 148), when there are three or more leaves in a circle (*whorl* or *verticil*) on one joint of stem. But this is only a variation of the opposite mode; or rather the latter arrangement is the same as the whorled, with the number of the leaves reduced to two in each whorl.

182. Only one leaf is ever produced from the same point. When two are borne on the same joint, they are always on opposite sides of the stem, that is, are separated by half the circumference; when in whorls of three, four, five, or any other number, they are equally distributed around the joint of stem, at a distance of one third, one fourth, or one fifth of the circumference from each other, according to their number. So they always have the greatest possible divergence from each other. Two or more leaves belonging to the same joint of stem never stand side by side, or one above the other, in a cluster.



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183. What are called *clustered* or *fascicled* leaves, and which

FIG. 139. Clustered or fascicled leaves of the Larch.

appear to be so, are always the leaves of a whole branch which remains so very short that they are all crowded together in a bundle or rosette; as in the spring leaves of the Barberry and of the Larch (Fig. 139). In these cases an examination shows them to be nothing else than alternate leaves, very much crowded on a short spur; and some of these spurs are seen in the course of the season to lengthen into ordinary shoots with scattered alternate leaves. So, likewise, each cluster of two or three needle-shaped leaves in Pitch Pines (as in Fig. 140), or of five leaves in White Pine, answers to a similar, extremely short branch, springing from the axil of a thin and slender scale, which represents a leaf of the main shoot. For Pines produce two kinds of leaves; — 1. primary, the proper leaves of the shoots, not as foliage, but in the shape of delicate scales in spring, which soon fall away; and 2. secondary, the *fascicled* leaves, from buds in the axils of the former, and these form the actual foliage.

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184. **Spiral Arrangement of Leaves.** If we examine any alternate-leaved stem, we shall find that the leaves are placed upon it in symmetrical order, and in a way perfectly uniform for each species, but different in different plants. If we draw a line from the *insertion* (i. e. the point of attachment) of one leaf to that of the next, and so on, this line will wind spirally around the stem as it rises, and in the same species will always have just the same number of leaves upon it for each turn round the stem. That is, any two successive leaves will always be separated from each other by just an equal portion of the circumference of the stem. The distance in *height* between any two leaves may vary greatly, even on the same shoot, for that depends upon the length of the *internodes* or spaces between each leaf; but the distance as measured around the circumference (in other words, the *angular divergence*, or angle formed by any two successive leaves) is uniformly the same.

185. The greatest possible divergence is, of course, where the second leaf stands on exactly the opposite side of the stem from the first, the third on the side opposite the second, and therefore over the

FIG. 140. Piece of a branchlet of Pitch Pine, with three leaves in a fascicle or bundle, in the axil of a thin scale which answers to a primary leaf. The bundle is surrounded at the base by a short sheath, formed of the delicate scales of the axillary bud.

first, and the fourth over the second. This brings all the leaves into two ranks, one on one side of the stem and one on the other; and is therefore called the *two-ranked* arrangement. It occurs in all Grasses, — in Indian Corn, for instance; also in the Spiderwort, the Bellwort (Fig. 131) and Iris (Fig. 132), in the Basswood or Lime-tree, &c. This is the simplest of all arrangements.

186. Next to this is the *three-ranked* arrangement, such as we see in Sedges, and in the Veratrum or White Hellebore. The plan of it is shown on a Sedge in Fig. 141, and in a diagram or cross-section underneath, in Fig. 142. Here the second leaf is placed one third of the way round the stem, the third leaf two thirds of the way round, the fourth leaf accordingly directly over the first, the fifth over the second, and so on. That is, three leaves occur in each turn round the stem, and they are separated from each other by one third of the circumference.

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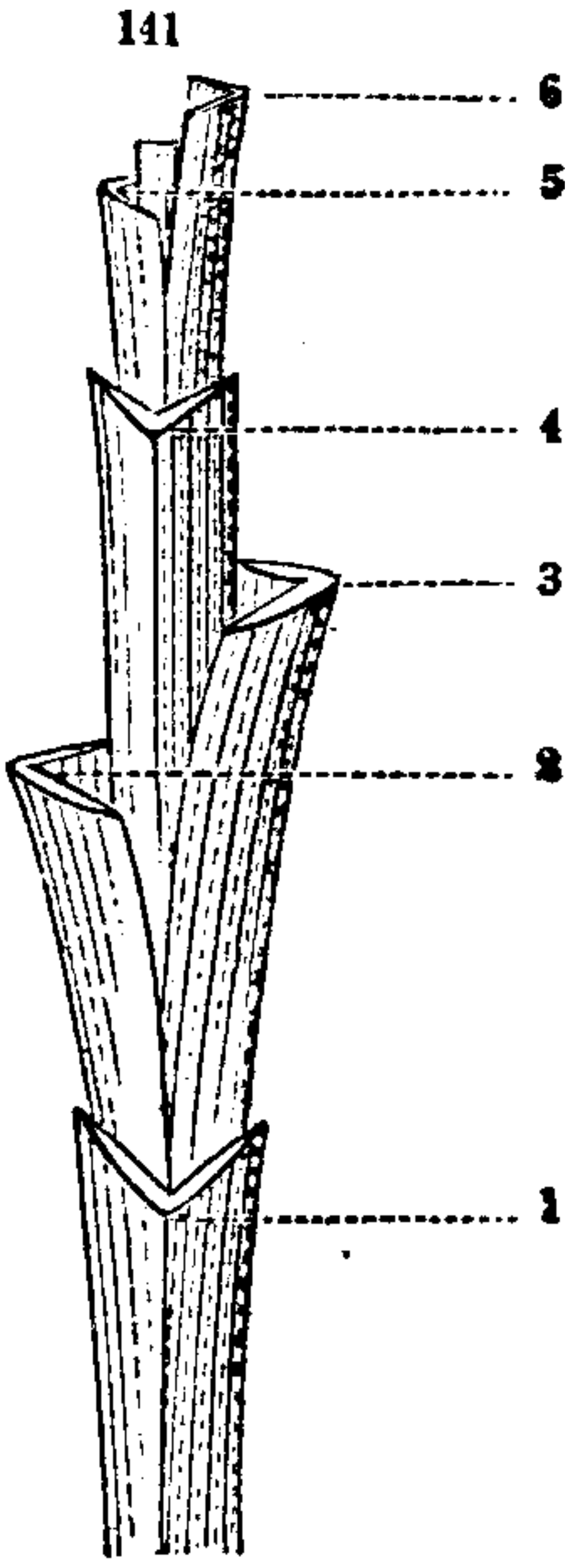

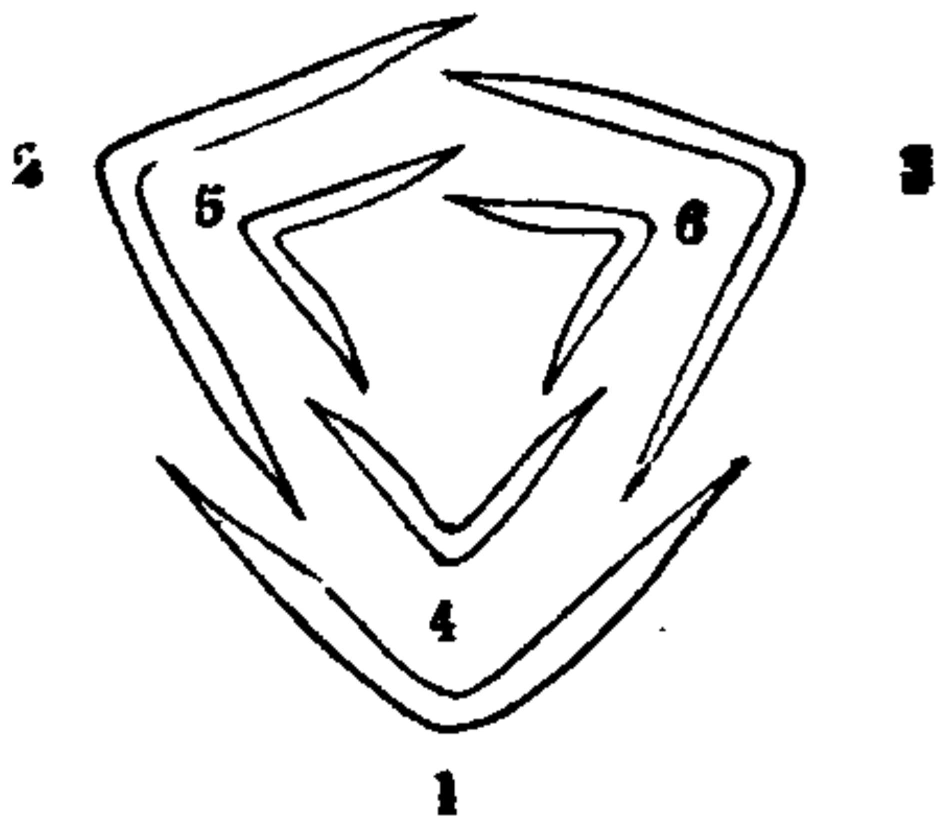

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187. The next and one of the most common is the *five-ranked* arrangement; which is seen in the Apple (Fig. 143), Cherry, Poplar, and the greater part of our trees and shrubs. In this case the line traced from leaf to leaf will pass twice round the stem before it reaches a leaf situated directly over any below (Fig. 144). Here the sixth leaf is over the first; the leaves stand in five perpendicular ranks, equally distant from each other; and the distance between any two successive leaves is just two fifths of the circumference of the stem.

188. The five-ranked arrangement is expressed by the fraction $\frac{2}{5}$. This fraction denotes the divergence of the successive leaves, i. e. the angle they form with each other: the numerator also expresses the number of turns made round the stem by the spiral line in completing one cycle or set of leaves, namely 2; and the denominator gives the number of leaves in each cycle, or the number of perpendicular

FIG. 141. Piece of the stalk of a Sedge, with the leaves cut away, leaving their bases; the leaves are numbered in order, from 1 to 6. 142. Diagram or cross-section of the same, all in one plane; the leaves similarly numbered.

ranks, namely 5. In the same way the fraction $\frac{1}{2}$ stands for the two-ranked mode, and $\frac{1}{3}$ for the three-ranked: and so these different sorts are expressed by the series of fractions $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$. And the other cases known follow in the same numerical progression.

143

189. The next is the *eight-ranked* arrangement, where the ninth leaf stands over the first, and three turns are made around the stem to reach it; so it is expressed by the fraction $\frac{3}{8}$. This is seen in the Holly, and in the common Plantain. Then comes the *thirteen-ranked* arrangement, in which the fourteenth leaf is over the first, after five turns around the stem. Of this we have a good example in the common Houseleek (Fig. 146).

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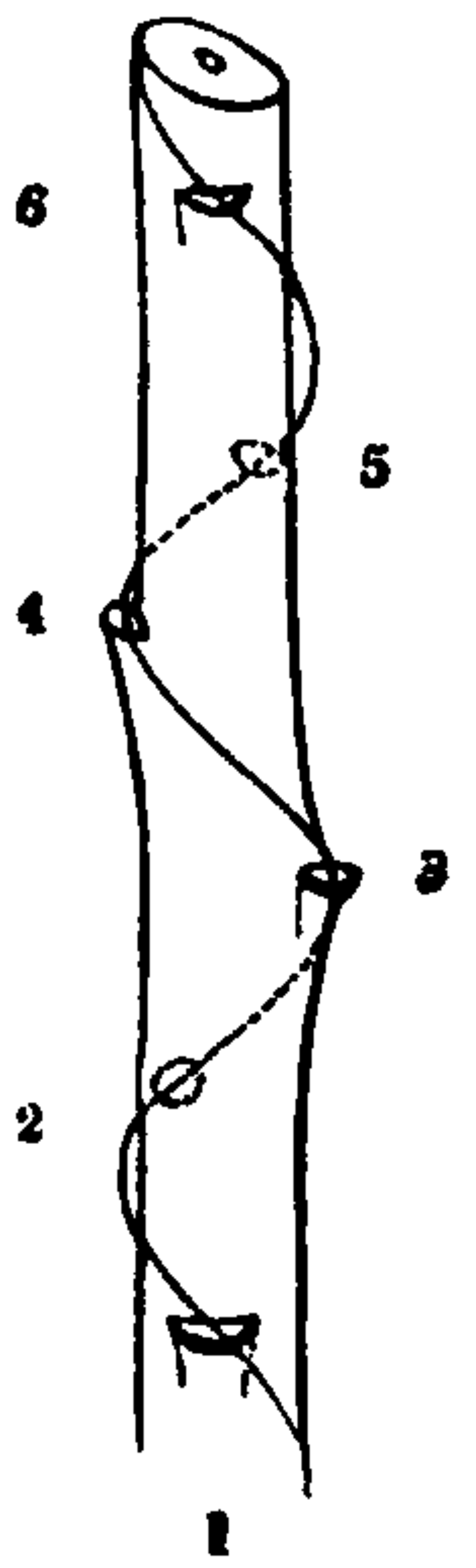
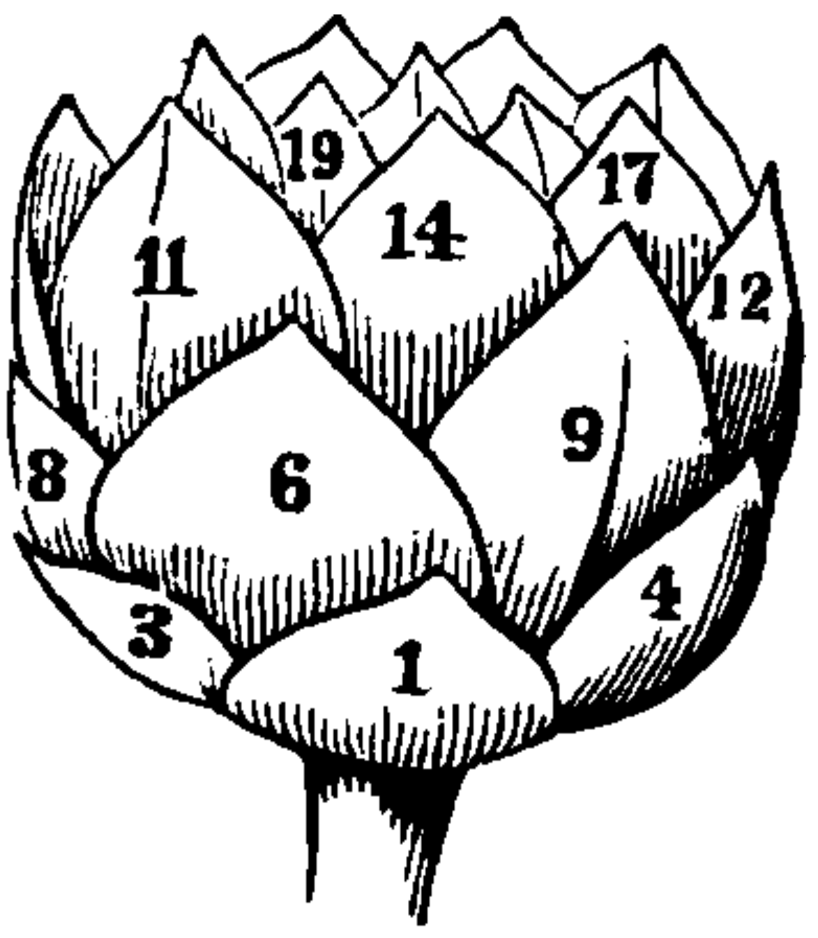


190. The series so far, then, is $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$; the numerator and the denominator of each fraction being those of the two next preceding ones added together. At this rate the next higher should be $\frac{8}{21}$, then $\frac{13}{34}$, and so on; and in fact just such cases are met with, and (commonly) no others. These higher sorts are found in the Pine Family, both in the leaves and the cones (Fig. 324), and in many other plants with small and crowded leaves. But the number of the ranks, or of leaves in each cycle, can here rarely be made out by direct inspection: they may be ascertained, however, by certain simple mathematical computations, which are rather too technical for these Lessons.



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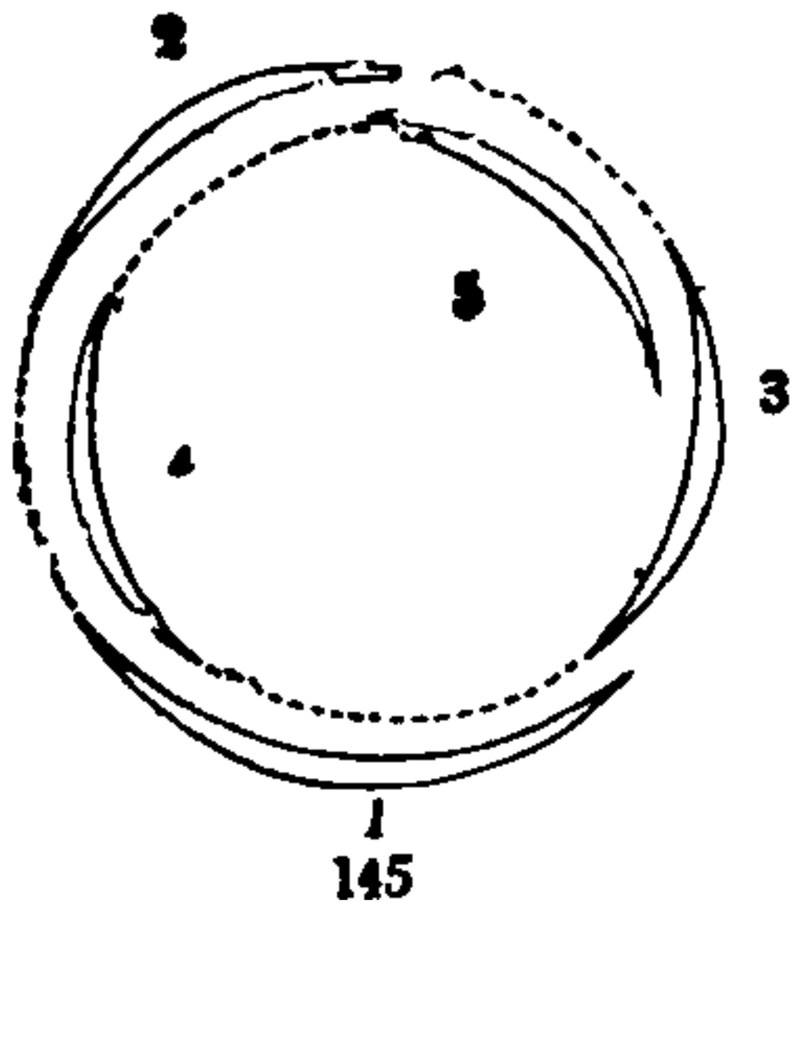

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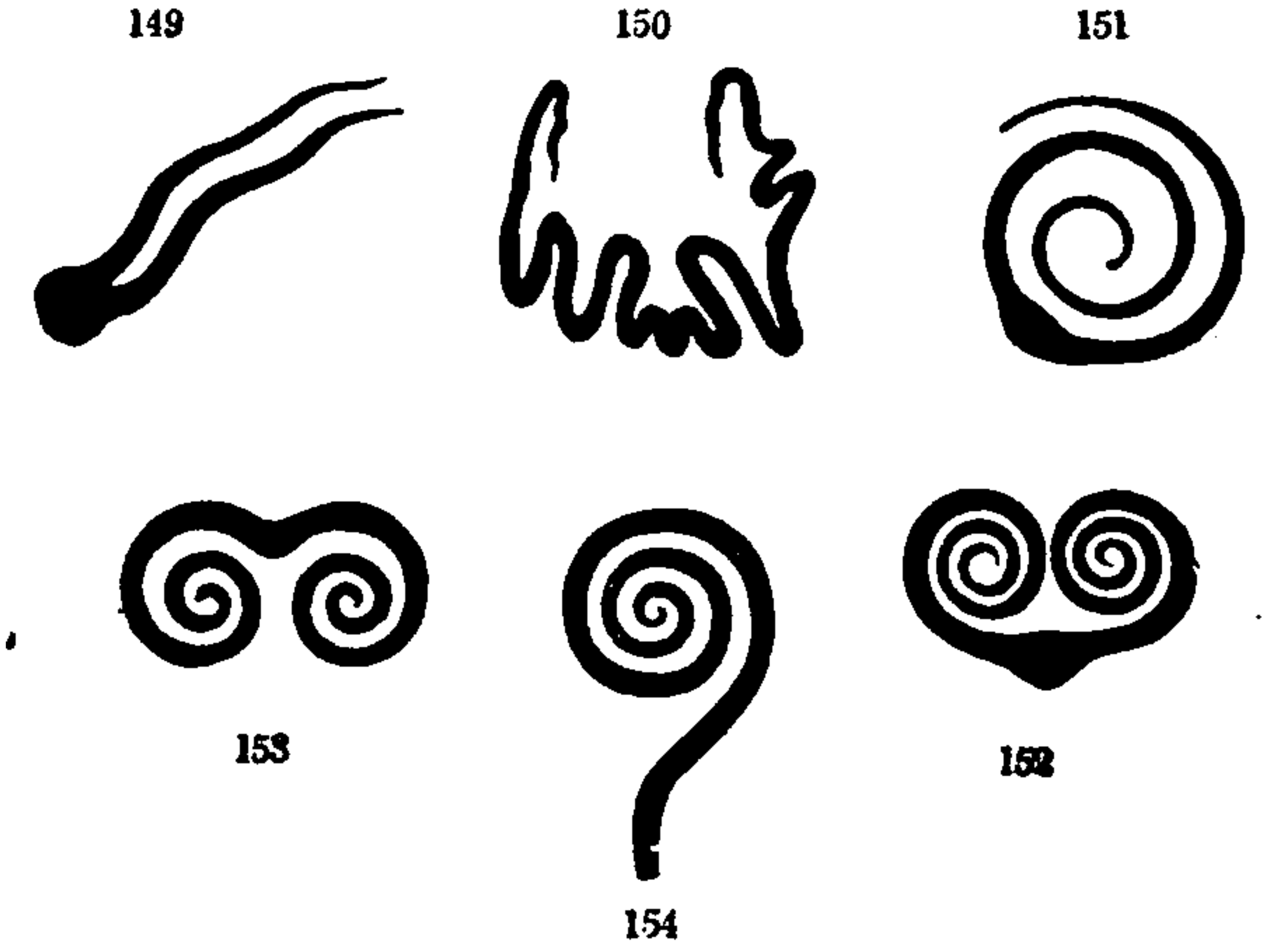
FIG. 143. Shoot with its leaves 5-ranked, the sixth leaf over the first; as in the Apple-tree.

FIG. 144. Diagram of this arrangement, with a spiral line drawn from the attachment of one leaf to the next, and so on; the parts on the side turned from the eye are fainter.

FIG. 145. A ground-plan of the same; the section of the leaves similarly numbered; a dotted line drawn from the edge of one leaf to that of the next completes the spiral.

FIG. 146. A young plant of the Houseleek, with the leaves (not yet expanded) numbered, and exhibiting the 13-ranked arrangement.

by the midrib so that the two halves are placed face to face, it is *conduplicate* (Fig. 149), as in the Magnolia, the Cherry, and the Oak: when folded back and forth like the plaits of a fan, it is *plicate* or *plaited* (Fig. 150), as in the Maple and Currant. If rolled, it may be so either from the tip downwards, as in Ferns and the Sundew (Fig. 154), when in unrolling it resembles the head of a crosier, and is said to be *circinate;* or it may be rolled up parallel with the axis, either from one edge into a coil, when it is *convolute* (Fig. 151), as in the Apricot and Plum, or rolled from both edges towards the midrib; — sometimes inwards, when it is *involute* (Fig. 152), as in the Violet and Water-Lily; sometimes outwards, when it is *revolute* (Fig. 153), in the Rosemary and Azalea. The figures are diagrams, representing sections through the leaf, in the way they were represented by Linnæus.



LESSON XI.

THE ARRANGEMENT OF FLOWERS ON THE STEM, OR INFLORESCENCE.

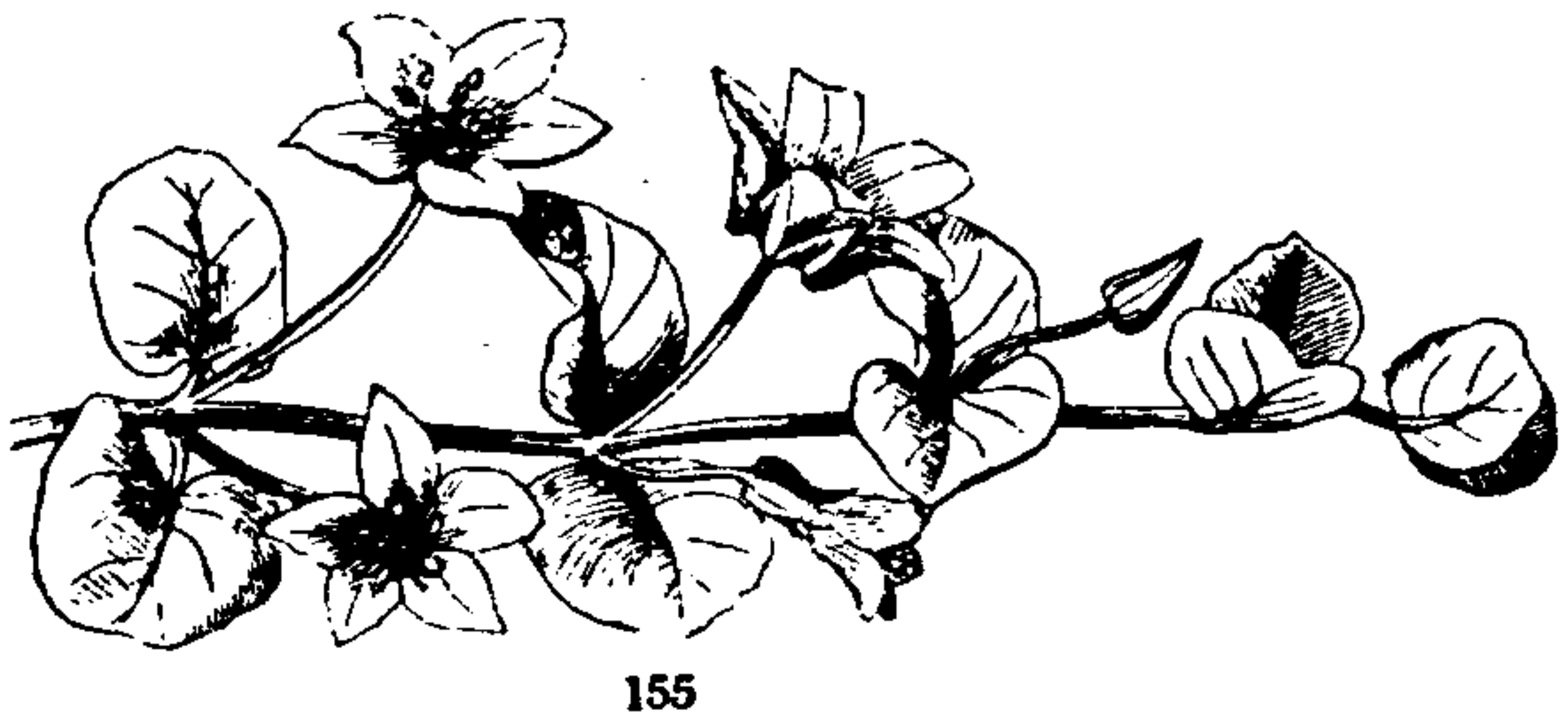
195. THUS far we have been considering the *vegetation* of the plant, and studying those parts, viz. root, stem, and leaves, by which it increases in size and extent, and serves the purpose of its individual life. But after a time each plant produces a different set of organs, — viz. flowers, fruit, and seed, — subservient to a different purpose, that is, the increase in numbers, or the continuance of the

species. The plant reproduces itself in new individuals by seed. Therefore the *seed*, and the *fruit* in which the seed is formed, and the *flower*, from which the fruit results, are named the *Organs of Reproduction* or *Fructification*. These we may examine in succession. We begin, of course, with the flower. And the first thing to consider is the

196. **Inflorescence**, or the mode of flowering, that is, the situation and arrangement of blossoms on the plant. Various as this arrangement may seem to be, all is governed by a simple law, which is easily understood. As the position of every leaf is fixed beforehand by a mathematical law which prescribes where it shall stand (192), so is that of every blossom;—and by the same law in both cases. For flowers are buds, developed in a particular way; and flower-buds occupy the position of leaf-buds, and no other As leaf-buds are either terminal (at the summit of a stem or branch, 42), or axillary (in the axil of a leaf, 43), so likewise

197. Flowers are either *terminal* or *axillary*. In blossoming as in vegetation we have only buds terminating (i. e. on the summit of) stems or branches, and buds from the axils of leaves. But while the same plant commonly produces both kinds of leaf-buds, it rarely bears flowers in both situations. These are usually either all axillary or all terminal;—giving rise to two classes of inflorescence, viz. the *determinate* and the *indeterminate*.

198. **Indeterminate Inflorescence** is that where the flowers all arise from axillary buds; as in Fig. 155, 156, 157, &c.; and the reason why it is called indeterminate (or *indefinite*) is, that while the axillary buds give rise to flowers, the terminal bud goes on to grow, and continues the stem indefinitely.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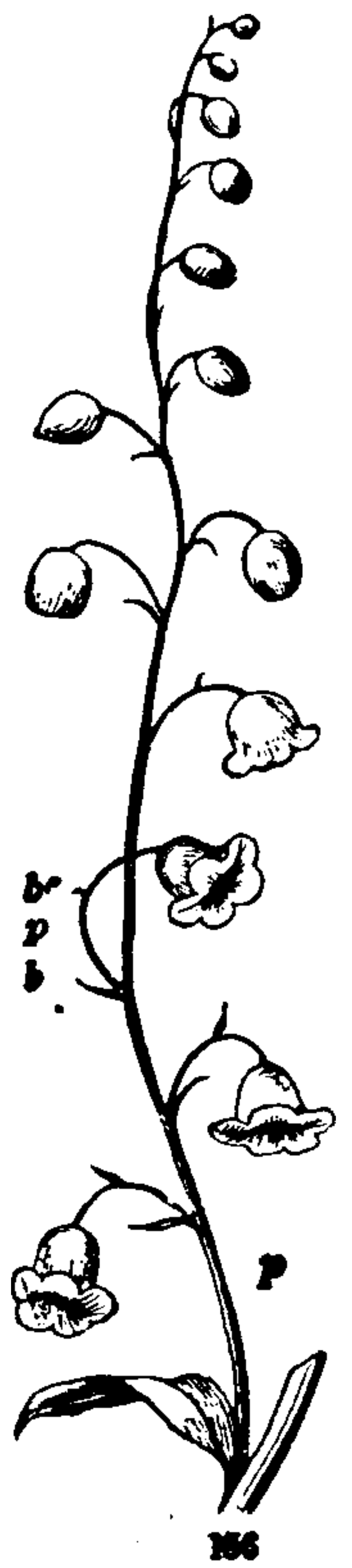
199. Where the flowers arise, as in Fig. 155, singly from the axils of the ordinary leaves of the plant, they do not form flower-clusters, but are *axillary* and *solitary*. But when several or many flowers are produced near each other, the accompanying leaves are usually of smaller size, and often of a different shape or character: then they are called *bracts*; and the flowers thus brought together

FIG. 155 Moneywort (Lysimachia nummularia) of the gardens, with axillary flowers form one cluster or inflorescence. The sorts of inflorescence of the indeterminate class which have received separate names are chiefly the following: viz. the *Raceme*, the *Corymb*, the *Umbel*, the *Spike*, the *Head*, the *Spadix*, the *Catkin*, and the *Panicle*.

200. Before illustrating these, one or two terms, of common occurrence, may be defined. A flower (or other body) which has no stalk to support it, but which sits directly on the stem or axis it proceeds from, is said to be *sessile*. If it has a stalk, this is called its *peduncle*. If the whole flower-cluster is raised on a stalk, this is called the peduncle, or the *common peduncle* (Fig. 156, *p*); and the stalk of each particular flower, if it have any, is called the *pedicel* or *partial peduncle* (*p'*). The portion of the general stalk along which flowers are disposed is called the *axis of inflorescence*, or, when covered with sessile flowers, the *rhachis* (back-bone), and sometimes the *receptacle*. The leaves of a flower-cluster generally are termed *bracts*. But when we wish particularly to distinguish them, those on the peduncle, or main axis, and which have a flower in their axil, take the name of *bracts* (Fig. 156, *b*); and those on the pedicels or partial flower-stalks, if any, that of *bractlets* (Fig. 156, *b'*).



201. **A Raceme** (Fig. 156, 157) is that form of flower-cluster in which the flowers, each on their own foot-stalk or pedicel, are arranged along a common stalk or axis of inflorescence; as in the Lily of the Valley, Currant, Choke-Cherry, Barberry, &c. Each flower comes from the axil of a small leaf, or bract, which, however, is often so small that it might escape notice, and which sometimes (as in the Mustard Family) disappears altogether. The lowest blossoms of a raceme are of course the oldest, and therefore open first, and the order of blossoming is *ascending*, from the bottom to the top. The summit, never being stopped by a terminal flower, may go on to grow, and often does so (as in the common Shepherd's Purse), producing lateral flowers one after another the whole summer long.

202. All the various kinds of flower-clusters pass one into another

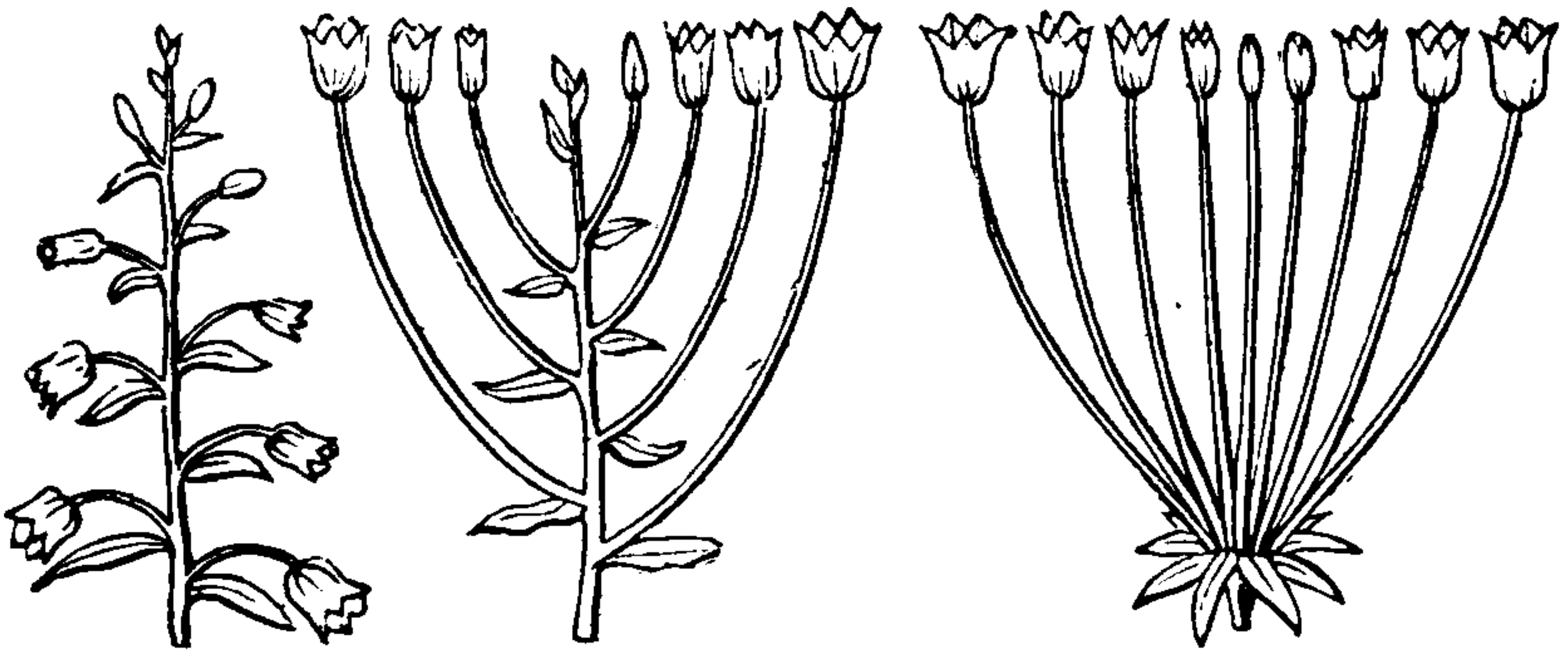
FIG. 156. A Raceme, with a general peduncle (*p*), pedicels (*p'*), bracts (*b*), and bractlets (*b'*).

by intermediate gradations of every sort. For instance, if we lengthen the lower pedicels of a raceme, and keep the main axis rather short, it is converted into

203. **A Corymb** (Fig. 158). This is the same as a raceme, except that it is flat and broad, either convex, or level-topped, as in the Hawthorn, owing to the lengthening of the lower pedicels while the uppermost remain shorter.

204. The main axis of a corymb is short, at least in comparison with the lower pedicels. Only suppose it to be so much contracted that the bracts are all brought into a cluster or circle, and the corymb becomes

205. **An Umbel** (Fig. 159), — as in the Milkweed and Primrose, — a sort of flower-cluster where the pedicels all spring apparently from the same point, from the top of the peduncle, so as to resemble, when spreading, the rays of an umbrella, whence the name. Here the pedicels are sometimes called the *rays* of the umbel. And the bracts, when brought in this way into a cluster or circle, form what is called an *involucre.*



157 158 159

206. For the same reason that the order of blossoming in a raceme is ascending (201), in the corymb and umbel it is *centripetal*, that is, it proceeds from the margin or circumference regularly towards the centre; the lower flowers of the former answering to the outer ones of the latter. Indeterminate inflorescence, therefore, is said to be centripetal in evolution. And by having this order of blossoming, all the sorts may be distinguished from those of the other, or the determinate class. In all the foregoing cases the flowers are raised on pedicels. These, however, are very short in many instances, or are wanting altogether; when the flowers are *sessile* (200). They are so in

FIG. 157. A raceme. 158 A corymb. 159. An umbel.

207. **The Spike.** This is a flower-cluster with a more or less lengthened axis, along which the flowers are sessile or nearly so; as in the Mullein and the Plantain (Fig. 160). It is just the same as a raceme, therefore, without any pedicels to the flowers.

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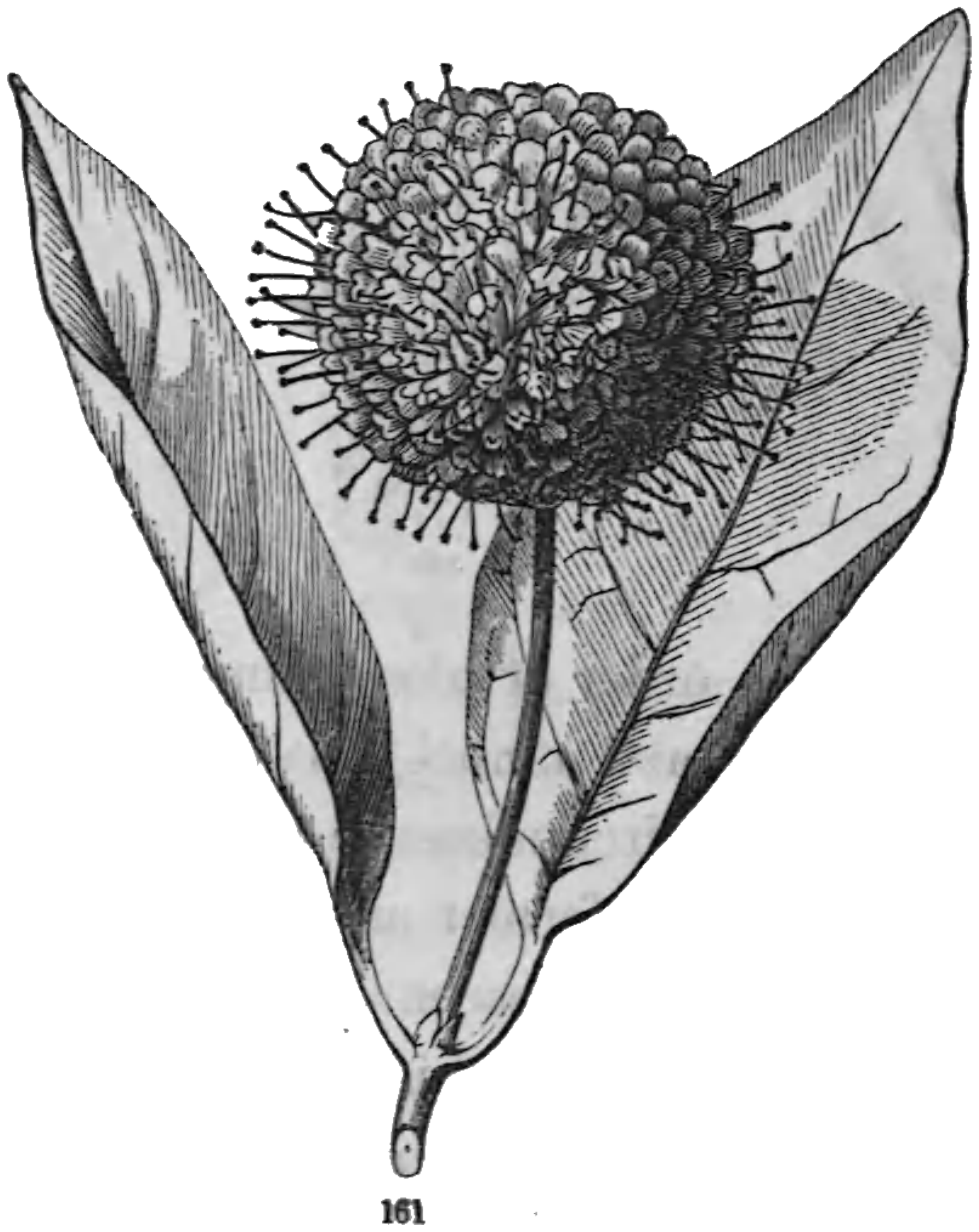
208. **The Head** is a round or roundish cluster of flowers which are sessile on a very short axis or receptacle, as in the Button-ball, Button-bush (Fig. 161), and Red Clover. It is just what a spike would become if its axis were shortened; or an umbel, if its pedicels were all shortened until the flowers became sessile or apparently so. The head of the Button-bush (Fig. 161) is naked; but that of the Thistle, of the Dandelion, the Cichory (Fig. 221), and the like, is surrounded by empty bracts, which form an *involucre.* Two particular forms of the spike and the head have received particular names, namely, the *Spadix* and the *Catkin.*

209. **A Spadix** is nothing but a fleshy spike or head, with small and often imperfect flowers, as in the Calla, the Indian Turnip



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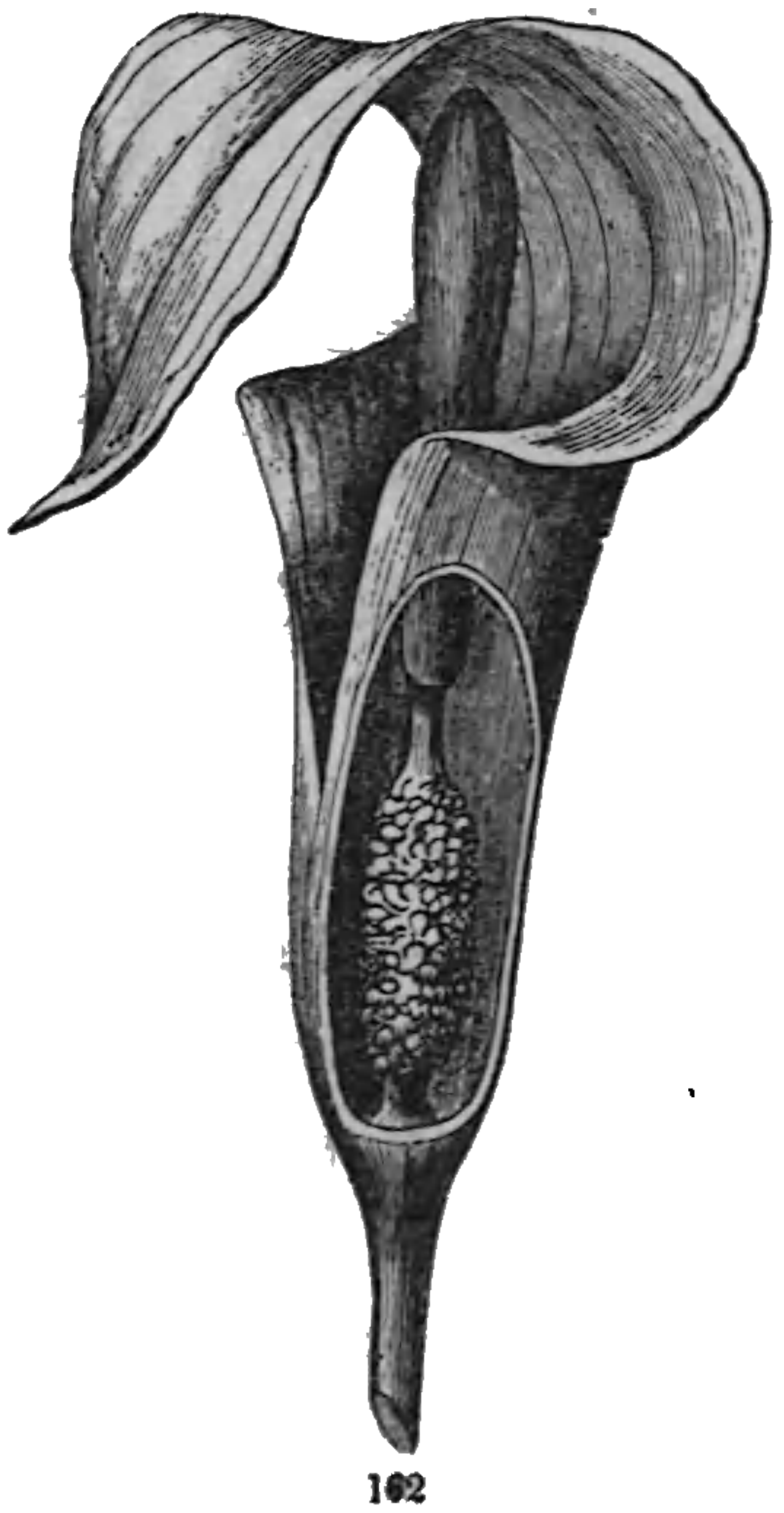

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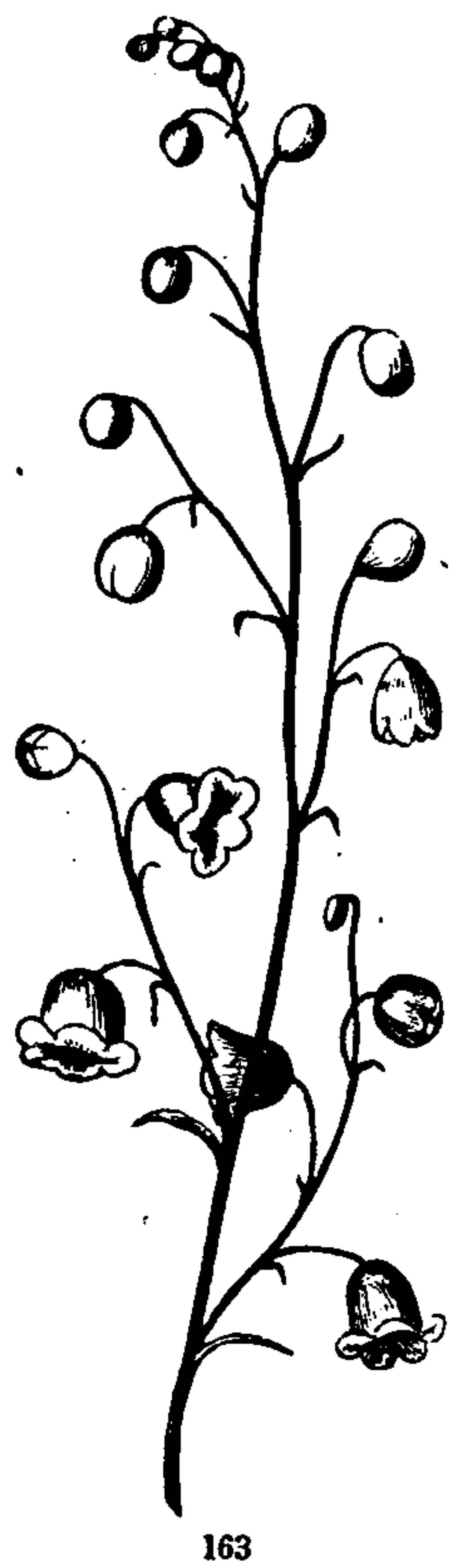
(Fig. 162), Sweet Flag, &c. It is commonly covered by a peculiar enveloping leaf, called a *spathe.*

FIG. 160. Spike of the common Plantain or Ribwort.
FIG. 161. Head of the Button-bush (Cephalanthus).
FIG. 162. Spadix and spathe of the Indian Turnip; the latter cut through below.

210. **A Catkin or Ament** is the name given to the scaly sort of spike of the Birch and Alder, the Willow and Poplar, and one sort of flower-clusters of the Oak, Hickory, and the like; — on which account these are called *Amentaceous* trees.

211. Sometimes these forms of flower-clusters become *compound.* For example, the stalks which, in the simple umbel such as has been described (Fig. 159), are the pedicels of single flowers, may themselves branch in the same way at the top, and so each become the support of a smaller umbel; as is the case in the Parsnip, Caraway, and almost the whole of the great family of what are called *Umbelliferous* (i. e. umbel-bearing) plants. Here the whole is termed a *compound umbel;* and the smaller or *partial* umbels take the name in English of *umbellets.* The *general involucre,* at the base of the main umbel, keeps that name; while that at the base of each umbellet is termed a *partial involucre* or an *involucel.*

212. So a corymb (Fig. 158) with its separate stalks branching again, and bearing smaller clusters of the same sort, is a *compound corymb;* of which the Mountain Ash is a good example. A raceme where what would be the pedicels of single flowers become stalks, along which flowers are disposed on their own pedicels, forms a *compound raceme,* as in the Goat's-beard and the False Spikenard. But when what would have been a raceme or a corymb branches irregularly into an open and more or less compound flower-cluster, we have what is called



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213. **A Panicle** (Fig. 163); as in the Oat and in most common Grasses. Such a raceme as that of the diagram, Fig. 156, would be changed into a panicle like Fig. 163, by the production of a flower from the axil of each of the bractlets *b'*.

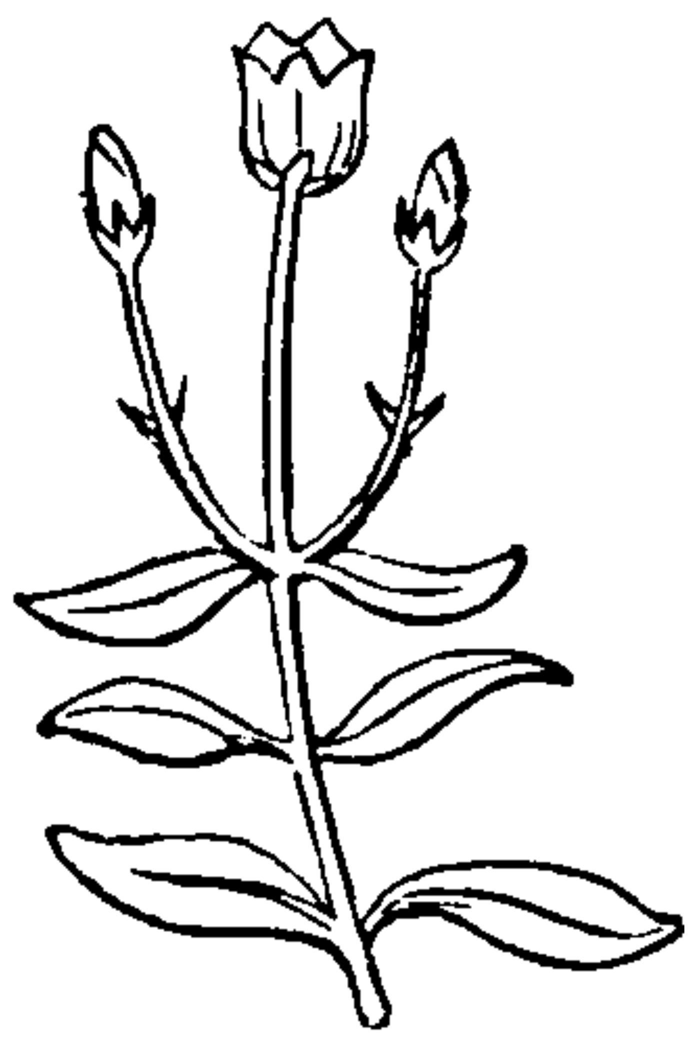
214. **A Thyrsus** is a compact panicle of a pyramidal or oblong shape; such as a bunch of grapes, or the cluster of the Lilac or Horsechestnut.

215. **Determinate Inflorescence** is that in which the flowers are from terminal buds. The simplest case is where a stem bears a solitary, terminal flower, as in Fig. 163^a. This stops the growth of

FIG. 163. A Panicle

the stem; for its terminal bud, being changed into a blossom, can no more lengthen in the manner of a leaf-bud. Any further growth

163 *a*



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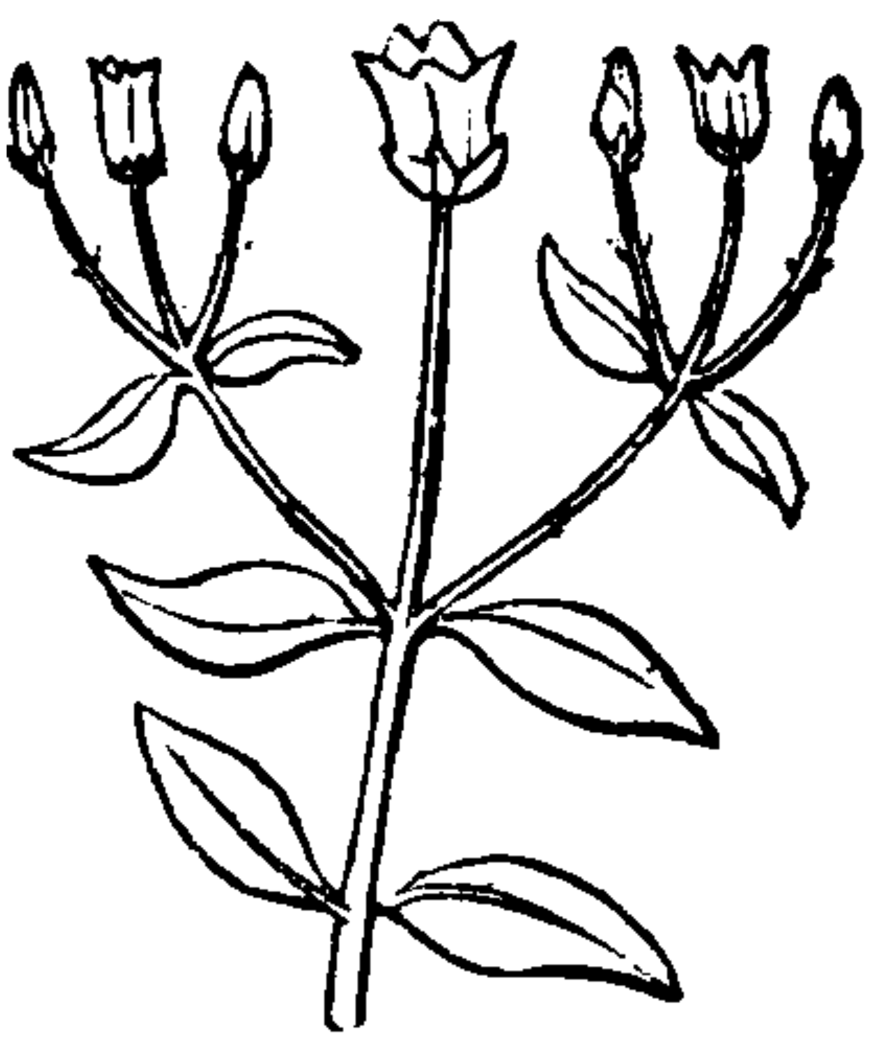

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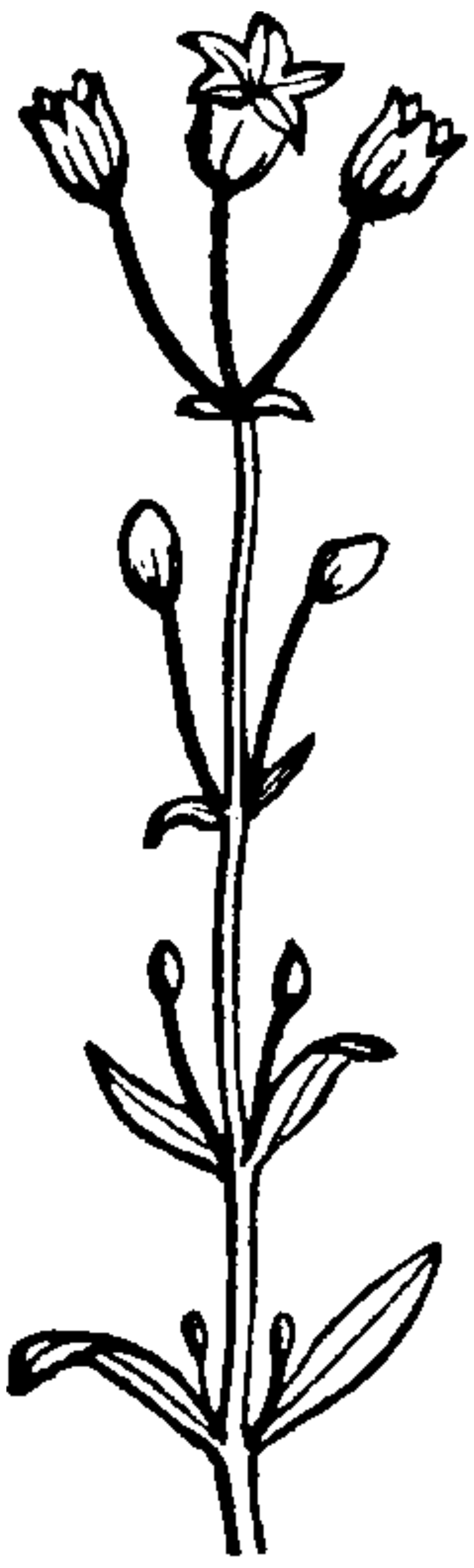
must be from axillary buds developing into branches. If such branches are leafy shoots, at length terminated by single blossoms, the inflorescence still consists of solitary flowers at the summit of the stem and branches. But if the flowering branches bear only bracts in place of ordinary leaves, the result is the kind of flower-cluster called



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216. **A Cyme.** This is commonly a flat-topped or convex flower-cluster, like a corymb, only the blossoms are from terminal buds. Fig. 164 illustrates the simplest cyme in a plant with opposite leaves, namely, with three flowers. The middle flower, *a*, terminates the stem; the two others, *b b*, terminate short branches, one from the axil of each of the uppermost leaves; and being later than the middle one, the flowering proceeds from the centre outwards, or is *centrifugal;*—just the opposite of the indeterminate mode, or that where all the flower-buds are axillary. If flowering branches appear from the axils below, the lower ones are the later, so that the order of blossoming continues *centrifugal* or *descending* (which is the same thing), as in Fig. 166, making a sort of reversed raceme;—a kind of cluster which is to the true raceme just what the flat cyme is to the corymb.

217. Wherever there are bracts or leaves, buds may be produced from their axils and appear as flowers. Fig. 165 represents the case where the branches, *b b*, of Fig. 164, each with a pair of small

FIG. 163 *a*. Diagram of an opposite-leaved plant, with a single terminal flower. 164 Same, with a cyme of three flowers; *a*, the first flower, of the main axis; *b b*, those of branches 165. Same, with flowers of the third order, *c c*. 166. Same, with flowers only of the second order from all the axils; the central or uppermost opening first, and so on downwards

the flower-clusters are centrifugal, that is, are cymes or fascicles; but they are themselves commonly disposed in spikes or racemes, which are centripetal, or develop in succession from below upwards.

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LESSON XII.

THE FLOWER: ITS PARTS OR ORGANS.

223. HAVING considered, in the last Lesson, the arrangement of flowers on the stem, or the places from which they arise, we now direct our attention to the flower itself.

224. **Nature and Use of the Flower.** The object of the flower is the production of seed. The flower consists of all those parts, or *organs*, which are subservient to this end. Some of these parts are necessary to the production of seed. Others serve merely to protect or support the more essential parts.

FIG. 167. Cyme of the Wild Hydrangea (With neutral flowers in the border).

225. **The Organs of the Flower** are therefore of two kinds; namely, first, the *protecting organs*, or *leaves of the flower*, — also called the *floral envelopes*, — and, second, the *essential organs*. The latter are situated within or a little above the former, and are enclosed by them in the bud.

226. **The Floral Envelopes** in a complete flower are double; that is, they consist of two whorls (181), or circles of leaves, one above or within the other. The outer set forms the *Calyx;* this more commonly consists of green or greenish leaves, but not always. The inner set, usually of a delicate texture, and of some other color than green, and in most cases forming the most showy part of the blossom, is the *Corolla.*

227. The floral envelopes, taken together, are sometimes called the *Perianth.* This name is not much used, however, except in cases where they form only one set, at least in appearance, as in the Lily, or where, for some other reason, the limits between the calyx and the corolla are not easily made out.

228. Each leaf or separate piece of the corolla is called a *Petal;* each leaf of the calyx is called a *Sepal.* The sepals and the petals — or, in other words, the leaves of the blossom — serve to protect, support, or nourish the parts within. They do not themselves make a perfect flower.

229. Some plants, however, naturally produce, besides their perfect flowers, others which consist only of calyx and corolla (one or both), that is, of leaves. These, destitute as they are of the essential organs, and incapable of producing seed, are called *neutral* flowers. We have an example in the flowers round the margin of the cyme of the Hydrangea (Fig. 167), and of the Cranberry-Tree, or Snowball, in their wild state. By long cultivation in gardens the whole cluster has been changed into showy, but useless, neutral flowers, in these and some other cases. What are called *double flowers*, such as full Roses (Fig. 173), Buttercups, and Camellias, are blossoms which, under the gardener's care, have developed with all their essential organs changed into petals. But such flowers are always in an unnatural or monstrous condition, and are incapable of maturing seed, for want of

230. **The Essential Organs.** These are likewise of two kinds, placed one above or within the other; namely, first, the *Stamens* or fertilizing organs, and, second, the *Pistils*, which are to be fertilized and bear the seeds.

231. Taking them in succession, therefore, beginning from below, or at the outside, we have (Fig. 168, 169), first, the *calyx* or outer circle of leaves, which are individually termed *sepals* (*a*); secondly, the *corolla*, or inner circle of delicate leaves, called *petals* (*b*); then a set of *stamens* (*c*); and in the centre one or more pistils (*d*). The end of the flower-stalk, or the short axis, upon which all these parts stand, is called the *Torus* or *Receptacle*.


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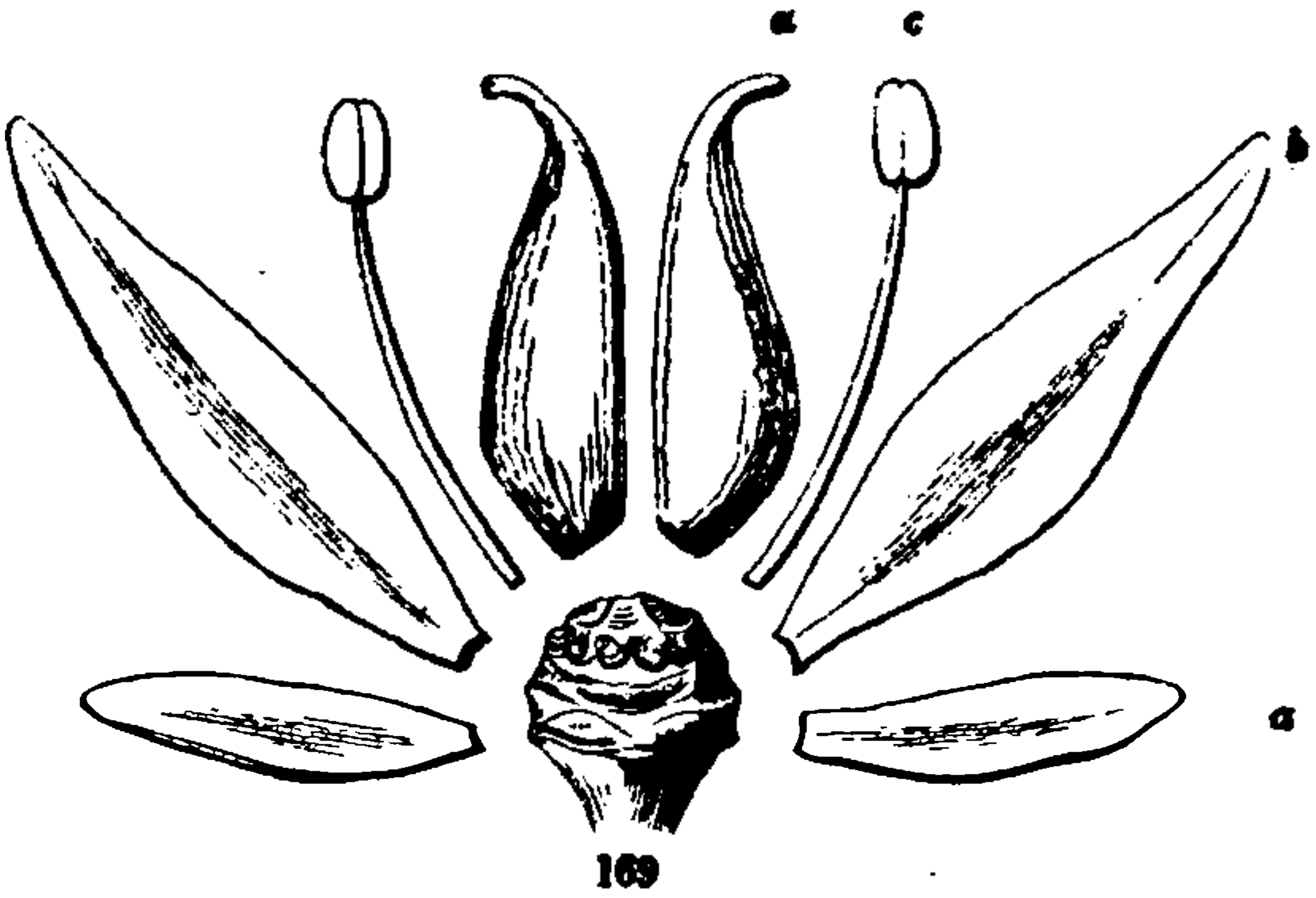
232. We use here for illustration the flower of a species of Stonecrop (Sedum ternatum), — which is a common plant wild in the Middle States, and in gardens almost everywhere, — because, although small, it exhibits all the parts in a perfectly simple and separate state, and so answers for a sort of pattern flower, better than any larger one that is common and well known.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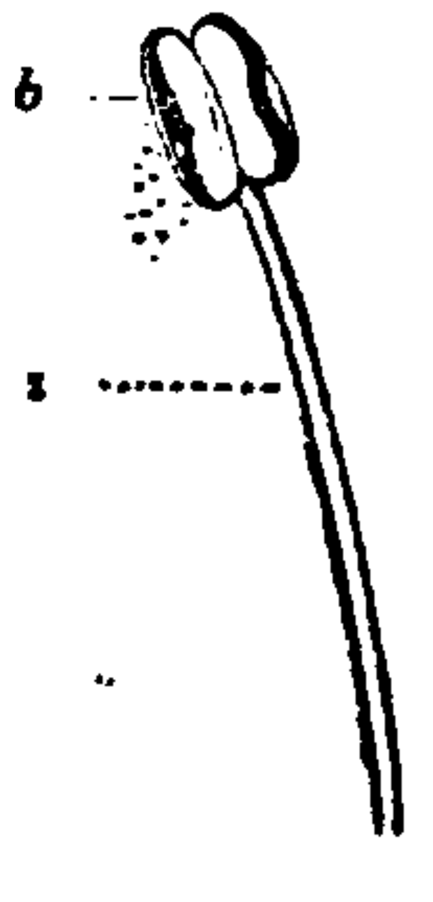
233. **A Stamen** consists of two parts, namely, the *Filament* or stalk (Fig. 170, *a*), and the *Anther* (*b*). The latter is the only essential part. It is a case, commonly with two lobes or cells, each opening lengthwise by a slit, at the proper time, and discharging a powder or dust-like substance, usually of a yellow color. This powder is the *Pollen*, or fertilizing matter, to produce which is the sole office of the stamen.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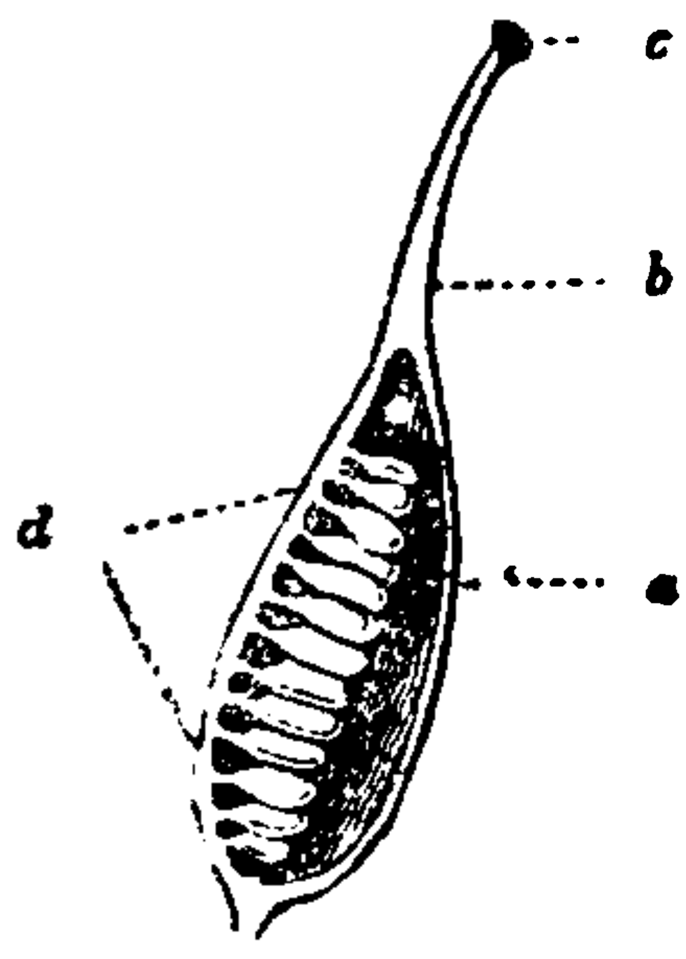
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234. **A Pistil** is distinguished into three parts; namely, — beginning from below, — the *Ovary*, the *Style*, and the *Stigma*. The *Ovary* is the hollow case or young pod (Fig. 171, *a*), containing rudimentary seeds, called *Ovules* (*d*). Fig. 172, representing a pistil like that of

FIG. 168. Flower of a Stonecrop: Sedum ternatum.
FIG. 169. Two parts of each kind of the same flower, displayed and enlarged.
FIG. 170. A stamen: *a*, the filament; *b*, the anther, discharging pollen.
FIG. 171. A pistil divided lengthwise, showing the interior of the ovary, *a*, and its ovules, *d*; *b*, the style; *c*, stigma.
FIG. 172. A pistil, enlarged; the ovary cut across to show the ovules within.
FIG. 173. "Double" Rose; the essential organs all replaced by petals.

LESSON XIII.

THE PLAN OF THE FLOWER.

235. THE FLOWER, like every other part of the plant, is formed upon *a plan*, which is essentially the same in all blossoms; and the student should early get a clear idea of the plan of the flower. Then the almost endless varieties which different blossoms present will be at once understood whenever they occur, and will be regarded with a higher interest than their most beautiful forms and richest colors are able to inspire.

236. We have already become familiar with the plan of the vegetation; — with the stem, consisting of joint raised upon joint, each bearing a leaf or a pair of leaves; with the leaves arranged in symmetrical order, every leaf governed by a simple arithmetical law, which fixes beforehand the precise place it is to occupy on the stem; and we have lately learned (in Lesson 11) how the position of each blossom is determined beforehand by that of the leaves; so that the shape of every flower-cluster in a bouquet is given by the same simple mathematical law which arranges the foliage. Let us now contemplate the flower in a similar way. Having just learned what parts it consists of, let us consider the plan upon which it is made, and endeavor to trace this plan through some of the various forms which blossoms exhibit to our view.

237. In order to give at the outset a correct idea of the blossom, we took, in the last Lesson, for the purpose of explaining its parts, a *perfect*, *complete*, *regular*, and *symmetrical* flower, and one nearly as *simple* as such a flower could well be. Such a blossom the botanist regards as

238. **A Typical Flower**, that is, a *pattern flower*, because it well exemplifies the plan upon which all flowers are made, and serves as what is called a *type*, or standard of comparison.

239. Another equally good typical flower (except in a single respect, which will hereafter be mentioned), and one readily to be obtained in the summer, is that of the Flax (Fig. 174). The parts differ in shape from those of the Stonecrop; but the whole plan is evidently just the same in both. Only, while the Stonecrop has ten stamens, or in many flowers eight stamens, — in all cases just twice

as many as there are petals, — the Flax has only five stamens, or just as many as the petals. Such flowers as these are said to be

Perfect, because they are provided with both kinds of essential organs (230), namely, stamens and pistils;

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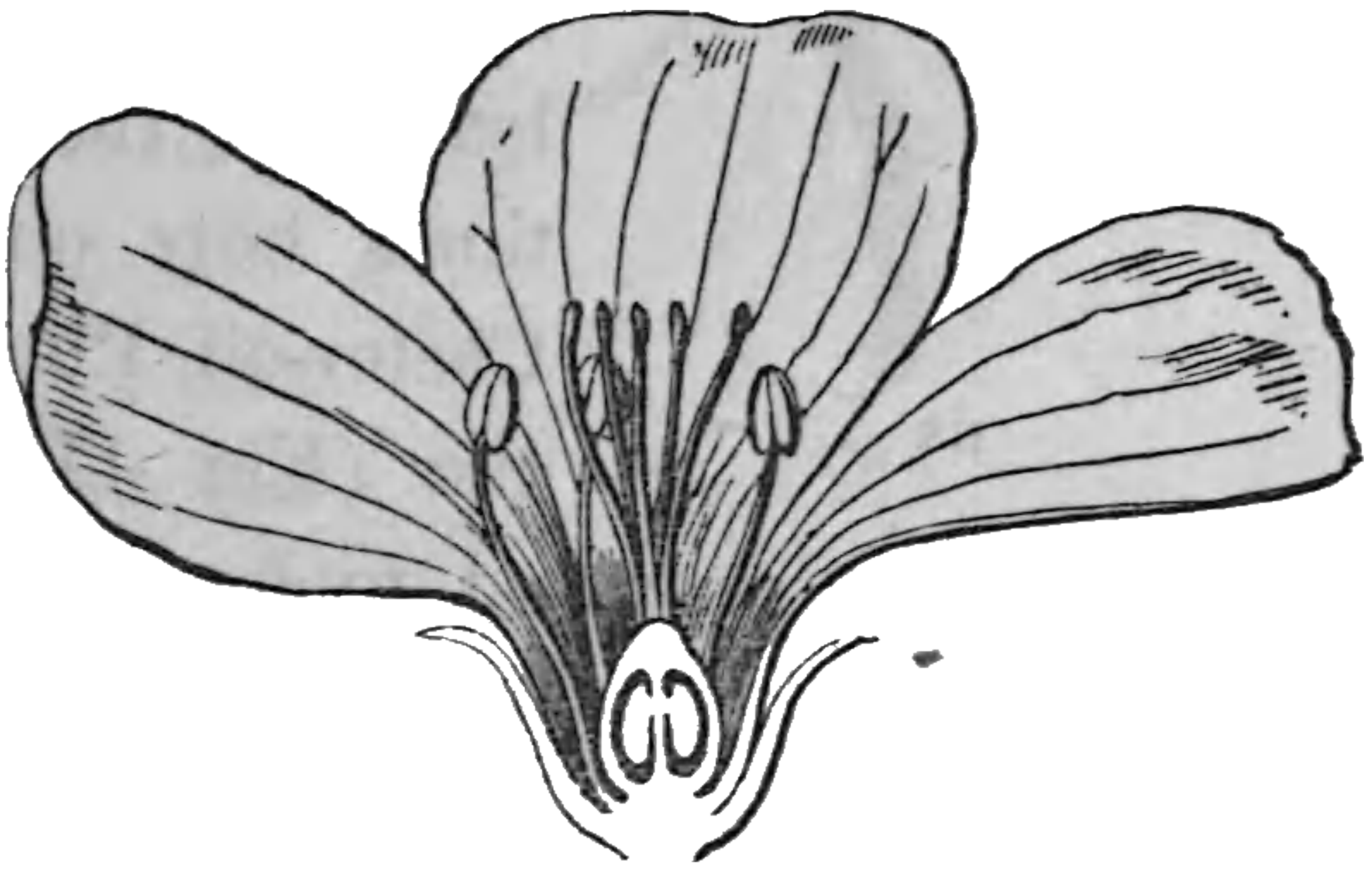
Complete, because they have all the *sorts* of organs which any flower has, namely, both calyx and corolla, as well as stamens and pistils;

Regular, because all the parts of each set are alike in shape and size; and

Symmetrical, because they have an equal number of parts of each sort, or in each set or circle of organs. That is, there are five sepals, five petals, five stamens, or in the Stonecrop ten stamens (namely, two sets of five each), and five pistils.



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240. On the other hand, many flowers do not present this perfect symmetry and regularity, or this completeness of parts. Accordingly, we may have

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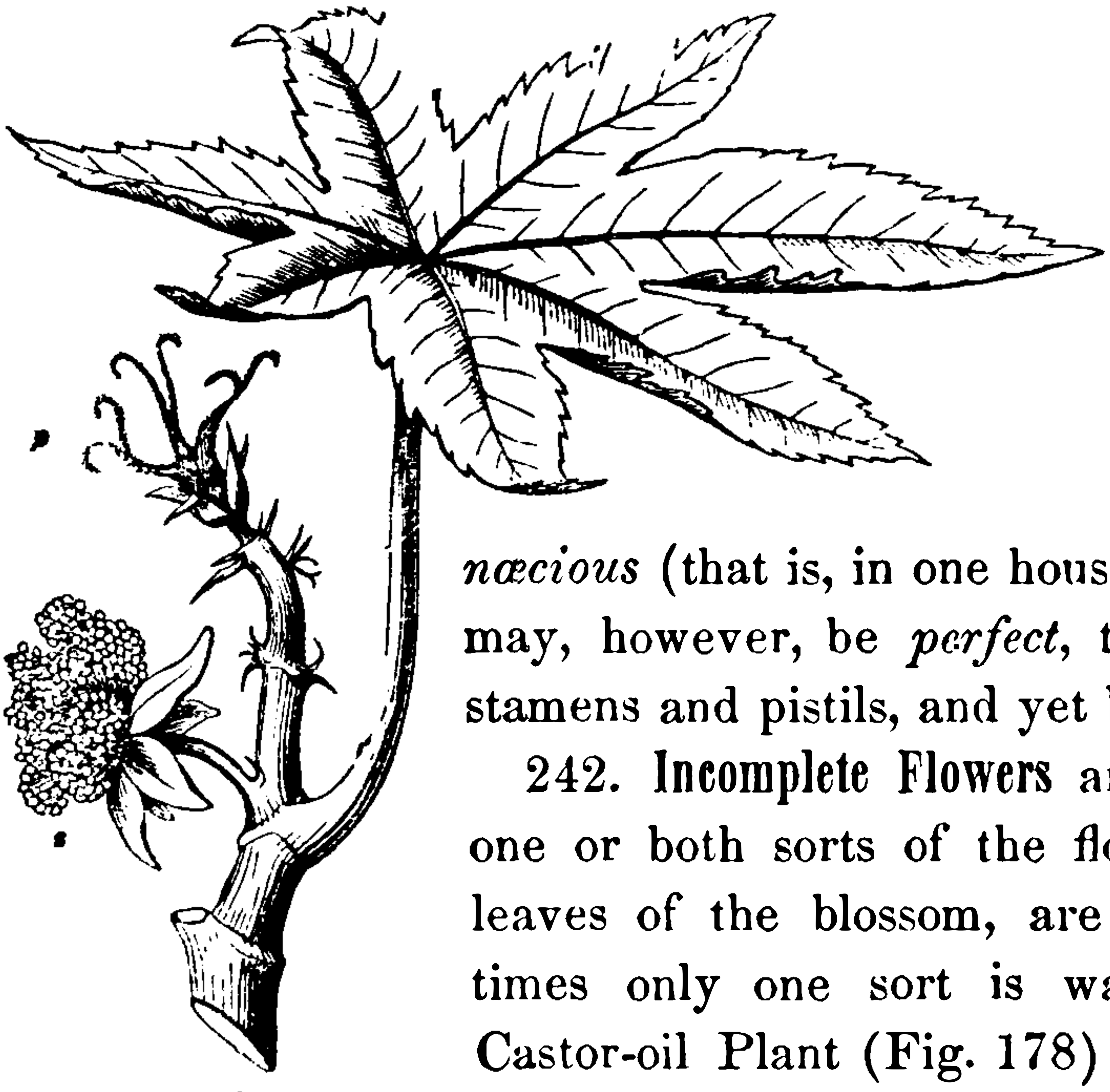
241. **Imperfect, or Separated Flowers;** which are those where the stamens and pistils are in separate blossoms; that is, one sort of flowers has stamens and no pistils, and another has pistils and no stamens, or only imperfect ones. The blossom which has stamens but no pistils is called a *staminate* or *sterile* flower (Fig. 176); and the corresponding one with pistils but no stamens is called a *pistillate* or *fertile* flower (Fig. 177). The two sorts may grow on distinct plants, from different roots, as they do in the Willow and Poplar, the Hemp, and the Moonseed

FIG. 174. Flowers of the common Flax: a perfect, complete, regular, and symmetrical blossom, all its parts in fives. 175. Half of a Flax-flower divided lengthwise, and enlarged.

FIG. 176. Staminate flower of Moonseed (Menispermum Canadense). 177. Pistillate flower of the same.

(Fig. 176, 177); when the flowers are said to be *diœcious* (from two Greek words meaning in two households). Or the two may occur on the same plant or the same stem, as in the Oak, Walnut, Nettle, and the Castor-oil Plant (Fig. 178); when the flowers are said to be *monœcious* (that is, in one household). A flower may, however, be *perfect*, that is, have both stamens and pistils, and yet be *incomplete.*



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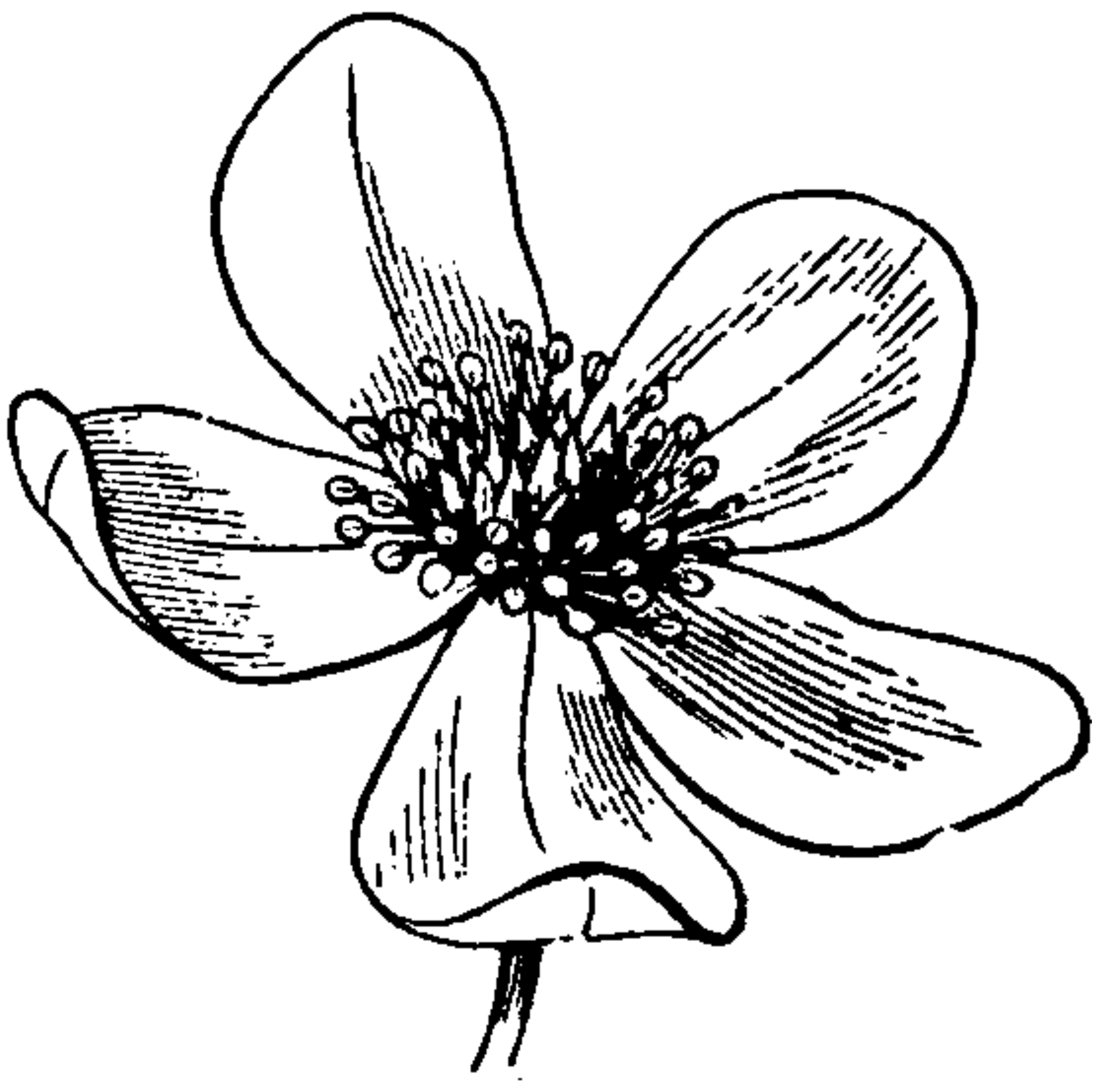
242. **Incomplete Flowers** are those in which one or both sorts of the floral envelopes, or leaves of the blossom, are wanting. Sometimes only one sort is wanting, as in the Castor-oil Plant (Fig. 178) and in the Anemone (Fig. 179). In this case the missing sort is always supposed to be the inner, that is, the corolla; and accordingly such flowers are said to be *apetalous* (meaning without petals). Occasionally both the corolla and the calyx are wanting, when the flower has no proper coverings or floral envelopes at all. It is then said to be *naked*, as in the Lizard's-tail (Fig. 180), and in the Willow.



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243. Our two pattern flowers (Fig. 168, 174) are regular and symmetrical (239). We commonly expect this to be the case in living things. The corresponding parts of plants, like the limbs or members of animals, are generally alike, and the whole arrangement is symmetrical. This symmetry pervades the blossom, especially. But the student may often fail to perceive

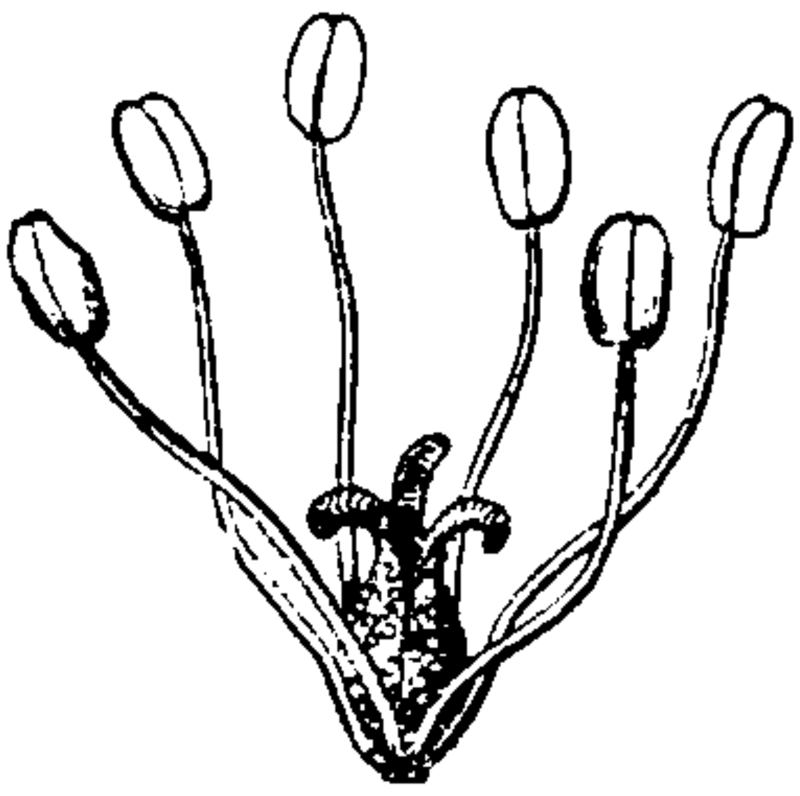

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FIG. 178. Monœcious flowers, i. e. one staminate (*s*) and one pistillate (*p*) flower, of the Castor-oil Plant, growing on the same stem.

FIG. 179. Apetalous (incomplete) flower of Anemone Pennsylvanica.

FIG. 180. A naked (but perfect) flower of the Lizard's-tail.

the fifth, needed to complete the symmetry, being left out. And the Monkshood (Fig. 185, 186) has five very dissimilar sepals,

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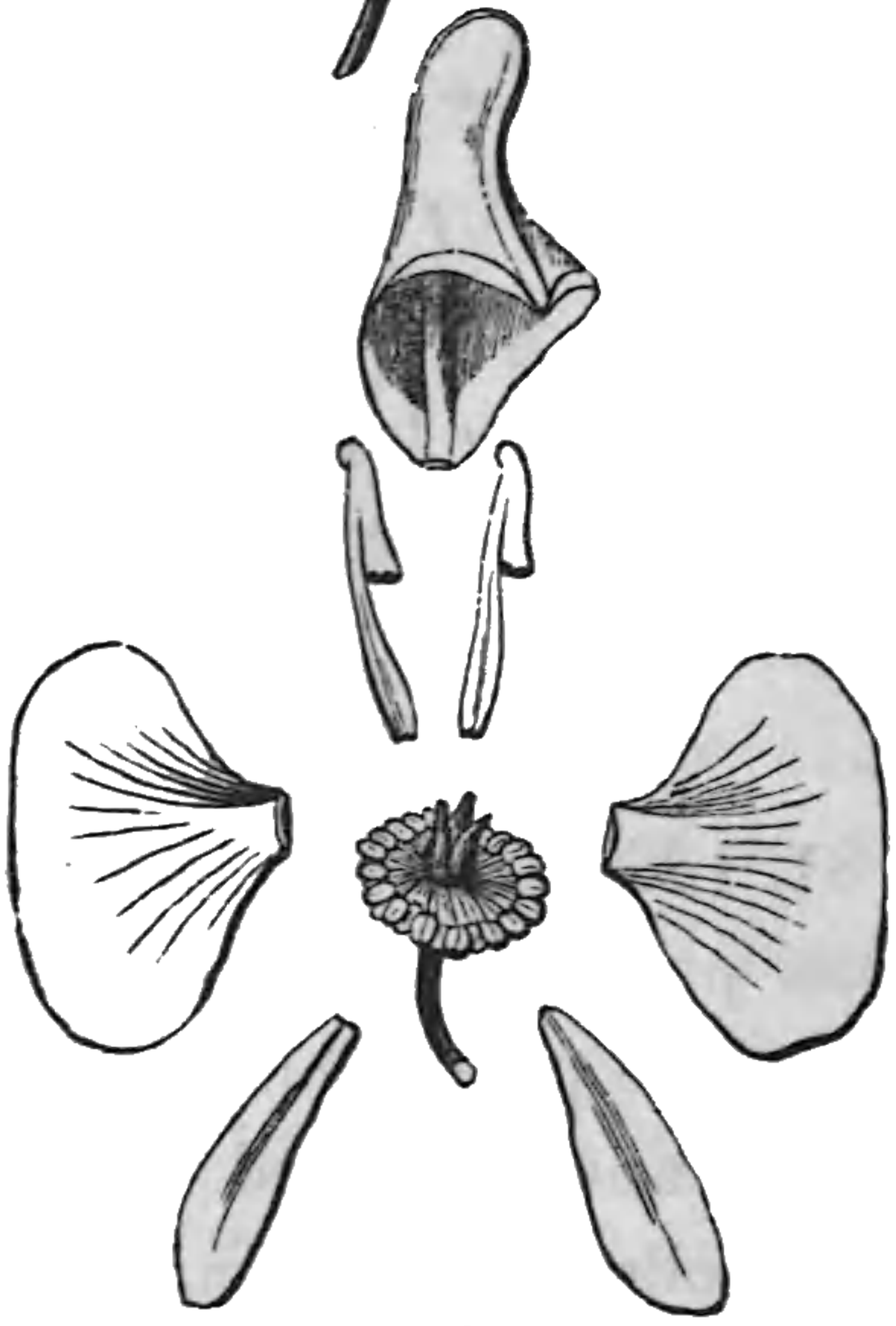

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and a corolla of only two, very small, curiously-shaped petals; the three needed to make up the symmetry being left out. For a flower which is unsymmetrical but regular, we may take the common Purslane, which has a calyx of only two sepals, but a corolla of five petals, from seven to twelve stamens, and about six styles. The Mustard, and all flowers of that family, are unsymmetrical as to the stamens, these being six in number (Fig. 188, while the leaves of the blossom (sepals and petals) are each only four (Fig. 187). Here the stamens are *irregular* also, two of them being shorter than the other four.

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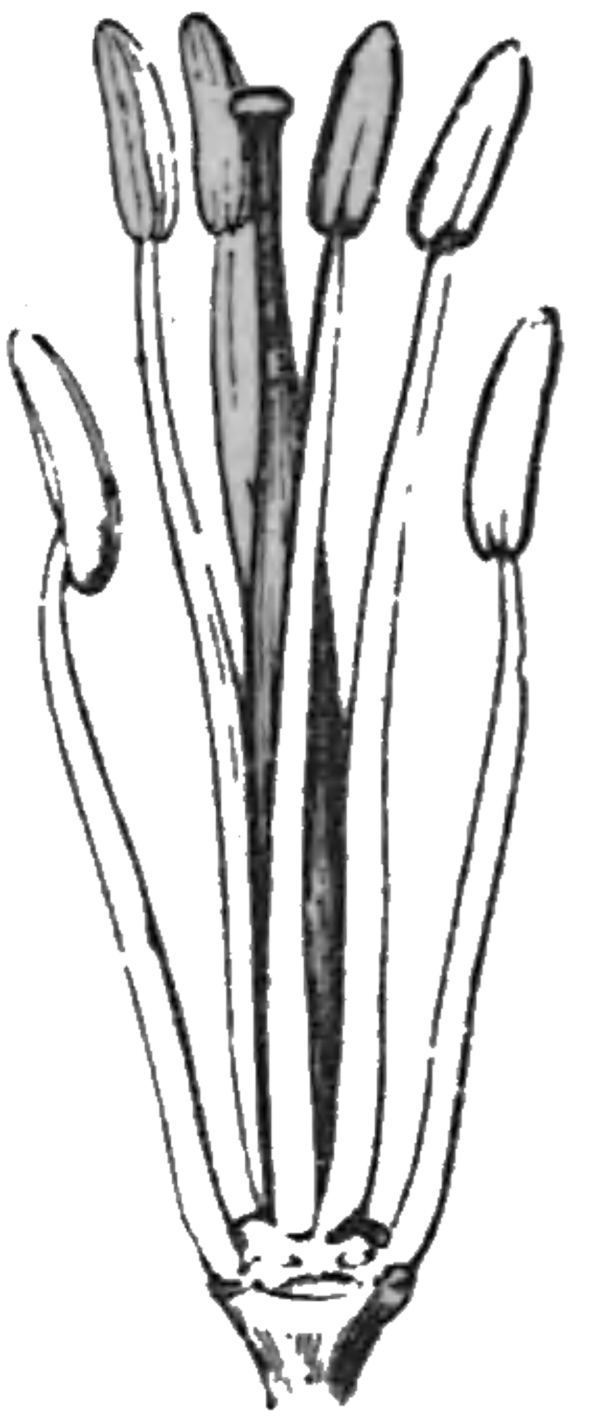

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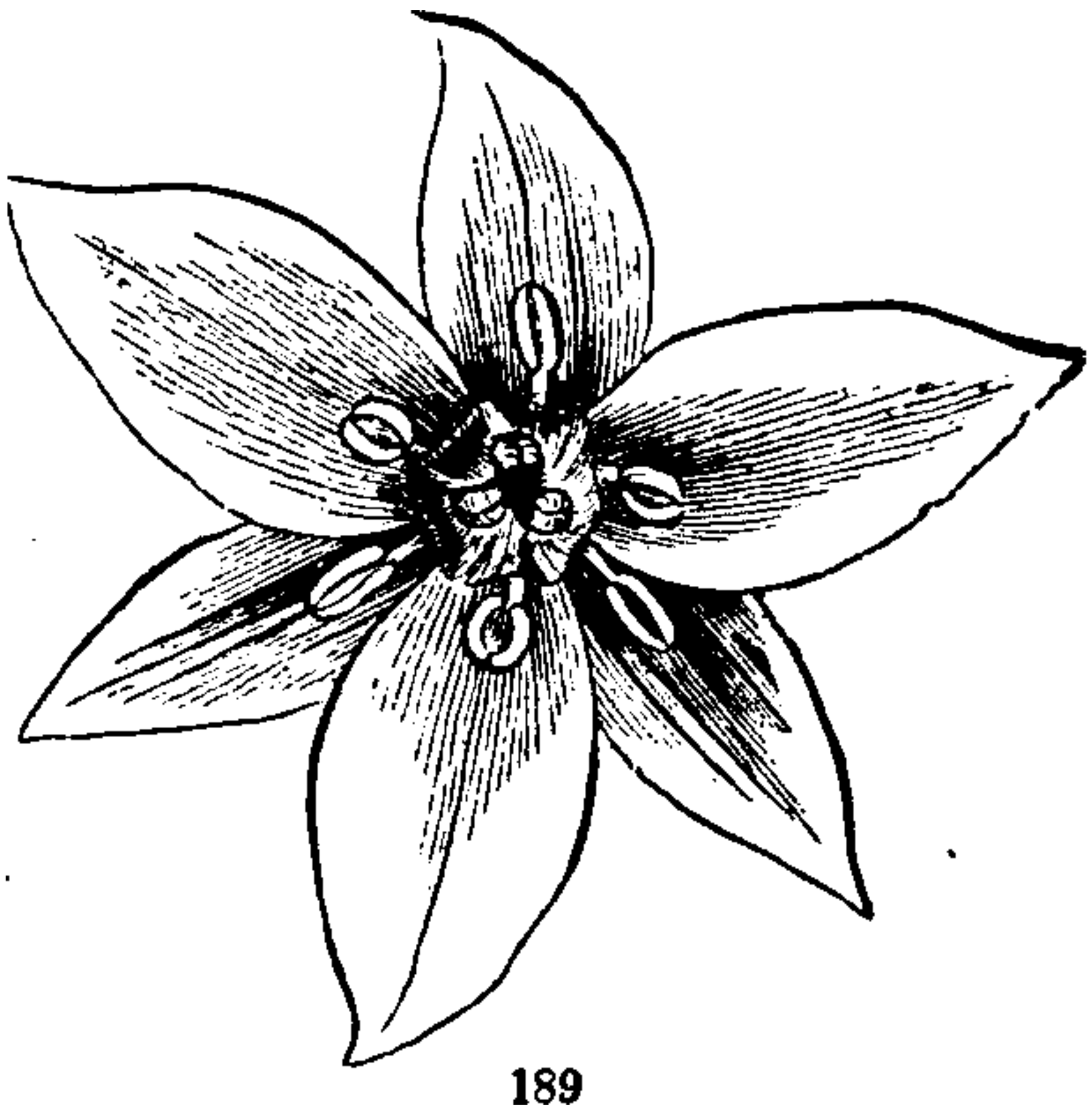
246. **Numerical Plan of the Flower.** Although not easy to make out in all cases, yet generally it is plain to see that each blossom is based upon a particular number, which runs through all or most of its parts. And a principal thing which a botanist notices when examining a flower is its numerical plan. It is upon this that the symmetry of the blossom depends. Our two pattern flowers, the Stonecrop (Fig. 168) and the Flax (Fig. 174), are based upon the number five, which is exhibited in all their parts. Some flowers of this same Stonecrop have their parts in fours, and then that number runs throughout; namely, there are four sepals, four petals, eight stamens (two sets), and four pistils. The Mustard (Fig. 187, 188), Radish,

FIG. 185. Flower of a Monkshood. 186. Its parts displayed: the five larger pieces are the sepals; the two small ones under the hood are petals; the stamens and pistils are in the centre.

FIG. 187. Flower of Mustard. 188. Its stamens and pistil separate and enlarged.

&c., also have their flowers constructed on the plan of four as to the calyx and corolla, but this number is interfered with in the stamens, either by the leaving out of two stamens (which would complete two sets), or in some other way. Next to five, the most common number in flowers is three. On this number the flowers of Lily, Crocus, Iris, Spiderwort, and Trillium (Fig. 189) are constructed. In the Lily and Crocus the leaves of the flower at first view appear to be six in one set; but the bud or just-opening blossom plainly shows these to consist of an outer and an inner circle, each of three parts, namely, of calyx and corolla, both of the same bright color and delicate texture. In the Spiderwort and Trillium (Fig. 189) the three outer leaves, or sepals, are green, and different in texture from the three inner, or the petals; the stamens are six (namely, two sets of three each), and the pistils three, though partly grown together into one mass.



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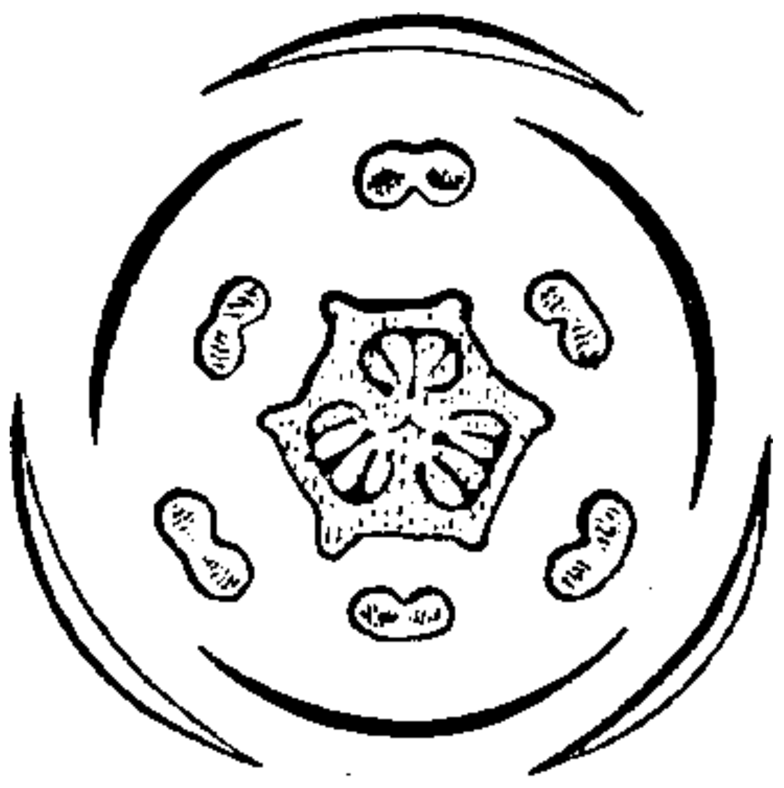

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247. **Alternation of Parts.** The symmetry of the flower is likewise shown in the arrangement or relative position of successive parts. The rule is, that the parts of successive circles *alternate* with one another. That is, the petals stand over the intervals between the sepals; the stamens, when of the same number, stand over the intervals between the petals; or when twice as many, as in the Trillium, the outer set alternates with the petals, and the inner set, alternating with the other, of course stands before the petals; and the pistils alternate with these. This is shown in Fig. 189, and in the diagram, or cross-section of the same in the bud Fig. 190. And Fig. 191 is a similar diagram or ground-plan (in the form of a

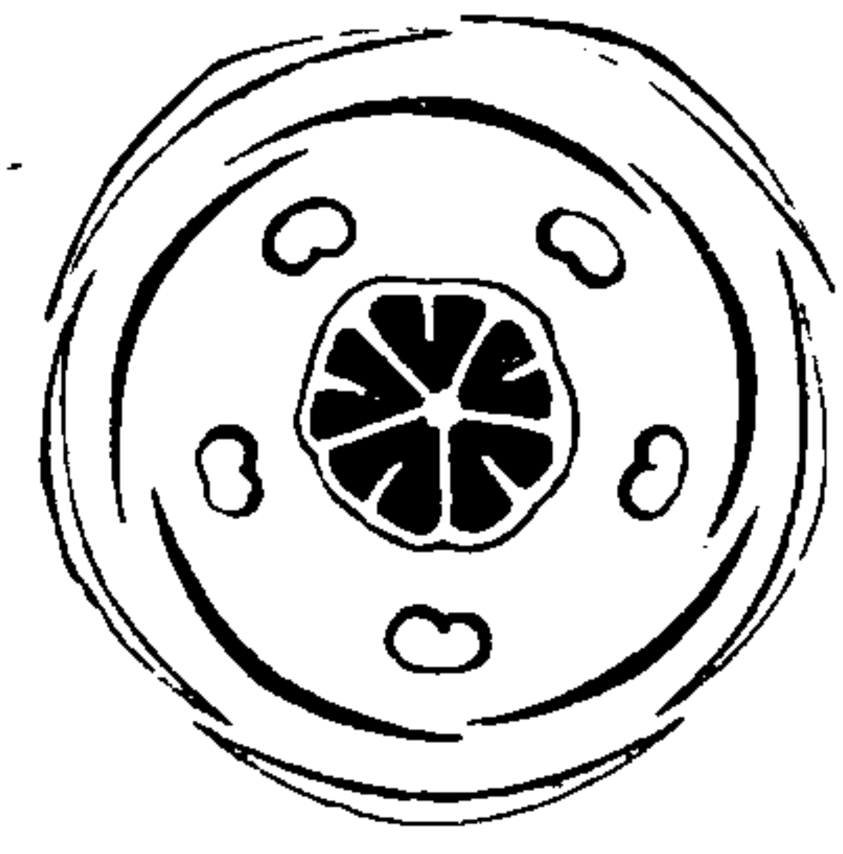

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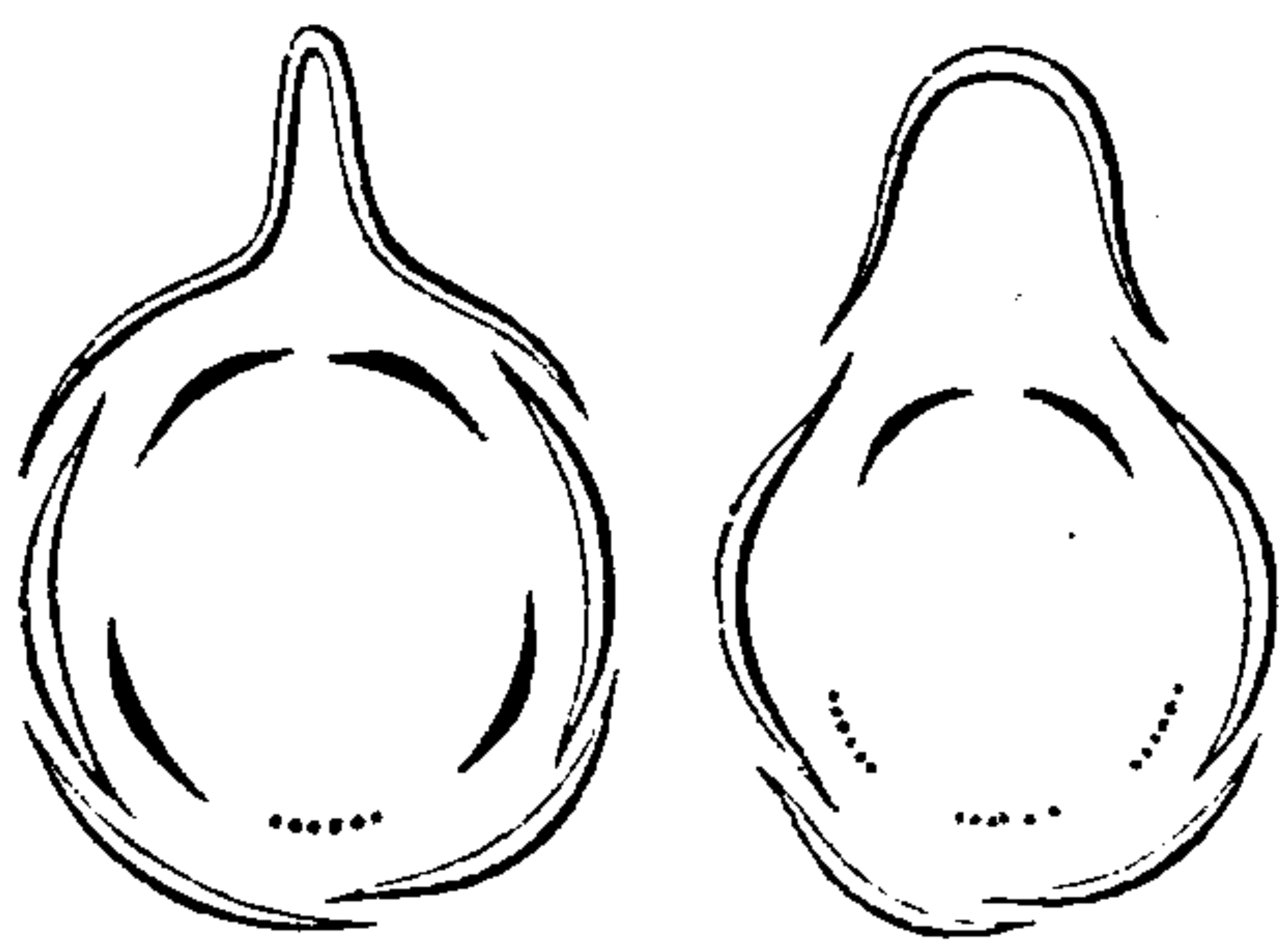
FIG. 189. Flower of Trillium erectum, or Birthroot, spread out a little, and viewed from above.

FIG. 190. Diagram or ground-plan of the same, as it would appear in a cross-section of the bud;—the parts all in the same relative position

FIG. 191. Diagram, or ground-plan, of the Flax-flower, Fig. 174.

section made across the bud) of the Flax blossom, the example of a pattern symmetrical flower taken at the beginning of this Lesson, with its parts all in fives.

248. Knowing in this way just the position which each organ should occupy in the flower it is readily understood that flowers often become unsymmetrical through the loss of some parts, which belong to the plan, but are obliterated or left out in the execution. For example, in the Larkspur (Fig. 183, 184), as there are five sepals, there should be five petals likewise. We find only four; but the vacant place where the fifth belongs is plainly recognized at the lower side of the flower.



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Also the similar plan of the Monkshood (Fig. 186) equally calls for five petals; but three of them are entirely obliterated, and the two that remain are reduced to slender bodies, which look as unlike ordinary petals as can well be imagined. Yet their position, answering to the intervals between the upper sepals and the side ones, reveals their true nature. All this may perhaps be more plainly shown by corresponding diagrams of the calyx and corolla of the Larkspur and Monkshood (Fig. 192, 193), in which the places of the missing petals are indicated by faint dotted lines. The obliteration of stamens is a still more common case. For example, the Snapdragon, Foxglove, Gerardia, and almost all flowers of the large Figwort family they belong to, have the parts of the calyx and corolla five each, but only four stamens (Fig. 194); the place on the upper side of the flower where the fifth stamen belongs is vacant. That there is in such cases a real obliteration of the missing part is shown by the

249. **Abortive Organs**, or vestiges which are sometimes met with; — bodies which stand in the place of an organ, and represent it, although wholly incapable of fulfilling its office. Thus, in the Figwort family, the fifth stamen, which is altogether missing in Gerardia (Fig. 194) and most others, appears in the Figwort as a little scale, and in Pentstemon (Fig. 195) and Turtlehead as a sort of filament without any anther; — a thing of no use whatever to the plant, but

FIG. 192. Diagram of the calyx and corolla of a Larkspur. 193. Similar diagram of Monkshood. The dotted lines show where the petals are wanting; one in the former, three in the latter.


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LESSON XIV.

MORPHOLOGY OF THE FLOWER.

251. In all the plant till we came to the blossom we found nothing but root, stem, and leaves (23, 118). However various or strange their shapes, and whatever their use, everything belongs to one of these three organs, and everything above ground (excepting the rare case of aerial roots) is either stem or leaf. We discern the stem equally in the stalk of an herb, the trunk and branches of a tree, the trailing or twining Vine, the straw of Wheat or other Grasses, the columnar trunk of Palms (Fig. 47), in the flattened joints of the Prickly-Pear Cactus, and the rounded body of the Melon Cactus (Fig. 76). Also in the slender runners of the Strawberry, the tendrils of the Grape-vine and Virginia Creeper, the creeping subterranean shoots of the Mint and Couchgrass, the tubers of the Potato and Artichoke, the solid bulb of the Crocus, and the solid part or base of scaly bulbs; as is fully shown in Lesson 6. And in Lesson 7 and elsewhere we have learned to recognize the leaf alike in the thick seed-leaves of the Almond, Bean, Horsechestnut, and the like (Fig. 9–24), in the scales of buds (Fig. 77), and the thickened

FIG. 197. A Cactus-flower, viz. of Mamillaria cæspitosa of the Upper Missouri.

scales of bulbs (Fig. 73 – 75), in the spines of the Barberry and the tendrils of the Pea, in the fleshy rosettes of the Houseleek, the strange fly-trap of Dionæa (Fig. 81), and the curious pitcher of Sarracenia (Fig. 79).

252. Now the student who understands these varied forms or *metamorphoses* of the stem and leaf, and knows how to detect the real nature of any part of the plant under any of its disguises, may readily trace the leaf into the blossom also, and perceive that, as to their morphology,

253. **Flowers are altered Branches,** and their parts, therefore, altered leaves. That is, certain buds, which might have grown and lengthened into a leafy branch, do, under other circumstances and to accomplish other purposes, develop into blossoms. In these the axis remains short, nearly as it is in the bud; the leaves therefore remain close together in sets or circles; the outer ones, those of the calyx, generally partake more or less of the character of foliage; the next set are more delicate, and form the corolla, while the rest, the stamens and pistils, appear under forms very different from those of ordinary leaves, and are concerned in the production of seed. This is the way the scientific botanist views a flower; and this view gives to Botany an interest which one who merely notices the shape and counts the parts of blossoms, without understanding their plan, has no conception of.

254. That flowers answer to branches may be shown first from their position. As explained in the Lesson on Inflorescence, flowers arise from the same places as branches, and from no other; flower-buds, like leaf-buds, appear either on the summit of a stem, that is, as a terminal bud, or in the axil of a leaf, as an axillary bud (196). And at an early stage it is often impossible to foretell whether the bud is to give rise to a blossom or to a branch.

255. That the sepals and petals are of the nature of leaves is evident from their appearance; persons who are not botanists commonly call them the leaves of the flower. The calyx is most generally green in color, and foliaceous (leaf-like) in texture. And though the corolla is rarely green, yet neither are proper leaves always green. In our wild Painted-Cup, and in some scarlet Sages, common in gardens, the leaves just under the flowers are of the brightest red or scarlet, often much brighter-colored than the corolla itself. And sometimes (as in many Cactuses, and in Carolina All-spice) there is sueh a regular gradation from the last leaves of the

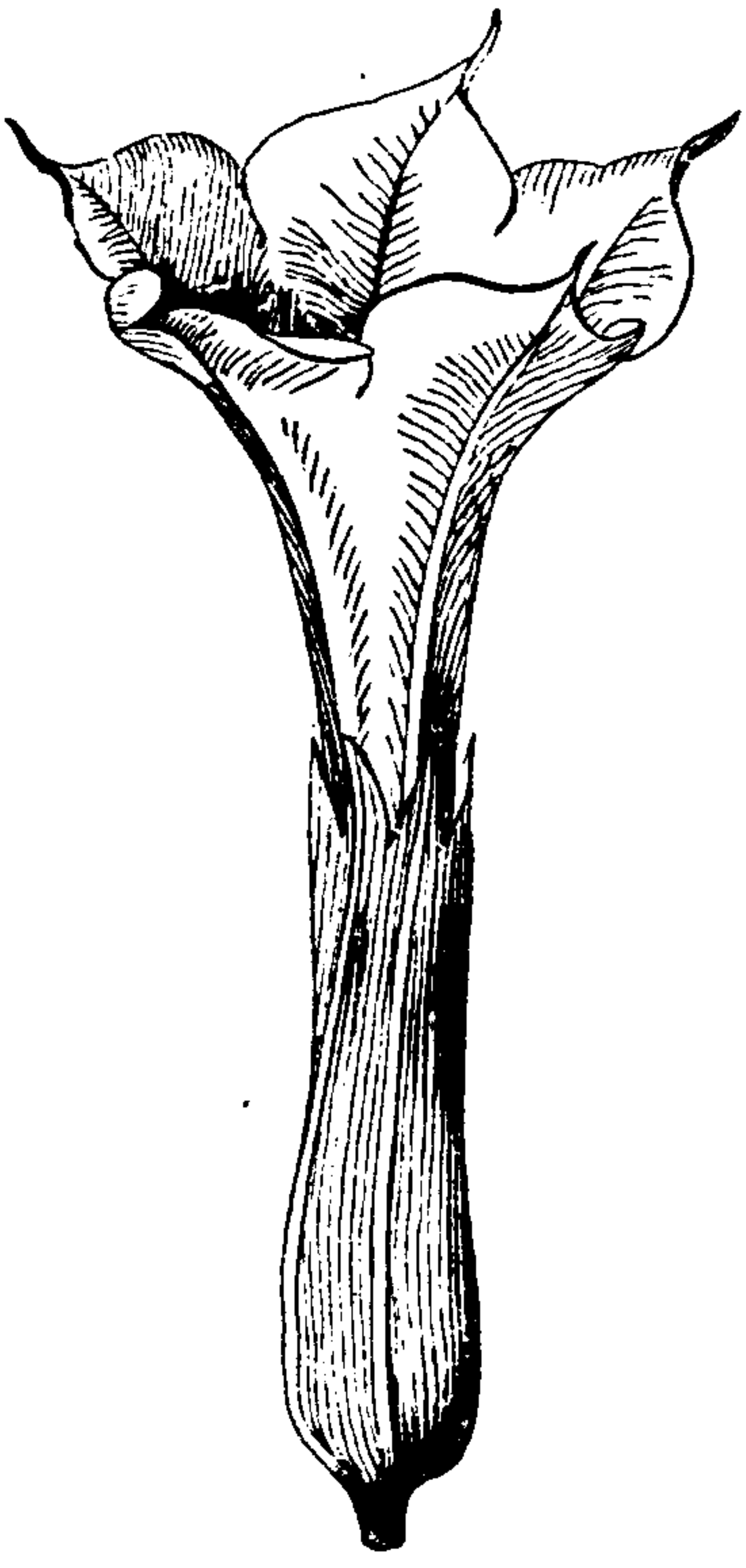
plant (bracts or bractlets) into the leaves of the calyx, that it is impossible to say where the one ends and the other begins. And if sepals are leaves, so also are petals; for there is no clearly fixed limit between them. Not only in the Carolina Allspice and Cactus (Fig. 197), but in the Water-Lily (Fig. 198) and a variety of flowers with more than one row of petals, there is such a complete transition between calyx and corolla that no one can surely tell how many of the leaves belong to the one and how many to the other.

256. It is very true that the calyx or the corolla often takes the form of a cup or tube, instead of being in separate pieces, as in Fig. 194–196. It is then composed of two or more leaves grown together. This is no objection to the petals being leaves; for the same thing takes place with the ordinary leaves of many plants, as, for instance, in the upper ones of Honeysuckles (Fig. 132).

257. That stamens are of the same general nature as petals, and therefore a modification of leaves, is shown by the gradual transitions that occur between the one and the other in many blossoms; especially in cultivated flowers, such as Roses and Camellias, when they begin to *double*, that is, to change their stamens into petals. Some wild and natural flowers show the same interesting transitions. The Carolina Allspice and the White Water-Lily exhibit complete gradations not only between sepals and petals, but between petals and stamens. The sepals of the Water-Lily are green outside, but white and petal-like on the inside; the petals, in many rows, gradually grow narrower towards the centre of the flower; some of these are tipped with a trace of a yellow anther, but still are petals; the next are more contracted and stamen-like, but with a flat petal-like filament; and a further narrowing of this completes the genuine stamen. A series of these stages is shown in Fig. 198.

258. Pistils and stamens now and then change into each other in some Willows; pistils often turn into petals in cultivated flowers; and in the Double Cherry they occasionally change directly into small green leaves. Sometimes a whole blossom changes into a cluster of green leaves, as in the "green roses" which are occasionally noticed in gardens, and sometimes it degenerates into a leafy branch. So the botanist regards pistils also as answering to leaves. And his idea of a pistil is, that it consists of a leaf with its margins curved inwards till they meet and unite to form a closed cavity, the ovary, while the tip is prolonged to form the style and bear the stigma; as will be illustrated in the Lesson upon the Pistil.

together takes place in two ways: either parts of the same kind, or parts of different kinds, may be united. The first we may call simply the *union*, the second the *consolidation*, of parts.



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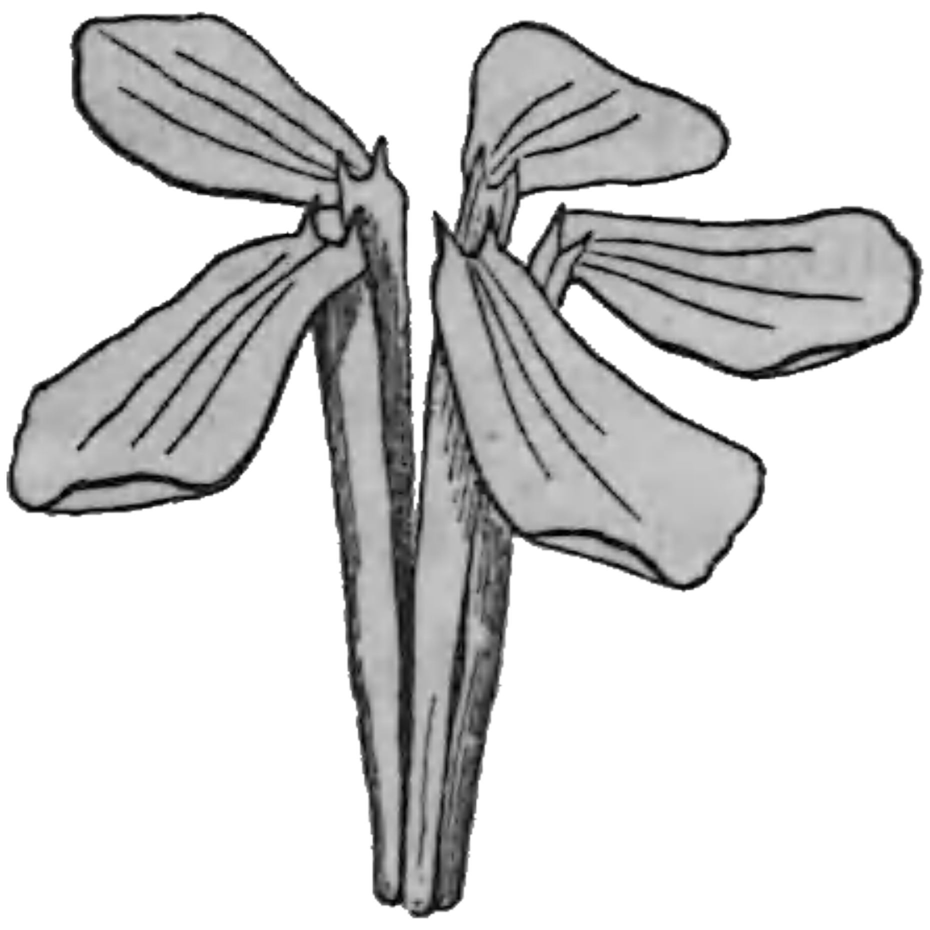
262. **Union or Cohesion** *with one another of parts of the same sort.* We very commonly find that the calyx or the corolla is a cup or tube, instead of a set of leaves Take, for example, the flower of the Stramonium or Thorn-Apple, where both the calyx and the corolla are so (Fig. 199); likewise the common Morning-Glory, and the figures 201 to 203, where the leaves of the corolla are united into one piece, but those of the calyx are separate. Now there are numerous cases of real leaves growing together much in the same way, — those of the common Thoroughwort, and the upper pairs in Woodbines or Honeysuckles, for example (Fig. 132); so that we might expect it to occur in the leaves of the blossom also. And that this is the right view to take of it plainly appears from the transitions everywhere met with in different plants, between a calyx or a corolla of separate pieces and one forming a perfect tube or cup. Figures 200 to 203 show one complete set of such gradations in the corolla, and Fig. 204 to 206 another, in short and open corollas. How many leaves or petals each corolla is formed of may be seen by the number of points or tips, or of the notches (called *sinuses*) which answer to the intervals between them.

263. When the parts are united in this way, whether much or little, the corolla is said to be *monopetalous*, and the calyx *monosepalous*. These terms mean "of one petal," or "of one sepal"; that is, of one piece. Wherefore, taking the corolla or the calyx as a whole, we say that it is *parted* when the parts are separate almost to the base, as in Fig. 204; *cleft* or *lobed* when the notches do not extend below the middle or thereabouts, as in Fig. 205;

FIG. 199. Flower of the common Stramonium; both the calyx and the corolla with their parts united into a tube.

toothed or *dentate*, when only the tips are separate as short points *entire*, when the border is even, without points or notches, as in the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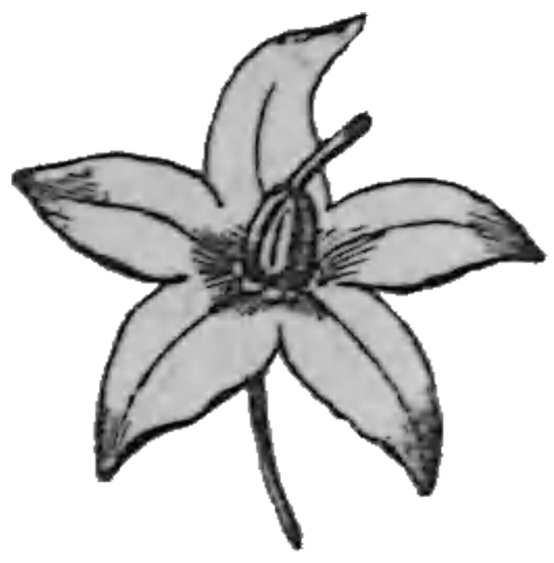
common Morning-Glory, and very nearly so in Fig. 203; and so on; — the terms being just the same as those applied to leaves and all other flat bodies, and illustrated in Lessons 8 and 9.

264. There is a set of terms applied particularly to calyxes, corollas, or other such bodies of one piece, to express their general shape, which we see is very various. The following are some of the principal: —

Wheel-shaped, or *rotate;* when spreading out at once, without a tube or with a very short one, something in the shape of a wheel or of its diverging spokes, as in the corolla of the Potato and Bitter-sweet (Fig. 204, 205).

Salver-shaped, or *salver-form;* when a flat-spreading border is raised on a narrow tube, from which it diverges at right angles,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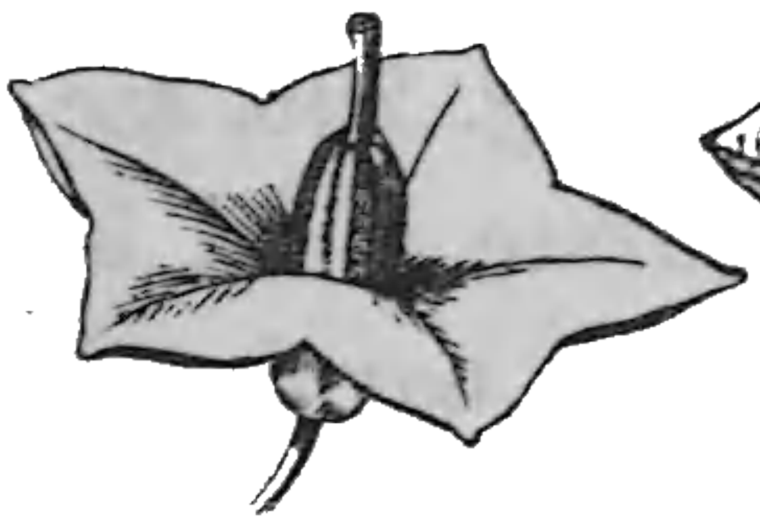
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like the salver represented in old pictures, with a slender handle beneath. The corolla of the Phlox (Fig. 208) and of the Cypress-Vine (Fig. 202) are of this sort.

FIG. 200. Corolla of Soapwort (the same in Pinks, &c.), of 5 separate, long-clawed petals.

FIG. 201. Flower of Gilia or Ipomopsis coronopifolia; the parts answering to the claws of the petals of the last figure here all united into a tube.

FIG. 202. Flower of the Cypress-Vine; the petals a little farther united into a five-lobed spreading border.

FIG. 203. Flower of the small Scarlet Morning-Glory, the five petals it is composed of perfectly united into a trumpet-shaped tube, with the spreading border nearly even (or entire).

FIG. 204. Wheel-shaped and five-parted corolla of Bittersweet (Solanum Dulcamara).

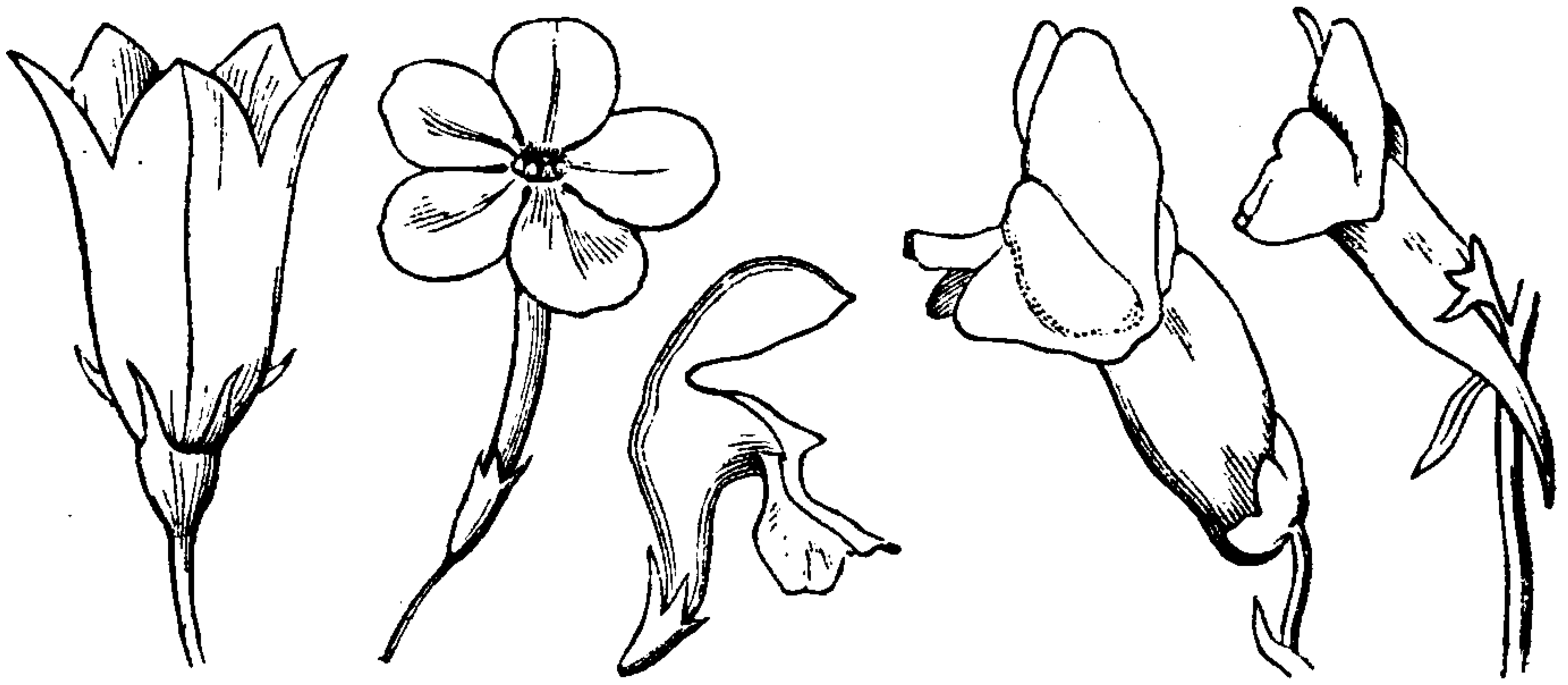
FIG. 205. Wheel-shaped and five-cleft corolla of the common Potato.

FIG. 206. Almost entire and very open bell-shaped corolla of a Ground Cherry (Physalis)

Bell-shaped, or *campanulate;* where a short and broad tube widens upward, in the shape of a bell, as in Fig. 207.

Funnel-shaped, or *funnel-form;* gradually spreading at the summit of a tube which is narrow below, in the shape of a funnel or tunnel, as in the corolla of the common Morning-Glory, and of the Stramonium (Fig. 199).

Tubular; when prolonged into a tube, without much spreading at the border, as in the corolla of the Trumpet Honeysuckle, the calyx of Stramonium (Fig. 199), &c.



265. In most of these cases we may distinguish two parts; namely, the *tube*, or the portion all in one piece and with its sides upright or nearly so; and the *border* or *limb*, the spreading portion or summit. The limb may be entire, as in Fig. 203, but it is more commonly *lobed*, that is, partly divided, as in Fig. 202, or *parted* down nearly to the top of the tube, as in Fig. 208, &c.

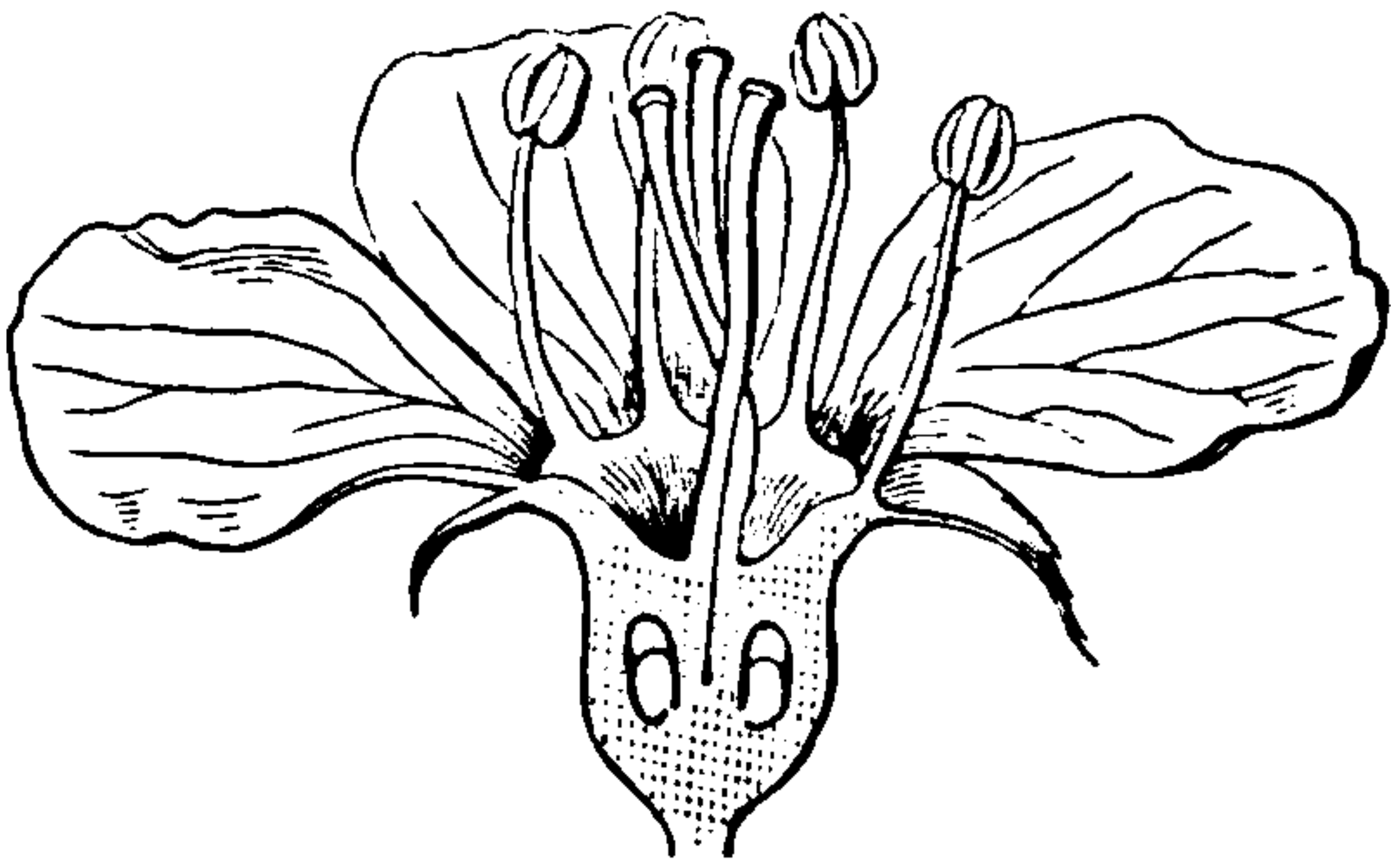
266. So, likewise, a separate petal is sometimes distinguishable into two parts; namely, into a narrowed base or stalk-like part (as in Fig. 200, where this part is peculiarly long), called the *claw*, and a spreading and enlarged summit, or body of the petal, called the *lamina* or *blade*.

267. When parts of the same set are not united (as in the Flax, Cherry, &c., Fig. 212 – 215), we call them *distinct*. Thus the sepals or the petals are distinct when not at all united with each other. As a calyx with sepals united into one body is called *monosepalous* (263, that is, one-sepalled), or sometimes *monophyllous*, that is, one-leaved; so, on the other hand, when the sepals are distinct, it is said to be

FIG. 207. Flower of the Harebell, with a campanulate or bell-shaped corolla. 208. Of a Phlox, with salver-shaped corolla. 209. Of Dead-Nettle (Lamium), with labiate *ringent* (or gaping) corolla. 210. Of Snapdragon, with labiate *personate* corolla. 211. Of Toad-Flax, with a similar corolla spurred at the base.

270. Fig. 213 is a flower of a Cherry, cut through lengthwise in the same way. Here the petals and the stamens grow out of, that is, are *inserted* on, the calyx; in other words they cohere or are consolidated with the base of the calyx up to a certain height. In such cases they are said to be *perigynous* (from two Greek words, meaning around the pistil). The consolidation in the Cherry is confined to the calyx, corolla, and stamens: the calyx is still *free* from the pistil. One step more we have in

271. Fig. 214, which is a similar section of a flower of a Purslane. Here the lower part of the calyx (carrying with it of course the petals and stamens) is *coherent* with the surface of the whole lower half of the ovary. Therefore the calyx, seeming to rise from the middle of the ovary, is said to be *half superior*, instead of being *inferior*, as it is when entirely free. It is better to say, however, *calyx half-adherent* to the ovary. Every gradation occurs between such a case and that of a calyx altogether *free* or inferior, as we see in different Purslanes and Saxifrages. The consolidation goes farther,



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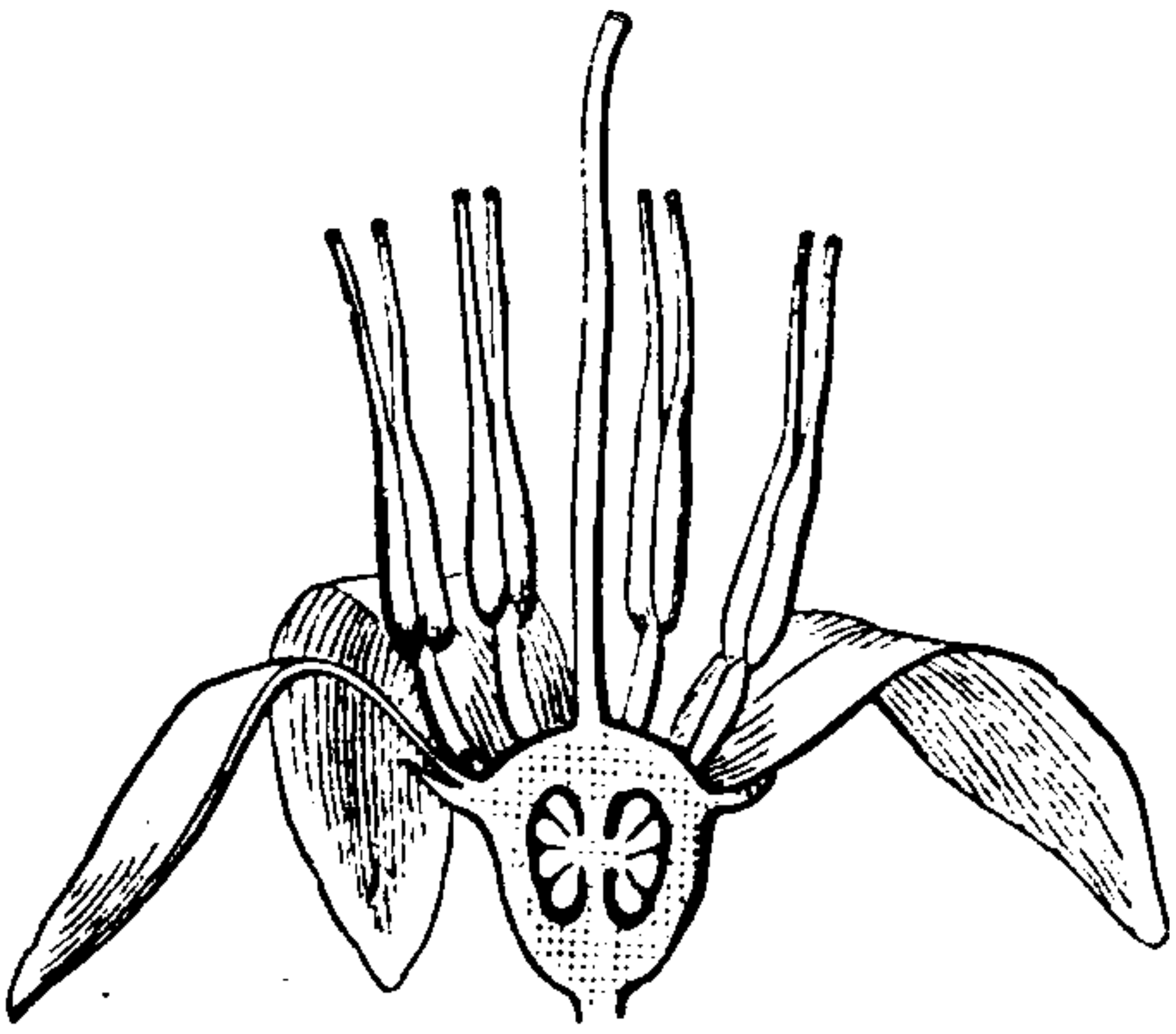

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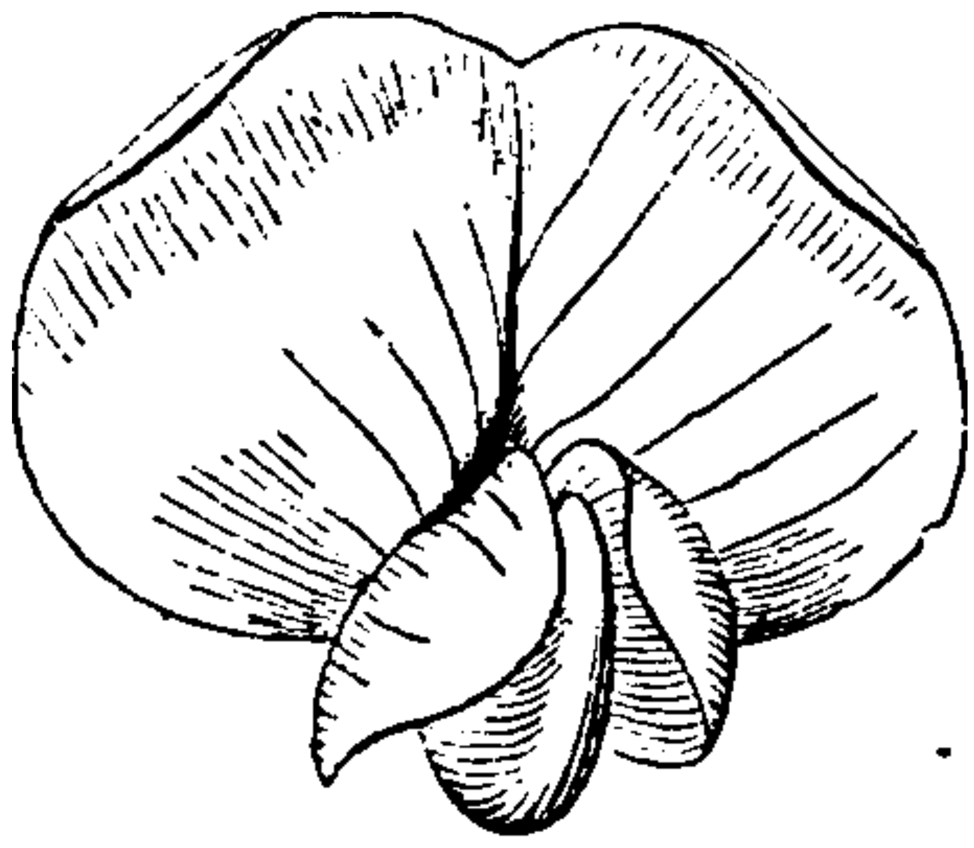
272. In the Apple, Quince, Hawthorn (Fig. 215), &c. Here the tube of the calyx is consolidated with the whole surface of the ovary; and its limb, or free part, therefore appears to spring from its top, instead of underneath it, as it naturally should. So the calyx is said to be *superior*, or (more properly) *adherent* to, or *coherent* with, the ovary. In most cases (and very strikingly in the Evening Primrose), the tube of the calyx is continued on more or less beyond the ovary, and has the petals and stamens consolidated with it for some distance; these last, therefore, being borne on the calyx, are said to be *perigynous*, as before (270).

FIG. 215. Flower of a Hawthorn, divided lengthwise.
FIG. 216. Flower of the Cranberry, divided lengthwise.

273. But if the tube of the calyx ends immediately at the summit of the ovary, and its lobes as well as the corolla and stamens are as it were inserted directly on the ovary, they are said to be *epigynous* (meaning on the pistil), as in Cornel, the Huckleberry, and the Cranberry (Fig. 216).

274. **Irregularity of Parts** in the calyx and corolla has already been noticed (244) as sometimes obstructing one's view of the real plan of a flower. There is infinite variety in this respect; but what has already been said will enable the student to understand these irregularities when they occur. We have only room to mention one or two cases which have given rise to particular names. A very common kind, among polypetalous (267) flowers, is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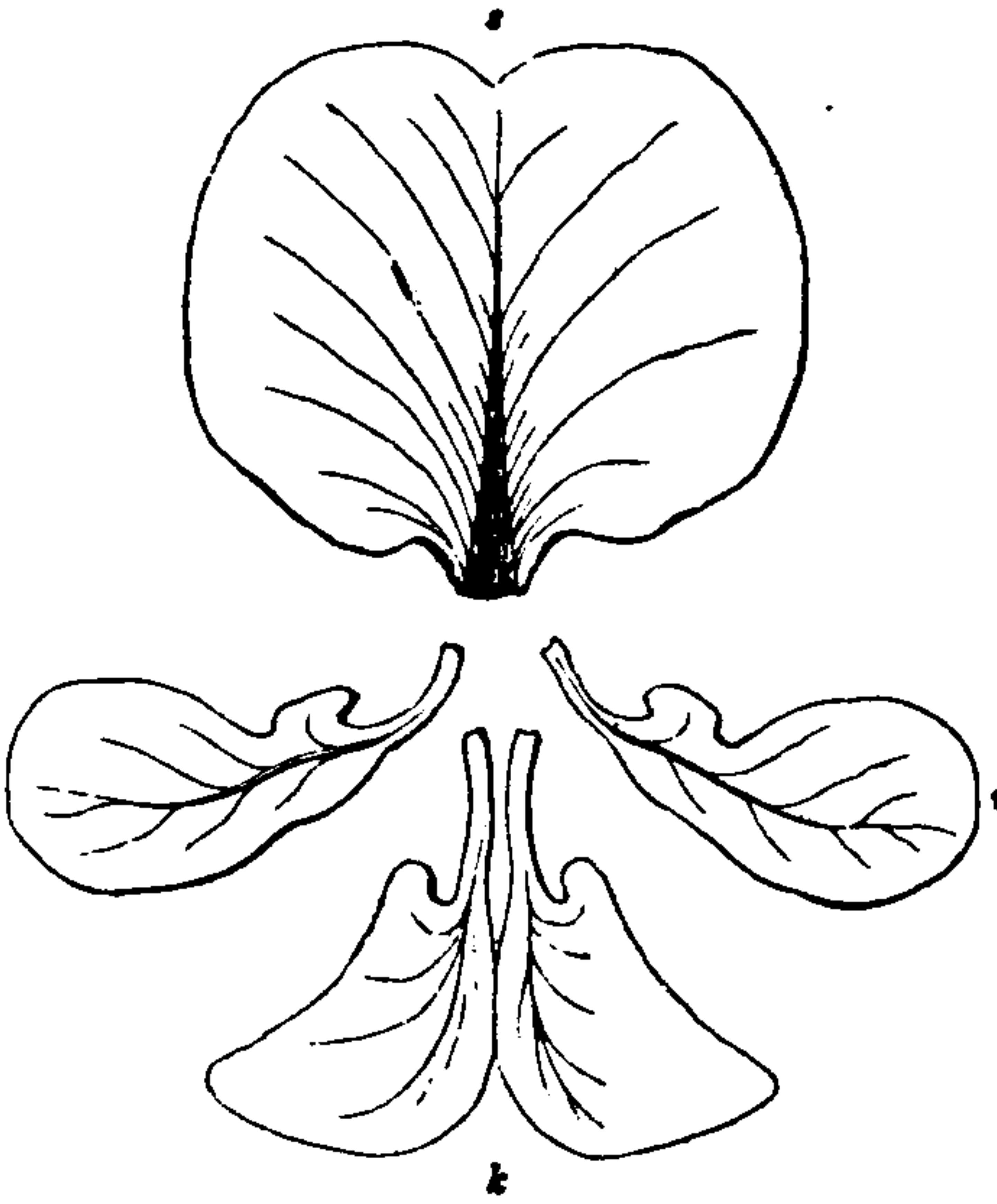
275. The *Papilionaceous* flower of the Pea, Bean, and nearly all that family. In this we have an irregular corolla of a peculiar shape, which Linnæus likened to a butterfly (whence the term, *papilio* being the Latin name for a butterfly); but the resemblance is not very obvious. The five petals of a papilionaceous corolla (Fig. 217) have received different names taken from widely different objects. The upper and larger petal (Fig. 218, *s*), which is generally wrapped round all the rest in the bud, is called the *standard* or *banner*. The two side petals (*w*) are called the *wings*. And the two anterior ones (*k*), the blades of which commonly stick together a little, and which enclose the stamens and pistil in the flower, from their forming a body shaped somewhat like the keel, or rather the prow, of an ancient boat, are together named the *keel.*



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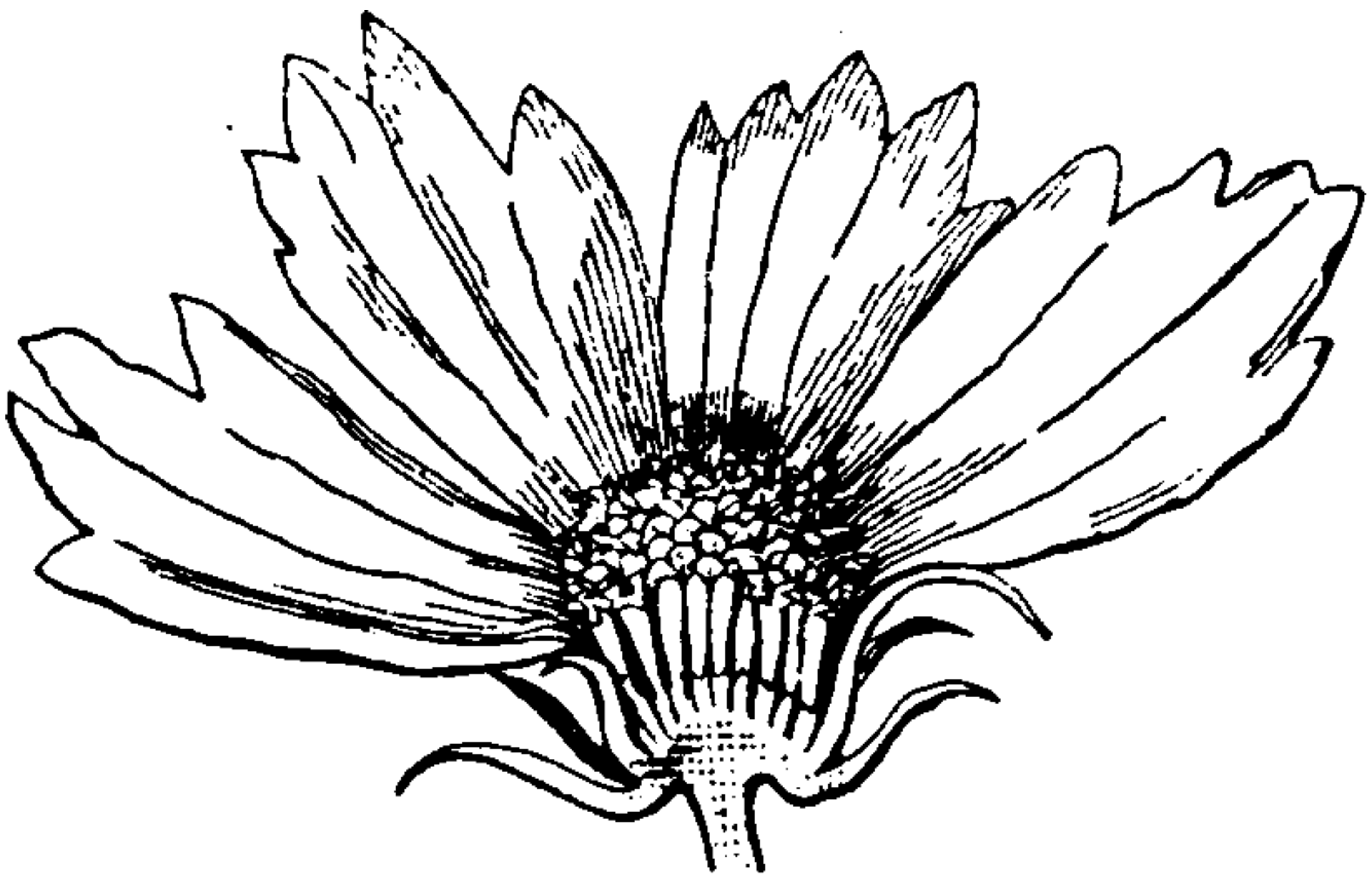
276. The *Labiate* or *bilabiate* (that is, *two-lipped*) flower is a very common form of the monopetalous corolla, as in the Snapdragon

FIG. 217. Front view of the papilionaceous corolla of the Locust-tree. 218. The parts of the same, displayed.

(Fig. 210), Toad-Flax (Fig. 211), Dead-Nettle (Fig. 209), Catnip, Horsemint, &c.; and in the Sage, the Catalpa, &c., the calyx also is two-lipped. This is owing to unequal union of the different parts of the same sort, as well as to diversity of shape. In the corolla two of the petals grow together higher than the rest, sometimes to the very top, and form the *upper lip*, and the three remaining ones join on the other side of the flower to form the *lower lip*, which therefore is more or less three-lobed, while the upper lip is at most only two-lobed. And if the calyx is also two-lipped, as in the Sage,— since the parts of the calyx always alternate with those of the corolla (247),— then the upper lip has three lobes or teeth, namely, is composed of three sepals united, while the lower has only two; which is the reverse of the arrangement in the corolla. So that all these flowers are really constructed on the plan of five, and not on that of two, as one would at first be apt to suppose. In Gerardia, &c. (Fig. 194, 195), the number five is evident in the calyx and corolla, but is more or less obscured in the stamens (249). In Catalpa this number is masked in the calyx by irregular union, and in the stamens by abortion. A different kind of irregular flower is seen in



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277. The *Ligulate* or *strap-shaped* corolla of most *compound flowers*. What was called the compound flower of a Dandelion, Succory (Fig. 221), Thistle, Sunflower, Aster, Whiteweed, &c., consists of many distinct blossoms, closely crowded together into a head, and surrounded by an involucre (208). People who are not botanists commonly take the whole for one flower, the involucre for a calyx, and corollas of the outer or of all the flowers as petals. And this is a very natural mistake when the flowers around the edge have flat and open or strap-shaped corollas, while the rest are regular and tubular, but small, as in the Whiteweed, Sunflower, &c. Fig. 219 represents such a case in a Coreopsis, with the head, or so-called compound flower, cut through; and in Fig. 220 we see one of the perfect flowers of the centre or *disk*, with a regular tubular corolla (*a*), and with the slender bract (*b*) from whose

FIG. 219. Head of flowers (the so-called "compound flower") of Coreopsis, divided lengthwise.

one side, and spread out flat. To prove that this is the case, we have only to compare such a corolla (that of Coreopsis, Fig. 220, *c*, or one from the Succory, for instance) with that of the Cardinal-flower, or of any other Lobelia, which is equally split down along one side; and this again with the less irregular corolla of the Woodbine, partially split down on one side.

221

LESSON XVI.

ÆSTIVATION, OR THE ARRANGEMENT OF THE CALYX AND COROLLA IN THE BUD.

279. ÆSTIVATION or *Præfloration* relates to the way in which the leaves of the flower, or the lobes of the calyx or corolla, are placed with respect to each other in the bud. This is of some importance in distinguishing different families or tribes of plants, being generally very uniform in each. The æstivation is best seen

FIG. 221. Compound flowers, i. e. heads of flowers, of Succory.

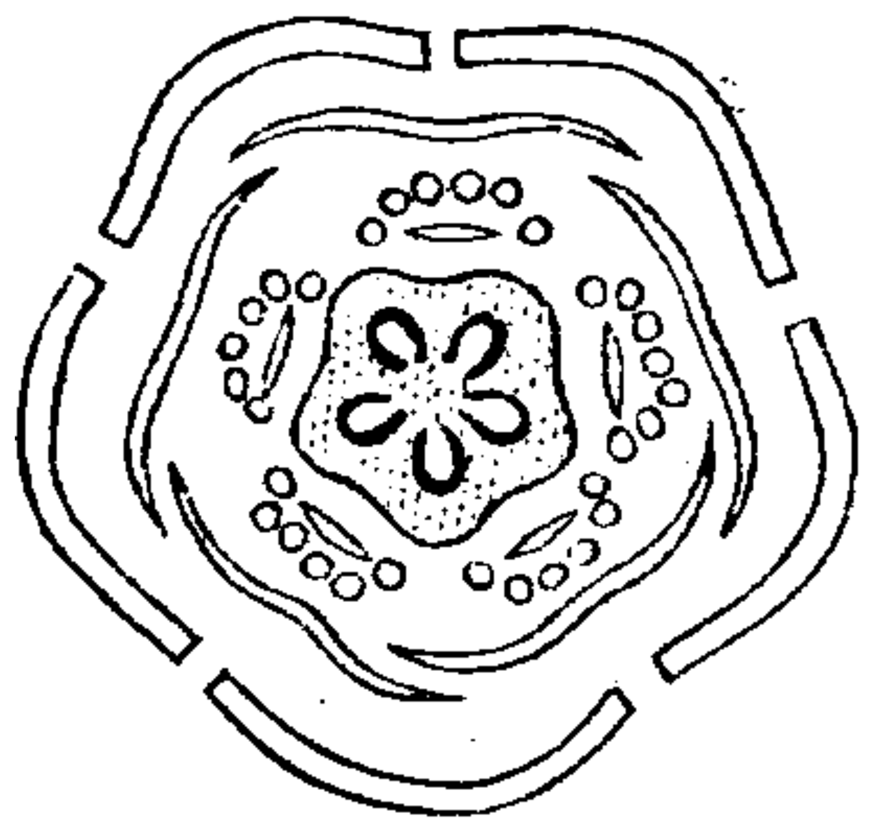
by making a horizontal slice of the flower-bud when just ready to open; and it may be expressed in diagrams, as in Fig. 223, 224.

280. The pieces of the calyx or the corolla either overlap each other in the bud, or they do not. When they do not, the æstivation is commonly

Valvate, as it is called when the pieces meet each other by their abrupt edges without any infolding or overlapping; as the calyx of the Linden or Basswood (Fig. 223) and the Mallow, and the corolla of the Grape, Virginia Creeper, &c. Or it may be

Induplicate, which is valvate with the margins of each piece projecting inwards, or involute (like the leaf in Fig. 152), as in the calyx of Virgin's-Bower and the corolla of the Potato, or else

Reduplicate, like the last, but the margins projecting outwards instead of inwards; these last being mere variations of the valvate form.



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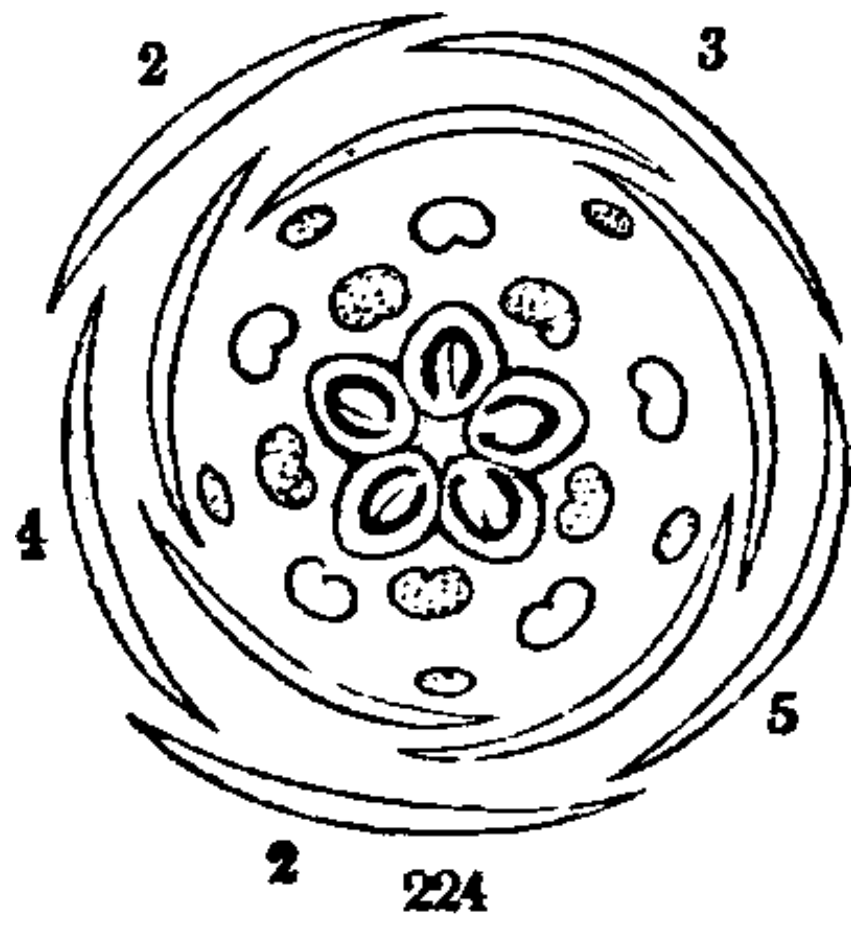
281. When the pieces overlap in the bud, it is in one of two ways: either every piece has one edge in and one edge out; or some pieces are wholly outside and others wholly inside. In the first case the æstivation is

Convolute or *twisted*, as in the corolla of Geranium (most commonly, Fig. 224), Flax (Fig. 191), and of the Mallow Family. Here one edge of every petal covers the next before it, while its other edge is covered by the next behind it. In the second case it is



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Imbricated or *imbricate*, or *breaking joints*, like shingles on a roof, as in the calyx of Geranium (Fig. 224) and of Flax (Fig. 191), and the corolla of the Linden (Fig. 223). In these cases the parts are five in number; and the regular way then is (as in the calyx of the figures above cited) to have two pieces entirely external (1 and 2), one (3) with one edge covered by the first, while the other edge covers that of the adjacent one on the other side, and two (4 and 5) wholly within, their margins at least being covered by the rest. That is, they just represent a circle of five leaves spirally arranged on the five-ranked or $\frac{2}{5}$ plan (187, 188, and Fig. 143 – 145), only with the stem shortened so as to bring the parts close together. The spiral arrangement of the parts of

FIG. 223. Section across the flower-bud of Linden.

FIG. 224. Section across the flower-bud of Geranium: the sepals numbered in their order

the blossom is the same as that of the foliage, — an additional evidence that the flower is a sort of branch. The petals of the Linden, with only one outside and one inside, as shown in Fig. 223, exhibit a gradation between the imbricated and the convolute modes. When the parts are four in number, generally two opposite ones overlap the other two by both edges. When three in number, then one is outermost, the next has one edge out and the other covered, and the third is within, being covered by the other two; as in Fig. 190. This is just the three-ranked ($\frac{1}{3}$) spiral arrangement of leaves (186, and Fig. 171).

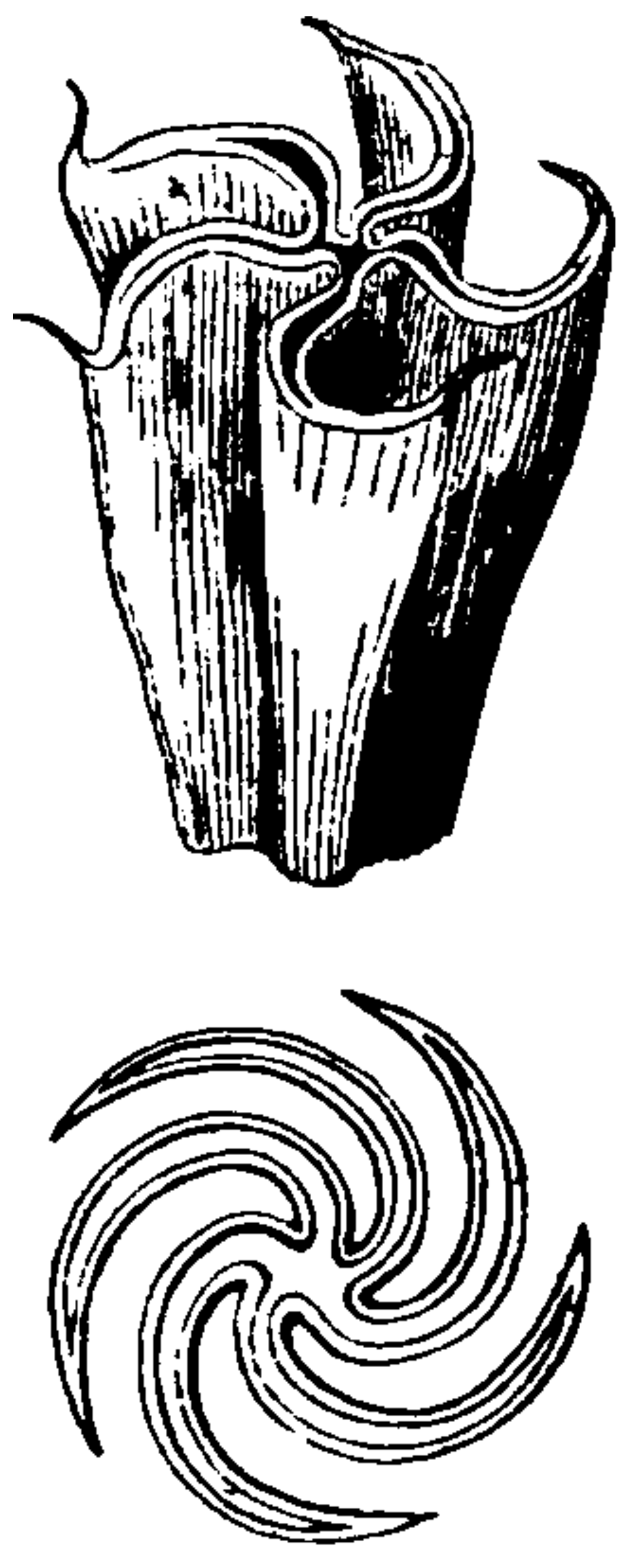
282. In the Mignonette, and some other flowers, the æstivation is *open;* that is, the calyx and corolla are not closed at all over the other parts of the flower, even in the young bud.

283. When the calyx or the corolla is tubular, the shape of the tube in the bud has sometimes to be considered, as well as the way the lobes are arranged. For example, it may be

Plaited or *plicate*, that is, folded lengthwise; and the plaits may either be turned outwards, forming projecting ridges, as in the corolla of Campanula; or turned inwards, as in the corolla of the Gentian, &c. When the plaits are wrapped round all in one direction, so as to cover one another in a convolute manner, the æstivation is said to be

Supervolute, as in the corolla of Stramonium (Fig. 225) and the Morning-Glory; and in the Morning-Glory it is twisted besides.

FIG. 225. Upper part of the corolla of a Stramonium (Datura meteloides), in the bud. Underneath is a cross-section of the same.



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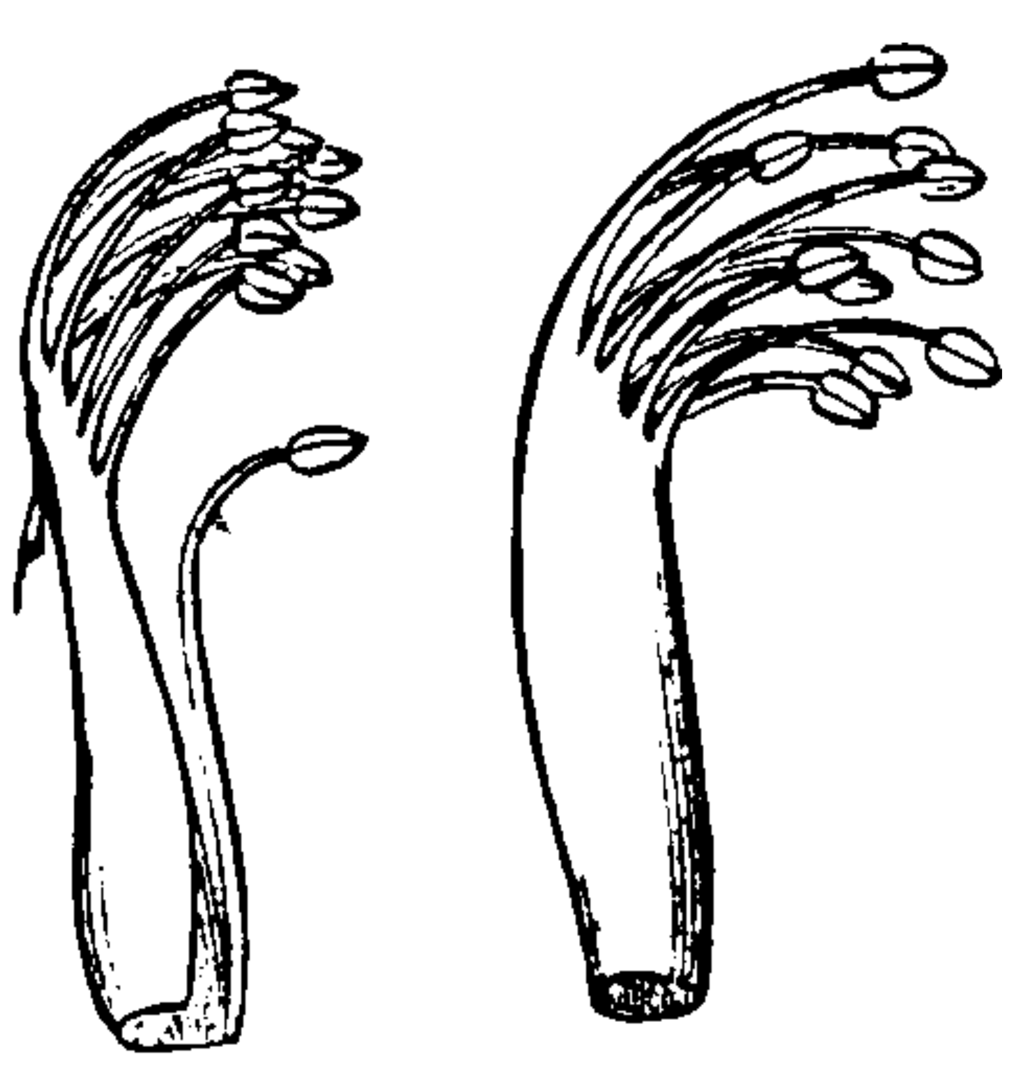
Triadelphous, in three sets or parcels, as in the common St. Johnswort; or

Polyadelphous, when in more numerous sets, as in the Loblolly Bay, where they are in five clusters. On the other hand, stamens are said to be



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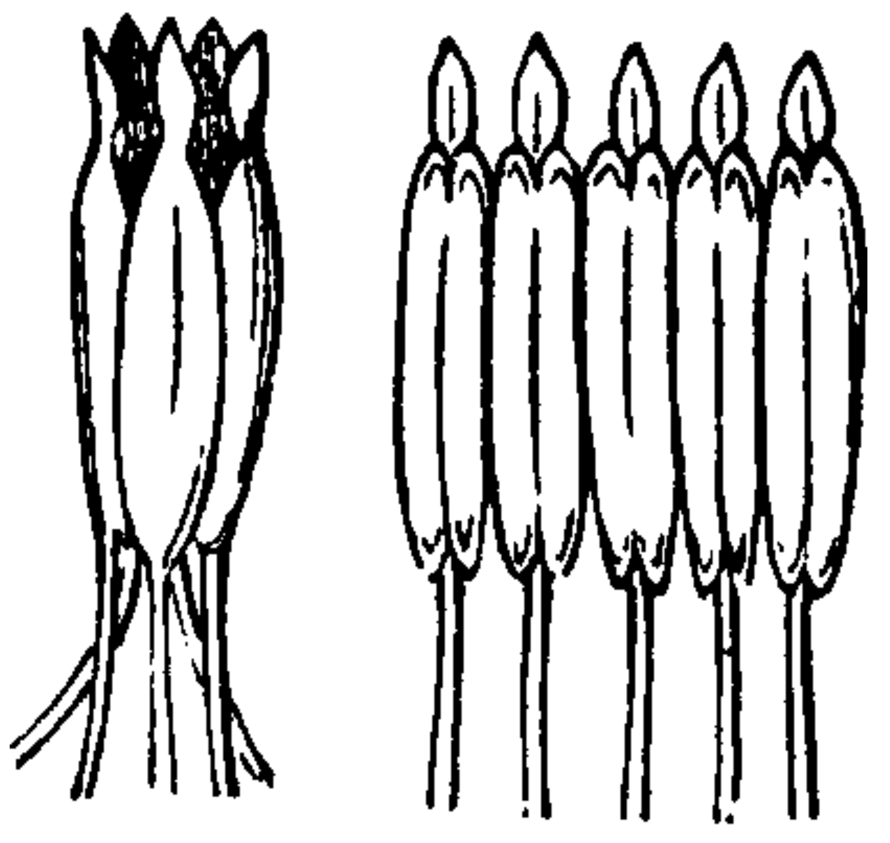
Syngenesious, when united by their anthers (Fig. 229, 230), as they are in Lobelia, in the Violet (slightly), and in what are called *compound flowers*, such as the Thistle, Sunflower, Coreopsis (Fig. 220), and Succory (Fig. 222). In Lobelia, and in the Squash and Pumpkin, the stamens are united both by their anthers and their filaments.

287. **Their Number** in the flower is sometimes expressed by terms compounded of the Greek numerals and the word used to signify stamen; as, *monandrous*, for a flower having only one stamen; *diandrous*, one with two stamens; *triandrous*, with three stamens; *tetrandrous*, with four stamens; *pentandrous*, with five stamens; and so on, up to *polyandrous* (meaning with many stamens), when there are twenty or a larger number, as in a Cactus (Fig. 197). All such terms may be found in the Glossary at the end of the book.



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288. Two terms are used to express particular numbers with unequal length. Namely, the stamens are *didynamous* when only four in number, two longer than the other two, as in the Mint, Catnip, Gerardia (Fig. 194), Trumpet-Creeper, &c.; and *tetradynamous*, when they are six, with four of them regularly longer than the other two, as in Mustard (Fig. 188), and all that family.

289. **Their Parts.** As already shown (233), a stamen consists of two parts, the *Filament* and the *Anther* (Fig. 231).

290. **The Filament** is a kind of stalk to the anther: it is to the anther nearly what the petiole is to the blade of a leaf. Therefore it is not an essential part. As a leaf may be without a stalk, so the anther may be *sessile*, or without a filament. When present,

FIG. 227. Diadelphous stamens of the Pea, &c. 228. Monadelphous stamens of the Lupine.

FIG. 229. Syngenesious stamens of Coreopsis (Fig. 220, *a*), &c. 230. Same, with the tube of anthers split down on one side and spread open.

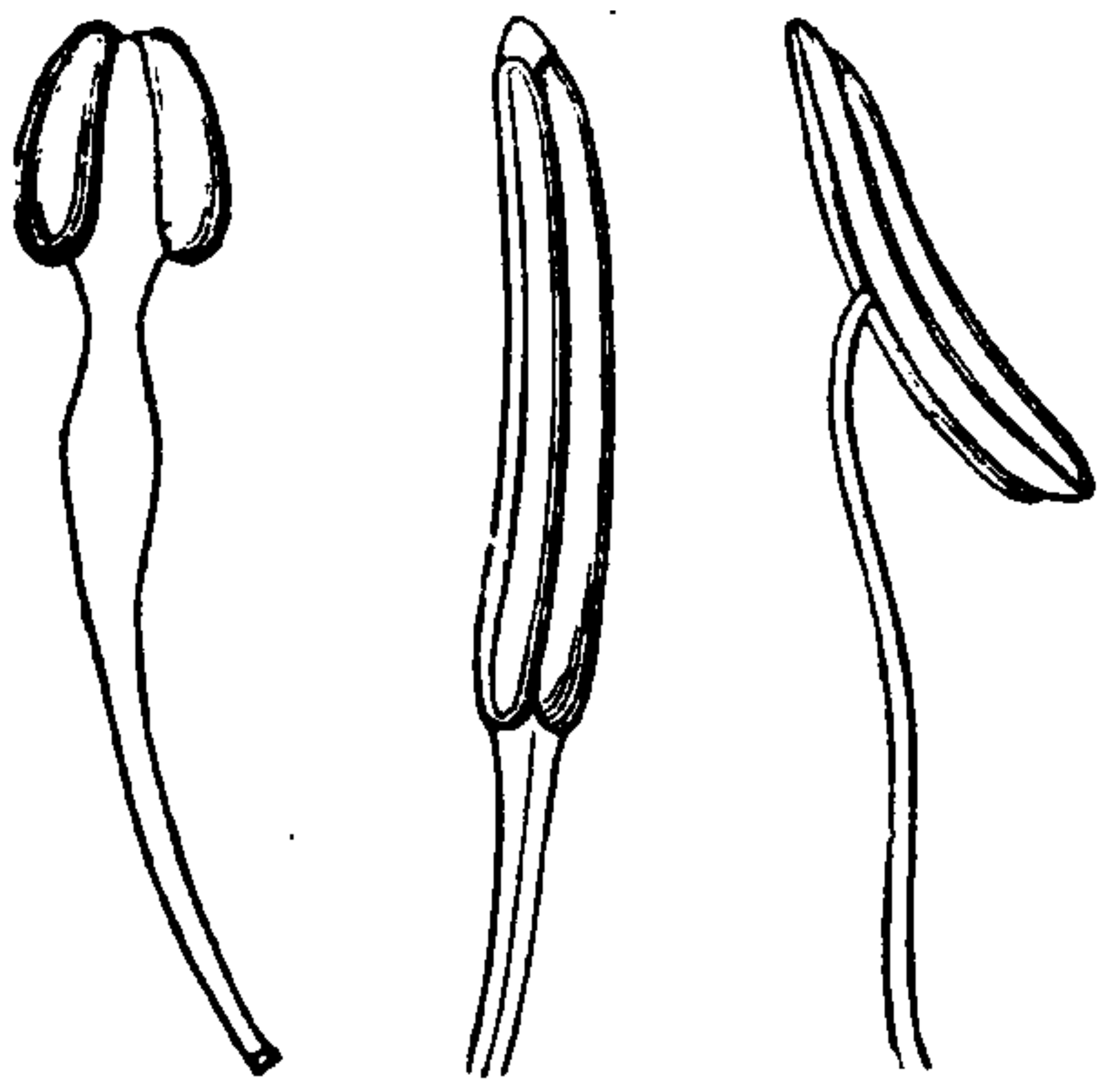
the filament may be of any shape; but it is commonly thread-like, as in Fig. 231, 234, &c.

231

291. **The Anther** is the essential part of the stamen. It is a sort of case, filled with a fine powder, called *Pollen*, which serves to fertilize the pistil, so that it may perfect seeds. The anther may be considered, first, as to

292. **Its Attachment** to the filament. Of this there are three ways; namely, the anther is

Innate (as in Fig. 232), when it is attached by its base to the very apex of the filament, turning neither inwards nor outwards; or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Adnate (as in Fig. 233), when attached by one face, usually for its whole length, to the side of the filament; and

Versatile (as in Fig. 234), when fixed by its middle only to the very point of the filament, so as to swing loosely, as we see it in the Lily, in Grasses, &c.

293. In both the last-named cases, the anther either looks inwards or outwards. When it is turned inwards, or is fixed to that side of the filament which looks towards the pistil or centre of the flower, the anther is *incumbent* or *introrse*, as in Magnolia and the Water-Lily. When turned outwards, or fixed to the outer side of the filament, it is *extrorse*, as in the Tulip-tree.

294. **Its Structure**, &c. There are few cases in which the stamen bears any resemblance to a leaf. Nevertheless, the botanist's idea of a stamen is, that it answers to a leaf developed in a peculiar form and for a special purpose. In the filament he sees the stalk of the leaf; in the anther, the blade. The blade of a leaf consists of two similar sides; so the anther consists of two lobes or cells, one answering to the left, the other to the right, side of the blade. The two lobes are often connected by a prolongation of the filament, which answers to the midrib of a leaf: this is called the *connective*. It is very conspicuous in Fig. 232, where the connective is so broad that it separates the two cells of the anther to some distance from each other.

FIG. 231. A stamen: *a*, filament; *b*, anther discharging pollen.
FIG. 232. Stamen of Isopyrum, with innate anther. 233. Of Tulip-tree, with adnate (and extrorse) anther. 234. Of Evening Primrose, with versatile anther.

295. To discharge the pollen, the anther opens (or is *dehiscent*) at maturity, commonly by a line along the whole length of each cell, and which answers to the margin of the leaf (as in Fig. 231); but when the anthers are extrorse, this line is often on the outer face, and when introrse, on the inner face of each cell. Sometimes the anther opens only by a chink, hole, or pore at the top, as in the Azalea, Pyrola or False Wintergreen (Fig. 235), &c.; and sometimes a part of the face separates as a sort of trap-door (or valve), hinged at the top, and opening to allow the escape of the pollen, as in the Sassafras, Spice-bush, and Barberry (Fig. 236). Most anthers are really four-celled when young; a slender partition running lengthwise through each cell and dividing it into two compartments, one answering to the upper, and the other to the lower, layer of the green pulp of the leaf. Occasionally the anther becomes one-celled. This takes place mostly by *confluence*, that is, the two cells running together into one, as they do slightly in Pentstemon (Fig. 237) and thoroughly in the Mallow Family (Fig. 238). But sometimes it occurs by the obliteration or disappearance of one half of the anther, as in the Globe Amaranth of the gardens (Fig. 239).


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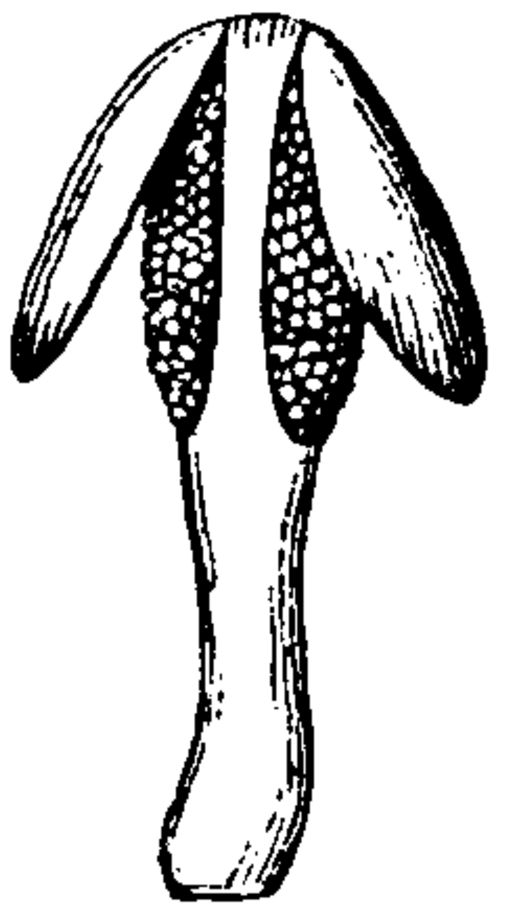
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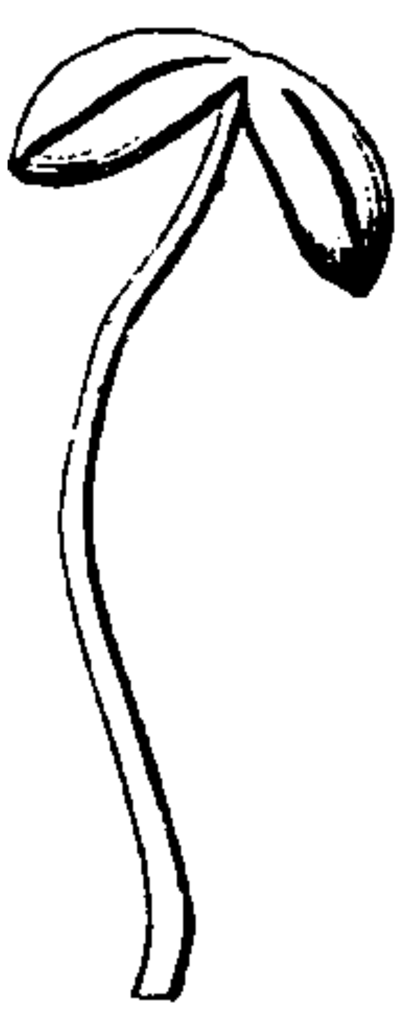
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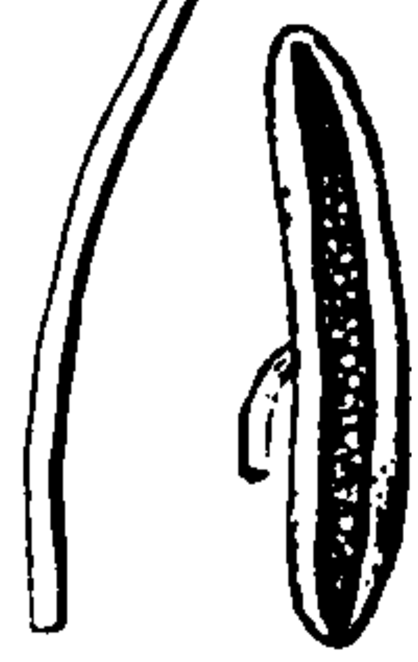
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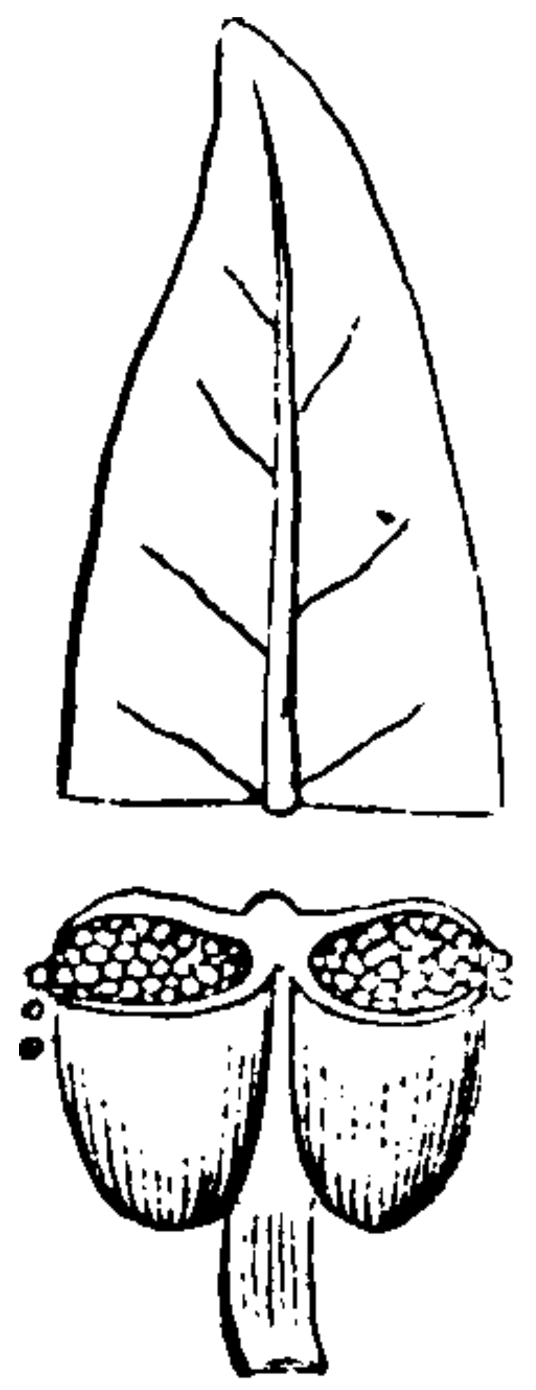
296. The way in which a stamen is supposed to be constructed out of a leaf, or rather on the plan of a leaf, is shown in Fig. 240, an ideal figure, the lower part representing a stamen with the top of its anther cut away; the upper, the corresponding upper part of a leaf. — The use of the anther is to produce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297. **Pollen.** This is the powder, or fine dust, commonly of a yellow color, which fills the cells of the anther, and is discharged during blossoming, after which the stamens generally fall off or wither away.

FIG. 235. Stamen of Pyrola; the anther opening by holes at the top.
FIG. 236. Stamen of Barberry; the anther opening by uplifted valves.
FIG. 237. Stamen of Pentstemon pubescens; anther-cells slightly confluent.
FIG. 238. Stamen of Mallow; the two cells confluent into one, opening round the margin.
FIG. 239. Anther of Globe Amaranth, of only one cell; the other cell wanting.
FIG. 240 Diagram of the lower part of an anther, cut across above, and the upper part of a leaf, to show how the one answers to the other.

LESSON XVIII.

MORPHOLOGY OF PISTILS.

300. The Pistil, when only one, occupies the centre of the flower; when there are two pistils, they stand facing each other in the centre of the flower; when several, they commonly form a ring or circle; and when very numerous, they are generally crowded in rows or spiral lines on the surface of a more or less enlarged or elongated receptacle.

301. Their number in a blossom is sometimes expressed, in Systematic Botany, by terms compounded of the Greek numerals and the Greek word used to signify pistil, in the following way. A flower with one pistil is said to be *monogynous;* with two, *digynous;* with three, *trigynous;* with four, *tetragynous;* with five, *pentagynous,* and so on; with many pistils, *polygynous,* — terms which are explained in the Glossary, but which there is no need to commit to memory.

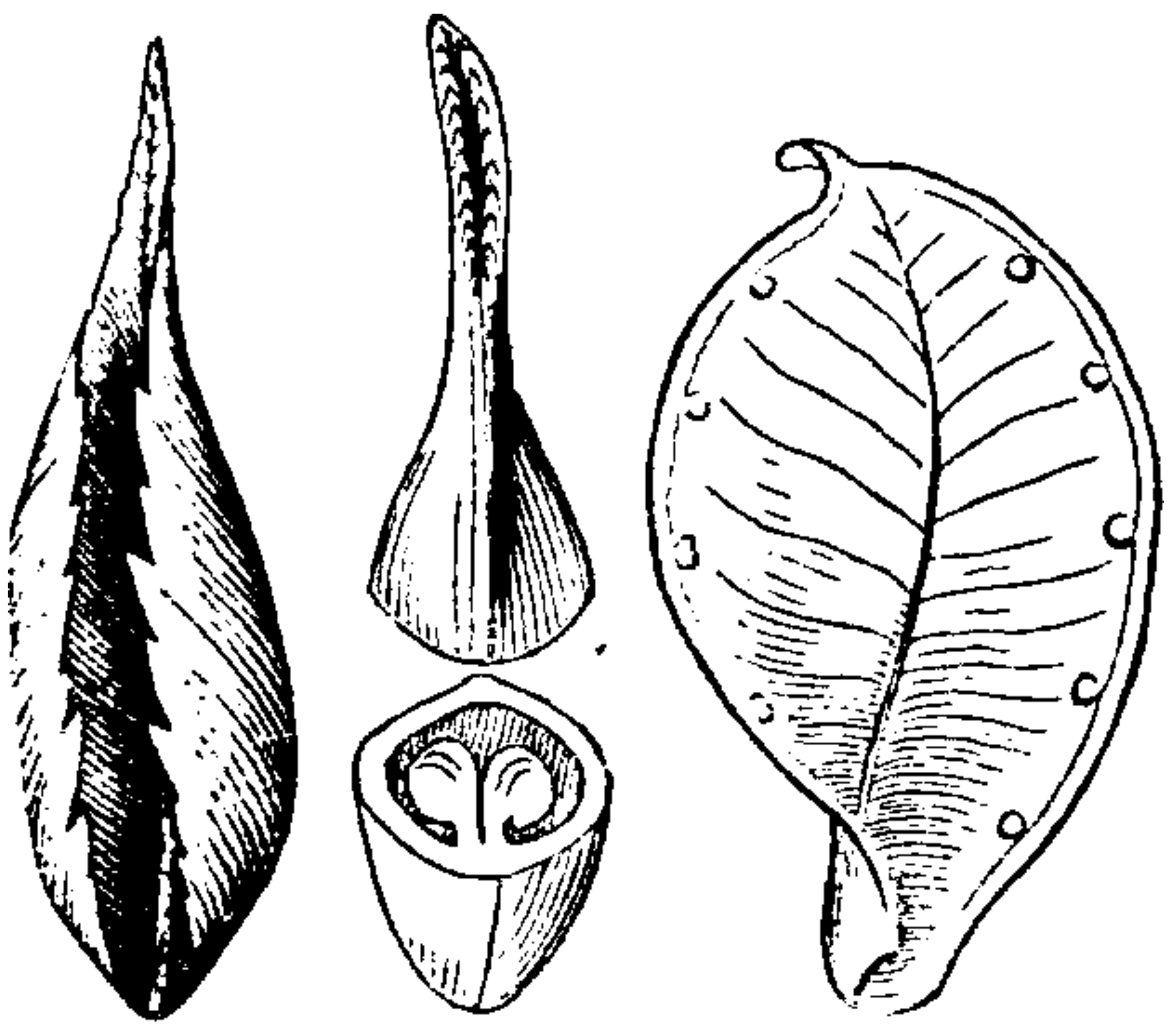
302. **The Parts of a Pistil,** as already explained (234), are the *Ovary,* the *Style,* and the *Stigma.* The ovary is one essential part: it contains the rudiments of seeds, called *Ovules.* The stigma at the summit is also essential: it receives the pollen, which fertilizes the ovules in order that they may become seeds. But the style, the tapering or slender column commonly borne on the summit of the ovary, and bearing the stigma on its apex or its side, is no more necessary to a pistil than the filament is to the stamen. Accordingly, there is no style in many pistils: in these the stigma is *sessile,* that is, rests directly on the ovary. The stigma is very various in shape and appearance, being sometimes a little knob (as in the Cherry, Fig. 213), sometimes a small point, or small surface of bare, moist tissue (as in Fig. 254 – 256), and sometimes a longitudinal crest or line (as in Fig. 252, 258, 267, 269), and also exhibiting many other shapes.

303. The pistil exhibits an almost infinite variety of forms, and many complications. To understand these, it is needful to begin with the simple kinds, and to proceed gradually to the complex. And, first of all, the student should get a clear notion of

304. **The Plan or Ideal Structure of the Pistil,** or, in other words, of the way in which a simple pistil answers to a leaf. Pistils are either

simple or *compound.* A simple pistil answers to a single leaf. A compound pistil answers to two or more leaves combined, just as a monopetalous corolla (263) answers to two or more petals, or leaves of the flower, united into one body. In theory, accordingly,

305. **The Simple Pistil, or Carpel** (as it is sometimes called), consists of the blade of a leaf, curved until the margins meet and unite, forming in this way a closed case or pod, which is the ovary. So that the upper face of the altered leaf answers to the inner surface of the ovary, and the lower, to its outer surface. And the ovules are borne on what answers to the united edges of the leaf. The tapering summit, rolled together and prolonged, forms the style, when there is any; and the edges of the altered leaf turned outwards, either at the tip or along the inner side of the style, form the stigma. To make this perfectly clear, compare a leaf folded together in this way (as in Fig. 251) with a pistil of a Garden Pæony, or Larkspur, or with that in Fig. 252; or, later in the season, notice how these, as ripe pods, split down along the line formed by the united edges, and open out again into a sort of leaf, as in the Marsh-Marigold (Fig. 253). In the Double-flowering Cherry the pistil occasionally is found changed back again into a small green leaf, partly folded, much as in Fig. 251.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306. Fig. 172 represents a simple pistil on a larger scale, the ovary cut through to show how the ovules (when numerous) are attached to what answers to the two margins of the leaf. The Stonecrop (Fig. 168) has five such pistils in a circle, each with the side where the ovules are attached turned to the centre of the flower.

307 The line or seam down the inner side, which answers to the united edges of the leaf, and bears the ovules, is called the *ventral* or *inner Suture.* A corresponding line down the back of the ovary, and which answers to the middle of the leaf, is named the *dorsal* or *outer Suture.*

308. The ventral suture inside, where it projects a little into the

FIG. 251. A leaf rolled up inwards, to show how the pistil is supposed to be formed.

FIG. 252. Pistil of Isopyrum biternatum cut across, with the inner suture turned towards the eye.

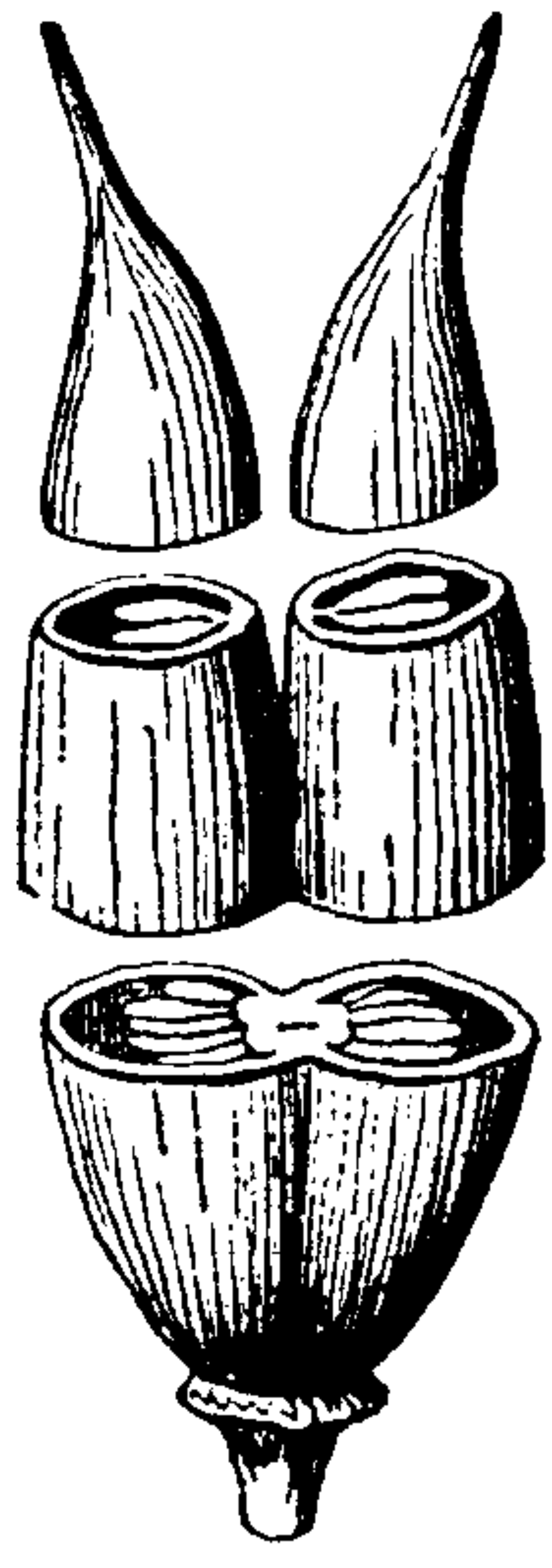
FIG. 253. Pod or ripe pistil of the Caltha, or Marsh-Marigold, after opening.

cavity of the ovary, and bears the ovules, is called the *Placenta.* Obviously a simple pistil can have but one placenta; but this is in its nature double, one half answering to each margin of the leaf. And if the ovules or seeds are at all numerous, they will be found to occupy two rows, one for each margin, as we see in Fig. 252, 172, in the Marsh-Marigold, in a Pea-pod, and the like.

309. A simple pistil obviously can have but one cavity or cell; except from some condition out of the natural order of things. But the converse does not hold true: all pistils of a single cell are not simple. Many compound pistils are one-celled.

310. A simple pistil necessarily has but one style. Its stigma, however, may be double, like the placenta, and for the same reason (305); and it often exhibits two lines or crests, as in Fig. 252, or it may even be split into two lobes.

311. **The Compound Pistil** consists of two, three, or any greater number of pistil-leaves, or carpels (305), in a circle, united into one body, at least by their ovaries. The Cultivated Flax, for example (Fig. 212), has a compound pistil composed of five simple ones with their ovaries united, while the five styles are separate. But in one of our wild species of Flax, the styles are united into one also, for about half their length. So the Common St. John's-wort of the fields has a compound ovary, of three united carpels, but the three styles are separate (Fig. 255), while some of our wild, shrubby species have the styles also combined into one (Fig. 256), although in the fruit they often split into three again. Even the ovaries may only partially combine with each other, as we see in different species of Saxifrage, some having their two pistils nearly separate, while in others they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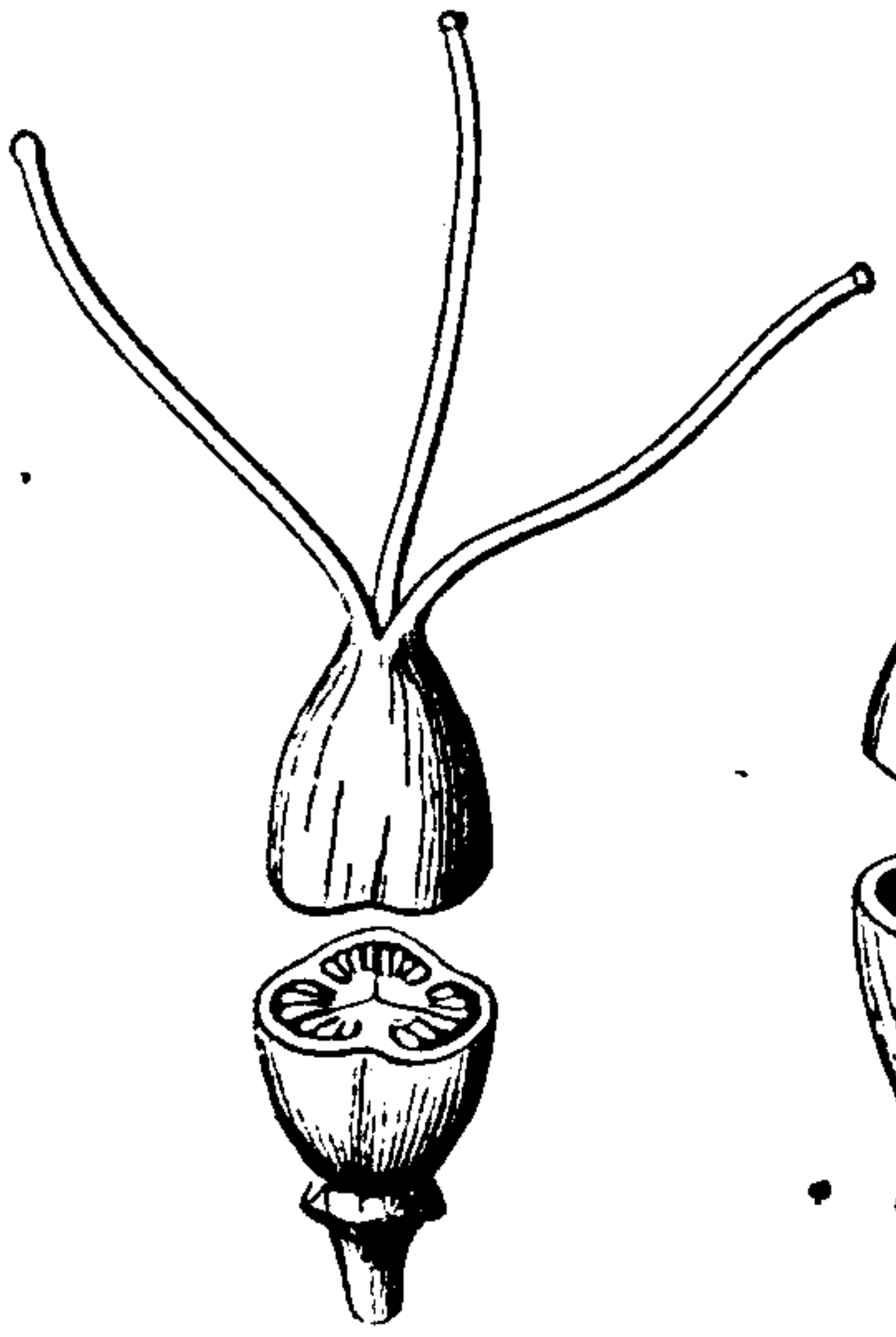
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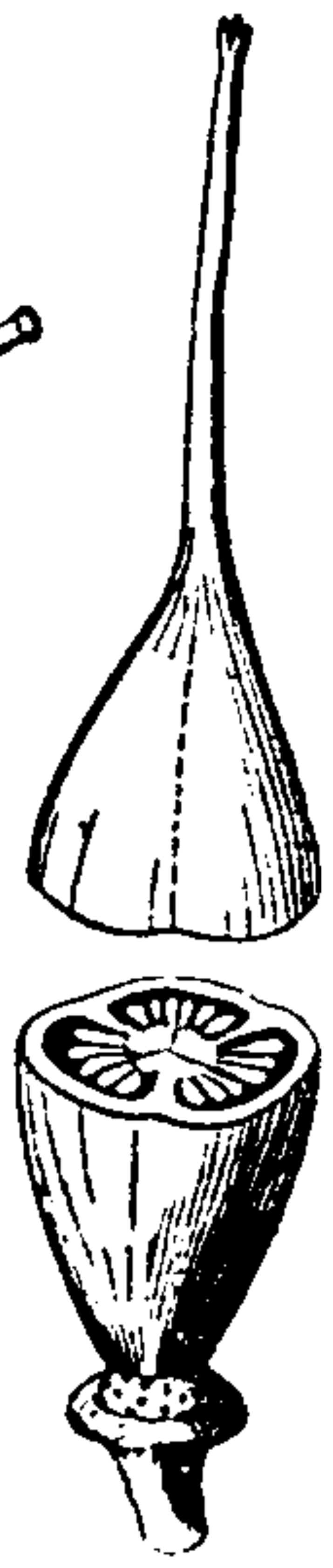
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FIG. 254. Pistil of a Saxifrage, of two simple carpels or pistil-leaves, united at the base only, cut across both above and below.

FIG. 255. Compound pistil of common St. John's-Wort, cut across: styles separate.

FIG. 256. The same of shrubby St. John's-Wort; the three styles united into one.

318. **With a Free Central Placenta**, is what we find in Purslane (Fig. 214), and in most Chickweeds (Fig. 258, 259) and Pinks. The difference between this and the foregoing case is only that the delicate partitions have very early vanished; and traces of them may often be detected. Or sometimes this is a variation of the mode

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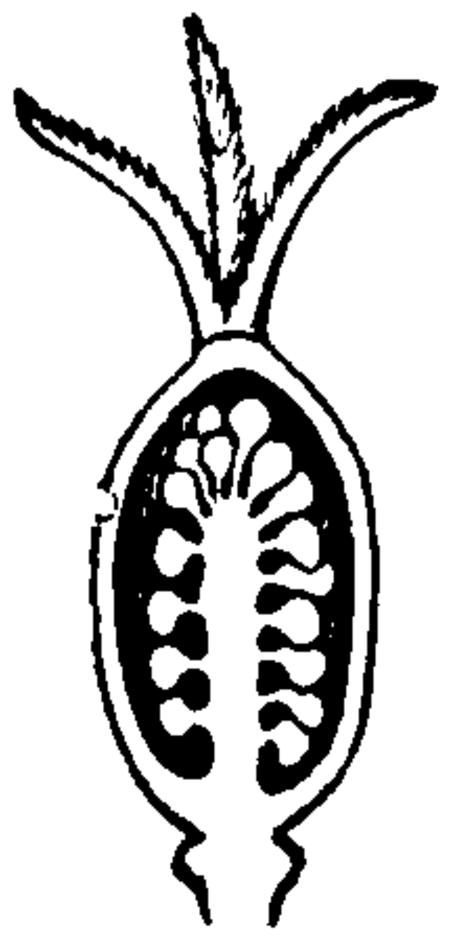

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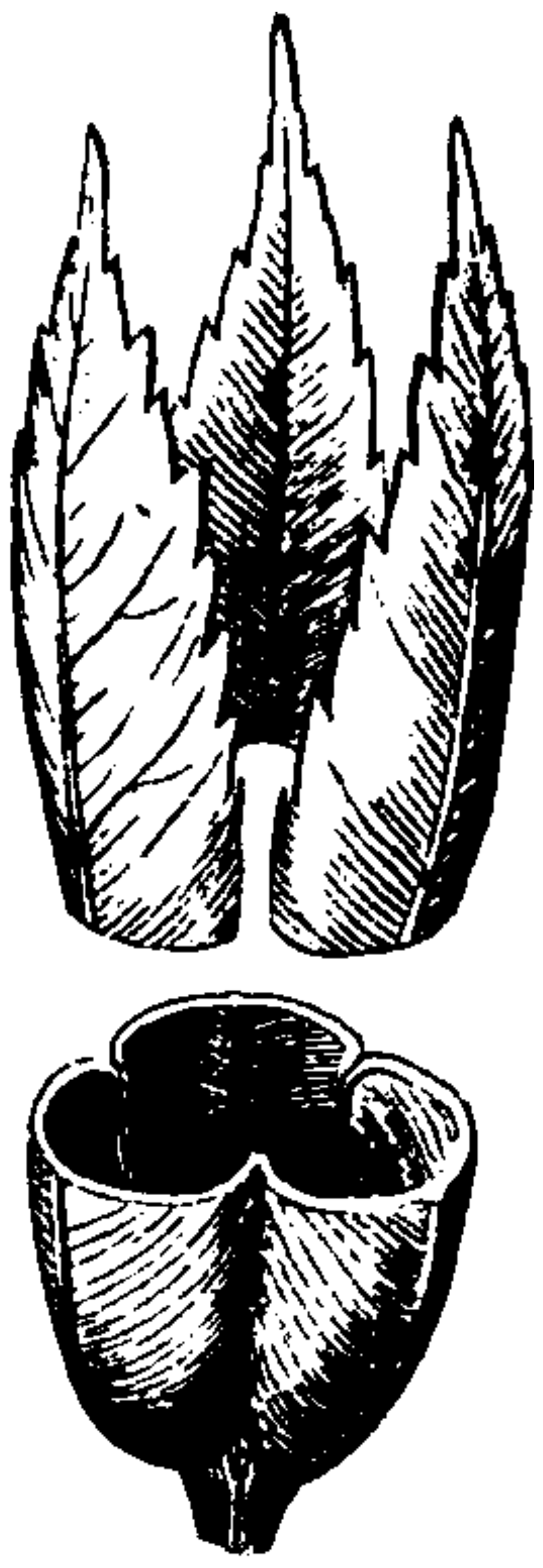
319. **With Parietal Placentæ**, namely, with the ovules and seeds borne on the sides or wall (*parietes*) of the ovary. The pistil of the Prickly Poppy, Bloodroot, Violet, Frost-weed (Fig. 261), Gooseberry, and of many Hypericums, are of this sort. To understand it perfectly, we have only to imagine two, three, or any number of carpel-leaves (like that of Fig. 251), arranged in a circle, to unite by their contiguous edges, and so form one ovary or pod (as we have endeavored to show in Fig. 260); — very much as in the Stramonium (Fig. 199) the five petals unite by their edges to compose a monopetalous corolla, and the five sepals to form a tubular calyx. Here each carpel is an open leaf, or partly open, bearing ovules along its margins; and each placenta consists of the contiguous margins of two pistil-leaves grown together.



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320. All degrees occur between this and the several-celled ovary with the placentæ in the axis. Compare, for illustration, the common St. John's-worts, Fig. 255 and 256, with Fig. 262, a cross-section of the ovary of a different species, in which the three large placentæ meet in the axis, but scarcely unite, and with Fig. 263, a similar section of the ripe pod of the same plant, showing three parietal placentæ borne on imperfect partitions projecting a little way into the general cell. Fig. 261 is the same in plan, but with hardly any trace of partitions; that is, the united edges of the leaves only slightly project into the cell.

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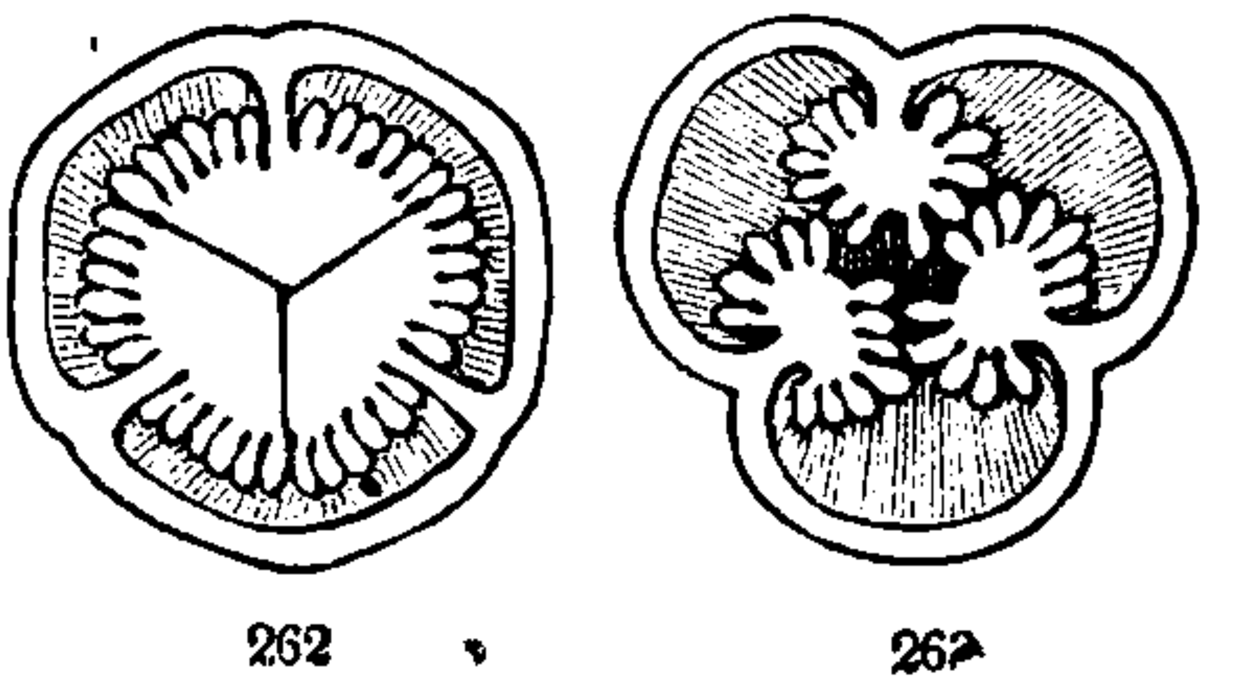
FIG. 258. Pistil of a Sandwort, with the ovary divided lengthwise; and 259, the same divided transversely, to show the free central placenta

FIG. 260. Plan of a one-celled ovary of three carpel-leaves, with parietal placentæ, cut across below, where it is complete; the upper part showing the top of the three leaves it is composed of, approaching, but not united.

FIG. 261 Cross-section of the ovary of Frost-weed (Helianthemum), with three parietal placentæ bearing ovules.

321. The ovary, especially when compound, is often covered by and united with the tube of the calyx, as has already been explained (272). We describe this by saying either "ovary adherent," or "calyx adherent," &c. Or we say "*ovary inferior*," when the tube of the calyx is adherent throughout to the surface of the ovary, so that its lobes, and all the rest of the flower, appear to be borne on its summit, as in Fig. 215 and Fig. 216; or "*half-inferior*," as in the Purslane (Fig. 214), where the calyx is adherent part way up; or "*superior*," where the calyx and the ovary are not combined, as in the Cherry (Fig. 213) and the like, that is, where these parts are *free*. The term "ovary superior," therefore, means just the same as "calyx inferior"; and "ovary inferior," the same as "calyx superior."



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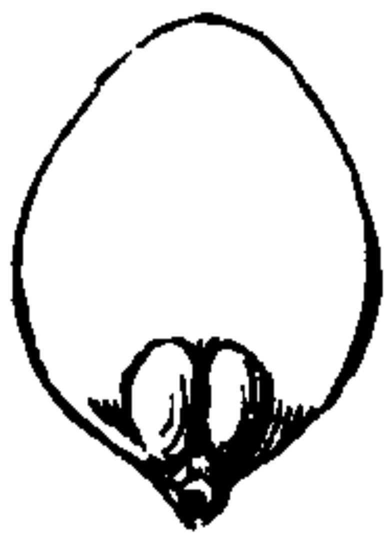
322. **Open or Gymnospermous Pistil.** This is what we have in the whole Pine family, the most peculiar, and yet the simplest, of all pistils. While the ordinary simple pistil in the eye of the botanist represents a leaf rolled together into a closed pod (305), those of the Pine, Larch (Fig. 264), Cedar, and Arbor-Vitæ (Fig. 265, 266) are plainly open leaves, in the form of scales, each bearing two or more ovules on the inner face, next the base. At the time of blossoming, these pistil-leaves of the young cone diverge, and the pollen, so abundantly shed from the staminate blossoms, falls directly upon the exposed ovules. Afterwards the scales close over each other until the seeds are ripe. Then they separate again, that the seeds may be shed. As their ovules and seeds are not enclosed in a pod, all such plants are said to be *Gymnospermous*, that is, *naked-seeded*.



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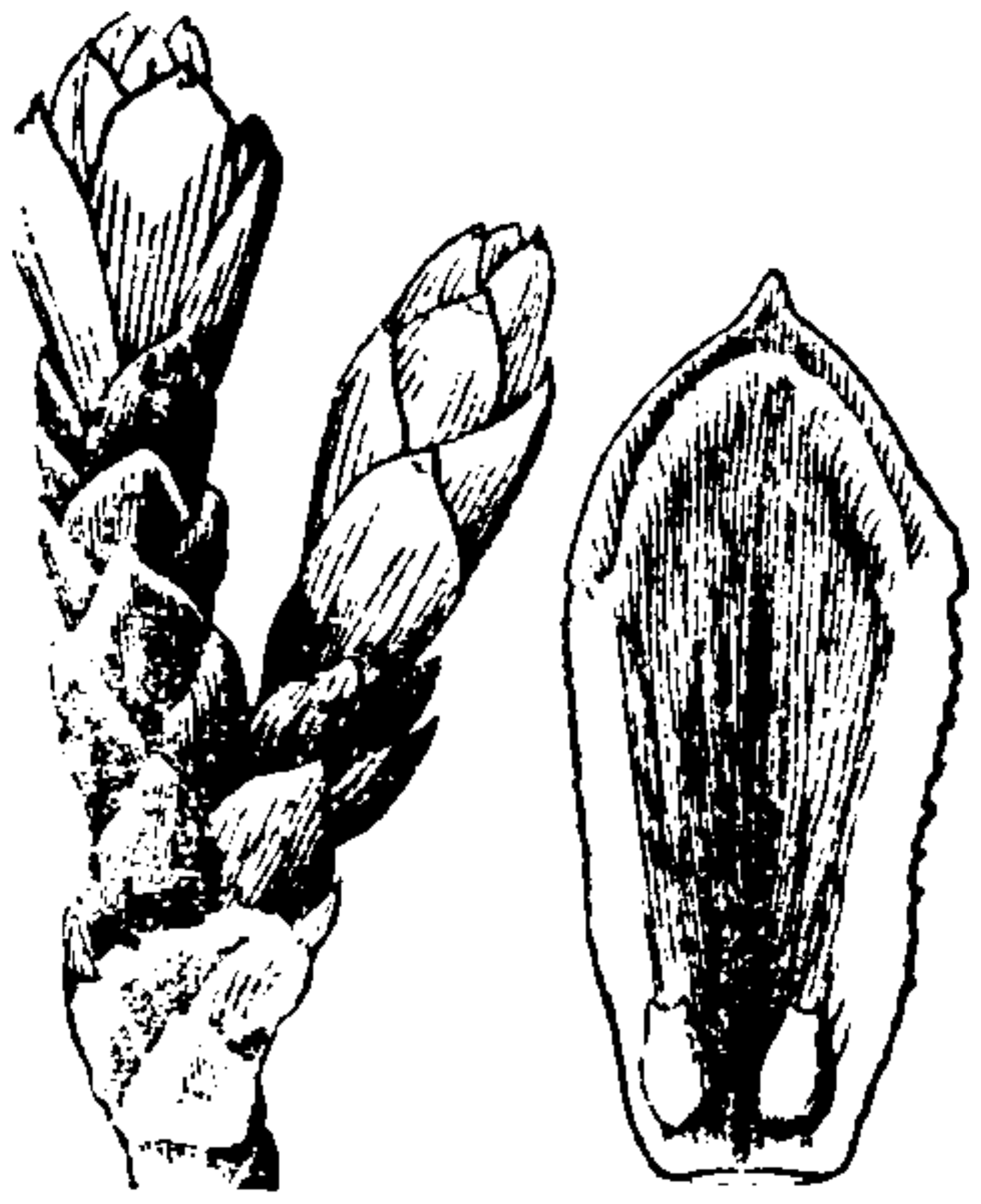

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FIG. 262. Cross-section of the ovary of Hypericum graveolens. 263. Similar section of the ripe pod of the same.

FIG. 264. A pistil, that is, a scale of the cone, of a Larch, at the time of flowering; inside view, showing its pair of naked ovules.

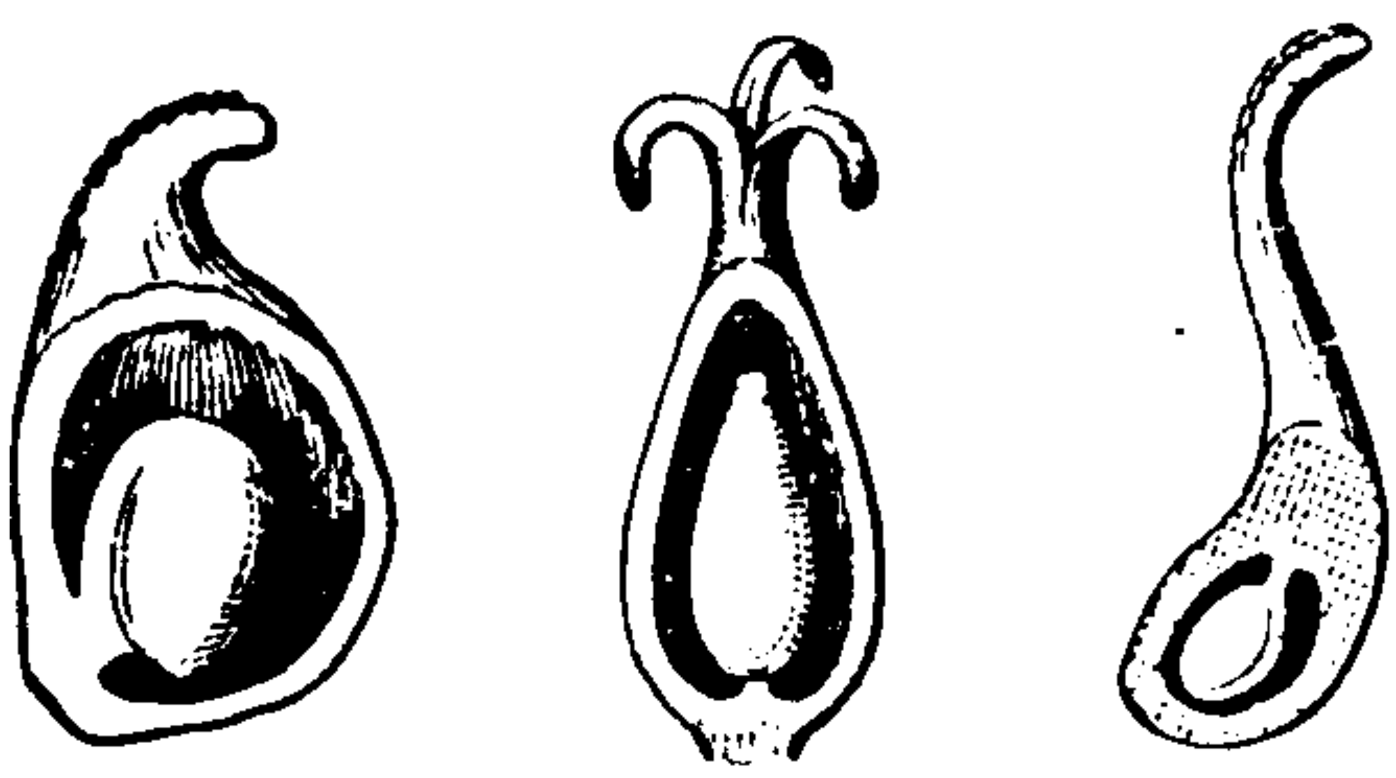
FIG. 265. Branchlet of the American Arbor-Vitæ, considerably larger than in nature, terminated by its pistillate flowers, each consisting of a single scale (an open pistil), together forming a small cone.

FIG. 266. One of the scales or pistils of the last, removed and more enlarged, the inside exposed to view, showing a pair of ovules on its base.

323. **Ovules** (234). These are the bodies which are to become seeds. They are either *sessile,* that is, stalkless, or else borne on a stalk, called the *Funiculus.* They may be produced along the whole length of the cell, or only at some part of it, generally either at the top or the bottom. In the former case they are apt to be numerous; in the latter, they may be few or single (*solitary,* Fig. 267 – 269). As to their direction, ovules are said to be

Horizontal, when they are neither turned upwards nor downwards, as in Fig. 252, 261;

Ascending, when rising obliquely upwards, usually from the side of the cell, not from its very base, as in the Buttercup (Fig. 267), and the Purslane (Fig. 214);



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Erect, when rising upright from the base of the cell, as in the Buckwheat (Fig. 268);

Pendulous, when hanging from towards the top, as in the Flax (Fig. 212); and

Suspended, when hanging perpendicularly from the very summit of the cell, as in the Anemone (Fig. 269), Dogwood, &c. All these terms equally apply to seeds.

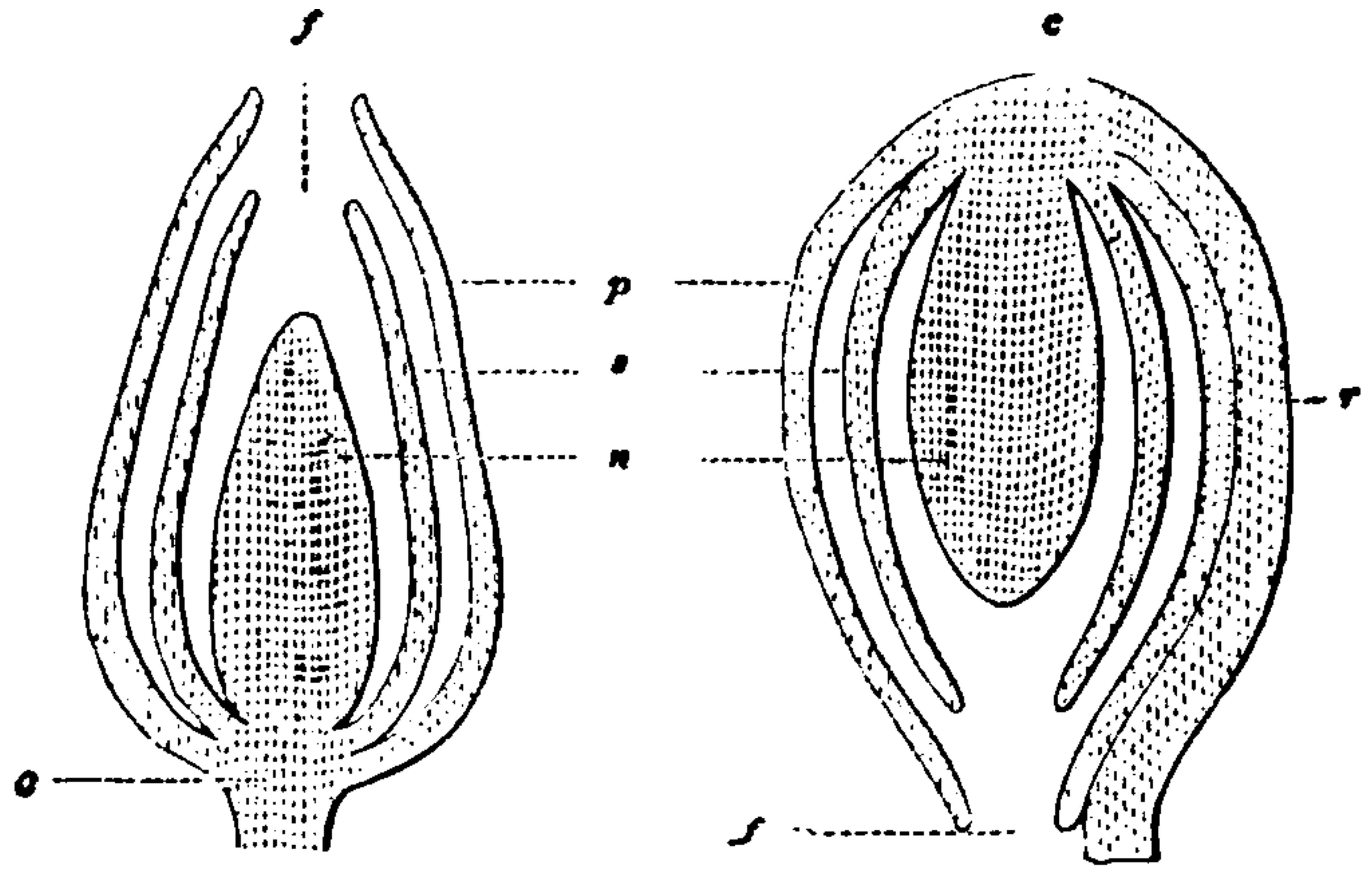
324. An ovule consists of a pulpy mass of tissue, the *Nucleus* or kernel, and usually of one or two coats. In the nucleus the embryo is formed, and the coats become the skin or coverings of the seed. There is a hole (*Orifice* or *Foramen*) through the coats, at the place which answers to the apex of the ovule. The part by which the ovule is attached is its base; the point of attachment, where the ripe seed breaks away and leaves a scar, is named the *Hilum.* The place where the coats blend, and cohere with each other and with the nucleus, is named the *Chalaza.* We will point out these parts in illustrating the four principal kinds of ovule. These are not difficult to understand, although ovules are usually so small that a good magnifying-glass is needed for their examination. Moreover, their names, all taken from the Greek, are unfortunately rather formidable.

325. The simplest sort, although the least common, is what is called the

Orthotropous, or *straight* ovule. The Buckwheat affords a good

FIG. 267. Section of the ovary of a Buttercup, lengthwise, showing its ascending ovule.
FIG. 268. Section of the ovary of Buckwheat, showing the erect ovule.
FIG. 269. Section of the ovary of Anemone, showing its suspended ovule

ovules; Fig. 274, an orthotropous, Fig. 275, an anatropous ovule. The letters correspond in the two; *c*, the chalaza; *f*, the orifice; *r*, rhaphe (of which there is of course none in Fig. 274); *p*, the outer coat, called *primine; s*, inner coat, called *secundine; n*, nucleus or kernel.



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LESSON XIX.

MORPHOLOGY OF THE RECEPTACLE.

327. THE RECEPTACLE (also called the *Torus*) is the axis, or stem, which the leaves and other parts of the blossom are attached to (231). It is commonly small and short (as in Fig. 169); but it sometimes occurs in more conspicuous and remarkable forms.

328. Occasionally it is elongated, as in some plants of the Caper family (Fig. 276), making the flower really look like a branch, having its circles of leaves, stamens, &c., separated by long spaces or internodes.

329. The Wild Geranium or Cranesbill has the receptacle prolonged above and between the insertion of the pistils, in the form of a slender beak. In the blossom, and until the fruit is ripe, it is concealed by the five pistils united around it, and their flat styles covering its whole surface (Fig. 277). But at maturity, the five small and one-seeded fruits separate, and so do their styles, from the beak, and hang suspended from the summit. They split off elasti-

cally from the receptacle, curving upwards with a sudden jerk, which scatters the seed, often throwing it to a considerable distance.

330. When a flower bears a great many pistils, its receptacle is generally enlarged so as to give them room; sometimes becoming broad and flat, as in the Flowering Raspberry, sometimes elongated, as in the Blackberry, the Magnolia, &c. It is the receptacle in the Strawberry (Fig. 279), much enlarged and pulpy when ripe, which forms the eatable part of the fruit, and bears the small seed-like pistils on its surface. In the Rose (Fig. 280), instead of being convex or conical, the receptacle is deeply concave, or urn-shaped. Indeed, a Rose-hip may be likened to a strawberry turned inside out, like the finger of a glove reversed, and the whole covered by the adherent tube of the calyx, which remains beneath in the strawberry.


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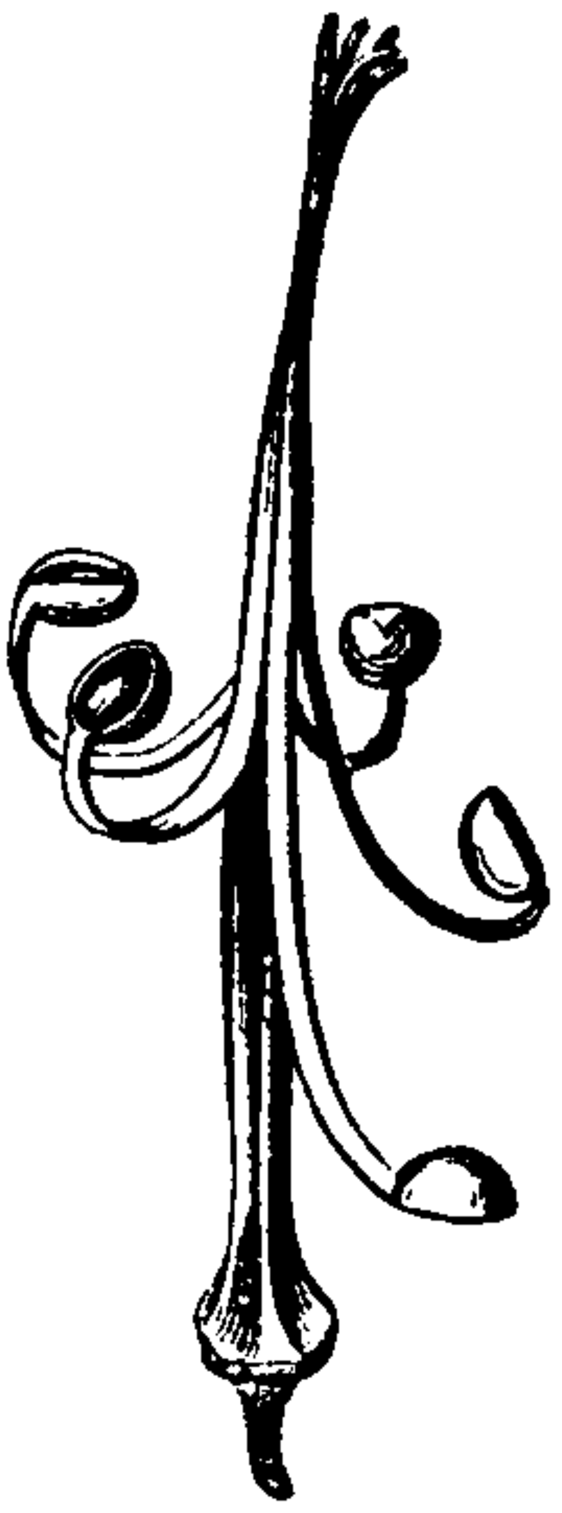
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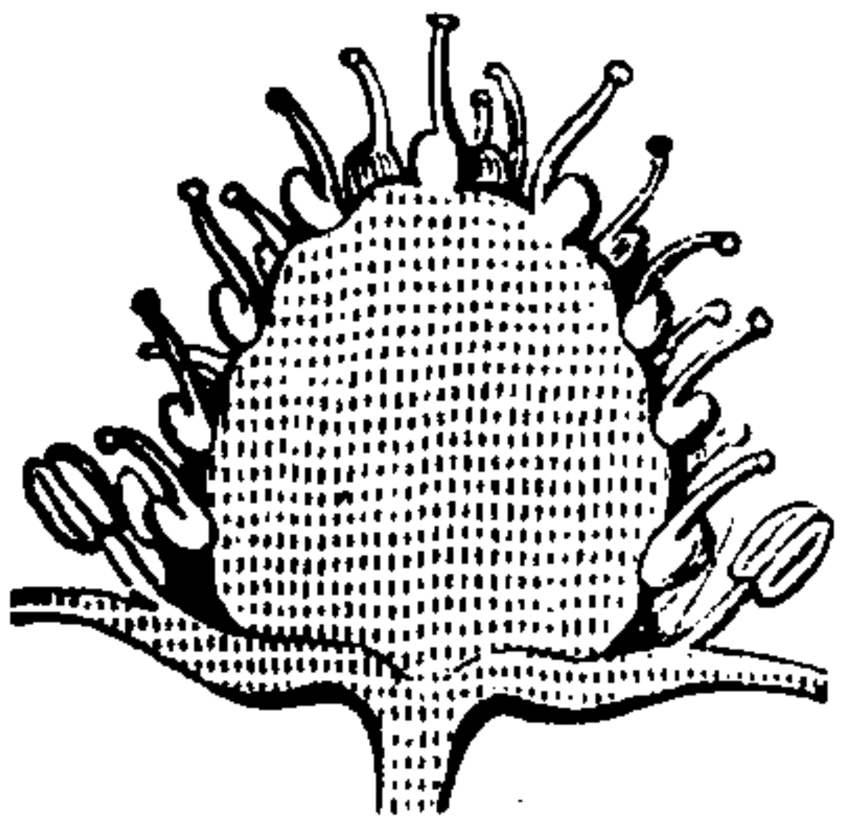
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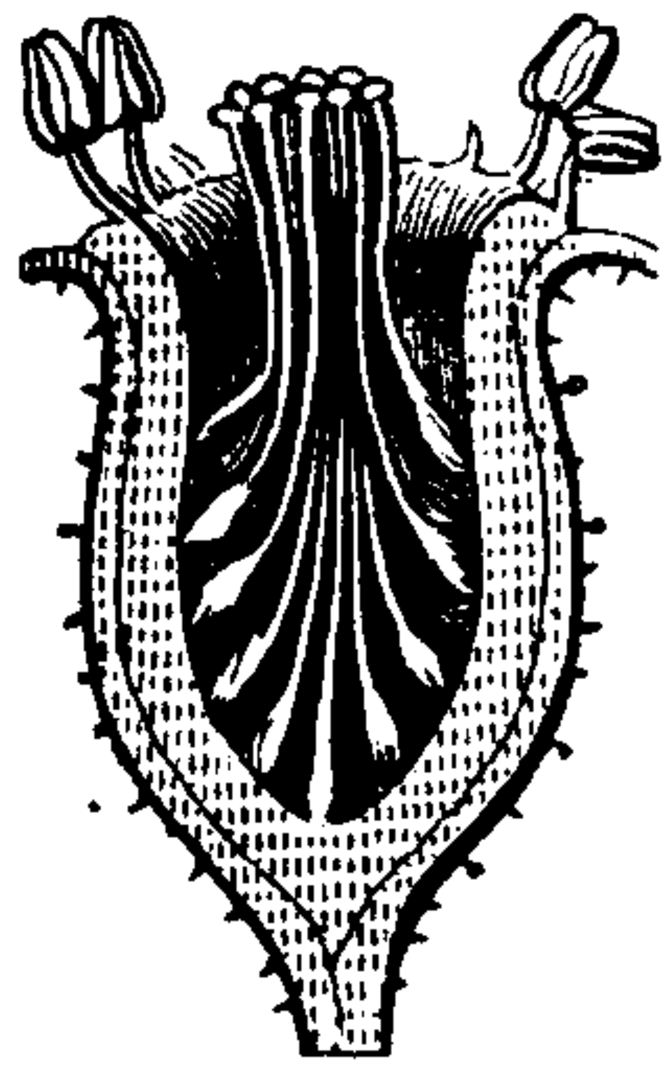
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331. A **Disk** is a part of the receptacle, or a growth from it, enlarged under or around the pistil. It is *hypogynous* (269), when free from all union either with the pistil or the calyx, as in the Rue and the Orange (Fig. 281). It is *perigynous* (270), when it adheres to the base of the calyx, as in the Bladder-nut and Buckthorn (Fig. 282,

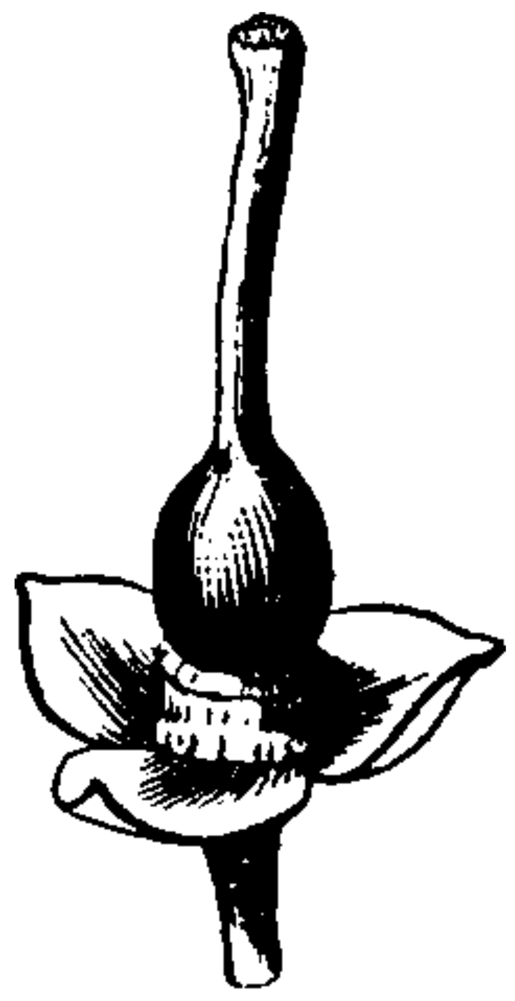
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FIG. 276. Flower of Gynandropsis, the receptacle enlarged and flattened where it bears the sepals and petals, then elongated into a slender stalk, bearing the stamens (in appearance, but they are monadelphous) above its middle, and a compound ovary on its summit.

FIG. 277. Young fruit of the common Wild Cranesbill.

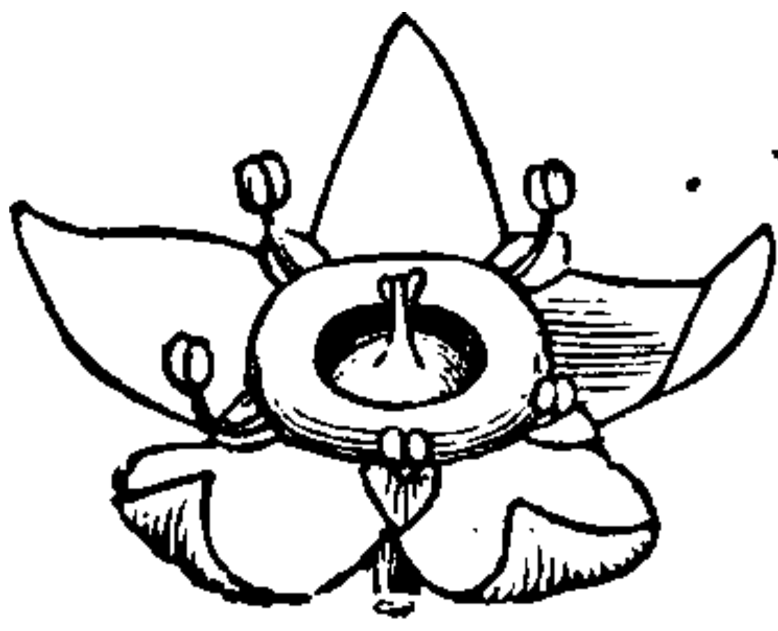
FIG 278. The same, ripe, with the five pistils splitting away from the long beak or receptacle, and hanging from its top by their styles.

FIG. 279. Longitudinal section of a young strawberry, enlarged.

FIG. 280. Similar section of a young Rose-hip.

FIG. 281. Pistil of the Orange, with a large hypogynous disk at its base.

283). Often it adheres both to the calyx and to the ovary, as in New Jersey Tea, the Apple, &c., consolidating the whole together. In such cases it is sometimes carried up and expanded on the top of the ovary, as in the Parsley and the Ginseng families, when it is said to be *epigynous* (273).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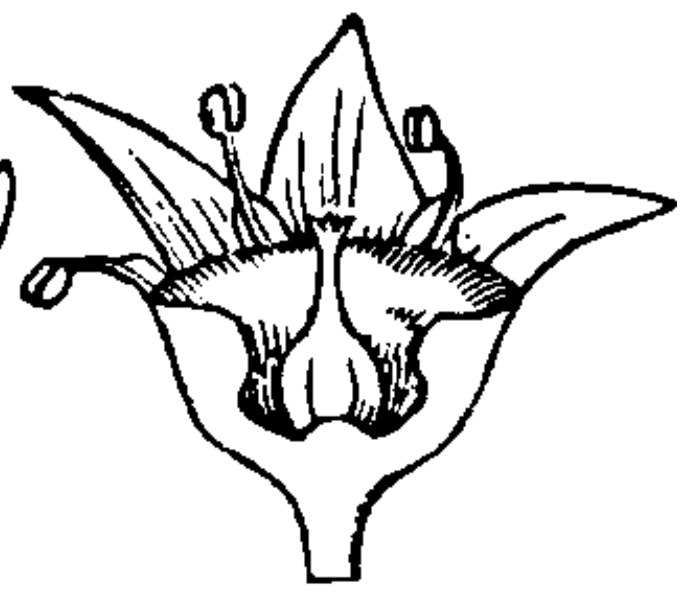
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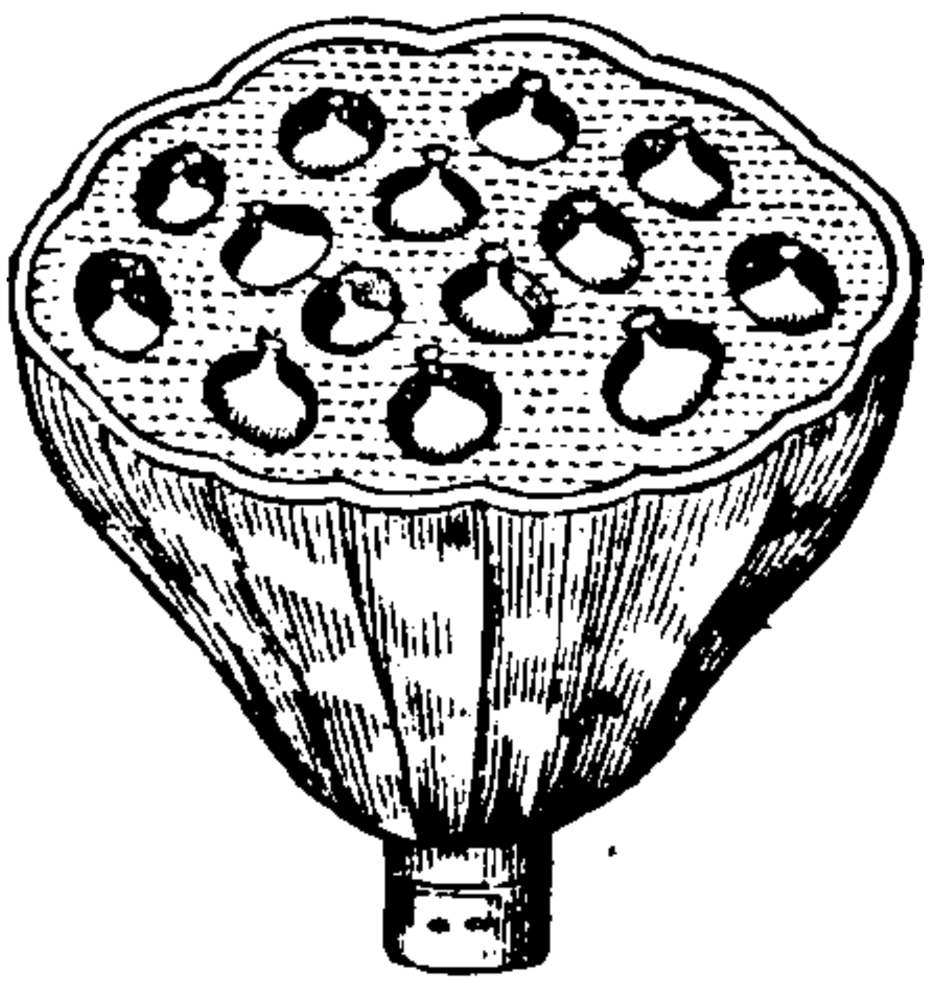
332. In Nelumbium, — a large Water-Lily, abounding in the waters of our Western States, — the singular and greatly enlarged receptacle is shaped like a top, and bears the small pistils immersed in separate cavities of its flat upper surface (Fig. 284).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LESSON XX.

THE FRUIT.

333 THE ripened ovary, with its contents, becomes the *Fruit.* When the tube of the calyx adheres to the ovary, it also becomes a part of the fruit: sometimes it even forms the principal bulk of it, as in the apple and pear.

334. Some fruits, as they are commonly called, are not fruits at all in the strict botanical sense. A strawberry, for example (as we have just seen, 330, Fig. 282), although one of the choicest *fruits* in the common acceptation, is only an enlarged and pulpy receptacle, bearing the real fruits (that is, the ripened pistils) scattered over its

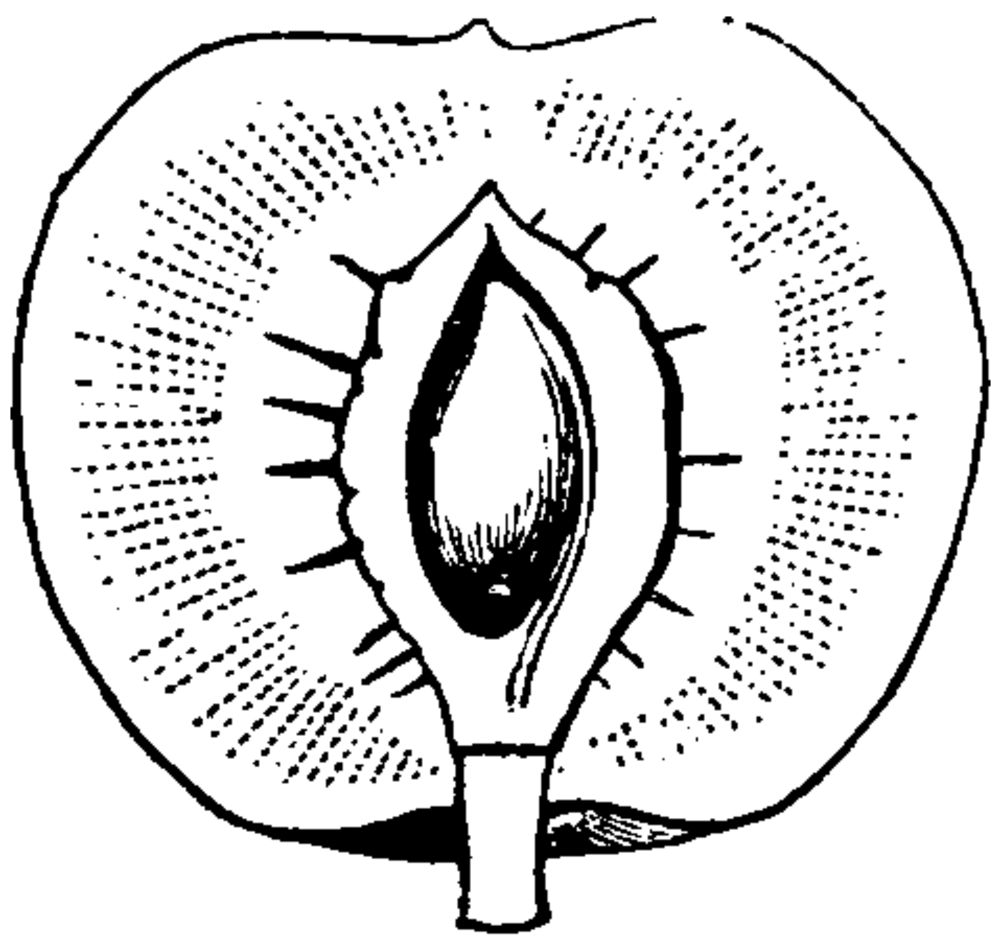
FIG. 282. Flower of a Buckthorn, With a large perigynous disk. 283. The same, divided.
FIG. 284. Receptacle of Nelumbium, in fruit.

341. **The Pepo**, or *Gourd-fruit*, is the sort of berry which belongs to the Gourd family, mostly with a hard rind and the inner portion softer. The pumpkin, squash, cucumber, and melon are the principal examples.

342. **The Pome** is a name applied to the apple, pear, and quince; fleshy fruits like a berry, but the principal thickness is calyx, only the papery pods arranged like a star in the core really belonging to the pistil itself (333).

343. Secondly, as to fruits which are partly fleshy and partly hard, one of the most familiar kinds is

344. **The Drupe**, or *Stone-fruit;* of which the cherry, plum, and peach (Fig. 285) are familiar examples. In this the outer part of the thickness of the pericarp becomes fleshy, or softens, like a berry, while the inner hardens, like a nut. From the way in which the pistil is constructed (305), it is evident that the fleshy part here answers to the lower, and the stone to the upper, side of the leaf; — a leaf always consisting of two layers of green pulp, an upper and an under layer, which are considerably different (439).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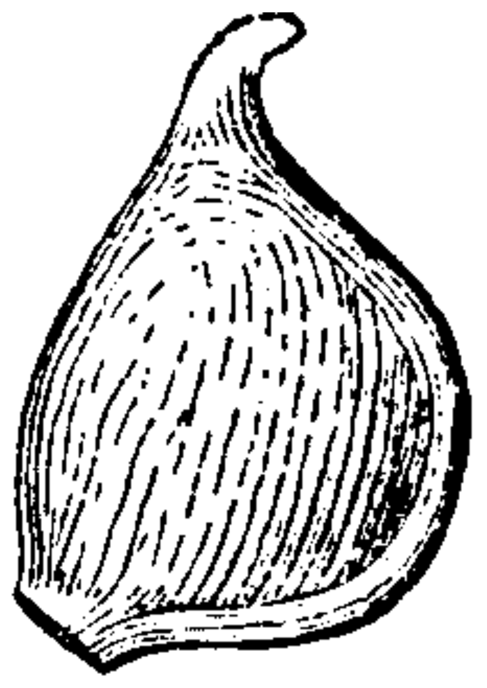
345. Whenever the walls of a fruit are separable into two layers, the outer layer is called the *Exocarp*, the inner, the *Endocarp* (from Greek words meaning "outside fruit" and "inside fruit"). But in a drupe the outer portion, being fleshy, is likewise called *Sarcocarp* (which means "fleshy fruit"), and the inner, the *Putamen* or stone. The stone of a peach, and the like, it will be perceived, belongs to the fruit, not to the seed. When the walls are separable into three layers, the outer layer is named either exocarp or *Epicarp;* the middle one is called the *Mesocarp* (i. e. middle fruit); and the innermost, as before, the *Endocarp*.

346. Thirdly, in *dry fruits* the seed-vessel remains herbaceous in texture, or becomes thin and membranaceous, or else it hardens throughout. Some forms remain closed, that is, are *indehiscent* (338); others are *dehiscent*, that is, split open at maturity in some regular way. Of indehiscent or closed dry fruits the principal kinds are the following.

347. **The Achenium**, or *Akene*, is a small, one-seeded, dry, indehis-

FIG. 285. Longitudinal section of a peach, showing the flesh, the stone, and the seed

cent frnit, such as is popularly taken for a naked seed: but it is plainly a ripened ovary, and shows the remains of its style or stigma, or the place from which it has fallen. Of this sort are the fruits of the Buttercup (Fig. 286, 287), the Cinque-foil, and the Strawberry (Fig. 279, 288); that is, the real fruits, botanically speaking, of the latter, which are taken for seeds, not the large juicy receptacle on the surface of which they rest (330). Here the akenes are simple pistils (305), very numerous in the same flower, and forming a head of such fruits. In the Nettle, Hemp, &c., there is only one pistil to each blossom.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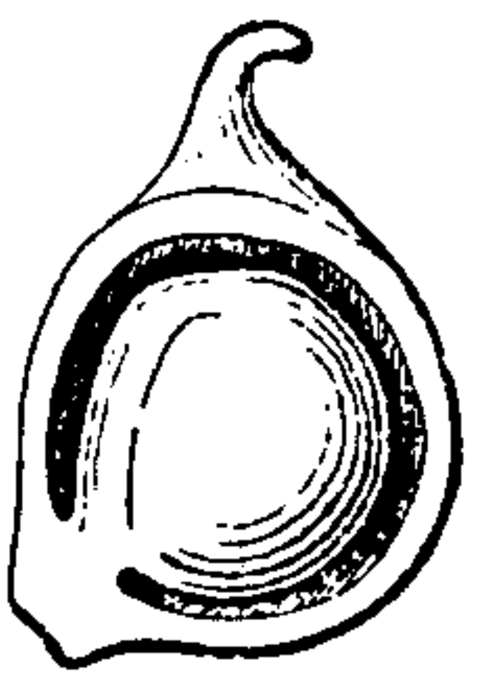
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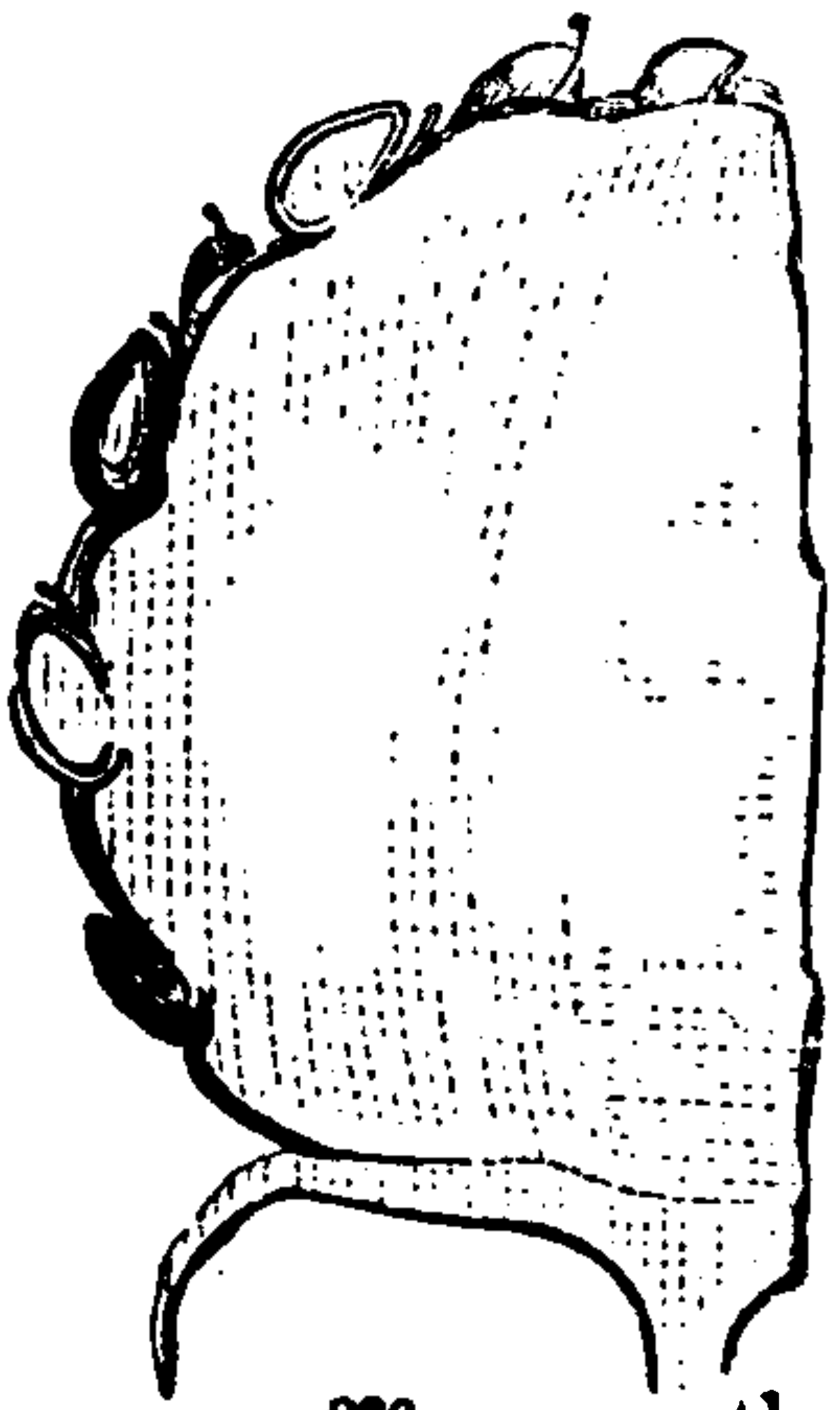

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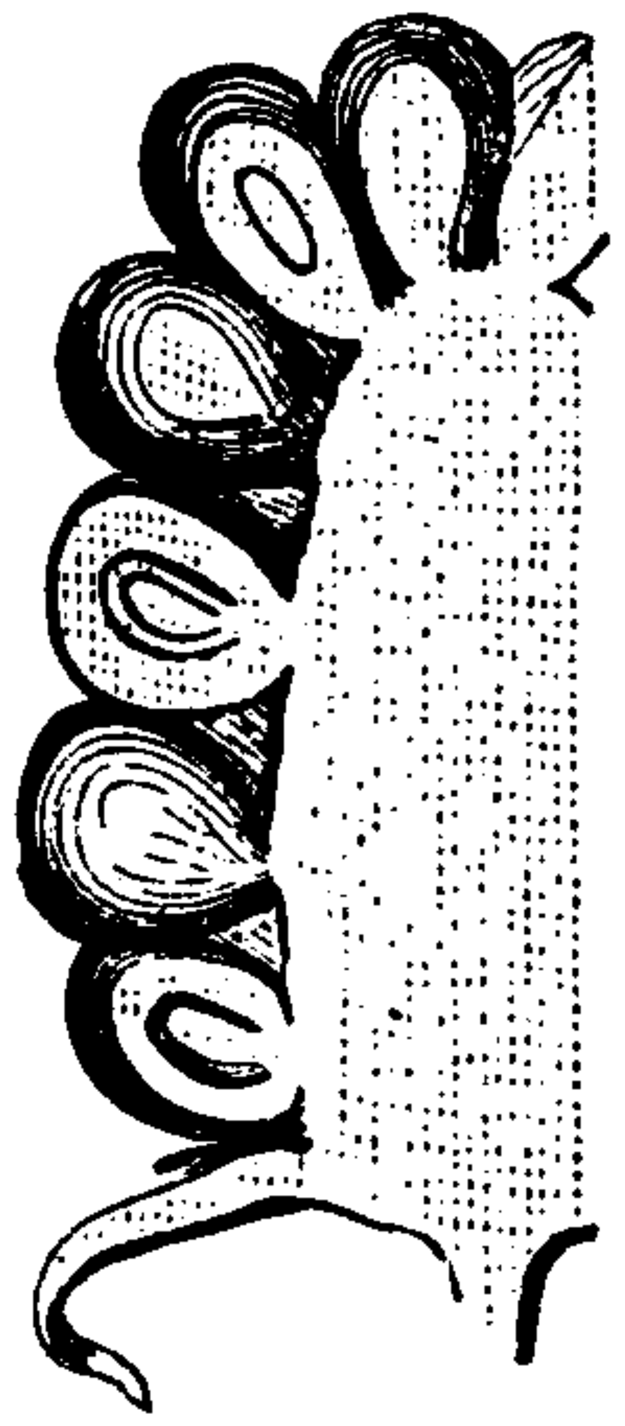
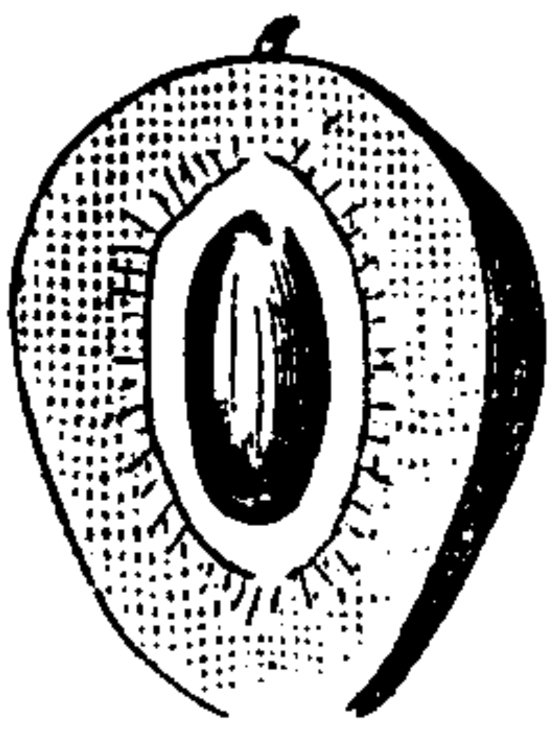


348. In the raspberry and blackberry, each grain is a similar pistil, like that of the strawberry in the flower, but ripening into a miniature stone-fruit, or drupe. So that in the strawberry we eat the receptacle, or end of the flower-stalk; in the raspberry, a cluster of stone-fruits, like cherries on a very small scale; and in the blackberry, both a juicy receptacle and a cluster of stone-fruits covering it (Fig. 289, 290).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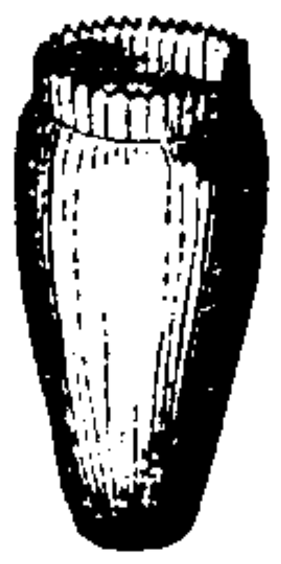
349. The fruit of the Composite family is also an achenium. Here the surface of the ovary is covered by an adherent calyx-tube, as is evident from the position of the corolla, apparently standing on its summit (321, and Fig. 220, *a*). Sometimes the limb or divisions of the calyx are entirely wanting, as in Mayweed (Fig. 291) and Whiteweed. Sometimes the limb of the calyx forms a *crown* or cup on the top of the achenium, as in Succory (Fig. 292); in Coreopsis, it often takes the form of two blunt teeth or scales; in the Sunflower (Fig. 293), it consists of two

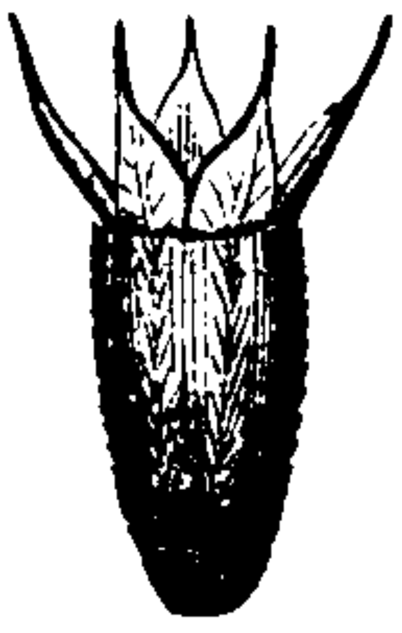
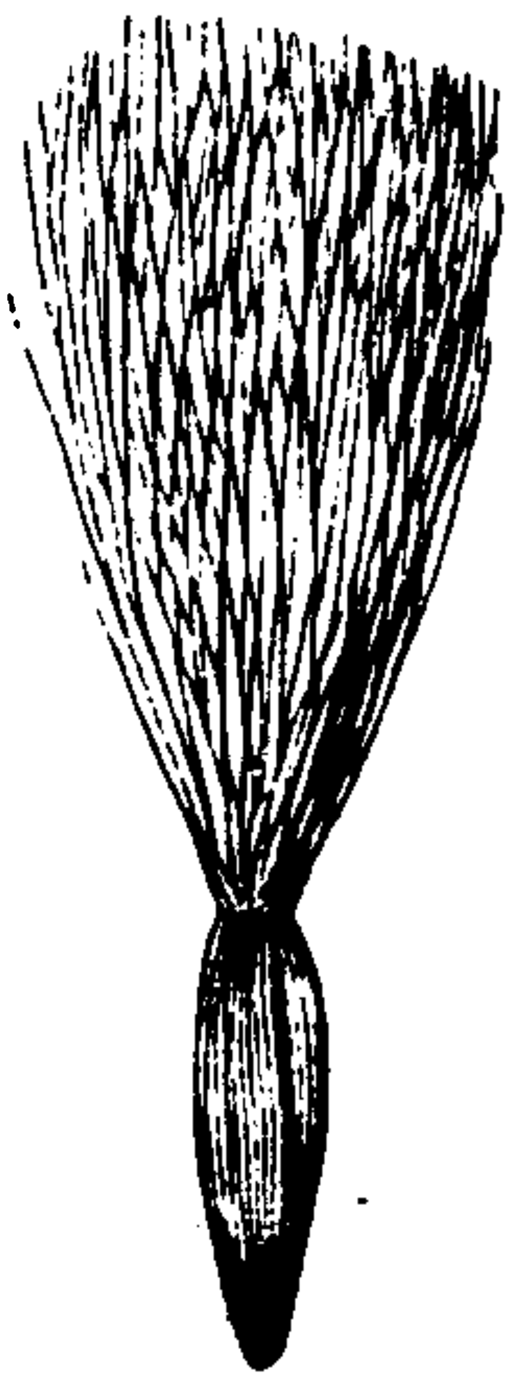
FIG. 286. Achenium of Buttercup. 287. Same, cut through, to show the seed within.

FIG. 288. Slice of a part of a ripe strawberry, enlarged; some of the achenia shown cut through.

FIG. 289. Slice of a part of a blackberry. 290 One of the grains or drupes divided, more enlarged; showing the flesh, the stone, and the seed, as in Fig. 285.

thin scales which fall off at the touch; in the Sneezeweed, of about five very thin scales, which look more like a calyx (Fig. 294); and in the Thistle, Aster, Sow-Thistle (Fig. 295), and hundreds of others, it is cut up into a tuft of fine bristles or hairs. This is called the *Pappus;*— a name which properly means the down like that of the Thistle; but it is applied to all these forms, and to every other under which the limb of the calyx of the "compound flowers" appears. In Lettuce, Dandelion (Fig. 296), and the like, the achenium as it matures tapers upwards into a slender beak, like a stalk to the pappus.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350. A **Utricle** is the same as an achenium, but with a thin and bladdery loose pericarp; like that of the Goosefoot or Pigweed (Fig. 297). When ripe it bursts open irregularly to discharge the seed; or sometimes it opens by a circular line all round, the upper part falling off like a lid; as in the Amaranth (Fig. 298).

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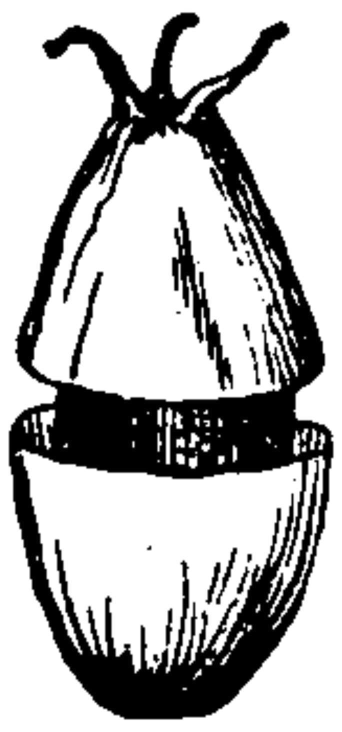

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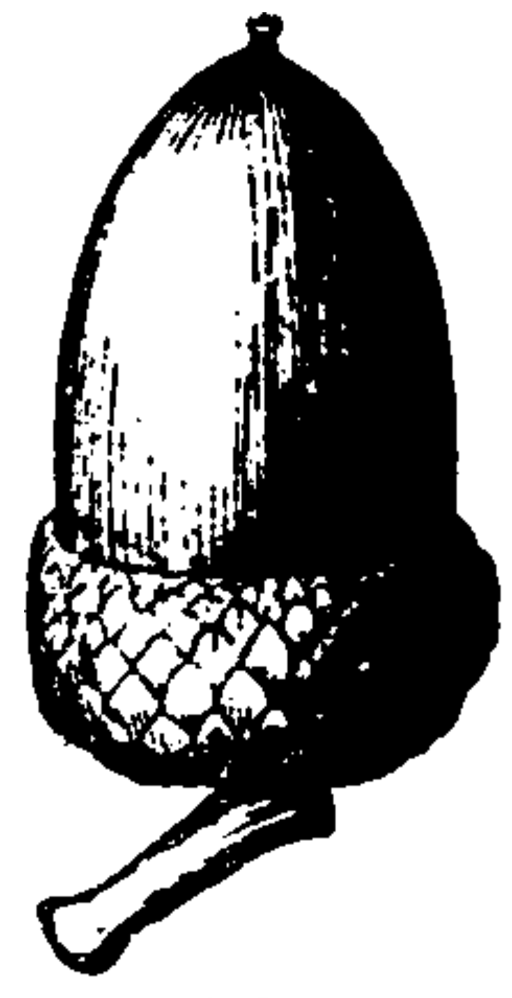
351. A **Caryopsis, or Grain,** differs from the last only in the seed adhering to the thin pericarp throughout, so that fruit and seed are incorporated into one body; as in wheat, Indian corn, and other kinds of grain.



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352. A **Nut** is a dry and indehiscent fruit, commonly one-celled and one-seeded, with a hard, crustaceous, or bony wall, such as the cocoanut, hazelnut, chestnut, and the acorn (Fig. 21, 299). Here the involucre, in the form of a cup at the base, is called the *Cupule.* In the Chestnut it forms the bur; in the Hazel, a leafy husk.

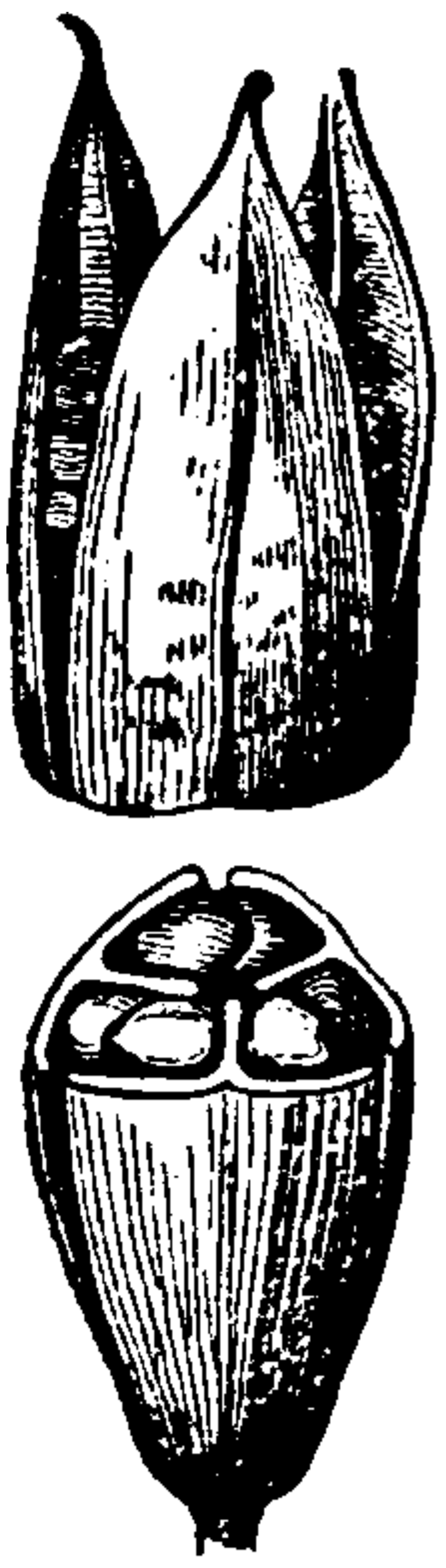
FIG. 291. Achenium of MayWeed (no pappus). 292. That of Succory (its pappus a shallow cup). 293. Of SunfloWer (pappus of two deciduous scales). 294. Of SneezeWeed (Helenium), With its pappus of five scales. 295. Of Sow-Thistle, With its pappus of delicate doWny hairs. 296. Of the Dandelion, its pappus raised on a long beak.

FIG. 297. Utricle of the common Pigweed (Chenopodium album).

FIG. 298. Utricle (pyxis) of Amaranth, opening all round (circumcissile).

FIG. 299. Nut (acorn) of the Oak, with its cup (or cupule).

358. *Dehiscence* of a pod resulting from a compound pistil, when regular, takes place in one of two principal ways, which are best shown in pods of two or three cells. Either the pod splits open down the middle of the back of each cell, when the dehiscence is *loculicidal*, as in Fig. 305; or it splits through the partitions, after which each cell generally opens at its inner angle, when it is *septicidal*, as in Fig. 306. These names are of Latin derivation, the first meaning "cutting into the cells"; the second, "cutting through the partitions." Of the first sort, the Lily and Iris (Fig. 305) are good examples; of the second, the Rhododendron, Azalea, and St. John's-wort. From the structure of the pistil (305–311) the student will readily see, that the line down the back of each cell answers to the dorsal suture of the carpel; so that the pod opens by this when loculicidal, while it separates into its component carpels, which open as follicles, when septicidal. Some pods open both ways, and so split into twice as many valves as the carpels of which they are formed.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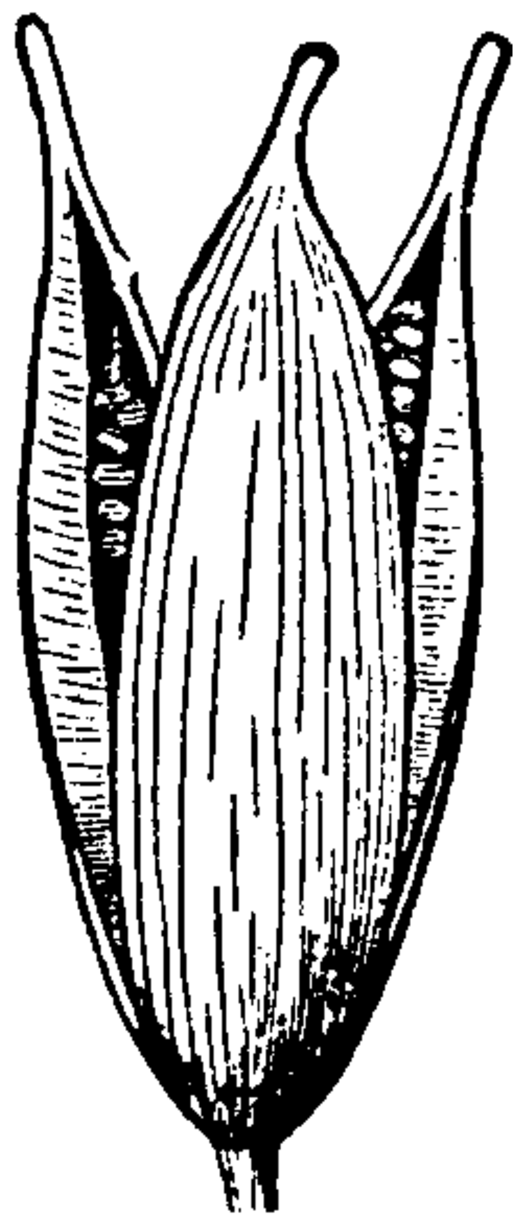
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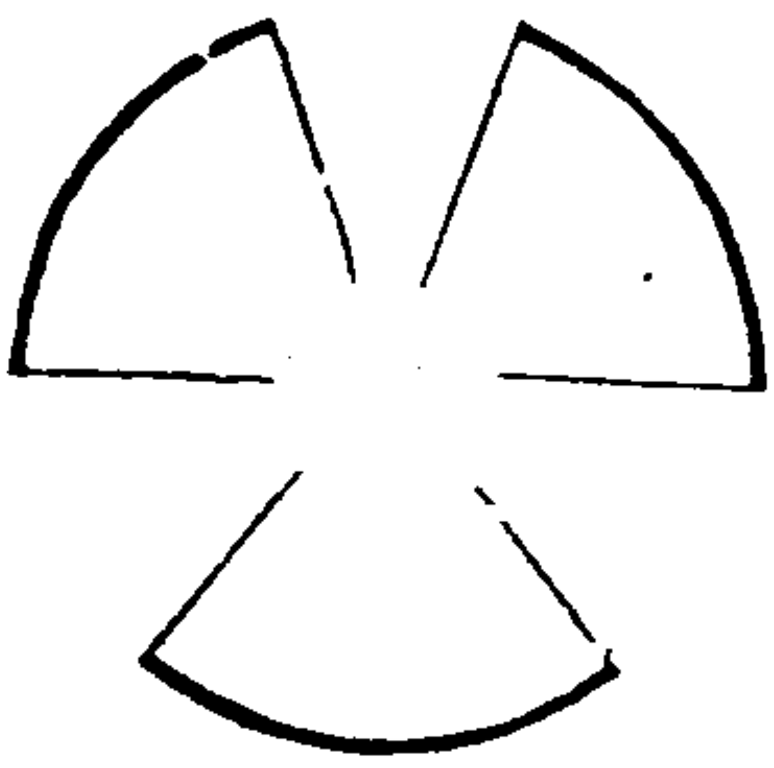
359. In loculicidal dehiscence the valves naturally bear the partitions on their middle; in the septicidal, half the thickness of a partition is borne on the margin of each valve. See the diagrams, Fig. 307–309. A variation of either mode sometimes occurs, as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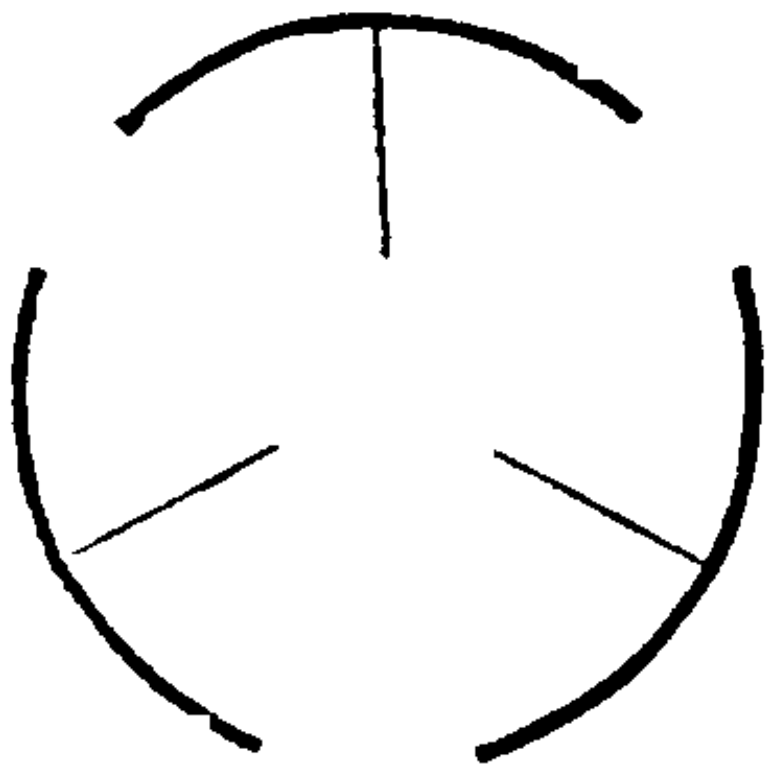
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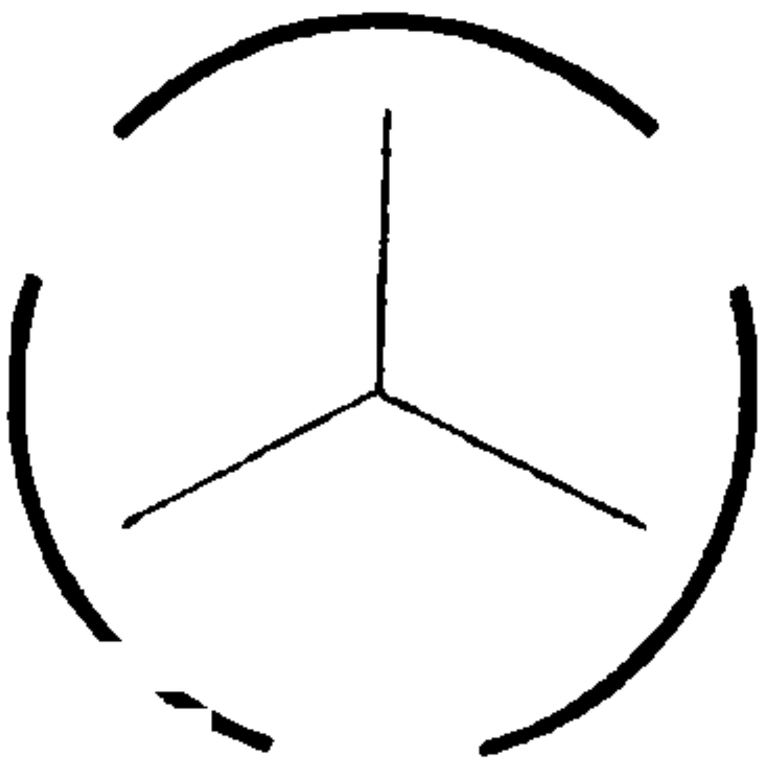
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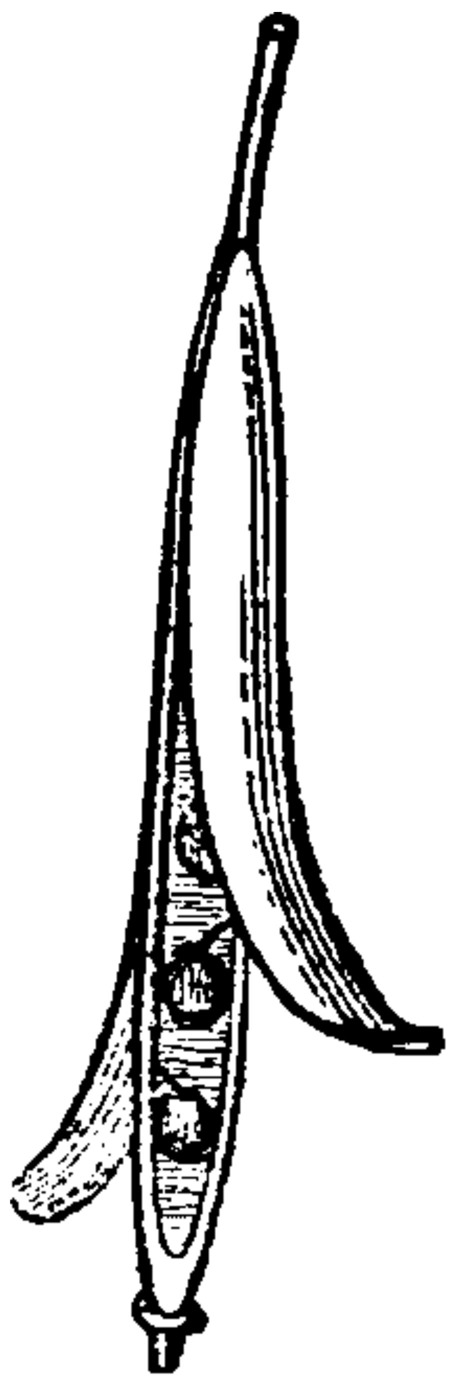
shown in the diagram, Fig. 309, where the valves break away from the partitions. This is called *septifragal* dehiscence; and may be seen in the Morning-Glory.

360. Three remaining sorts of pods are distinguished by proper names, viz.:—

FIG. 305. Capsule of Iris (with loculicidal dehiscence), below cut across.
FIG. 306. Pod of a Marsh St. John's-Wort, with septicidal dehiscence.
FIG. 307. Diagram of septicidal; 308, of loculicidal; and 309, of septifragal dehiscence.

361. **The Silique** (Fig. 310), the peculiar pod of the Mustard family; which is two-celled by a false partition stretched across between two parietal placentæ. It generally opens by two valves from below upwards, and the placentæ with the partition are left behind when the valves fall off.



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362. **A Silicle or Pouch** is only a short and broad silique, like that of the Shepherd's Purse, of the Candy-tuft, &c.

363. **The Pyxis** is a pod which opens by a circular horizontal line, the upper part forming a lid, as in Purslane (Fig. 311), the Plantain, Henbane, &c. In these the dehiscence extends all round, or is *circumcissile*. So it does in Fig. 298, which represents a sort of one-seeded pyxis. In Jeffersonia or Twin-leaf, the line does not separate quite round, but leaves a portion to form a hinge to the lid.

311

364. **Multiple or Collective Fruits** (334) are, properly speaking, masses of fruits, resulting from several or many blossoms, aggregated into one body. The pine-apple, mulberry, Osage-orange, and the fig, are fruits of this kind. This latter is a peculiar form, however, being to a mulberry nearly what a Rose-hip is to a strawberry (Fig. 279, 280), namely, with a hollow receptacle bearing the flowers concealed inside; and the whole eatable part is this pulpy common receptacle, or hollow thickened flower-stalk.

365. **A Strobile, or Cone** (Fig. 314), is the peculiar multiple fruit of Pines, Cypresses, and the like; hence named *Coniferæ*, viz. cone-bearing plants. As already shown (322), these cones are made of *open pistils*, mostly in the form of flat scales, regularly overlying each other, and pressed together in a spike or head. Each scale bears one or two naked seeds on its inner face. When the cone is ripe and dry, the scales turn back or diverge, and the seed peels off and falls, generally carrying with it a wing, which was a part of the lining of the scale, and which facilitates the dispersion of the seeds by the wind (Fig. 312, 313). In Arbor-Vitæ, the scales

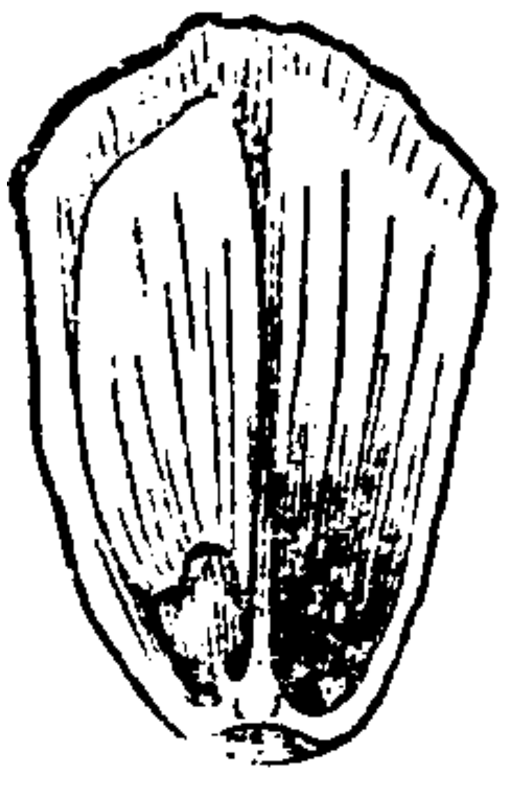

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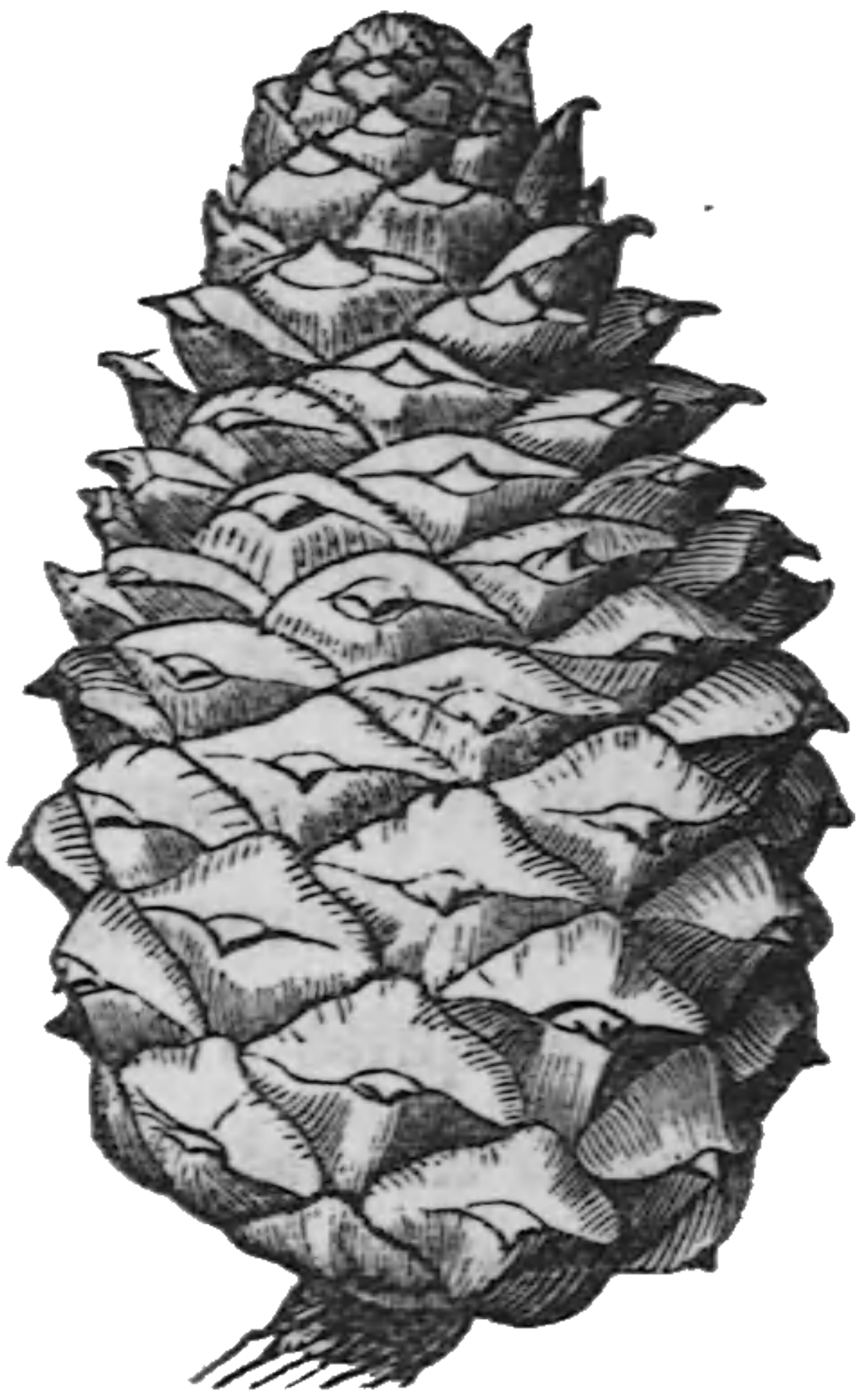
FIG. 310. Silique of Spring Cress (Cardamine rhomboidea), opening.
FIG. 311. The pyxis, or pod, of the common Purslane
FIG. 312. Inside view of a scale from the cone of Pitch-Pine; With one of the seeds (Fig. 313) detached; the other in its place on the scale.

of the small cone are few, and not very unlike the leaves (Fig. 265). In Cypress they are very thick at the top and narrow at the base, so as to make a peculiar sort of closed cone. In Juniper and Red Cedar, the few scales of the very small cone become fleshy, and ripen into a fruit which might be taken for a berry.



314

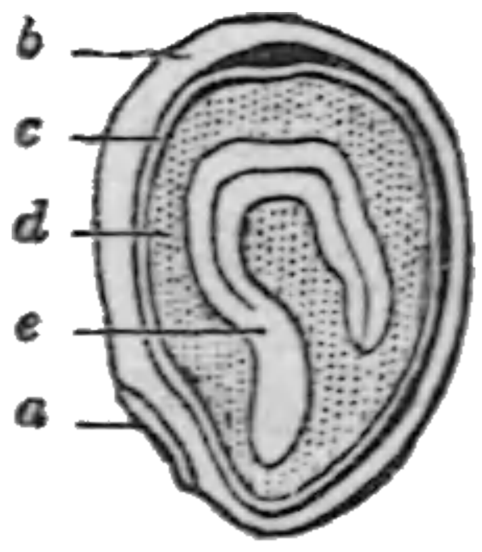
LESSON XXI.

THE SEED.

366. The ovules (323), when they have an embryo (or undeveloped plantlet, 16) formed in them, become seeds.

367. The *Seed*, like the ovule from which it originates, consists of its coats, or integuments, and a kernel.

368. **The Seed-coats** are commonly two (324), the outer and the inner. Fig. 315 shows the two, in a seed cut through lengthwise. The outer coat is often hard or crustaceous, whence it is called the *Testa*, or shell of the seed; the inner is thin and delicate.



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369. The shape and the markings, so various in different seeds, depend mostly on the outer coat. Sometimes it fits

FIG. 314. Cone of Pitch-Pine (Pinus rigida).

FIG. 315. Seed of Basswood cut through lengthwise: *a*, the hilum or scar; *b*, the outer coat; *c*, the inner; *d*, the albumen; *e*, the embryo.

apply to seeds just as they do to ovules (325); and so do those terms which express the direction of the ovule or the seed in the cell; such as *erect*, *ascending*, *horizontal*, *pendulous*, or *suspended* (323): therefore it is not necessary to explain them anew. The accompanying figures (Fig. 319 – 322) show all the parts of the most common kind of seed, namely, the anatropous.

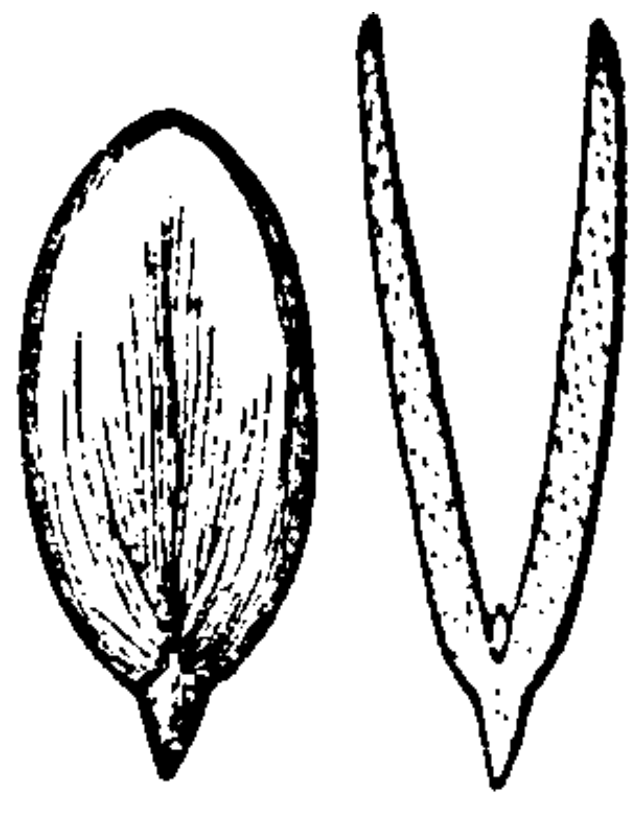
372. **The Kernel, or Nucleus,** is the whole body of the seed within the coats. In many seeds the kernel is all *Embryo;* in others a large part of it is the *Albumen.*

373. **The Albumen** of the seed is an accumulation of nourishing matter (starch, &c.), commonly surrounding the embryo, and destined to nourish it when it begins to grow, as was explained in the earlier Lessons (30 – 32). It is the floury part of wheat, corn (Fig. 38, 39), buckwheat, and the like. But it is not always *mealy* in texture. In Poppy-seeds it is *oily*. In the seeds of Pæony and Barberry, and in the cocoanut, it is *fleshy;* in coffee it is *corneous* (that is, hard and tough, like horn); in the Ivory Palm it has the hardness as well as the general appearance of ivory, and is now largely used as a substitute for it in the fabrication of small objects. However solid its texture, the albumen always softens and partly liquefies during germination; when a considerable portion of it is transformed into sugar, or into other forms of fluid nourishment, on which the growing embryo may feed.

374. **The Embryo,** or *Germ,* is the part to which all the rest of the seed, and also the fruit and the flower, are subservient. When the embryo is small and its parts little developed, the albumen is the more abundant, and makes up the principal bulk of the seed, as in Fig. 30, 321, 325. On the other hand, in many seeds there is no albumen at all; but the strong embryo forms the whole kernel; as in the Maple (Fig. 2, 3), Pumpkin (Fig. 9), Almond, Plum, and Apple (Fig. 11, 12), Beech (Fig. 13), and the like. Then, whatever nourishment is needed to establish the plantlet in the soil is stored up in the body of the embryo itself, mostly in its seed-leaves. And these accordingly often become very large and thick, as in the almond, bean, and pea (Fig. 16, 19), acorn (Fig. 21), chestnut, and horsechestnut (Fig. 23, 24). Besides these, Fig. 25, 26, 30 to 37, 43, and 45 exhibit various common forms of the embryo; and also some of the ways in which it is placed in the albumen; being sometimes straight, and sometimes variously coiled up or packed away.

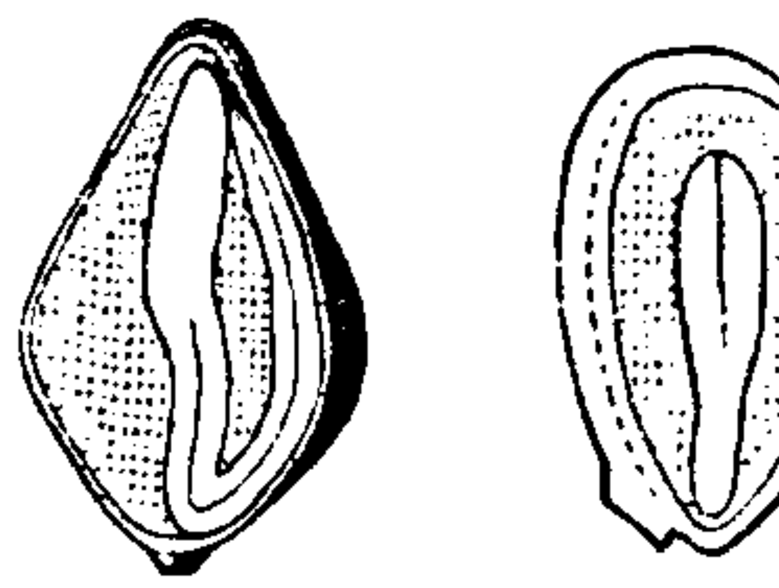
375. The embryo, being a rudimentary plantlet, ready formed in the seed, has only to grow and develop its parts to become a young plant (15). Even in the seed these parts are generally distinguishable, and are sometimes very conspicuous; as in a Pumpkin-seed, for example (Fig. 323, 324). They are, first,

376. **The Radicle,** or rudimentary stemlet, which is sometimes long and slender, and sometimes very short, as we may see in the numerous figures already referred to. In the seed it always points to the micropyle (371), or what answers to the foramen of the ovule (Fig. 325, 326). As to its position in the fruit, it is said to be *inferior* when it points to the base of the pericarp, *superior* when it points to its summit, &c. The base or free end of the radicle gives rise to the root; the other extremity bears



323 324

377. **The Cotyledons or Seed-Leaves.** With these in various forms we have already become familiar. The number of cotyledons has also been explained to be important (32, 33). In Corn (Fig. 40), and in all Grasses, Lilies, and the like, we have a



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Monocotyledonous embryo, namely, one furnished with only a single cotyledon or seed-leaf.—Nearly all the rest of our illustrations exhibit various forms of the

Dicotyledonous embryo; namely, with a pair of cotyledons or seed-leaves, always opposite each other. In the Pine family we find a

Polycotyledonous embryo (Fig. 45, 46); that is, one with several, or more than two, seed-leaves, arranged in a circle or whorl.

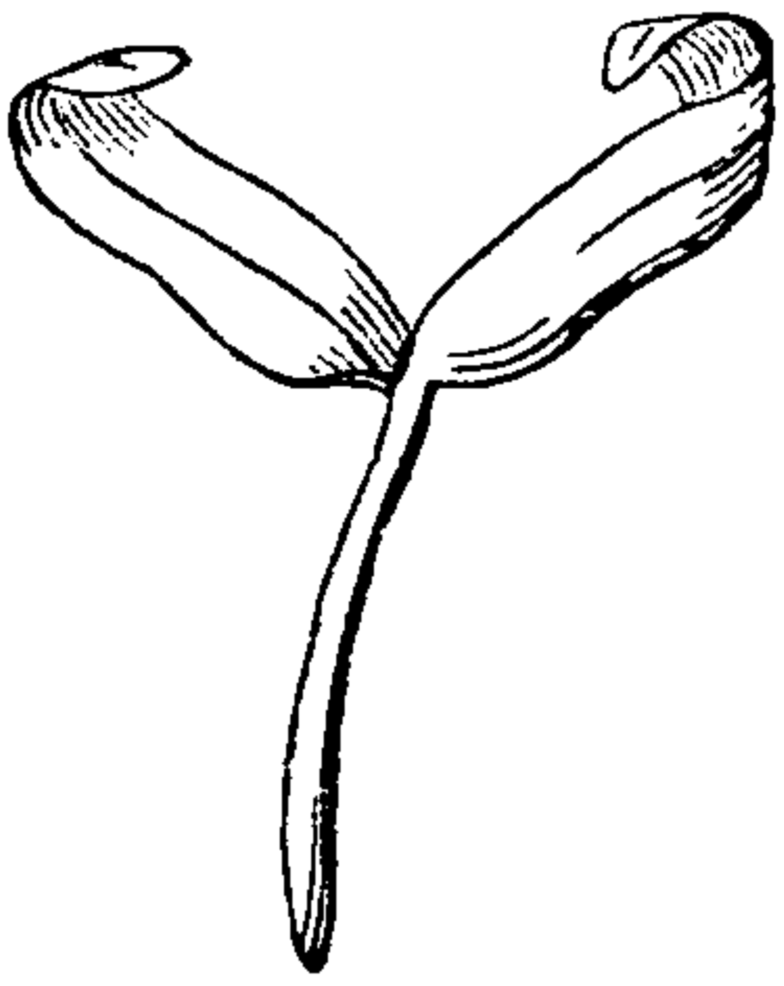
378. **The Plumule** is the little bud, or rudiment of the next leaf or pair of leaves after the seed-leaves. It appears at the summit of the radicle, between the cotyledons when there is a pair of them, as in Fig. 324, 14, 24, &c.; or the cotyledon when only one is wrapped round it, as in Indian Corn, Fig. 40. In germination the plumule develops upward, to form the ascending trunk or stem of the plant, while the other end of the radicle grows downward, and becomes the root.

FIG. 323. Embryo of the Pumpkin, seen flatwise. 324. Same cut through and viewed edgewise, enlarged; the small plumule seen between the cotyledons at their base.

FIG. 325. Seed of a Violet (Fig. 319) cut through, showing the embryo in the section, edgewise; being an *anatropous* seed, the radicle of the straight embryo points down to the base near the hilum.

FIG. 326. Similar section of the *orthotropous* seed of Buckwheat. Here the radicle points directly away from the hilum, and to the apex of the seed; also the thin cotyledons happen in this plant to be bent round into the same direction.

379. This completes the circle, and brings our vegetable history round to its starting-point in the Second Lesson; namely, The Growth of the Plant from the Seed.



LESSON XXII.

HOW PLANTS GROW.

380. A PLANT grows from the seed, and from a tiny embryo, like that of the Maple (Fig. 327), becomes perhaps a large tree, producing every year a crop of seeds, to grow in their turn in the same way. But *how* does the plant grow? A little seedling, weighing only two or three grains, often doubles its weight every week of its early growth, and in time may develop into a huge bulk, of many tons' weight of vegetable matter. How is this done? What is vegetable matter? Where did it all come from? And by what means is it increased and accumulated in plants? Such questions as these will now naturally arise in any inquiring mind; and we must try to answer them.

381. **Growth** *is the increase of a living thing in size and substance.* It appears so natural to us that plants and animals should grow, that people rarely think of it as requiring any explanation. They say that a thing is so because it grew so. Still we wish to know how the growth takes place.

382. Now, in the foregoing Lessons we explained the whole structure of the plant, with all its organs, by beginning with the seedling plantlet, and following it onward in its development through the

FIG. 327. Germinating embryo of a Maple.

385. The pollen (297) which falls upon the stigma grows there in a peculiar way: its delicate inner coat extends into a tube (the pollen-tube), which sinks into the loose tissue of the stigma and the interior of the style, something as the root of a seedling sinks into the loose soil, reaches the cavity of the ovary, and at length penetrates the orifice of an ovule. The point of the pollen-tube reaches the surface of the embryo-sac, and in some unexplained way causes a particle of soft pulpy or mucilaginous matter (Fig. 328) to form a membranous coat and to expand into a vesicle, which is the germ of the embryo.

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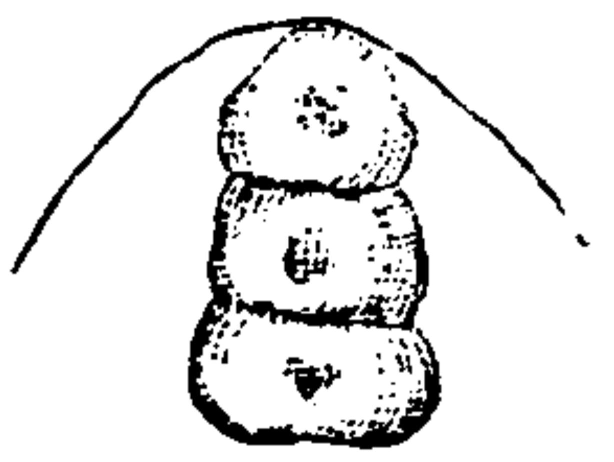

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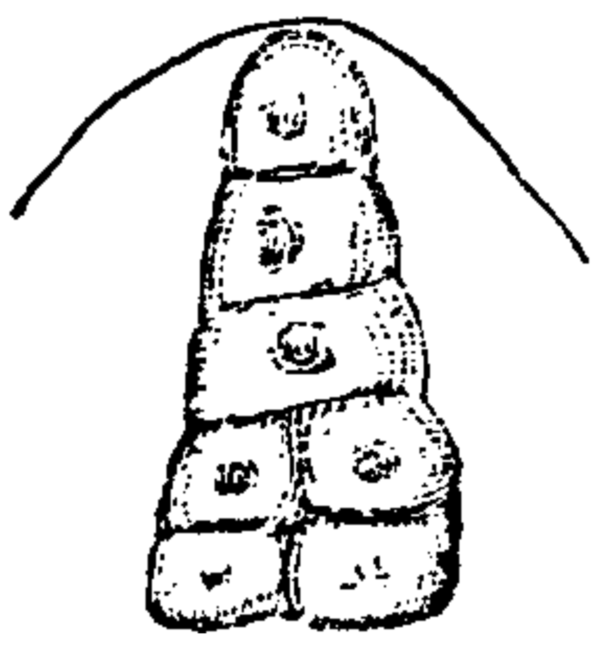

386. This vesicle (shown detached and more magnified in Fig. 329) is a specimen of what botanists call a *Cell.* Its wall of very delicate membrane encloses a mucilaginous liquid, in which there are often some minute grains, and commonly a larger soft mass (called its *nucleus*).

387. Growth takes place by this vesicle or cell, after enlarging to a certain size, dividing by the formation of a cross partition into two such cells, cohering together (Fig. 330); one of these into two more (Fig. 331); and these repeating the process by partitions formed in both directions (Fig. 332); forming a cluster or mass of cells, essentially like the first, and all proceeding from it. After increasing in number for some time in this way, and by a continuation of the same process, the embryo begins to shape itself; the upper end forms the radicle or root-end, while the other end shows a notch between two lobes (Fig. 333), these lobes become the cotyledons or seed-leaves, and the embryo as it exists in the seed is at length completed (Fig. 336)

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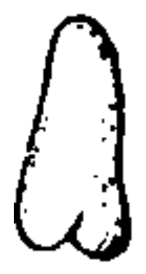

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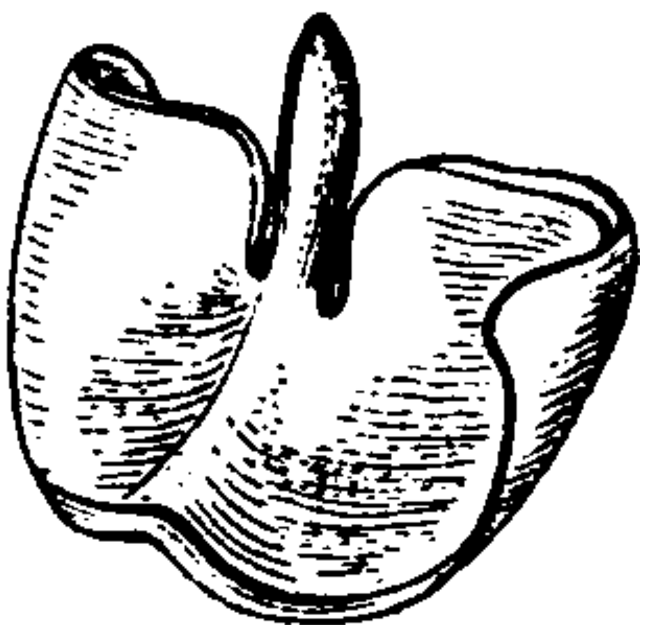
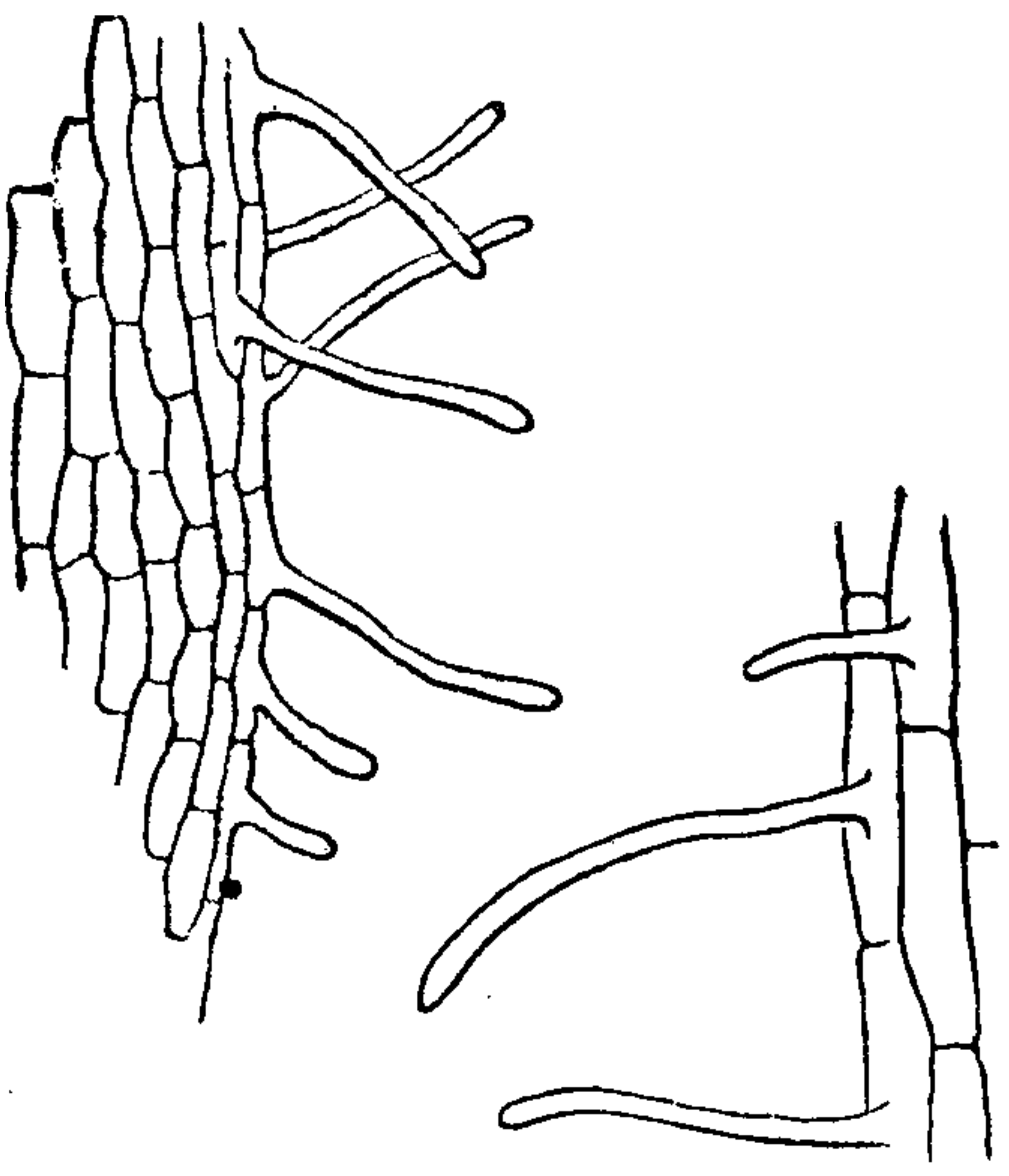


FIG. 329. Vesicle or first cell of the embryo, with a portion of the summit of the embryo-sac, detached. 330. Same, more advanced, divided into two cells. 331. Same, a little farther advanced, consisting of three cells. 332. Same, still more advanced, consisting of a little mass of young cells.

FIG. 333. Forming embryo of Buckwheat, moderately magnified, showing a nick at the end where the cotyledons are to be. 334. Same, more advanced in growth. 335. Same, still farther advanced. 336. The completed embryo, displayed and straightened out; the same as shown in a section when folded together in Fig. 326.

388. **The Growth of the Plantlet** when it springs from the seed is only a continuation of the same process. The bladder-like cells of which the embryo consists multiply in number by the repeated division of each cell into two. And the plantlet is merely the aggregation of a vastly larger number of these cells. This may be clearly ascertained by magnifying any part of a young plantlet. The young root, being more transparent than the rest, answers the purpose best. Fig. 56, on page 30, represents the end of the rootlet of Fig. 55, magnified enough to show the cells that form the surface. Fig. 337 and 338 are two small bits of the surface more highly magnified, showing the cells still larger. And if we make a thin slice through the young root both lengthwise and crosswise, and view it under a good microscope (Fig. 340), we may perceive that the whole interior is made up of just such cells. It is the same with the young stem and the leaves (Fig. 355, 357). It is essentially the same in the full-grown herb and the tree.

337



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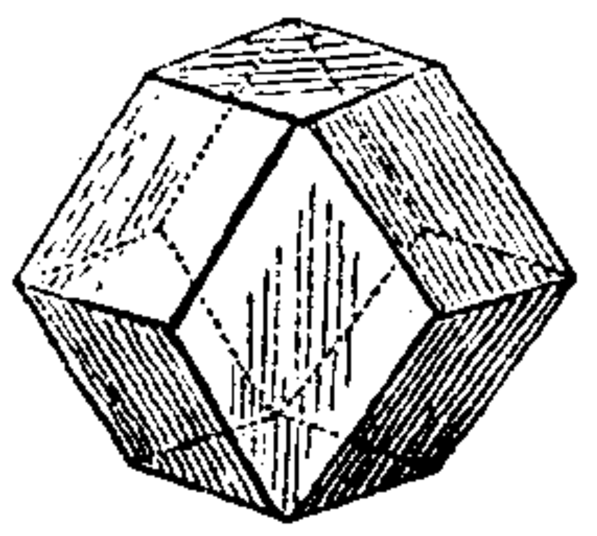
389. So the plant is an aggregation of countless millions of little vesicles, or cells (Fig. 339), as they are called, essentially like the cell it began with in the formation of the embryo (Fig. 329); and this first cell is the foundation of the whole structure, or the ancestor of all the rest. And a plant is a kind of structure built up of these individual cells, something as a house is built of bricks,—only the bricks or cells are not brought to the forming plant, but are made in it and by it; or, to give a better comparison, the plant is constructed much as a honeycomb is built up of cells,—only the plant constructs itself, and shapes its own materials into fitting forms.



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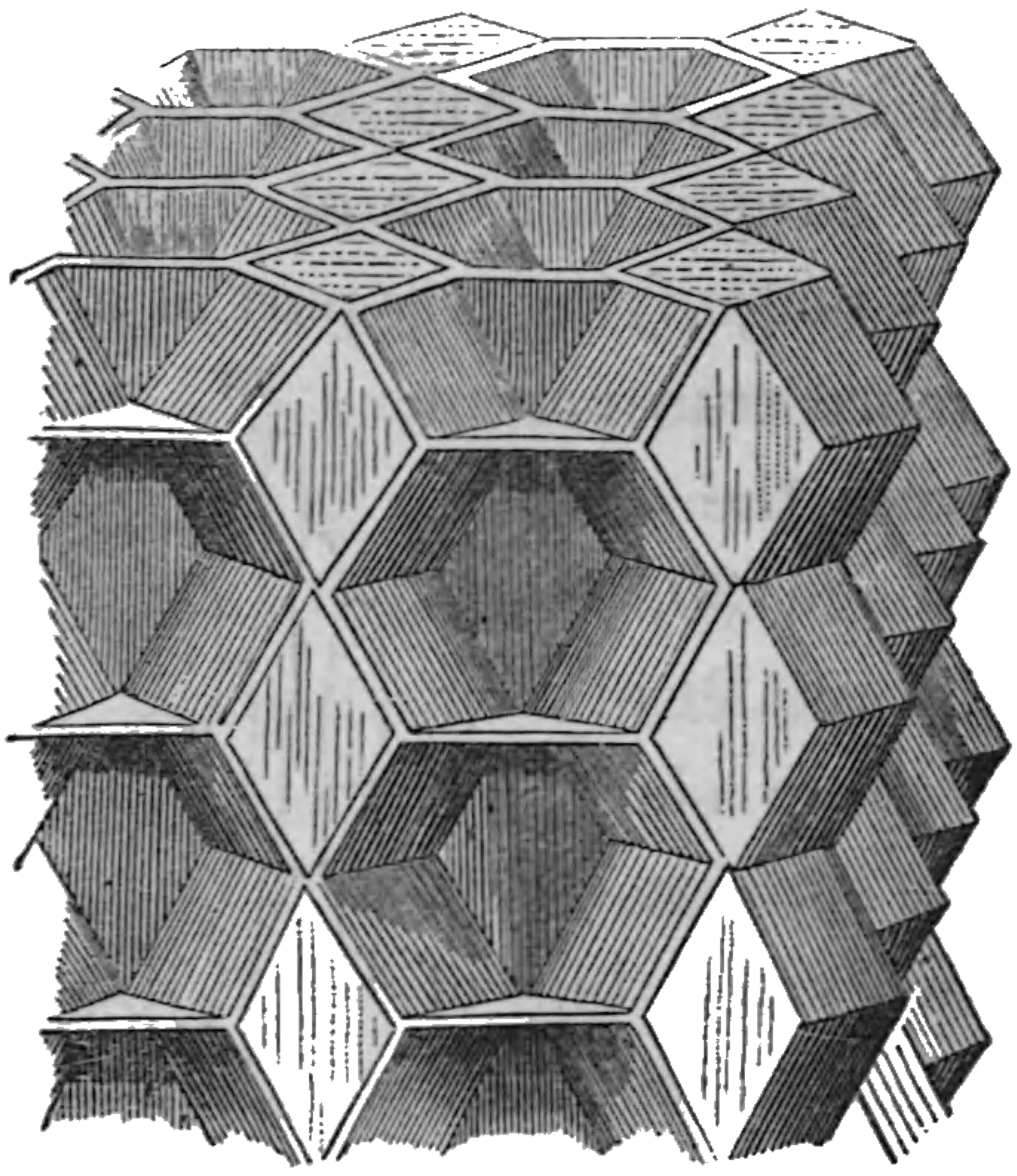
390. And vegetable growth consists of two things;—1st, the expansion of each cell until it gets its full size (which is commonly not more than $\frac{1}{400}$ of an inch in diameter); and 2d, the multiplication

FIG. 337. Tissue from the rootlet of a seedling Maple, magnified, showing root-hairs. 338. A small portion, more magnified.

FIG. 339. A regularly twelve-sided cell, like those of Fig. 340, detached.

of the cells in number. It is by the latter, of course, that the principal increase of plants in bulk takes place.



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LESSON XXIII.

VEGETABLE FABRIC: CELLULAR TISSUE.

391. **Organic Structure.** A mineral — such as a crystal of spar, or a piece of marble — may be divided into smaller and still smaller pieces, and yet the minutest portion that can be seen with the microscope will have all the characters of the larger body, and be capable of still further subdivision, if we had the means of doing it, into just such particles, only of smaller size. A plant may also be divided into a number of similar parts: first into branches; then each branch or stem, into joints or similar parts (34), each with its leaf or pair of leaves. But if we divide these into pieces, the pieces are not all alike, nor have they separately the properties of the whole; they are not whole things, but fragments or slices.

392. If now, under the microscope, we subdivide a leaf, or a piece of stem or root, we come down in the same way to the set of similar things it is made of, — to cavities with closed walls, — to *Cells*, as we call them (386), essentially the same everywhere, however they may vary in shape. These are the *units*, or the elements of which every part consists; and it is their growth and their multiplication which

FIG. 340. Magnified view, or diagram, of some perfectly regular cellular tissue, formed of twelve-sided cells, cut crosswise and lengthwise.

soft and yielding, as young cells are, when pressed together they will become twelve-sided, like that in Fig. 339. And a section in any direction will be six-sided, as are the meshes in Fig. 340.

398. The size of the common cells of plants varies from about the thirtieth to the thousandth of an inch in diameter. An ordinary size is from $\frac{1}{300}$ to $\frac{1}{500}$ of an inch; so that there may generally be from 27 to 125 millions of cells in the compass of a cubic inch!

399. Now when it is remembered that many stems shoot up at the rate of an inch or two a day, and sometimes of three or four inches, knowing the size of the cells, we may form some conception of the rapidity of their formation. The giant Puff-ball has been known to enlarge from an inch or so to nearly a foot in diameter in a single night; but much of this is probably owing to expansion. We take therefore a more decisive, but equally extraordinary case, in the huge flowering stem of the Century-Plant. After waiting many years, or even for a century, to gather strength and materials for the effort, Century-Plants in our conservatories send up a flowering stalk, which grows day after day at the rate of a foot in twenty-four hours, and becomes about six inches in diameter. This, supposing the cells to average $\frac{1}{300}$ of an inch in diameter, requires the formation of over twenty thousand millions of cells in a day!

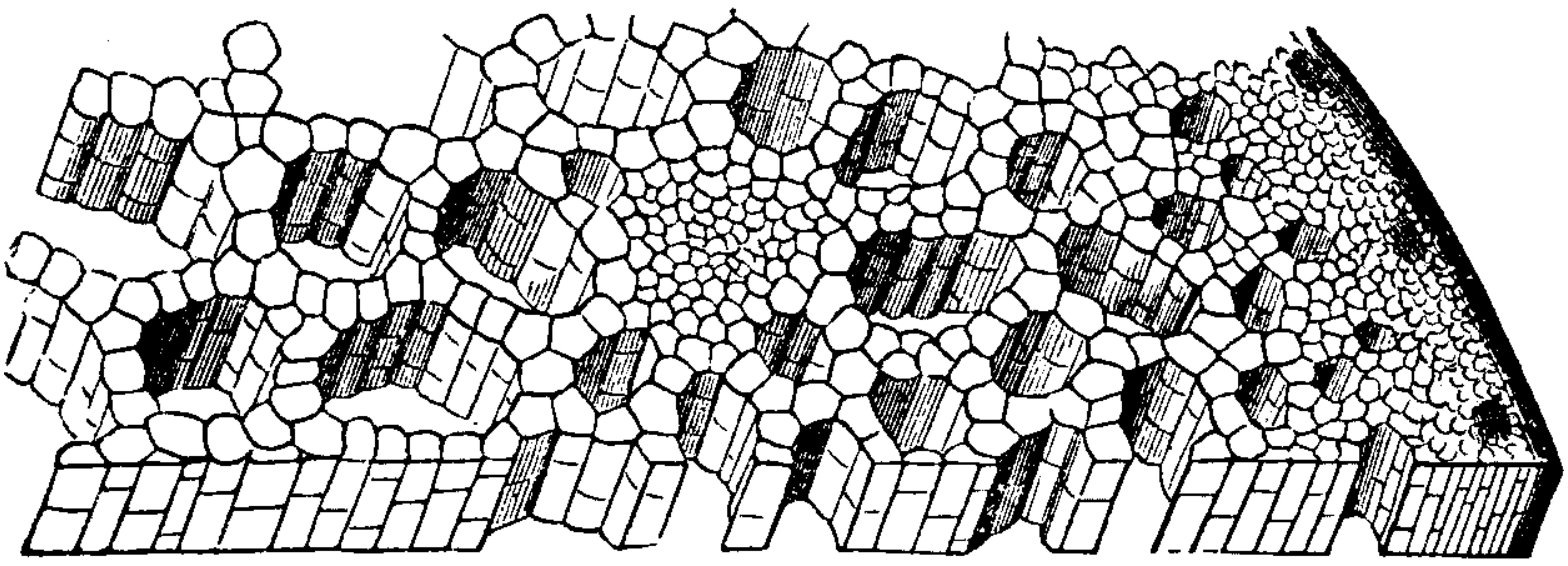
400. The walls of the cells are almost always colorless. The green color of leaves and young bark, and all the brilliant hues of flowers, are due to the contents of the cells, seen through their more or less transparent walls.

401. At first the walls are always very thin. In all soft parts they remain so; but in other cases they thicken on the inside and harden, as we see in the stone of stone-fruits, and in all hard wood (Fig. 345) Sometimes this thickening continues until the cell is nearly filled up solid.

402. The walls of cells are perfectly closed and whole, at least in all young and living cells. Those with thickened walls have thin places, indeed; but there are no holes opening from one cell into another. And yet through these closed cells the sap and all the juices are conveyed from one end of the plant to the other.

403. Vegetable cells may vary widely in shape, particularly when not combined into a tissue or solid fabric. The hairs of plants, for example, are cells drawn out into tubes, or are composed of a row of cells, growing on the surface. Cotton consists of simple long hairs on the coat of the seed; and these hairs are single cells. The hair-

like bodies which abound on young roots are very slender projections of some of the superficial cells, as is seen in Fig. 337. Even the fibres of wood, and what are called vessels in plants, are only peculiar forms or transformations of cells.



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LESSON XXIV.

VEGETABLE FABRIC: WOOD.

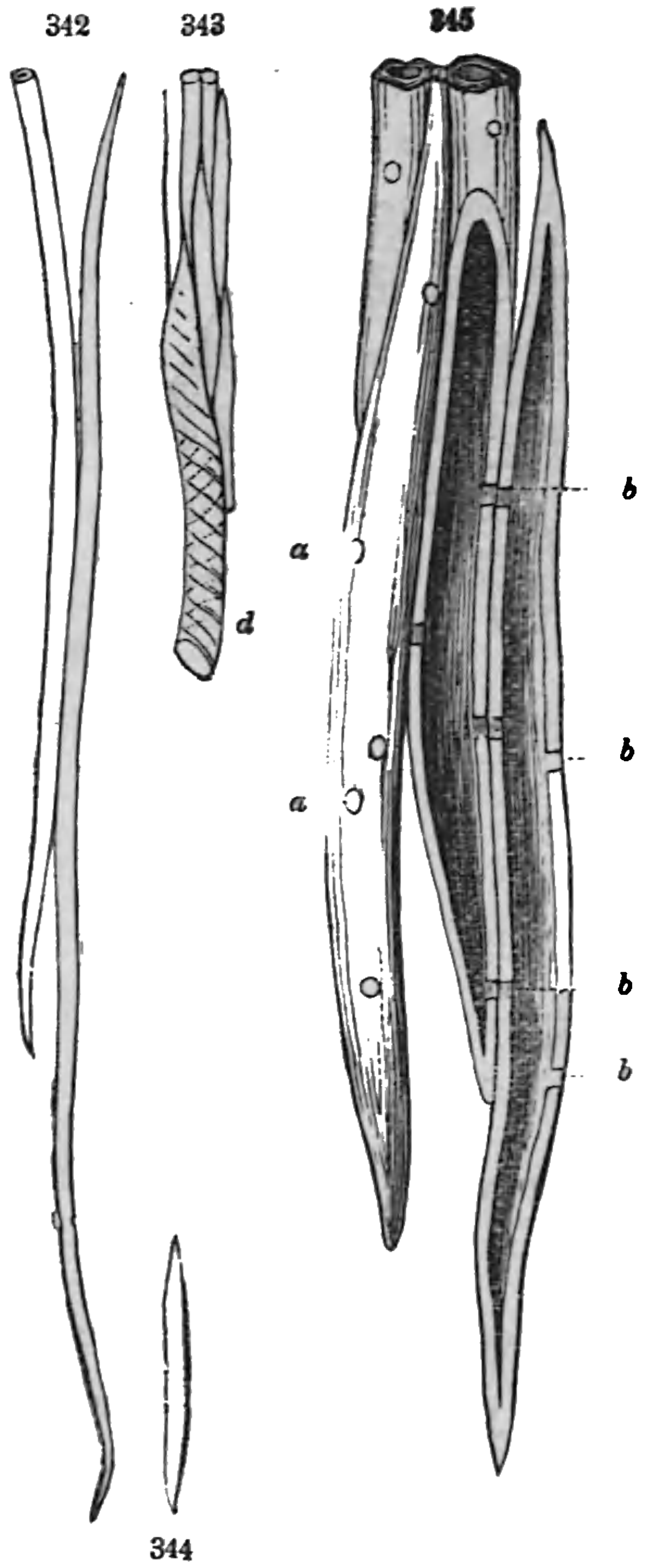
404. Cellular tissue, such as described in the last Lesson, makes up the whole structure of all very young plants, and the whole of Mosses and other vegetables of the lowest grade, even when full grown. But this fabric is too tender or too brittle to give needful strength and toughness for plants which are to rise to any considerable height and support themselves. So all such plants have also in their composition more or less of

405. **Wood.** This is found in all common herbs, as well as in shrubs and trees; only there is not so much of it in proportion to the softer cellular tissue. It is formed very early in the growth of the root, stem, and leaves; traces of it appearing in large embryos even while yet in the seed.

406. Wood is likewise formed of cells, — of cells which at first are just like those that form the soft parts of plants. But early in their growth, some of these lengthen and at the same time thicken their walls; these are what is called *Woody Fibre* or *Wood-Cells;* others grow to a greater size, have thin walls with various markings upon them, and often run together end to end so as to form pretty

FIG. 341. Part of a slice across the stem of the Calla, or rather Richardia [illegible]icana, magnified

large tubes, comparatively; these are called *Ducts*, or sometimes *Vessels*. Wood almost always consists of both woody fibres and ducts, variously intermingled, and combined into bundles or threads which run lengthwise through the root and stem, and are spread out to form the framework of the leaves (136). In trees and shrubs they are so numerous and crowded together, that they make a solid mass of wood. In herbs they are fewer, and often scattered. That is all the difference.



407. The porosity of some kinds of wood, which is to be seen by the naked eye, as in mahogany and Oak-wood, is owing to a large sort of ducts. These generally contain air, except in very young parts, and in the spring of the year, when they are often gorged with sap, as we see in a wounded Grapevine, or in the trunk of a Sugar-Maple at that time. But in woody plants through the season, the sap is usually carried up from the roots to the leaves by the

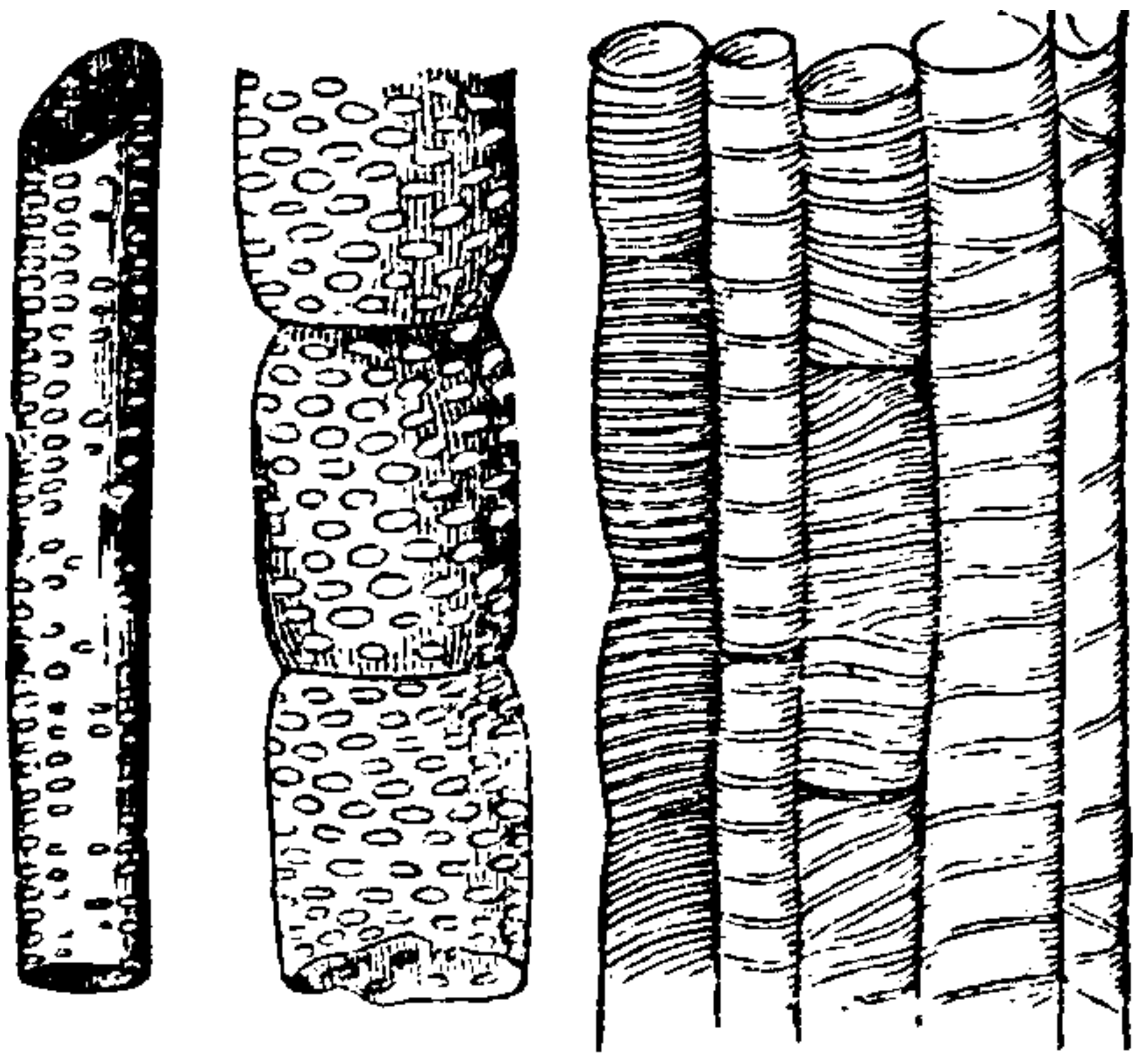
408. **Wood-Cells, or Woody Fibre.** (Fig. 342 – 345.) These are small tubes, commonly between one and two thousandths, but in Pine-wood sometimes two or three hundredths, of an inch in diameter. Those from the tough bark of the Basswood, shown in Fig. 342, are only the fifteen-hundredth of an inch wide. Those of Buttonwood (Fig. 345) are larger, and are here highly magnified besides. They also show the way wood-cells are commonly put together, namely, with their tapering ends overlapping each other, — spliced together, as it were, — thus giving more strength and toughness to the stem, &c.

FIG. 342. Two Wood-cells from the inner or fibrous bark of the Linden or Basswood. 343. Some tissue of the Wood of the same, viz. Wood-cells, and below (*d*) a portion of a spirally marked duct. 344. A separate Wood-cell. All equally magnified.

FIG. 345. Some Wood-cells of ButtonWood, highly magnified: *a*, thin spots in the walls, looking like holes; on the right-hand side, where the walls are cut through, these (*b*) are seen in profile.

furnish the invaluable fibres of flax and hemp; the wood of the stem being tender, brittle, and destroyed by the processes which separate for use the tough and slender hast-cells.

413. **Ducts** (Fig. 348–350) are larger than wood-cells, some of them having a calibre large enough to be seen by the naked eye, when cut across (407), although they are usually much too small for this. They are either long single cells, or are formed of a row of cells placed end to end. Fig. 349, a piece of a large dotted duct, and two of the ducts in Fig. 350, show this by their joints, which mark the boundaries of the several cells they are composed of.



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414. The walls of ducts under the microscope display various kinds of markings. In what are called

Dotted Ducts (Fig. 348, 349), which are the commonest and the largest of all, — their cut ends making the visible porosity of Oak-wood, — the whole wall is apparently riddled with holes; but until they become old, these are only thin places.

Spiral Ducts, or *Spiral Vessels*, also the varieties of these called *Annular* or *Banded Ducts* (Fig. 350), are marked by a delicate fibre spirally coiled, or by rings or bands, thickening the wall. In the genuine spiral duct, the thread may be uncoiled, tearing the transparent wall in pieces; — as may be seen by breaking most young shoots, or the leaves of Strawberry or Amaryllis, and pulling the broken ends gently asunder, uncoiling these gossamer threads in abundance. In Fig. 355, some of these various sorts of ducts or vessels are shown in their place in the wood.

415. *Milk-Vessels*, *Turpentine-Vessels*, *Oil-Receptacles*, and the like, are generally canals or cavities formed between or among the cells, and filled with the particular products of the plant.

FIG. 348. Part of a dotted duct from a Grape-vine. 349. A similar one, evidently composed of a row of cells. 350. Part of a bundle of spiral and annular ducts from the stem of Polygonum orientale, or Princes' Feather. All highly magnified.

LESSON XXV.

ANATOMY OF THE ROOT, STEM, AND LEAVES.

416. HAVING in the last preceding Lessons learned what the materials of the vegetable fabric are, we may now briefly consider how they are put together, and how they act in carrying on the plant's operations.

417. The root and the stem are so much alike in their internal structure, that a description of the anatomy of the latter will answer for the former also.

418. **The Structure of the Rootlets,** however, or the tip of the root, demands a moment's attention. The tip of the root is the newest part, and is constantly renewing itself so long as the plant is active (67). It is shown magnified in Fig. 56, and is the same in all rootlets as in the first root of the seedling. The new roots, or their new parts, are mainly concerned in imbibing moisture from the ground; and the newer they are, the more actively do they absorb. The absorbing ends of roots are entirely composed of soft, new, and very thin-walled cellular tissue; it is only farther back that some wood-cells and ducts are found. The moisture (and probably also air) presented to them is absorbed through the delicate walls, which, like those of the cells in the interior, are destitute of openings or pores visible even under the highest possible magnifying power.

419. But as the rootlet grows older, the cells of its external layer harden their walls, and form a sort of skin, or *epidermis* (like that which everywhere covers the stem and foliage above ground), which greatly checks absorption. Roots accordingly cease very actively to imbibe moisture almost as soon as they stop growing (67).

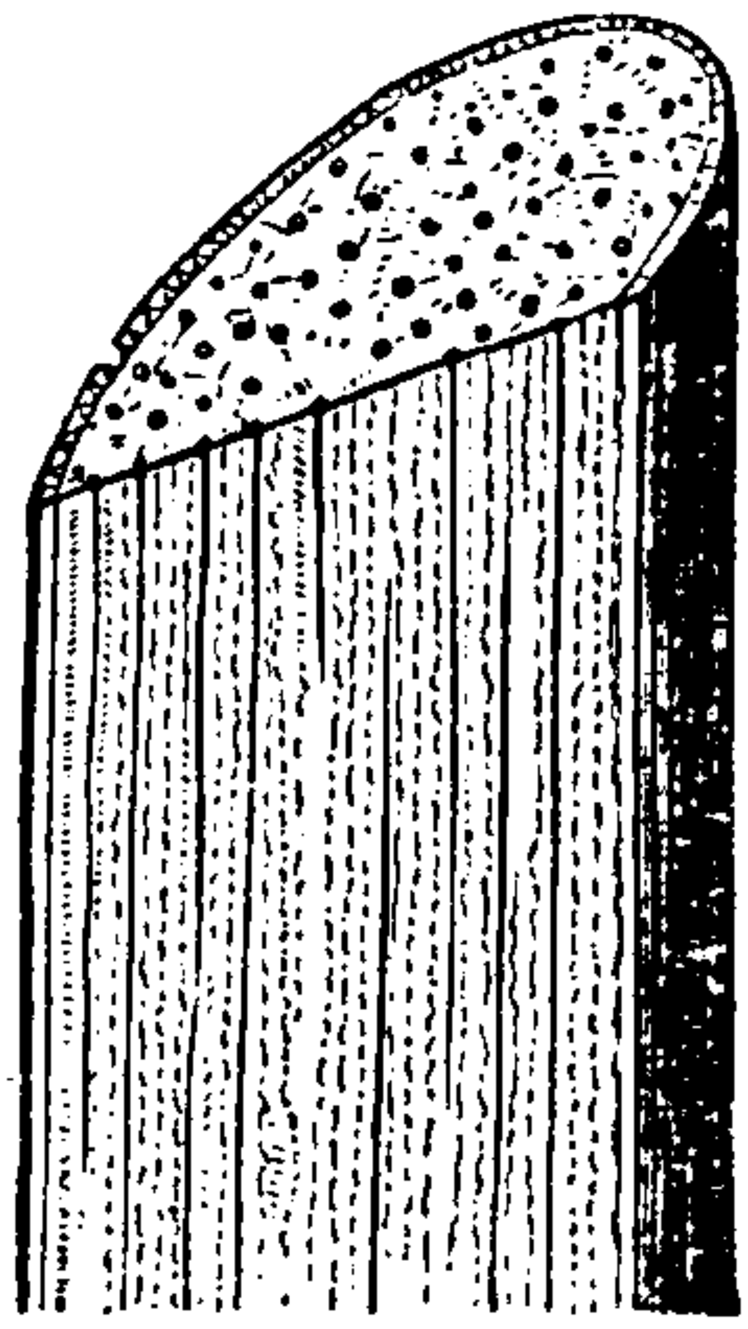
420. Many of the cells of the surface of young rootlets send out a prolongation in the form of a slender hair-like tube, closed of course at the apex, but at the base opening into the cavity of the cell. These tubes or *root-hairs* (shown in Fig. 55 and 56, and a few of them, more magnified, in Fig. 337 and 338), sent out in all directions into the soil, vastly increase the amount of absorbing surface which the root presents to it.

421. **Structure of the Stem** (also of the body of the root). At the beginning, when the root and stem spring from the seed, they consist

almost entirely of soft and tender cellular tissue. But as they grow, wood begins at once to be formed in them.

422. This woody material is arranged in the stem in two very different ways in different plants, making two sorts of wood. One sort we see in a Palm-stem, a rattan, and a Corn-stalk (Fig. 351); the other we are familiar with in Oak, Maple, and all our common kinds of wood. In the first, the wood is made up of separate threads, scattered here and there throughout the whole diameter of the stem. In the second the wood is all collected to form a layer (in a slice across appearing as a ring) of wood, between a central cellular part which has none in it, the *Pith*, and an outer cellular part, the *Bark*. This last is the plan of all our Northern trees and shrubs, and of the greater part of our herbs. The first kind is

423. **The Endogenous Stem**; so named from two Greek words meaning "inside-growing," because, when it lasts from year to year, the new wood which is added is interspersed among the older threads of wood, and in old stems the hardest and oldest wood is near the surface, and the youngest and softest towards the centre. All the plants represented in Fig. 47, on p. 19, (except the anomalous Cycas,) are examples of Endogenous stems. And all such belong to plants with only one cotyledon or seed-leaf to the embryo (32). Botanists therefore call them *Endogenous* or *Monocotyledonous Plants*, using sometimes one name, and sometimes the other. Endogenous stems have no separate pith in the centre, no distinct bark, and no layer or ring of wood between these two; but the threads of wood are scattered throughout the whole, without any particular order. This is very different from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424. **The Exogenous Stem**, the one we have most to do with, since all our Northern trees and shrubs are constructed on this plan. It belongs to all plants which have two cotyledons to the embryo (or more than two, such as Pines, 33); so that we call these either *Exogenous* or *Dicotyledonous Plants* (16), accordingly as we take the name from the stem or from the embryo.

425. In the Exogenous stem, as already stated, the wood is all collected into one zone, surrounding a pith of pure cellular tissue in the centre, and surrounded by a distinct and separable bark, the

FIG. 351. Section of a Corn-stalk (an endogenous stem), both crosswise and lengthwise.

ing plates, giving a peculiar appearance to Oak, Maple, and other wood with large medullary rays.

427. *The Bark* covers and protects the wood. At first it is all cellular, like the pith; but soon some slender woody fibres, called bast-cells (Fig. 342), generally appear in it, next the wood, forming

The Liber, or Fibrous Bark, the inner bark; to which belongs the fine fibrous *bast* or *bass* of Basswood, and the tough and slender fibres of flax and hemp, which are spun and woven, or made into cordage. In the Birch and Beech the inner bark has few if any bast-cells in its composition.

The Cellular or Outer Bark consists of cellular tissue only. It is distinguished into two parts, an inner and an outer, viz.: —

The Green Bark, or Green Layer, which consists of tender cells, containing the same green matter as the leaves, and serving the same purpose. In the course of the first season, in woody stems, this becomes covered with

The Corky Layer, so named because it is the same substance as *cork;* common cork being the thick corky layer of the bark of the Cork-Oak, of Spain. It is this which gives to the stems or twigs of shrubs and trees the aspect and the color peculiar to each; namely, light gray in the Ash, purple in the Red Maple, red in several Dogwoods, &c. Lastly,

The Epidermis, or skin of the plant, consisting of a layer of thick-sided empty cells, covers the whole.

428. **Growth of the Stem year after year.** So much for an exogenous stem only one year old. The stems of herbs perish at the end of the season. But those of shrubs and trees make a new growth every year. It is from their mode of growth in diameter that they take the name of *exogenous*, i. e. *outside-growing*. The second year, such a tem forms a second layer of wood outside of the first; the third year, nother outside of that; and so on, as long as the tree lives. So that the trunk of an exogenous tree, when cut off at the base, exhibits as many concentric rings of wood as it is years old. Over twelve hundred layers have actually been counted on the stump of an agrd tree, such as the Giant Cedar or Redwood of California; and there are doubtless some trees now standing in various parts of the world which were already in existence at the beginning of the Christian era.

429. As to the bark, the green layer seldom grows much after the first season. Sometimes the corky layer grows and forms new layers, inside of the old, for a good many years, as in the Cork-Oak,

the Sweet Gum-tree, and the White and the Paper Birch. But it all dies after a while; and the continual enlargement of the wood within finally stretches it more than it can bear, and sooner or later cracks and rends it, while the weather acts powerfully upon its surface; so the older bark perishes and falls away piecemeal year by year.

430. But the inner bark, or liber, does make a new growth annually, as long as the tree lives, inside of that formed the year before, and next the surface of the wood. More commonly the liber occurs in the form of thin layers, which may be distinctly counted, as in Basswood: but this is not always the case. After the outer bark is destroyed, the older and dead layers of the inner bark are also exposed to the weather, are riven or split into fragments, and fall away in succession. In many trees the bark acquires a considerable thickness on old trunks, although all except the innermost portion is dead; in others it falls off more rapidly; in the stems of Honeysuckles and Grape-vines, the bark all separates and hangs in loose shreds when only a year or two old.

431. **Sap-wood.** In the wood, on the contrary, — owing to its growing on the outside alone, — the older layers are quietly buried under the newer ones, and protected by them from all disturbance. All the wood of the young sapling may be alive, and all its cells or woody tubes active in carrying up the sap from the roots to the leaves. It is all *Sap-wood* or *Alburnum*, as young and fresh wood is called. But the older layers, removed a step farther every year from the region of growth, — or rather the zone of growth every year removed a step farther from them, — soon cease to bear much, if any, part in the circulation of the tree, and probably have long before ceased to be alive. Sooner or later, according to the kind of tree, they are turned into

432. **Heart-wood,** which we know is drier, harder, more solid, and much more durable as timber, than sap-wood. It is generally of a different color, and it exhibits in different species the hue peculiar to each, such as reddish in Red-Cedar, brown in Black-Walnut, black in Ebony, &c. The change of sap-wood into heart-wood results from the thickening of the walls of the wood-cells by the deposition of hard matter, lining the tubes and diminishing their calibre; and by the deposition of a vegetable coloring-matter peculiar to each species.

433. The heart-wood, being no longer a living part, may decay

and often does so, without the least injury to the tree, except by impairing the strength of the trunk, and so rendering it more liable to be overthrown.

434. **The Living Parts of a Tree**, of the exogenous kind, are only these: first, the rootlets at one extremity; second, the buds and leaves of the season at the other; and third, a zone consisting of the newest wood and the newest bark, connecting the rootlets with the buds or leaves, however widely separated these may be, — in the largest trees from two to four hundred feet apart. And these parts of the tree are all renewed every year. No wonder, therefore, that trees may live so long, since they annually reproduce everything that is essential to their life and growth, and since only a very small part of their bulk is alive at once. The tree survives, but nothing now living has existed long. In it, as elsewhere, life is a transitory thing, ever abandoning the *old*, and displaying itself afresh in the *new*.

435. **Cambium-Layer.** The new growth in the stem, by which it increases in diameter year after year, is confined to a narrow line between the wood and the inner bark. *Cambium* is the old name for the mucilage which is so abundant between the bark and the wood in spring. It was supposed to be poured out there, and that the bark really separated from the wood at this time. This is not the case. The newest bark and wood are still united by a delicate tissue of young and forming cells, — called the *Cambium-layer*, — loaded with a rich mucilaginous sap, and so tender that in spring the bark may be raised from the wood by the slightest force. Here, nourished by this rich mucilage, new cells are rapidly forming by division (387 – 390); the inner ones are added to the wood, and the outer to the bark, so producing the annual layers of the two, which are ever renewing the life of the trunk.

436. At the same time new rootlets, growing in a similar way, are extending the roots beneath; and new shoots, charged with new buds, annually develop fresh crops of leaves in the air above. Only, while the additions to the wood and bark remain as a permanent portion of the tree, or until destroyed by decay, the foliage is temporary, the crop of leaves being annually thrown off after they have served their purpose.

437. **Structure of the Leaf.** Leaves also consist both of a woody and a cellular part (135). The woody part is the framework of ribs and veins, which have already been described in full (136 – 147).

pacted, so as to expose as little surface as possible to the direct action of the hot sun. On the other hand, the leaves of marsh plants, and of others not intended to survive a drought, have their cells more loosely arranged throughout. In such leaves the epidermis, or skin, is made of only one layer of cells; while in the Oleander, and the like, it consists of three or four layers of hard and thick-walled cells. In all this, therefore, we plainly see an arrangement for tempering the action of direct sunshine, and for restraining a too copious evaporation, which would dry up and destroy the tender cells, at least when moisture is not abundantly supplied through the roots.

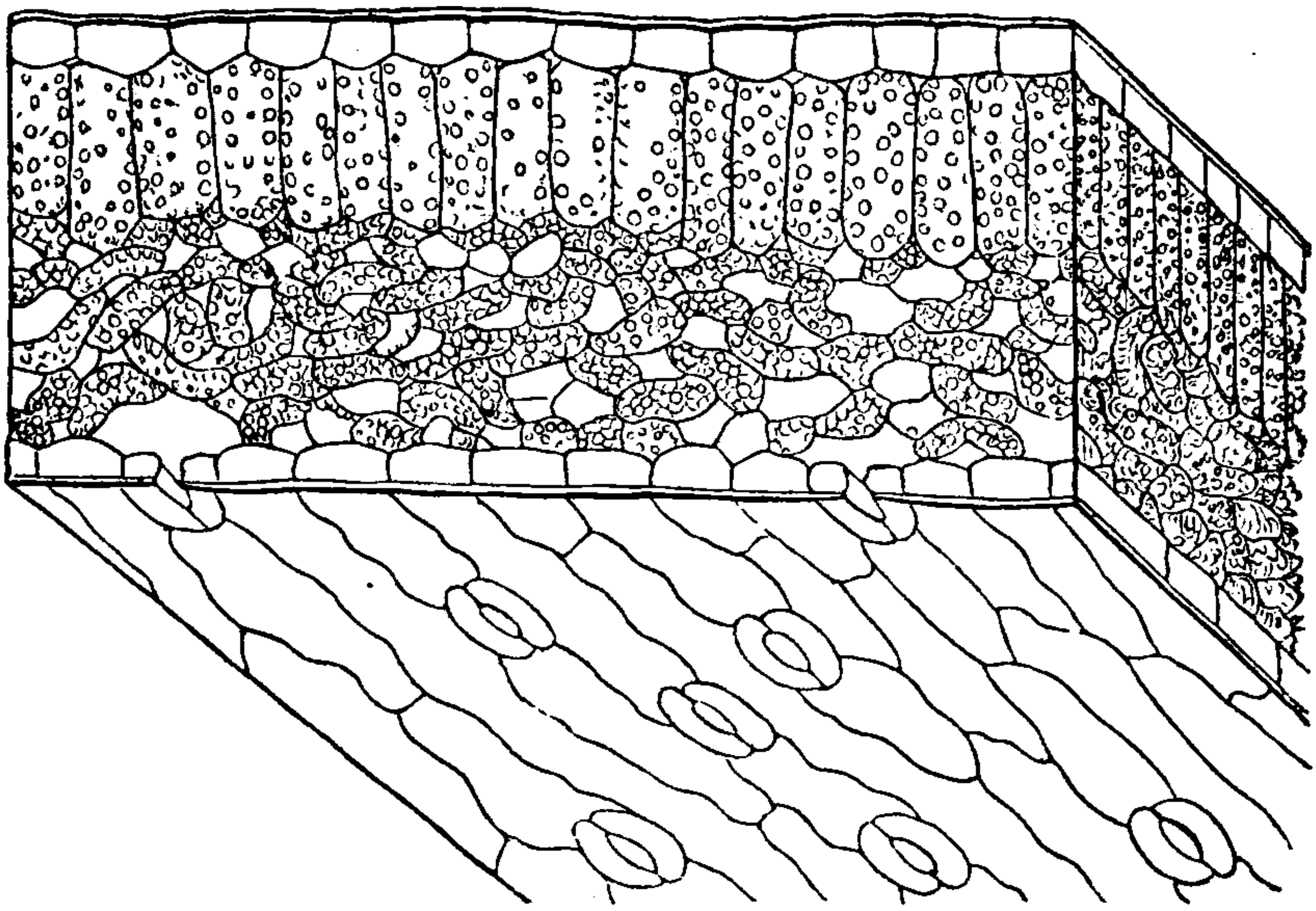
441. That the upper side of the leaf alone is so constructed as to bear the sunshine, is shown by what happens when their position is reversed: then the leaf soon twists on its stalk, so as to turn again its under surface away from the light; and when prevented from doing so, it perishes.

442. A large part of the moisture which the roots of a growing plant are constantly absorbing, after being carried up through the stem, is evaporated from the leaves. A Sunflower-plant, a little over three feet high, and with between five and six thousand square inches of surface in foliage, &c., has been found to exhale twenty or thirty ounces (between one and two pints) of water in a day. Some part of this, no doubt, flies off through the walls of the epidermis or skin, at least in sunshine and dry weather; but no considerable portion of it. The very object of this skin is to restrain evaporation. The greater part of the moisture exhaled escapes from the leaf through the

443. **Stomates or Breathing-pores.** These are small openings through the epidermis into the air-chambers, establishing a direct communication between the whole interior of the leaf and the external air. Through these the vapor of water and air can freely escape, or enter, as the case may be. The aperture is guarded by a pair of thin-walled cells, — resembling those of the green pulp within, — which open when moist so as to allow exhalation to go on, but promptly close when dry, so as to arrest it before the interior of the leaf is injured by the dryness.

444. Like the air-chambers, the breathing-pores belong mainly to the under side of the leaf. In the White Lily, — where they are unusually large, and easily seen by a simple microscope of moderate power, — there are about 60,000 to the square inch on the epidermis of the lower surface of the leaf, and only about 3,000 in

the same space of the upper surface. More commonly there are few or none on the upper side; direct sunshine evidently being unfavorable to their operation. Their immense numbers make up for their minuteness. They are said to vary from less than 1,000 to 170,000 to the square inch of surface. In the Apple-tree, where they are under the average as to number, there are about 24,000 to the square inch of the lower surface; so that each leaf has not far from 100,000 of these openings or mouths.



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LESSON XXVI.

THE PLANT IN ACTION, DOING THE WORK OF VEGETATION.

445. BEING now acquainted with the machinery of the plant, we naturally proceed to inquire what the use of it is, and how it works.

446. It has already been stated, in the first of these Lessons (7), that the great work of plants is *to change inorganic into organic matter;* that is, to take portions of earth and air, — of mineral matter, — upon which animals cannot live at all, and to convert them

FIG. 357. Portion of a White-Lily leaf, cut through and magnified, showing a section of the thickness, and also a part of the skin of the lower side, with some breathing-pores.

into something upon which they can live, namely, into food. All the food of all animals is produced by plants. Animals live upon vegetables; and vegetables live upon earth and air, principally upon the air.

447. **Plants feed upon Earth and Air.** This is evident enough from the way in which they live. Many plants will flourish in pure sand or powdered chalk, or on the bare face of a rock or wall, watered merely with rain-water. And almost any plant may be made to grow from the seed in pure sand, and increase its weight many times, even if it will not come to perfection. Many naturally live suspended from the branches of trees high in the air, and nourished by it alone, never having any connection with the soil (81); and some which naturally grow on the ground, like the Live-for-ever of the gardens, when pulled up by the roots and hung in the air will often flourish the whole summer long.

448. It is true that fast-growing plants, or those which produce considerable vegetable matter in one season,—especially in such a concentrated form as to be useful as food for man or the higher animals,—will come to maturity only in an enriched soil. But what is a rich soil? One which contains decomposing vegetable matter, or some decomposing animal matter; that is, in either case, some decomposing organic matter formerly produced by plants; aided by this, grain-bearing and other important vegetables will grow more rapidly and vigorously, and make a greater amount of nourishing matter, than they could if left to do the whole work at once from the beginning. So that in these cases also all the organic matter was made by plants, and made out of earth and air.

449. **Their Chemical Composition shows what Plants are made of.** The soil and the air in which plants live, and by which they are everywhere surrounded, supply a variety of materials, some likely to be useful to the plant, others not. To know what elements the plant makes use of, we must first know of what its fabric and its products are composed.

450. We may distinguish two sorts of materials in plants, one of which is absolutely essential, and is the same in all of them; the other, also to some extent essential, but very variable in different plants, or in the same plant under different circumstances. The former is the *organic*, the latter the *inorganic* or *earthy* materials.

451. **The Earthy or Inorganic Constituents.** If we burn thoroughly a leaf, a piece of wood, or any other part of a vegetable, almost all of

sue,—in the tender pot-herb and in the oldest tree. It is composed of carbon, hydrogen, and oxygen, 6 parts of the first to 10 of the second and 5 of the third. These, accordingly, are necessary materials of vegetable growth, and must be received by the growing plant.

455. **The Plant's Food** must contain these three elements in some shape or other. Let us look for them in the materials which the plant is constantly taking from the soil and the air.

456. *Water* is the substance of which it takes in vastly more than of anything else: we well know how necessary it is to vegetable life. The plant imbibes water by the roots, which are specially constructed for taking it in, as a liquid when the soil is wet, and probably also in the form of vapor when the soil is only damp. That water in the form of vapor is absorbed by the leaves likewise, when the plant needs it, is evident from the way partly wilted leaves revive and freshen when sprinkled or placed in a moist atmosphere. Now water is composed of *hydrogen* and *oxygen*, two of the three elements of cellulose or plant-fabric. Moreover, the hydrogen and the oxygen exist in water in exactly the same proportions that they do in cellulose: so it is clear that water furnishes these two elements.

457. We inquire, therefore, after the third element, *carbon*. This is the same as pure charcoal. Charcoal is the carbon of a vegetable left behind after charring, that is, heating it out of contact of the air until the hydrogen and oxygen are driven off. The charcoal of wood is so abundant in bulk as to preserve perfectly the shape of the cells after charring, and in weight it amounts to about half that of the original material. Carbon itself is a solid, and not at all dissolved by water: as such, therefore, it cannot be absorbed into the plant, however minute the particles; only liquid and air can pass through the walls of the cells (402, 410). It must therefore come to the plant in some combination, and in a fluid form. The only substance within the plant's reach containing carbon in the proper state is

458. *Carbonic Acid.* This is a gas, and one of the components of the atmosphere, everywhere making about $\frac{1}{2500}$ part of its bulk, —enough for the food of plants, but not enough to be injurious to animals. For when mixed in any considerable proportion with the air we breathe, carbonic acid is very poisonous. The air produced by burning charcoal is carbonic acid, and we know how soon burning charcoal in a close room will destroy life.

459. The air around us consists, besides this minute proportion of carbonic acid, of two other gases, mixed together, viz. *oxygen*

and *nitrogen*. The nitrogen gas does not support animal life: it only dilutes the oxygen, which does. It is the oxygen gas alone which renders the air fit for breathing.

460. Carbonic acid consists of carbon combined with oxygen. In breathing, animals are constantly forming carbonic acid gas by uniting carbon from their bodies with oxygen of the air; they inspire oxygen into their lungs; they breath it out as carbonic acid. So with every breath animals are diminishing the oxygen of the air, — so necessary to animal life, — and are increasing its carbonic acid, — so hurtful to animal life; or rather, which would be so hurtful if it were allowed to accumulate in the air. The reason why it does not increase in the air beyond this minute proportion is that plants feed upon it. They draw their whole stock of carbon from the carbonic acid of the air.

461. Plants take it in by their leaves. Every current, or breeze that stirs the foliage, brings to every leaf a succession of fresh atoms of carbonic acid, which it absorbs through its thousands of breathing-pores. We may prove this very easily, by putting a small plant or a fresh leafy bough into a glass globe, exposed to sunshine, and having two openings, causing air mixed with a known proportion of carbonic acid gas to enter by one opening, slowly traverse the foliage, and pass out by the other into a vessel proper to receive it: now, examining the air chemically, it will be found to have less carbonic acid than before. A portion has been taken up by the foliage.

462. Plants also take it in by their roots, some probably as a gas, in the same way that leaves absorb it, and much, certainly, dissolved in the water which the rootlets imbibe. The air in the soil, especially in a rich soil, contains many times as much carbonic acid as an equal bulk of the atmosphere above. Decomposing vegetable matter or manures, in the soil, are constantly evolving carbonic acid, and a large part of it remains there, in the pores and crevices, among which the absorbing rootlets spread and ramify. Besides, as this gas is dissolved by water in a moderate degree, every rain-drop that falls from the clouds to the ground brings with it a little carbonic acid, dissolving or washing it out of the air as it passes, and bringing it down to the roots of plants. And what flows off into the streams and ponds serves for the food of water-plants.

463. So water and carbonic acid, taken in by the leaves, or taken in by the roots and carried up to the leaves as crude sap, are the general food of plants, — are the raw materials out of which at least

the fabric and a part of the general products of the plant are made. Water and carbonic acid are *mineral matters:* in the plant, mainly in the foliage, they are changed into *organic matters.* This is

464. **The Plant's proper Work, Assimilation,** viz. the conversion by the vegetable of foreign, dead, mineral matter into its own living substance, or into organic matter capable of becoming living substance. To do this is, as we have said, the peculiar office of the plant. Ho and where is it done?

465. *It is done in the green parts of plants alone, and only when these are acted upon by the light of the sun.* The sun in some way supplies a power which enables the living plant to originate these peculiar chemical combinations, — to organize matter into forms which are alone capable of being endowed with life. The proof of this proposition is simple; and it shows at the same time, in the simplest way, what the plant does with the water and carbonic acid it consumes. Namely, 1st, it is only in sunshine or bright daylight that the green parts of plants give out oxygen gas, — then they do; and 2d, the giving out of this oxygen gas is just what is required to render the chemical composition of water and carbonic acid the same as that of *cellulose* (454), that is, of the plant's fabric. This shows why plants spread out so large a surface of foliage.

466. In plants growing or placed under water we may see bubbles of air rising from the foliage; we may collect enough of this air to test it by a candle's burning brighter in it; which shows it to be oxygen gas. Now if the plant is making cellulose or plant-substance, — that is, is making the very materials of its fabric and growth, as must generally be the case, — all this oxygen gas given off by the leaves comes from the decomposition of carbonic acid taken in by the plant.

467. This *must be so,* because cellulose is composed of 5 parts of oxygen and 10 of hydrogen to 6 of carbon (454): here the first two are just in the same proportions as in water, which consists of 1 part of oxygen and 2 of hydrogen,—so that 5 parts of water and 6 of carbon represent 1 of cellulose or plant-fabric; and to make it out of water and carbonic acid, the latter (which is composed of carbon and oxygen) has only to give up all its oxygen. In other words, the plant, in its foliage under sunshine, decomposes carbonic acid gas, and turns the carbon together with water into cellulose, at the same time giving off the oxygen of the carbonic acid into the air.

468. And we can readily prove that it is so,—namely, that plants

pended or transferred from one part of the plant to another. In the Sugar-cane and Indian Corn, starch is deposited in the seed; in germination this is turned into sugar for the plantlet to begin its growth with; the growing plant produces more, and deposits some as starch in the stalk; just before blossoming, this is changed into sugar again, and dissolved in the sap, to form and feed the flowers (which cannot, like the leaves, create nourishment for themselves); and what is left is deposited in the seed as starch again, with which to begin the same operation in the next generation.

471. We might enumerate other vegetable products of this class (such as oil, acids, jelly, the pulp of fruits, &c.), and show how they are formed out of the carbonic acid and water which the plant takes in. But those already mentioned are sufficient. In producing any of them, carbonic acid taken from the air is decomposed, its carbon retained, and its oxygen given back to the air. That is to say,

472. **Plants purify the Air for Animals**, by taking away the carbonic acid injurious to them, continually poured into it by their breathing, as well as by the burning of fuel and by decay, and restoring in its place an equal bulk of life-sustaining oxygen (460). And by the same operation, combining this carbon with the elements of water, &c., and elaborating them into organic matter,—especially into starch, sugar, oil, and the like,—

473. **Plants produce all the Food and Fabric of Animals.** The herbivorous animals feed directly upon vegetables; and the carnivorous feed upon the herbivorous. Neither the one nor the other originate any organic matter. They take it all ready-made from plants,—altering the form and qualities more or less, and at length destroying or decomposing it.

474. Starch, sugar, and oil, for example, form a large part of the food of herbivorous animals and of man. When digested, they enter into the blood; any surplus may be stored up for a time in the form of fat, being changed a little in its nature; while the rest (and finally the whole) is decomposed into carbonic acid and water, and exhaled from the lungs in respiration;—in other words, is given back to the air by the animal as the very same materials which the plant takes from the air as its food (463);—is given back to the air in the same form that it would have been if the vegetable matter had been left to decay where it grew, or if it had been set on fire and burned;—and with the same result too as to the heat, the heat in this case producing and maintaining the proper temperature of the animal.

475. But starch, sugar, and the like, do not make any part of the flesh or fabric of animals. And that for the obvious reason, that they consist of only the three elements *carbon*, *hydrogen*, and *oxygen;* whereas the flesh of animals has nitrogen as well as these three elements in its composition. The materials of the animal body, called *Fibrine* in the flesh or muscles, *Gelatine* in the sinews and bones, *Caseine* in the curd of milk, &c., are all forms of one and the same substance, composed of *carbon*, *hydrogen*, *oxygen*, and *nitrogen*. As nitrogen is a large constituent of the atmosphere, and animals are taking it into their lungs with every breath they draw, we might suppose that they take this element of their frame directly from the air. But they do not. Even this is furnished by vegetables, and animals receive it ready-made in their food. And this brings us to consider still another and most important vegetable product, of a different class from the rest (omitted till now, for the sake of greater simplicity); namely, what is called

476. *Proteine.* This name has been given to it by chemists, because it occurs under such a protean variety of forms. The *Gluten* of wheat and the *Legumine* of beans and other leguminous plants may be taken to represent it. It occurs in all plants, at least in young and growing parts. It does not make any portion of their tissue, but is contained in all living cells, as a thin jelly, mingled with the sap or juice, or as a delicate mucilaginous lining. In fact, it is formed earlier than the cell-wall itself, and the latter is moulded on it, as it were; so it is also called *Protoplasm.* It disappears from common cells as they grow old, being transferred onward to new or forming parts, where it plays a very active part in growth. Mixed with starch, &c., it is accumulated in considerable quantity in wheat, beans, and other grains and seeds, especially those which are most nutritious as food. It is the proteine which makes them so nutritious. Taken by animals as food, it forms their flesh and sinews, and the animal part of their bones, without much change; for it has the same composition,—is just the same thing, indeed, in some slightly different forms. To produce it, the plant employs, in addition to the carbonic acid and water already mentioned as its general food, some *ammonia;* which is a compound of *hydrogen* and *nitrogen.* Ammonia (which is the same thing as hartshorn) is constantly escaping into the air in small quantities from all decomposing vegetable and animal substances. Besides, it is produced in every thunderstorm. Every flash of lightning causes some to be made (in the

form of *nitrate of ammonia*) out of the nitrogen of the air and the vapor of water. The reason why it never accumulates in the air so as to be perceptible is, that it is extremely soluble in water, as are all its compounds. So it is washed out of the atmosphere by the rain as fast as it is made or rises into it, and is brought down to the roots of plants, which take it in freely. When assimilated in the leaves along with carbon and water, proteine is formed, the very substance of the flesh of animals. So all flesh is vegetable matter in its origin.

477. Even the earthy matter of the bones, and the iron and other mineral matters in the blood of animals, are derived from the plants they feed upon, with hardly an exception. These are furnished by the earthy or mineral constituents of plants (452), and are merely accumulated in the animal frame.

478. Animals, therefore, depend absolutely upon vegetables for their being. The great object for which the All-wise Creator established the vegetable kingdom evidently is, that plants might stand on the surface of the earth between the mineral and the animal creations, and organize portions of the former for the sustenance of the latter.

LESSON XXVII.

PLANT-LIFE.

479. Life is known to us only by its effects. We cannot tell what it *is*; but we notice some things which it *does*. One peculiarity of living things, which has been illustrated in the last Lesson, is their power of transforming matter into new forms, and thereby making products never produced in any other way. Life is also manifested by

480. **Motion**, that is, by self-caused movements. Living things move; those not living are moved. Animals, living as they do upon organized food, — which is not found everywhere, — must needs have the power of going after it, of collecting it, or at least of taking it in; which requires them to make spontaneous movements. But plants, with their wide-spread surface (34, 131) always in con-

under the glass like strings of blue beads, each bead being a cell. But here a microscope magnifying six or eight hundred times in diameter is needed to see the current distinctly.

484. The movement belongs to the *protoplasm* (476), or jelly-like matter under the cell-wall. As this substance has just the same composition as the flesh of animals, it is not so strange that it should exhibit such animal-like characters. In the simplest water-plants, of the Sea-weed family, the body which answers to the seed is at first only a rounded little mass of protoplasm. When these bodies escape from the mother plant, they often swim about freely in the water in various directions, by a truly spontaneous motion, when they closely resemble animalcules, and are often mistaken for them. After enjoying this active life for several hours, they come to rest, form a covering of cellulose, and therefore become true vegetable cells, fix themselves to some support, germinate, and grow into the perfect plant.

485. **Absorption, Conveyance of the Sap, &c.** Although contained in cells with closed walls, nevertheless the fluids taken in by the roots are carried up through the stem to the leaves even of the topmost bough of the tallest tree. And the sap, after its assimilation by the leaves, is carried down in the bark or the cambium-layer, and distributed throughout the plant, or else is conveyed to the points where growth is taking place, or is accumulated in roots, stems, or wherever a deposit is being stored up for future use (71, 104, 128, 469).

486. That the rise of the sap is pretty rapid in a leafy and growing plant, on a dry summer's day, is evident from the amount of water it is continually losing by exhalation from the foliage (447); — a loss which must all the while be supplied from the roots, or else the leaves would dry up and die; as they do so promptly when separated from the stem, or when the stem is cut off from the roots. Of course they do not then lose moisture any faster than they did before the separation; only the supply is no longer kept up from below.

487. The rise of the sap into the leaves apparently is to a great degree the result of a mode of diffusion which has been called *Endosmose.* It acts in this way. Whenever two fluids of different density are separated by a membrane, whether of dead or of living substance, or are separated by any porous partition, a flow takes place through the partition, mainly towards the heavier fluid, until that is brought to the same density as the other. A familiar illus-

tration is seen when we place powdered sugar upon strawberries, and slightly moisten them: the dissolving sugar makes a solution stronger than the juice in the cells of the fruit; so this is gradually drawn out. Also when pulpy fruits are boiled in a strong sirup; as soon as the sirup becomes denser than the juice in the fruit, the latter begins to flow out and the fruit begins to shrivel. But when shrivelled fruits are placed in weak sirup, or in water, they become plump, because the flow then sets inwards, the juice in the cells being denser than the water outside. Now the cells of the living plant contain organic matter, in the form of mucilage, protoplasm, sometimes sugar, &c.; and this particularly abounds in young and growing parts, such as the tips of roots (Fig. 56), which, as is well known, are the principal agents in absorbing moisture from the ground. The contents of their cells being therefore always much denser than the moisture outside (which is water containing a little carbonic acid, &c., and a very minute quantity of earthy matter), this moisture is constantly drawn into the root. What makes it ascend to the leaves?

488. To answer this question, we must look to the leaves, and consider what is going on there. For (however it may be in the spring before the leaves are out), in a leafy plant or tree the sap is not forced up from below, but is drawn up from above. Water largely evaporates from the leaves (447); it flies off into the air as vapor, leaving behind all the earthy and the organic matters, — these not being volatile; — the sap in the cells of the leaf therefore becomes denser, and so draws upon the more watery contents of the cells of the stalk, these upon those of the stem below, and so on, from cell to cell down to the root, causing a flow from the roots to the leaves, which begins in the latter, — just as a wind begins in the direction towards which it blows. Somewhat similarly, elaborated sap is drawn into buds or any growing parts, where it is consolidated into fabric, or is conveyed into tubers, roots, seeds, and the like, in which it is condensed into starch and stored up for future use (74, 103, &c.).

489. So in absorbing moisture by the roots, and in conveying the sap or the juices from cell to cell and from one part to another, the plant appears to make use of a physical or inorganic force; but it manages and directs this as the purposes of the vegetable economy demand. Now, when the proper materials are brought to the growing parts, *growth* takes place; and in growth the plant moves

the particles of matter, arranges them, and shapes the fabric in a manner which we cannot at all explain by any mechanical laws. The organs are not shaped by any external forces; they shape themselves, and take such forms and positions as the nature of each part, or the kind of plant, requires.

490. **Special Movements.** Besides growing, and quite independent of it, plants not only assume particular positions, but move or bend one part upon another to do so. Almost every species does this, as well as what are called sensitive plants. In springing from the seed, the radicle or stem of the embryo, if not in the proper position already, bends itself round so as to direct its root-end downwards, and the stem-end or plumule upwards. It does the same when covered so deeply by the soil that no light can affect it, or when growing in a perfectly dark cellar. But after reaching the light, the stem bends towards that, as every one knows; and bends towards the stronger light, when the two sides are unequally exposed to the sun. It is now known that the shoot is bent by the shortening of the cells on the more illuminated side; for if we split the bending shoot in two, that side curves over still more, while the opposite side inclines to fly back. But how the light causes the cells to shorten on that side, we can no more explain, than we can tell how the will, acting through the nerves, causes the contraction of the fibres of the muscles by which a man bends his arm. We are sure that the bending of the shoot has nothing to do with growth, because it takes place after a shoot is grown; and the delicate stem of a young seedling will bend a thousand times faster than it grows. Also because it is yellow light that most favors growth and the formation of vegetable fabric, while the blue and violet rays produce the bending. Leaves also move, even more freely than stems. They constantly present their upper face to the light; and when turned upside down, they twist on their stalks, or curve round to recover their original position. The free ends of twining stems, as of Hop, or Morning Glory, or Bean, which apparently hang over to one side from their weight, are in fact bent over, and, the direction of the bend constantly changing, the shoot is steadily sweeping round the circle, making a revolution every few hours, or even more rapidly in certain cases, until it reaches a neighboring support, when, by a continuation of the same movement, it twines around it. Most tendrils revolve in the same way, sometimes even more rapidly; while others only turn from the

Desmodium gyrans of the East Indies, spontaneously falling and rising by turns in jerking motions nearly the whole day long? We can only say, that plants are alive, no less than animals, and that it is a characteristic of living things to move.

*** Cryptogamous or Flowerless Plants.

493. In all the foregoing Lessons, we have had what may be called plants of the higher classes alone in view. There are others, composing the lower grades of vegetation, to which some allusion ought to be made.

494. Of this sort are Ferns or Brakes, Mosses, Liverworts, Lichens, Sea-weeds, and Fungi or Mushrooms. They are all classed together under the name of *Flowerless Plants*, or *Cryptogamous Plants;* the former epithet referring to the fact that they do not bear real *blossoms* (with stamens and pistils) nor *seeds* (with an embryo ready-formed within). Instead of seeds they have *spores*, which are usually simple cells (392). The name *Cryptogamous* means, of hidden fructification, and intimates that they may have something answering to stamens and pistils, although not the same; and this is now known to be the case with most of them.

495. Flowerless plants are so very various, and so peculiar in each family, that a volume would be required to illustrate them. Curious and attractive as they are, they are too difficult to be studied botanically by the beginner, except the Ferns, Club-Mosses, and Horse-tails. For the study of these we refer the student at once to the *Manual of the Botany of the Northern United States*, and to the *Field, Forest, and Garden Botany.* The structure and physiology of these plants, as well as of the Mosses, Liverworts, Lichens, Sea-weeds, and Fungi, are explained in the *Structural Botany, or Botanical Text-Book,* and in other similar works. When the student has become prepared for the study, nothing can be more interesting than these plants of the lowest orders.

LESSON XXVIII.

SPECIES AND KINDS.

496. UNTIL now, we have been considering plants as to their structure and their mode of life. We have, as it were, been reading the biography of an individual plant, following it from the tiny seedling up to the mature and fruit-bearing herb or tree, and learning how it grows and what it does. The botanist also considers *plants as to their relationships.*

497. Plants and animals, as is well known, have two great peculiarities: 1st, they form themselves; and 2d, they multiply themselves. They reproduce themselves in a continued succession of

498. **Individuals** (3). Mineral things occur as *masses,* which are divisible into smaller and still smaller ones without alteration of their properties (391). But organic things (vegetables and animals) exist as *individual beings.* Each owes its existence to a parent, and produces similar individuals in its turn. So each individual is a link of a chain; and to this chain the natural-historian applies the name of

499. **Species.** All the descendants from the same stock therefore compose one species. And it was from our observing that the several sorts of plants or animals steadily reproduce themselves,—or, in other words, keep up a succession of similar individuals,—that the idea of species originated. So we are led to conclude that the Creator established a definite number of species at the beginning, which have continued by propagation, each after its kind.

500. There are few species, however, in which man has actually observed the succession for many generations. It could seldom be proved that all the White Pine trees or White Oaks of any forest came from the same stock. But observation having familiarized us with the general fact, that individuals proceeding from the same stock are essentially alike, we infer from their close resemblance that these similar individuals belong to the same species. That is, we infer it when the individuals are as much like each other as those are which we know to have sprung from the same stock.

501. We do not infer it from every resemblance; for there is the resemblance of *kind,*—as between the White Oak and the Red Oak,

and between the latter and the Scarlet Oak: these, we take for granted, have not originated from one and the same stock, but from three separate stocks. Nor do we deny it on account of every difference; for even the sheep of the same flock, and the plants raised from peas of the same pod, may show differences, and such differences occasionally get to be very striking. When they are pretty well marked, we call them

Varieties. The White Oak, for example, presents two or three varieties in the shape of the leaves, although they may be all alike upon each particular tree. The question often arises, practically, and it is often hard to answer, whether the difference in a particular case is that of a variety, or is specific. If the former, we may commonly prove it to be so by finding such intermediate degrees of difference in various individuals as to show that no clear line of distinction can be drawn between them; or else by observing the variety to vary back again, if not in the same individual, yet in its offspring. Our sorts of Apples, Pears, Potatoes, and the like, show us that differences which are permanent in the individual, and continue unchanged through a long series of generations when propagated by division (as by offsets, cuttings, grafts, bulbs, tubers, &c.), are not likely to be reproduced by seed. Still they sometimes are so: and such varieties are called

Races. These are strongly marked varieties, capable of being propagated by seed. Our different sorts of Wheat, Indian Corn, Peas, Radishes, &c., are familiar examples: and the races of men offer an analogous instance.

502. It should be noted, that all varieties have a *tendency* to be reproduced by seed, just as all the peculiarities of the parent tend to be reproduced in the offspring. And by selecting those plants which have developed or inherited any desirable peculiarity, keeping them from mingling with their less promising brethren, and selecting again the most promising plants raised from their seeds, we may in a few generations render almost any variety transmissible by seed, so long as we take good care of it. In fact, this is the way the cultivated or domesticated races, so useful to man, have been fixed and preserved. Races, in fact, can hardly, if at all, be said to exist independently of man. But man does not really produce them. Such peculiarities — often surprising enough — now and then originate, we know not how (the plant *sports*, as the gardeners say); they are only preserved, propagated, and generally further developed, by the culti-

the higher grade of Flowering plants, exhibiting the full plan of vegetation, and the lower grade of Flowerless plants, in which vegetation is so simplified that at length the only likeness between them and our common trees or Flowering plants is that they are both vegetables. From species, then, we rise first to

505. **Genera** (plural of *Genus*). The Rose kind or genus, the Oak genus, the Chestnut genus, &c., are familiar illustrations. Each genus is a group of nearly related species, exhibiting a particular plan. All the Oaks belong to one genus, the Chestnuts to another. the Beech to a third. The Apple, Pear, and Crab are species of one genus, the Quince represents another, the various species of Hawthorn a third. In the animal kingdom the common cat, the wild cat, the panther, the tiger, the leopard, and the lion are species of the cat kind or genus; while the dog, the jackal, the different species of wolf, and the foxes, compose another genus. Some genera are represented by a vast number of species, others by few, very many by only one known species. For the genus may be as perfectly represented in one species as in several, although, if this were the case throughout, genera and species would of course be identical (504). The Beech genus and the Chestnut genus would be just as distinct from the Oak genus even if but one Beech and one Chestnut were known; as indeed was the case formerly.

506. **Orders or Families** (the two names are used for the same thing in botany) are groups of genera that resemble each other; that is, they are to genera what genera are to species. As familiar illustrations, the Oak, Chestnut, and Beech genera, along with the Hazel genus and the Hornbeams, all belong to one order, viz. the Oak Family; the Birches and the Alders make another family; the Poplars and Willows, another; the Walnuts (with the Butternut) and the Hickories, another. The Apple genus, the Quince and the Hawthorns, along with the Plums and Cherries and the Peach, the Raspberry, with the Blackberry, the Strawberry, the Rose, and many other genera, belong to a large order, the Rose Family.

507. **Tribes and Suborders.** This leads us to remark, that even the genera of the same order may show very unequal degrees of resemblance. Some may be very closely related to one another, and at the same time differ strikingly from the rest in certain important particulars. In the Rose Family, for example, there is the Rose genus itself, with the Raspberry genus, the Strawberry, the Cinquefoil, &c. near it, but by no means so much like it as they are like each

other: this group, therefore, answers to what is called a *Tribe;* and the Rose itself stands for another tribe. But we further observe that the Apple genus, the Hawthorns, the Quince, and the June-berry, though of the same order, and nearly related among themselves, differ yet more widely from the Rose and its nearest relations; and so, on the other hand, do the Plum and Cherry, the Peach and the Almond. So this great Rose Family, or Order, is composed of three groups, of a more marked character than tribes,—groups which might naturally be taken for orders; and we call them *Sub-orders.* But students will understand these matters best after a few lessons in studying plants in a work describing the kinds.

508. **Classes.** These are great assemblages of orders, as already explained (515). The orders of Flowering Plants are numerous, no less than 134 being represented in the Botany of the Northern United States; but they all group themselves under two great classes. One class comprises all that have seeds with a monocotyledonous embryo (32), endogenous stems (423), and generally parallel-veined leaves (139); the other, those with dicotyledonous embryo, exogenous stems, and netted-veined leaves; and the whole aspect of the two is so different that they are known at a glance.

509. Finally, these two classes together compose the upper *Series* or grade of *Flowering or Phænogamous Plants,* which have their counterpart in the lower *Series* of *Flowerless or Cryptogamous Plants,* —composed of three classes, and about a dozen orders.

510. The universal members of classification are CLASS, ORDER, GENUS, SPECIES, always standing in this order. When there are more, they take their places as in the following schedule, which comprises all that are generally used in a natural classification, proceeding from the highest to the lowest, viz.:—

Series,
  CLASS,
    Subclass,
      ORDER, or FAMILY,
        Suborder,
          Tribe,
            Subtribe,
              GENUS,
                Subgenus or Section,
                  SPECIES,
                    Variety.

LESSON XXIX.

BOTANICAL NAMES AND CHARACTERS.

511. PLANTS are *classified*, — i. e. are marshalled under their respective classes, orders, tribes, genera, and species, — and they are *characterized*, — that is, their principal characteristics or distinguishing marks are described or enumerated, in order that,

First, their resemblances or differences, of various degrees, may be clearly exhibited, and all the species and kinds ranked next to those they are most related to; — and

Secondly, that students may readily ascertain the botanical names of the plants they meet with, and learn their peculiarities, properties, and place in the system.

512. It is in the latter that the young student is chiefly interested. And by his studies in this regard he is gradually led up to a higher point of view, from which he may take an intelligent survey of the whole general system of plants. But the best way for the student to learn the classification of plants (or Botany as a system), is to use it, in finding out by it the name and the peculiarities of all the wild plants he meets with.

513. **Names.** The botanical name of a plant, that by which a botanist designates it, is the name of its genus followed by that of the species. The name of the genus or kind is like the family name or surname of a person, as *Smith*, or *Jones*. That of the species answers to the baptismal name, as *John*, or *James*. Accordingly, the White Oak is called botanically *Quercus alba;* the first word, or *Quercus*, being the name of the Oak genus; the second, *alba*, that of this particular species. And the Red Oak is named *Quercus rubra;* the Black-Jack Oak, *Quercus nigra;* and so on. The botanical names are all in Latin (or are Latinized), this being the common language of science everywhere; and according to the usage of that language, and of most others, the name of the species comes after that of the genus, while in English it comes before it.

514. **Generic Names.** A plant, then, is named by two words. The generic name, or that of the genus, is one word, and a substantive. Commonly it is the old classical name, when the genus was known to the Greeks and Romans; as *Quercus* for the Oak, *Fagus* for the

worthia *Michauxii*, p. 65, named for the early botanist Michaux; and Polygala *Nuttallii*, in compliment to Mr. Nuttall, who described it under another name. Such names of persons are of course written with a capital initial letter. Occasionally some old substantive name is used for the species; as Magnolia *Umbrella*, p. 49, and Ranunculus *Flammula*, p. 41. These are also written with a capital initial, and need not accord with the generic name in gender, &c.

517. The name of a variety, when it is distinct enough to require any, is made on the same plan as that of the species, and is written after it; as, Ranunculus Flammula, variety *reptans*, p. 41 (i. e. the creeping variety), and R. abortivus, variety *micranthus*, p. 42, or the small-flowered variety of this species.

518. **Names of Groups.** The names of tribes, orders, and the like, are in the plural number, and are commonly formed by prolonging the name of a genus of the group taken as a representative of it. For example, the order of which the Buttercup or Crowfoot genus, *Ranunculus*, is the representative, takes from it the name of *Ranunculaceæ* (Manual, p. 34); meaning *Plantæ Ranunculaceæ* when written out in full, that is, Ranunculaceous Plants. This order comprises several tribes; one of which, to which Ranunculus itself belongs, takes the name of *Ranunculeæ;* another, to which the genus *Clematis*, or the Virgin's-Bower, belongs, takes accordingly the name of *Clematideæ;* and so on. So the term *Rosaceæ* (meaning Rosaceous plants) is the name of the order of which the Rose (*Rosa*) is the well-known representative; and *Roseæ* is the name of the particular tribe of it which comprises the Rose.

519. A few orders are named on a somewhat different plan. The great order *Leguminosæ*, for instance (Manual, p. 123), is not named after any genus in it; but the fruit, which is a legume (356), gives the name of *Leguminous Plants*. So, likewise, the order *Umbelliferæ* (Manual, p. 187) means Umbelliferous or Umbel-bearing Plants; and the vast order *Compositæ* (Manual, p. 215) is so named because it consists of plants whose blossoms are crowded into heads of the sort which were called "compound flowers" by the old botanists (277).

520. **Characters.** The brief description, or enumeration in scientific terms, of the principal distinctive marks of a species, genus, order, or other group, as given in botanical works, is called its *Character*. Thus, in the Manual, already referred to, at the begin-

ning, the character of the first great series is given; then that of the first class, of the first subclass, and of the first division under it. Then, after the name of the order, follows its character (the *ordinal* character): under the name of each genus (as, 1. *Clematis*, p. 35) is added the *generic* character, or description of what essentially distinguishes it; and finally, following the name of each species, is the *specific* character, a succinct enumeration of the points in which it mainly differs from other species of the same genus. See, for illustration, *Clematis Viorna*, p. 36, where the sentence immediately following the name is intended to characterize that species from all others like it.

521. Under this genus, and generally where we have several species of a genus, the species are arranged under *sections*, and these often under *subsections*, for the student's convenience in analysis, — the character or description of a section applying to all the species under it, and therefore not having to be repeated under each species. Under Clematis, also, are two sections with names, or sub-genera, which indicates that they might almost be regarded as two distinct genera. But these details are best understood by practice, in the actual studying of plants to ascertain their name and place. And to this the student is now ready to proceed.

LESSON XXX.

HOW TO STUDY PLANTS.

522. HAVING explained, in the two preceding Lessons, the general principles of Classification, and of Botanical Names, we may now show, by a few examples, how the student is to proceed in applying them, and how the name and the place in the system of an unknown plant are to be ascertained.

523. We suppose the student to be provided with a hand *magnifying-glass*, and, if possible, with a *simple microscope*, i. e. with a magnifying-glass, of two or more different powers, mounted on a support, over a stage, holding a glass plate, on which small flowers or their parts may be laid, while they are dissected under the microscope with the points of needles (mounted in handles), or divided

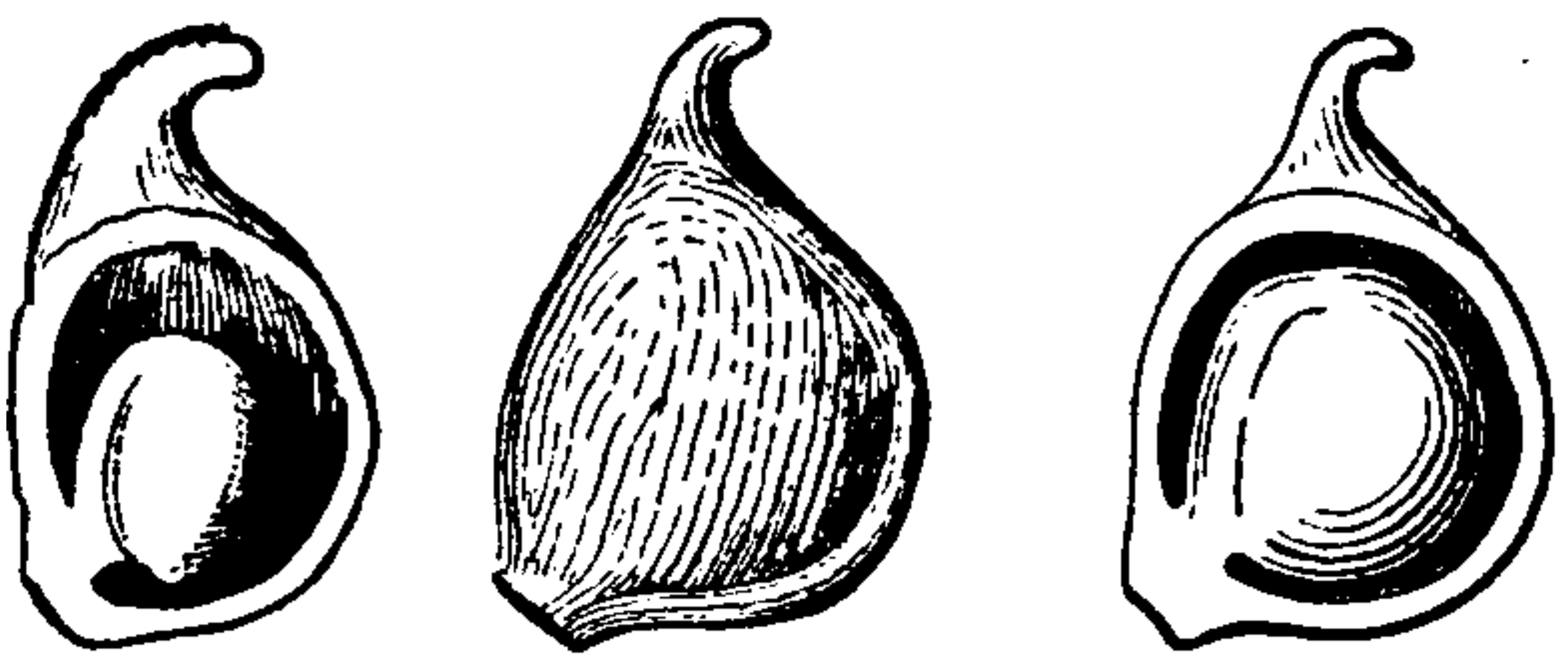
by a sharp knife. Such a microscope is not *necessary*, except for very small flowers; but it is a great convenience at all times, and is indispensable in studying the more difficult orders of plants.

524. We suppose the student now to have a work in which the plants of the country or district are scientifically arranged and described: if in the Southern Atlantic States, Dr. Chapman's *Flora of the Southern States;* if north of Carolina and Tennessee, Gray's *Manual of the Botany of the United States*, fifth edition; or, as covering the whole ground as to common plants, and including also all the common cultivated plants, Gray's *Field, Forest, and Garden Botany*, which is particularly arranged as the companion of the present work; that containing brief botanical descriptions of the plants, and this the explanation of their general structure, and of the technical terms employed in describing them. To express clearly the distinctions which botanists observe, and which furnish the best marks to know a plant by, requires a good many technical terms, or words used with a precise meaning. These, as they are met with, the student should look out in the Glossary at the end of this volume. The terms in common use are not so numerous as they would at first appear to be. With practice they will soon become so familiar as to give very little trouble. And the application of botanical descriptive language to the plants themselves, indicating all their varieties of form and structure, is an excellent discipline for the mind, equal, if not in some respects superior, to that of learning a classical language.

525. The following illustrations and explanations of the way to use the descriptive work are, first, for The *Field, Forest, and Garden Botany*, that being the one which will be generally used by beginners and classes. This and the *Lessons*, bound together in a single compact volume, will serve the whole purpose of all but advanced students, teachers, and working botanists. Thus equipped, we proceed to

526. **The Analysis of a Plant.** A Buttercup will serve as well as any. Some species or other may be found in blossom throughout nearly the whole spring and summer; and, except at the very beginning of the season, the fruit, more or less developed, may be gathered with the blossom. To a full knowledge of a plant the fruit is essential, although the name may almost always be ascertained without it. This common yellow flower being under examination, we are to refer the plant to its proper class and order or

little higher up on the receptacle, an indefinite number of stamens; and, lastly, covering the summit or centre of the receptacle, an indefinite number of pistils. A good view of the whole is to be had by cutting the flower directly through the middle, from top to bottom (Fig. 358). If this be done with a sharp knife, some of the pistils will be neatly divided, or may be so by a second slicing. Each pistil, we see, is a closed ovary, containing a single ovule (Fig. 359) ascending from near the base of the cell, and is tipped with a very short broad style, which has the stigma running down the whole length of its inner edge. The ovary is little changed as it ripens into the sort of fruit termed an *akene* (Fig. 360); the ovule becoming the seed and fitting the cell (Fig. 361). Reverting to the key, on p. 13, we find that the class to which our plant belongs has two subclasses, one "with pistil of the ordinary sort, the ovules in a closed ovary"; the other "without proper pistil, the ovules naked on a scale," &c. The latter is nearly restricted to the Pine Family. The examination already had makes it quite clear that our plant belongs to the first subclass. ANGIOSPERMOUS Exogenous or Dicotyledonous Plants.



359 360 361

530. We have here no less than 110 orders under this subclass. To aid the unpractised student in finding his way among them, they are ranked under three artificial divisions; the *Polypetalous*, the *Monopetalous*, and the *Apetalous*. The plant in hand being furnished, in the words of the key, "with both calyx and corolla, the latter of wholly separate petals," is to be sought under I. POLYPETALOUS DIVISION; for the analysis of which, see p. 14.

531. Fully half the families of the class rank under this division. The first step in the key is to the sections A and B; to the first of which, having "stamens more than 10, and more than twice the number of the sepals or divisions of the calyx," our plant must pertain.

532. Under this we proceed by a series of successive steps, their gradations marked by their position on the page, leading down to the name of the order or family, to which is appended the number

FIG. 359. A pistil taken from a Buttercup (Ranunculus bulbosus), and more magnified; its ovary cut through lengthwise, showing the ovule. 360. One of its pistils when ripened into a fruit (*achenium* or *akene*). 361. The same, cut through, to show the seed in it.

of the page where that family and the plants under it are described. The propositions of the same grade, two or more, from which determination is to be made, not only stand one directly under the other, but begin with the same word or phrase, or with some counterpart, — in the present case again with "Stamens," and with four propositions, with one and only one of which the flower in hand should agree. It agrees with the last of the four: "Stamens not monadelphous."

533. The propositions under this, to which we are now directed, are six, beginning with the word "Pistils" or "Pistil." The one which applies to the flower in hand is, clearly, the fourth: "Pistils numerous or more than one, separate, on the receptacle."

534. The terms of the analysis directly subordinate to this are only two: we have to choose between "Stamens borne on the calyx," and "Stamens borne on the receptacle." The latter is true of our flower. The terms subordinate to this are four, beginning with the word "Leaves." The fourth alone accords: "Leaves not peltate; herbs," — and this line leads out to the CROWFOOT FAMILY, and refers to p. 33.

535. Turning to that page, a perusal of the brief account of the marks of the RANUNCULACEÆ (the technical Latin name) or CROWFOOT FAMILY, assures us that the Key has led us safely and readily to a correct result. Knowing the order or family, we have next to ascertain the genus. Here are twenty genera to choose from; but their characters are analyzed under sections and successive subsections (§, * , +, ++, &c.) so as to facilitate the way to the desired result. Of the two primary sections, we must reject § 1, as it agrees only in respect to the pistils, and differs wholly in the characters furnished by the sepals, the petals, and the leaves. With "§ 2. *Sepals imbricated in the bud: not climbing nor woody,*" it agrees. It also agrees with the sub-section immediately following, viz.: "* *Pistils and akenes, several or many in a head, one-seeded.*" The subdivision following: "+ *Petals none: sepals petal-like,*" is inapplicable; but its counterpart, "+ + *Petals and sepals both conspicuous, five or more: akenes, naked, short-pointed,*" suits, and restricts our choice to the three genera, Adonis, Myosurus, and Ránunculus. The determination is soon made, upon noting the naked sepals, the petals with the little scale on the upper face of the short claw, and the akenes in a head: so the genus is, 7. RANUNCULUS.

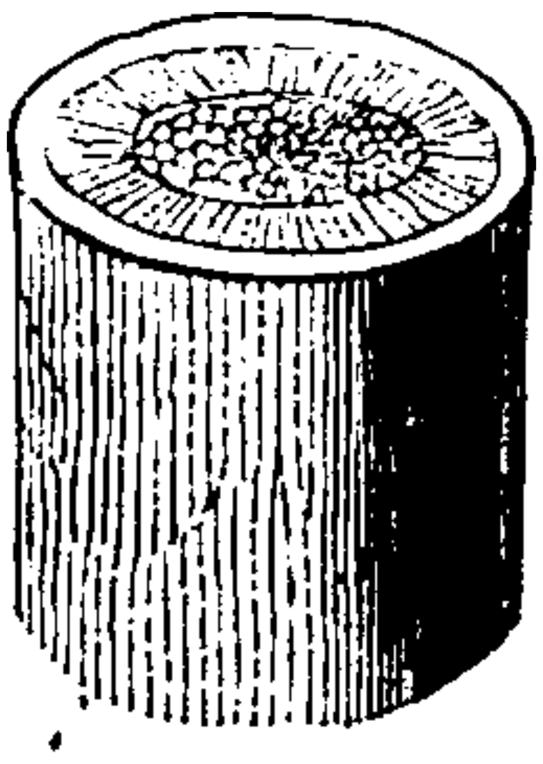
536. The arrangement of the species of Ranunculus is to be found, under the proper number, 7, on p. 37 and the following. The first section contains aquatic species; ours is terrestrial, and in all other particulars answers to § 2. The smooth ovary and akene, and the perennial root refer it to the sub-ection following, marked by the single star. The shape of the leaves excludes it from the "+– Spearwort Crowfoots," the large and showy petals from the "+– +– Small-flowered Crowfoots; while all the marks agree with +– +– +– BUTTERCUPS or COMMON CROWFOOTS. There is still a subdivision, one set marked, "++ *Natives of the country, low or spreading*," the other "++ ++ *Introduced weeds from Europe, common in fields, &c.: stem erect: leaves much cut*," — which is the case. We have then only to choose between the two field Crowfoots, and we have supposed the pupil to have in hand the lower, early-flowered one, common at the east, which has a solid bulb or corm at the base of the stem, and displays its golden flowers in spring or earliest summer, and which accordingly answers to the description of RANUNCULUS BULBOSUS, the BULBOUS BUTTERCUP.

537. Later in the season it might have been *R. acris*, the *Tall Buttercup*, or much earlier *R. fascicularis*, or *R. repens*. Having ascertained the genus from any one species, the student would not fail to recognize it again in any other, at a glance.

538. If now, with the same plant in hand, the *Manual* (Fifth edition) be the book used, the process of analysis will be so similar, that a brief indication of the steps may suffice. Here the corresponding Analytical Key, commencing on p. 21, leads similarly to the first Series, Class, Subclass, and Division; — to A, with numerous stamens; 1, with calyx entirely free and separate from the pistil or pistils, thence to the fourth line beginning with the word Pistils; thence to the third of the three subordinate propositions, viz. to "Stamens inserted on the receptacle"; to the second of the succeeding couplet, or "Filaments longer than the anther"; to the second of the next couplet, "Flowers perfect," &c., and to the first of the final couplet, "Leaves not peltate; petals deciduous," — which ends in "RANUNCULACEÆ, 34." This is the technical name of the family, and the page where it is described.

539. Turning to that page we read the general description of that order, particularly the portion at the beginning printed in *italics*, which comprises the more important points. The "Synopsis of the

p. 12, the student is led to ask, first, is the plant PHÆNOGAMOUS or FLOWERING? Of course it is; the blossom, with its stamens and pistils, answers that question. Next, to which of the two classes of Flowering Plants does it belong? If we judge by the stem, we ask whether it is exogenous or endogenous (422–424). A section of the stem, considerably magnified, given on page 151, we may here repeat (Fig. 362); it plainly shows a ring of wood between a central pith and a bark. It is therefore exogenous. Moreover, the leaves are netted-veined, though the veins are not conspicuous. We might even judge from the embryo; for there is little difficulty in dissecting a flax-seed, and in finding that almost the whole interior is occupied by an embryo with two cotyledons, much like that of an apple-seed (Fig. 11, 12), and this class, as one of its name denotes, is dicotyledonous. If we view the parts of the blossom, we perceive they are five throughout (Fig. 363, 365), a number which occurs in that class only. All these marks, or as many of them as the student is able to verify, show that the plant belongs to Class I. EXOGENOUS or DICOTYLEDONOUS PLANTS.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543. To which subclass, is the next inquiry. The single but several-celled ovary in the centre of the flower, enclosing the ovules, assures us that it belongs to the ANGIOSPERMOUS subclass, p. 13.

544. To get a good idea of the general plan of the flower, before proceeding farther, cut it through the middle lengthwise, as in Fig. 364, and also take a slice across a flower-bud, which will bring to view an arrangement somewhat like that of Fig. 365. Evidently the blossom is regularly constructed upon the number five. It has a calyx of five sepals, a corolla of five petals, five stamens, and five


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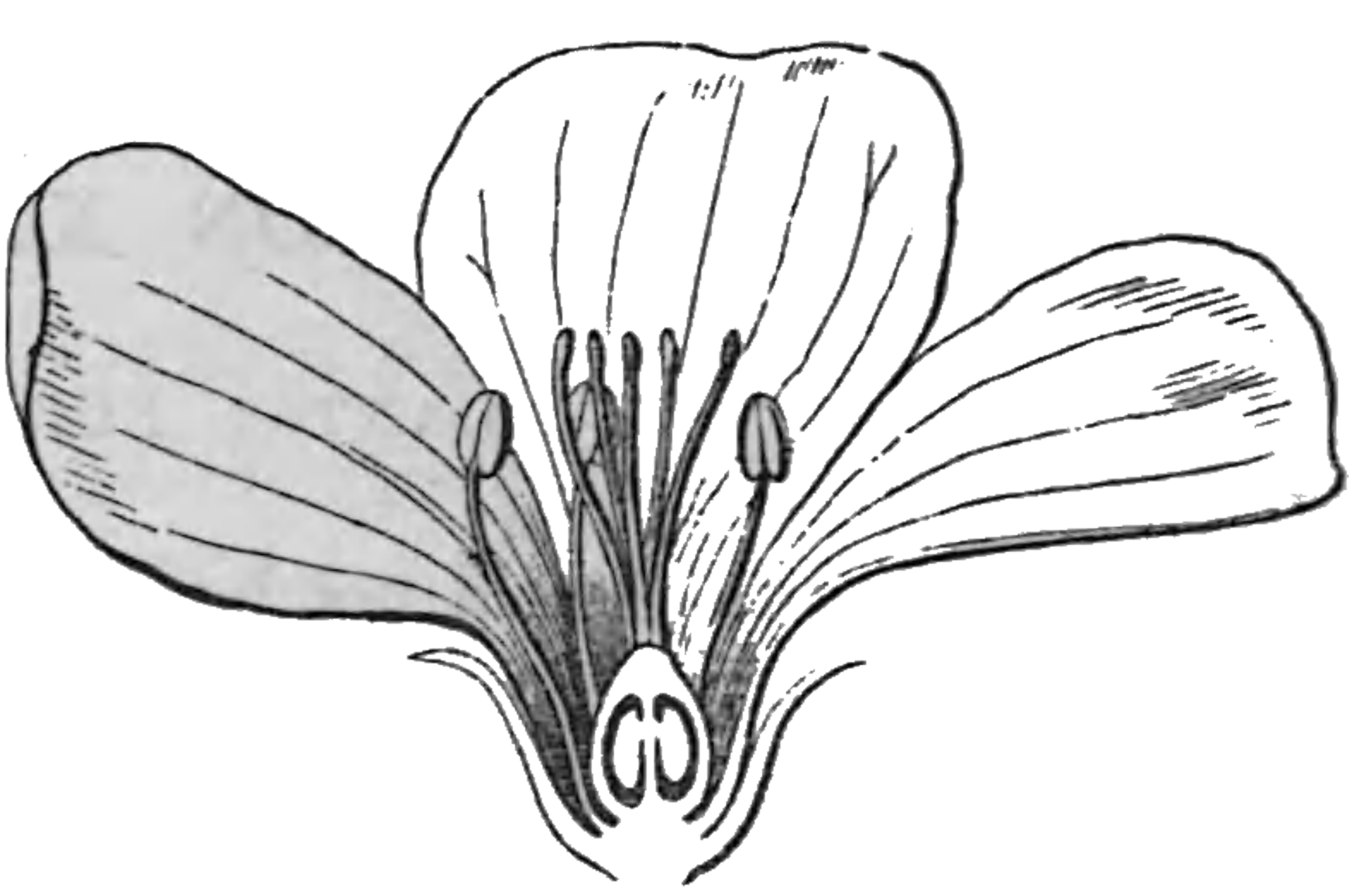
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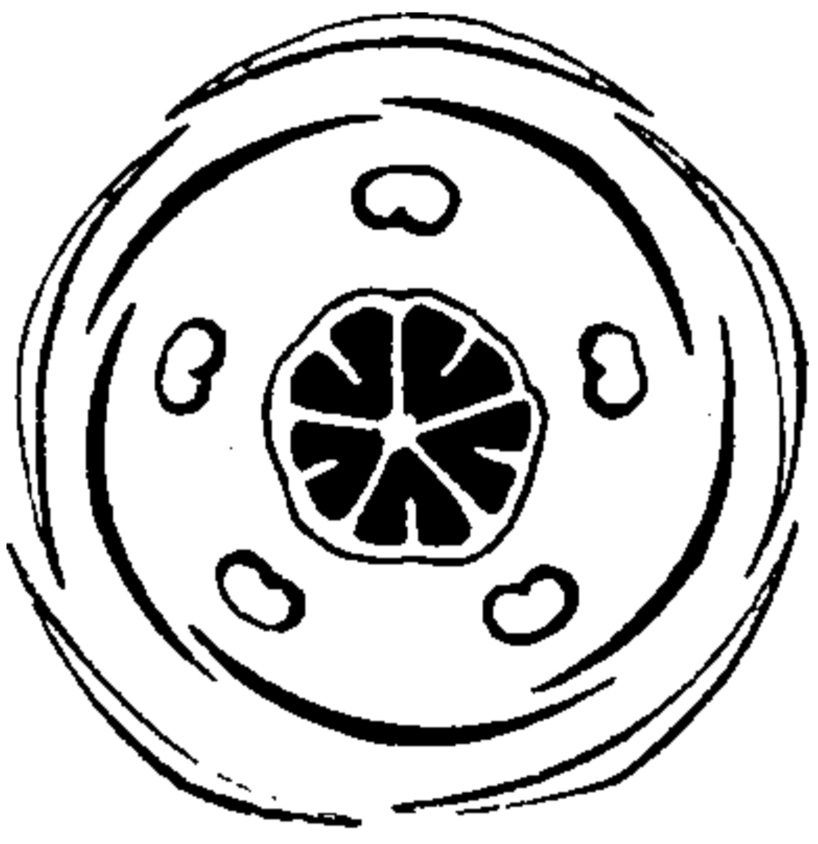
FIG. 362. Section of the stem of Flax, magnified. 363. Summit of a branch of the common Flax, with two flowers. 364. A flower divided lengthwise and enlarged.

styles, with their ovaries all combined into one compound ovary. We note, also, that the several parts of the blossom are all free and unconnected, — the leaves of the calyx, the petals, and the stamens all rising separately one after another from the receptacle underneath the ovary; but the filaments, on close inspection, may show a slight union among themselves, at the base.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545. So our plant, having 5 separate petals, is of the POLYPETALOUS division of the first class, for the analysis of which see page 14.

546. But it does not belong to the primary division A, which has more than 10 stamens. The student passes on, therefore, to the counterpart division B, on page 16, to which the few stamens, here only five, refer it.

547. Of the three subdivisions, with numerals prefixed, only the second answers; for the calyx is free from the ovary, and there is only one ovary, although the styles are five.

548. The divisions subordinate to this form a couplet; and our plant agrees with the second member of it, having "Stamens of the same number as the petals" [5] and "alternate with them." The division under this is a triplet, of which we take the third member; for the "Leaves are not punctate with pellucid dots." Under this, in turn, is a triplet beginning with the word Ovary, and the five, if not ten cells, determine our choice of the third member of it, "Ovary compound." Under this we have no less than nine choices, dependent upon the structure of the ovary, the number of ovules and seeds, &c. But the 5-celled ovary with a pair of ovules in each cell, separated by a false partition projecting from the back (Fig. 365), so that the pod becomes in fact 10-celled, with a solitary seed in each cell, is described only in the ninth and last of the set, p. 18. Under this, again, we have to choose among five propositions relating to the seeds. Here the fifth — "Seeds and ovules only one or two in each cell" — alone meets the case. Under this, finally, we have to choose from six lines, beginning with the words Tree, Shrubs, or Herbs. The fifth alone agrees, and leads to the FLAX FAMILY, p. 77.

549. There is only one genus of it in this country, namely, the FLAX genus itself, or LINUM. To determine the species, look first

FIG. 365. Cross-section of an unexpanded flower of the same, a sort of diagram.

at the three sections, marked with stars. The second answers to our plant; and the annual root, pointed sepals, and blue petals determine it to be the COMMON FLAX, LINUM USITATISSIMUM.

550. By the *Manual*, the same plant would be similarly traced, along a somewhat different order of steps, down to the genus on p. 104, and to the species, which being a foreign cultivated one, and only by chance spontaneous, is merely mentioned at the close.

551. After several analyses of this kind, the student will be able to pass rapidly over most of these steps; should ordinarily recognize the class and the division at a glance. Suppose a common Mallow to be the next subject. Having flowers and seeds, it is Phænogamous. The netted-veined leaves, the structure of the stem, and the leaves of the flower in fives, refer it to Class I. The pistils, of the ordinary sort, refer it to Subclass I. The five petals refer it to the Polypetalous division. Turning to the Key in the *Field, Forest, and Garden Botany*, and to the analysis of that division, commencing on p. 14, the numerous stamens fix it upon A, under which the very first line, "Stamens monadelphous, united with the base of the corolla; anthers kidney-shaped, one-celled," exactly expresses the structure of these organs in our plant, which is thus determined to be of the MALLOW FAMILY, — for which see page 70.

552. After reading the character of the family, and noting its agreement in all respects, we fix upon § 1, in which the anthers are all borne at the top, and not down the side of the tube of filaments. We pass the subdivision with a single star, and choose the alternative, with two stars, on account of the ring of ovaries, &c.; fix upon the division +—, on account of the stigmas running down one side of the slender style, instead of forming a little head or blunt tip at their apex; and then have to choose among five genera. The three separate bracts outside of the calyx, the obcordate petals, and the fruit determine the plant to be a MALVA. Then, referring to p. 71 for the species, the small whitish flowers point to the first division, and a comparison of the characters of the two species under it, assures us that the plant in hand is MALVA ROTUNDIFOLIA.

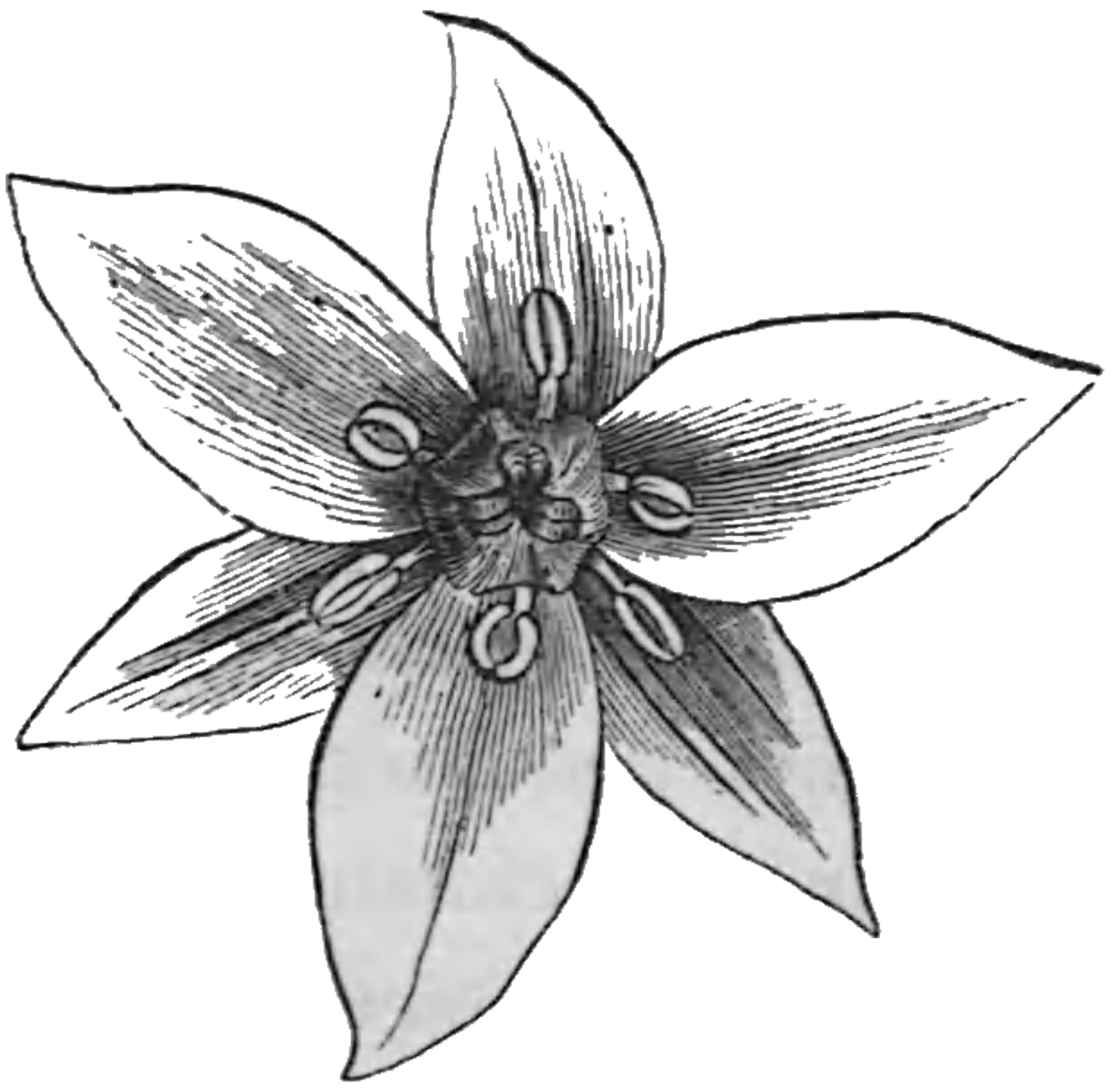
553. For the sake of an example in the Monopetalous Division, we take a sort of Morning-Glory which is often met with climbing over shrubs along the moist banks of streams. Its netted-veined leaves, the sepals and the stamens being five, — also the structure of the stem, if we choose to examine it, and the embryo with two leafy

LESSON XXXII.

HOW TO STUDY PLANTS: FURTHER ILLUSTRATIONS.

557. THE foregoing illustrations have all been of the first or Exogenous class. We will take one from the other class, and investigate it by the *Manual.*

558. It shall be a rather common plant of our woods in spring, the Three-leaved Nightshade, or Birthroot. With specimens in hand, and the *Manual* open at the Analytical Key, p. 21, seeing that the plant is of the Phænogamous series, we proceed to determine the class. The netted-veined leaves would seem to refer the plant to the first class; while the blossom (Fig. 366, 367), constructed on the number three, naturally directs us to the second class, in which this number almost universally prevails. Here the student will be somewhat puzzled. If the seeds were ripe, they might be examined, to see whether the embryo has one cotyledon only, or a pair. But the seeds are not to be had in spring, and if they were, the embryo would not readily be made out. We must judge, therefore, by the structure of the stem. Is it exogenous or endogenous? If we cut the stem through, or take off a thin slice crosswise and lengthwise, we shall perceive that the woody matter in it consists of a number of threads, interspersed throughout the soft cellular part without regularity, and not collected into a ring or layer. In fact, it is just like the Corn-stalk (Fig. 351), except that the woody threads are fewer. It is therefore *endogenous* (422); and this decides the question in favor of Class II. MONOCOTYLEDONOUS or ENDOGENOUS PLANTS (page 30), notwithstanding the branching veins of the leaves. For neither this character, nor the number of parts in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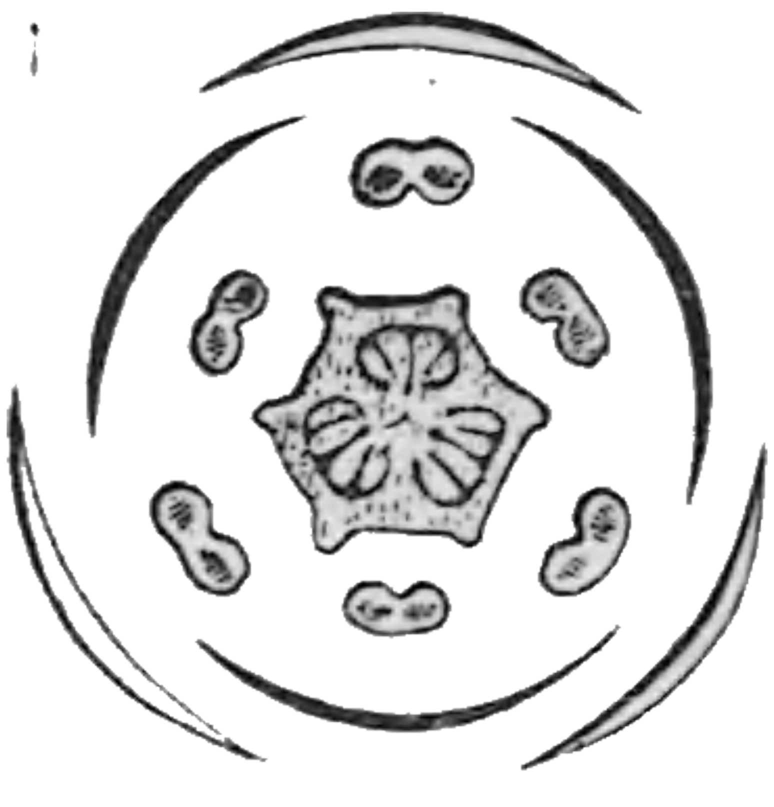
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FIG. 366. Flower of Trillium erectum, viewed from above. 367. Diagram of the same, a cross-section of the unopened blossom, showing the number and arrangement of parts.

the blossom, holds good universally, while the plan of the stem does.

559. The single flower of our plant with distinct calyx and corolla takes us over the Spadiceous to the PETALOIDEOUS DIVISION: the Petaloideous Division of Endogens there begins on p. 28. These parts being free from and beneath the ovary, refer us to the third subdivision, viz: "3· *Perianth wholly free from the ovary.*"

559a. The pistil is next to be considered: it accords with the third of the triplet: "Pistil one, compound (cells or placentæ 3); authers 2-celled." Under this follows a triplet, of which the initial word is "Perianth": our choice falls upon the first, as there is nothing "glumaceous" about this flower.

560. The succeeding triplet relates to the stamens; here 6, so we take the first alternative. The next refers to mode and place of growth: our plant is "Terrestrial, and not rush-like." The next again to the perianth: the second number of the triplet: "Perianth of 3 foliaceous and green sepals, and 3 colored withering-persistent petals" (as would be seen after flowering-time), brings us to a particular group in the great Lily family, or LILIACEÆ, p. 520.

561. Reading over the family character, and collating the five tribes comprised, we perceive that our plant belongs to the group, quite peculiar among Liliaceous plants, here ranked as Tribe I. TRILLIDEÆ, the Trillium tribe. And the next step, leading to a choice between two genera, determines the genus to be TRILLIUM.

562. Turning to this, on p. 522, and reading the full description of it, we proceed to the easy task of ascertaining the species. The "flower is raised on a peduncle," as in § 2. This peduncle is slender and nearly erect, and all the other particulars accord with the subdivision marked by a single star. And, finally, the ovate, acutish, widely-spreading, dark dull-purple petals mark the species as the PURPLE BIRTHROOT, TRILLIUM ERECTUM, L.

563. By the *Field, Forest, and Garden Botany*, the analysis is similar, only more simple. The details need not be particularly recapitulated.

564. The student residing west of New England will also be likely to find another species, with similar foliage, but with larger, pure white, and obovate petals, turning rose-color when about to fade. This will at once be identified as *T. grandiflorum.* And towards the north, in cold and damp woods or swamps, a smaller

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species will be met with, having dull-green and petioled leaves rounded at the base, and rather narrow, wavy, white petals, marked with pink or purple stripes at the base: this the student will refer to *T. erythrocarpum.* But the species principally found in the eastern parts of the country has a short peduncle recurved under the leaves, so as nearly to conceal the much less handsome, dull white flower: this, it will be seen, is *T. cernuum*, the *Nodding Trillium* or *Wake Robin.*

565. Whenever the student has fairly studied out one species of a genus, he will be likely to know the others when he sees them. And when plants of another genus of the same order are met with, the order may generally be recognized at a glance, from the family resemblance. For instance, having first become acquainted with the Convolvulus family in the genus Calystegia (555), we recognize it at once in the common Morning-Glory, and in the Cypress-Vine, and even in the Dodder, although these belong to as many different genera. Having examined the common Mallow (552), we immediately recognize the Mallow family (*Malvaceæ*) in the Marsh-Mallow, sparingly naturalized along the coast, in the Glade Mallow, and the Indian Mallow, in the Hibiscus or Rose-Mallow, and so of the rest: for the relationship is manifest in their general appearance, and in the whole structure of the flowers, if not of the foliage also.

566. So the study of one plant leads naturally and easily to the knowledge of the whole order or family of plants it belongs to:— which is a great advantage, and a vast saving of labor. For, although we have about one hundred and thirty orders of Flowering Plants represented in our Botany of the Northern States by about 2,540 species, yet half of these species belong to nine or ten of these orders; and more than four fifths of the species belong to forty of the orders. One or two hundred species, therefore, well examined, might give a good general idea of our whole botany. And students who will patiently and thoroughly study out twenty or thirty well-chosen examples will afterwards experience little difficulty in determining any of our Flowering Plants and Ferns, and will find the pleasure of the pursuit largely to increase with their increasing knowledge.

567. And the interest will be greatly enhanced as the student, rising to higher and wider views, begins to discern the *System* of Botany, or, in other words, comprehends more and more of *the Plan of the Creator in the Vegetable Kingdom.*

571. The Natural System, as we receive it, and as to that portion of it which is represented in the botany of our country, is laid before the student in the *Manual of the Botany of the Northern United States*. The orders, however, still require to be grouped, according to their natural relationships, into a considerable number of great groups (or *alliances*) ; but this cannot yet be done throughout in any easy way. So we have merely arranged them somewhat after a customary order, and have given, in the *Artificial Key*, a contrivance for enabling the student easily to find the natural order of any plant. This is a sort of

572. **Artificial Classification.** The object of an artificial classification is merely to furnish a convenient method of finding out the name and place of a plant. It makes no attempt at arranging plants according to their relationships, but serves as a kind of dictionary. It distributes plants according to some one peculiarity or set of peculiarities (just as a dictionary distributes words according to their first letters), disregarding all other considerations.

573. At present we need an artificial classification in Botany only as a Key to the Natural Orders, — as an aid in referring an unknown plant to its proper family; and for this it is very needful to the student. Formerly, when the orders themselves were not clearly made out, an artificial classification was required to lead the student down to the genus. Two such classifications were long in vogue. First, that of Tournefort, founded mainly on the leaves of the flower, the calyx and corolla: this was the prevalent system throughout the first half of the eighteenth century; but it has long since gone by. It was succeeded by the well-known artificial system of Linnæus, which has been used until lately; and which it is still worth while to give some account of.

574. **The Artificial System of Linnæus** was founded on the stamens and pistils. It consists of twenty-four classes, and of a variable number of orders, which were to take the place temporarily of the natural classes and orders; the genera being the same under all classifications.

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paper at least, a strictly definite limitation of genera, of tribes, and of orders, although observation shows so much blending here and there of natural groups, sufficiently distinct on the whole, as to warrant us in assuming the likelihood that the Creator's plan is one of *gradation, not of definite limitation*, even perhaps to the species themselves.

575. The twenty-four *classes* of Linnæus were founded upon something about the stamens. The following is an analysis of them. The first great division is into two great series, the *Phænogamous* and the *Cryptogamous*, the same as in the Natural System. The first of these is divided into those flowers which have the stamens in the same flower with the pistils, and those which have not; and these again are subdivided, as is shown in the following tabular view.

Series I. PHÆNOGAMIA; plants with stamens and pistils, i. e. with real flowers.

1. Stamens in the same flower as the pistils:		
* Not united with them,		
+ Nor with one another.		
++ Of equal length if either 6 or 4 in number.		
One to each flower,	Class 1.	MONANDRIA.
Two " "	2.	DIANDRIA.
Three " "	3.	TRIANDRIA.
Four " "	4.	TETRANDRIA.
Five " "	5.	PENTANDRIA.
Six " "	6.	HEXANDRIA.
Seven " "	7.	HEPTANDRIA.
Eight " "	8.	OCTANDRIA.
Nine " "	9.	ENNEANDRIA.
Ten " "	10.	DECANDRIA.
Eleven to nineteen to each flower,	11.	DODECANDRIA.
Twenty or more inserted on the calyx,	12.	ICOSANDRIA.
" " " on the receptacle,	13.	POLYANDRIA.
++ ++ Of unequal length and either 4 or 6.		
Four, 2 long and 2 shorter,	14.	DIDYNAMIA.
Six, 4 long and 2 shorter,	15.	TETRADYNAMIA.
+ + United with each other,		
By their filaments,		
Into one set or tube,	16.	MONADELPHIA.
Into two sets,	17.	DIADELPHIA.
Into three or more sets,	18.	POLYADELPHIA.
By their anthers into a ring,	19.	SYNGENESIA.
* * United with the pistil,	20.	GYNANDRIA.
2. Stamens and pistils in separate flowers,		
Of the same individuals,	21.	MONŒCIA.
Of different individuals,	22.	DIŒCIA.
Some flowers perfect, others staminate or pistillate either in the same or in different individuals,	23.	POLYGAMIA.
Series II. CRYPTOGAMIA. No. stamens and pistils, therefore no proper flowers,	24.	CRYPTOGAMIA.

576. The names of these classes are all compounded of Greek words. The first eleven consist of the Greek numerals, in succession, from 1 to 11, combined with *andria*, which here denotes stamens; — e. g. *Monandria*, with one stamen; and so on. The 11th has the numeral for twelve stamens, although it includes all which have from eleven to nineteen stamens, numbers which rarely occur. The 12th means "with twenty stamens," but takes in any higher number, although only when the stamens are borne on the calyx. The 13th means "with many stamens," but it takes only those with the stamens borne on the receptacle. The 14th means "two stamens powerful," the shorter pair being supposed to be weaker; the 15th, "four powerful," for the same reason. The names of the next three classes are compounded of *adelphia*, brotherhood, and the Greek words for *one*, *two*, and *many* (*Monadelphia*, *Diadelphia*, and *Polyadelphia*). The 19th means "united in one household." The 20th is compounded of the words for stamens and pistils united. The 21st and 22d are composed of the word meaning *house* and the numerals *one*, or single, and *two: Monœcia*, in one house, *Diœcia*, in two houses. The 23d is fancifully formed of the words meaning *plurality* and *marriage*, from which the English word *polygamy* is derived. The 24th is from two words meaning *concealed nuptials*, and is opposed to all the rest, which are called *Phænogamous*, because their stamens and pistils, or parts of fructification, are evident.

577. Having established the classes of his system on the stamens, Linnæus proceeded to divide them into *orders* by marks taken from the pistils, for those of the first thirteen classes. These orders depend on the number of the pistils, or rather on the number of styles, or of stigmas when there are no styles, and they are named, like the classes, by Greek numerals, prefixed to *gynia*, which means *pistil*. Thus, flowers of these thirteen classes with

One style or sessile stigma belong to	Order 1.	MONOGYNIA.
Two styles or sessile stigmas, to	2.	DIGYNIA.
Three " "	3.	TRIGYNIA.
Four " "	4.	TETRAGYNIA.
Five " "	5.	PENTAGYNIA.
Six	6.	HEXAGYNIA.
Seven "	7.	HEPTAGYNIA.
Eight "	8.	OCTOGYNIA.
Nine "	9.	ENNEAGYNIA.
Ten "	10.	DECAGYNIA.
Eleven or twelve	11.	DODECAGYNIA.
More than twelve	13.	POLYGYNIA.

582. Botanical specimens should be either in flower or in fruit. In the case of herbs, the same specimen will often exhibit the two; and both should by all means be secured whenever it is possible. Of small herbs, especially annuals, the whole plant, root and all, should be taken for a specimen. Of larger ones branches will suffice, with some of the leaves from near the root. Enough of the root or subterranean part of the plant should be collected to show whether the plant is an annual, biennial, or perennial. Thick roots, bulbs, tubers, or branches of specimens intended to be preserved, should be thinned with a knife, or cut into slices lengthwise.

583. **For drying Specimens** a good supply of soft and unsized paper — the more bibulous the better — is wanted; and some convenient means of applying pressure. All that is requisite to make good dried botanical specimens is, to dry them as rapidly as possible between many thicknesses of paper to absorb their moisture, under as much pressure as can be given without crushing the more delicate parts. This pressure may be given by a botanical press, of which various forms have been contrived; or by weights placed upon a board, — from forty to eighty or a hundred pounds, according to the quantity of specimens drying at the time. For use while travelling, a good portable press may be made of thick binders' boards for the sides, holding the drying paper, and the pressure may be applied by a cord, or, much better, by strong straps with buckles.

584. For drying paper, the softer and smoother sorts of cheap wrapping-paper answer very well. This paper may be made up into *driers*, each of a dozen sheets or less, according to the thickness, lightly stitched together. Specimens to be dried should be put into the press as soon as possible after gathering. If collected in a portfolio, the more delicate plants should not be disturbed, but the sheets that hold them should one by one be transferred from the portfolio to the press. Specimens brought home in the botanical box must be laid in a folded sheet of the same thin, smooth, and soft paper used in the portfolio; and these sheets are to hold the plants until they are dry. They are to be at once laid in between the driers, and the whole put under pressure. Every day (or at first even twice a day would be well) the specimens, left undisturbed in their sheets, are to be shifted into well-dried fresh driers, and the pressure renewed, while the moist sheets are spread out to dry, that they may take their turn again at the next shifting. This course must be continued until the specimens are no longer moist to the touch, —

which for most plants requires about a week; then they may be transferred to the sheets of paper in which they are to be preserved. If a great abundance of drying-paper is used, it is not necessary to change the sheets every day, after the first day or two.

585. **Herbarium.** The botanist's collection of dried specimens, ticketed with their names, place, and time of collection, and systematically arranged under their genera, orders, &c., forms a *Hortus Siccus* or *Herbarium.* It comprises not only the specimens which the proprietor has himself collected, but those which he acquires through friendly exchanges with distant botanists, or in other ways. The specimens of an herbarium may be kept in folded sheets of neat, and rather thick, white paper; or they may be fastened on half-sheets of such paper, either by slips of gummed paper, or by glue applied to the specimens themselves. Each sheet should be appropriated to one species; two or more different plants should never be attached to the same sheet. The generic and specific name of the plant should be added to the lower right-hand corner, either written on the sheet, or on a ticket pasted down at that corner; and the time of collection, the locality, the color of the flowers, and any other information which the specimens themselves do not afford, should be duly recorded upon the sheet or the ticket. The sheets of the herbarium should all be of exactly the same dimensions. The herbarium of Linnæus is on paper of the common foolscap size, about eleven inches long and seven wide. But this is too small for an herbarium of any magnitude. Sixteen and a half inches by ten and a half, or eleven and a half inches, is an approved size.

586. The sheets containing the species of each genus are to be placed in *genus-covers*, made of a full sheet of thick, colored paper (such as the strongest Manilla-hemp paper), which fold to the same dimensions as the species-sheet; and the name of the genus is to be written on one of the lower corners. These are to be arranged under the orders to which they belong, and the whole kept in closed cases or cabinets, either laid flat in compartments, like large "pigeon-holes," or else placed in thick portfolios, arranged like folio volumes, and having the names of the orders lettered on the back.

Acúleate: armed with prickles, i. e. *aculei;* as the Rose and Brier.
Acúleolate: armed with small prickles, or slightly prickly.
Acúminate: taper-pointed, as the leaf in fig. 97 and fig. 103.
Acute: merely sharp-pointed, or ending in a point less than a right angle.
Adelphous (stamens): joined in a fraternity (*adelphia*): see *monadelphous* and *diadelphous.*
Adherent: sticking to, or, more commonly, growing fast to another body; p. 104.
Adnate: growing fast to; it means born adherent. The anther is adnate when fixed by its whole length to the filament or its prolongation, as in Tulip-tree, fig. 233.
Adpressed, or *appressed:* brought into contact, but not united.
Adscendent, ascendent, or *ascending:* rising gradually upwards.
Adsurgent, or *assurgent:* same as ascending.
Adventitious: out of the proper or usual place; e. g. *Adventitious buds,* p. 26, 27.
Adventive: applied to foreign plants accidentally or sparingly spontaneous in a country, but hardly to be called naturalized.
Æquilateral: equal-sided; opposed to oblique.
Æstivation: the arrangement of parts in a flower-bud, p. 108.
Air-cells or *Air-passages:* spaces in the tissue of leaves and some stems, p. 143.
Air-Plants, p. 34.
Akénium, or *akene.* See *achenium.*
Ala (plural *alæ*): a wing; the side-petals of a papilionaceous corolla, p. 105, fig. 218, *w.*
Alabástrum: a flower-bud.
Alar: situated in the forks of a stem.
Alate: winged, as the seeds of Trumpet-Creeper (fig. 316) the fruit of the Maple, Elm (fig. 301), &c.
Albescent: whitish, or turning white.
Absorption, p. 168.
Albúmen of the seed: nourishing matter stored up with the embryo, but not within it; p. 15, 136.
Albúmen, a vegetable product; a form of proteine, p. 165.
Albuminous (seeds): furnished with albumen, as the seeds of Indian corn (fig. 38, 39), of Buckwheat (fig. 326), &c.
Albúrnum: young wood, sap-wood, p 153.
Alpine: belonging to high mountains above the limit of forests.
Altérnate (leaves): one after another, p. 24, 71. Petals are *alternate with* the sepals, or stamens with the petals, when they stand over the intervals between them, p. 93.
Alveolate: honeycomb-like, as the receptacle of the Cotton-Thistle.
Ament: a catkin, p. 81. *Amentaceous:* catkin-like, or catkin-bearing.
Amorphous: shapeless; without any definite form.
Amphigástrium (plural *amphigastria*): a peculiar stipule-like leaf of certain Liverworts.
Amphítropous or *Amphítropal* ovules or seeds, p. 123, fig. 272.
Ampléctant: embracing. *Amplexicaul* (leaves): clasping the stem by the base.
Ampulláceous: swelling out like a bottle or bladder.
Amyláceous: composed of starch, or starch-like.

Anántherous: without anthers. *Anánthous:* destitute of flowers; flowerless.
Anástomosing: forming a net-work (*anastomosis*), as the veins of leaves.
Anátropous or *Anátropal* ovules or seeds; p. 123, fig. 273.
Ancípital (*anceps*): two-edged, as the stem of Blue-eyed Grass.
Andrœcium: a name for the stamens taken together.
Andrógynous: having both staminate and pistillate flowers in the same cluster or inflorescence, as many species of Carex.
Ándrophore: a column of united stamens, as in a Mallow; or the support on which stamens are raised.
Anfráctuose: bent hither and thither, as the anthers of the Squash, &c.
Angiospérmæ, *Angiospérmous Plants:* with their seeds formed in an ovary or pericarp, p. 183.
Angular divergence of leaves, p. 72.
Annual (plant): flowering and fruiting the year it is raised from the seed, and then dying, p. 21.
Ánnular: in the form of a ring, or forming a circle.
Ánnulate: marked by rings; or furnished with an
Ánnulus, or ring, like that of the spore-case of most Ferns (Manual Bot. N. States, plate 9, fig. 2): in Mosses it is a ring of cells placed between the mouth of the spore-case and the lid, in many species.
Anterior, in the blossom, is the part next the bract, i. e. external: —while the posterior side is that next the axis of inflorescence. Thus, in the Pea, &c. the keel is *anterior*, and the standard *posterior*.
Anther: the essential part of the stamen, which contains the pollen; p. 86, 113.
Antherídium (plural *antheridia*): the organ in Mosses, &c. which answers to the anther of Flowering plants.
Antheríferous: anther-bearing.
Anthésis: the period or the act of the expansion of a flower
Anthocárpous (fruits): same as multiple fruits; p. 133.
Ánticous: same as anterior.
Antrórse: directed upwards or forwards.
Apétalous: destitute of petals; p. 90, fig. 179.
Aphýllous: destitute of leaves, at least of foliage.
Ápical: belonging to the apex or point.
Apículate: pointletted; tipped with a short and abrupt point.
Apocárpous (pistils): when the several pistils of the same flower are separate, as in a Buttercup, Sedum (fig. 168), &c.
Apóphysis: any irregular swelling; the enlargement at the base of the spore-case of the Umbrella-Moss.
Appendage: any superadded part.
Appendículate: provided with appendages.
Appressed: where branches are close pressed to the stem, or leaves to the branch, &c.
Ápterous: wingless.
Aquatic: living or growing in water; applied to plants whether growing under water, or with all but the base raised out of it.
Arachnoid: cobwebby; clothed with, or consisting of, soft downy fibres.
Arbòreous, *Arborescent:* tree-like, in size or form; p. 36.

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Archegónium (plural *archegonia*): the organ in Mosses, &c., which is analogous to the pistil of Flowering Plants.
Árcuate: bent or curved like a bow.
Aréolate: marked out into little spaces or *areolæ.*
Árillate (seeds): furnished with an
Aril or *Arillus:* a fleshy growth forming a false coat or appendage to a seed; p. 135, fig. 318.
Arístate: awned, i. e. furnished with an arista, like the beard of Barley, &c.
Arístulate: diminutive of the last; short-awned.
Arrow-shaped or *Arrow-headed:* same as *sagittate;* p. 59, fig. 95.
Artículated: jointed; furnished with joints or *articulations,* where it separates or inclines to do so. *Articulated leaves,* p. 64.
Artificial Classification, p 196.
Ascending (stems, &c.), p. 37; (seeds or ovules), p. 122.
Aspergílliform: shaped like the brush used to sprinkle holy water; as the stigmas of many Grasses.
Assimilation, p. 162.
Assurgent: same as ascending, p. 37.
Átropous or *Átropal* (ovules): same as orthotropous.
Auriculate: furnished with auricles or ear-like appendages, p. 59.
Awl-shaped: sharp-pointed from a broader base, p. 68.
Awn: the bristle or beard of Barley, Oats, &c.; or any similar bristle-like appendage.
Awned: furnished with an awn or long bristle-shaped tip.
Axil: the angle on the upper side between a leaf and the stem, p. 20.
Áxile: belonging to the axis, or occupying the axis; p. 119, &c.
Axillary (buds, &c.): occurring in an axil, p 21, 77, &c.
Áxis: the central line of any body; the organ round which others are attached; the root and stem. *Ascending Axis,* p. 9. *Descending Axis,* p. 9.

Baccate: berry-like, of a pulpy nature like a berry (in Latin *bacca*); p. 127.
Barbate: bearded; bearing tufts, spots, or lines of hairs.
Barbed: furnished with a *barb* or double hook; as the apex of the bristle on the fruit of Echinospermum (Stickseed), &c.
Bárbellate: said of the bristles of the pappus of some Compositæ (species of Liatris, &c), when beset with short, stiff hairs, longer than when denticulate, but shorter than when plumose.
Barbéllulate: diminutive of barbellate.
Bark: the covering of a stem outside of the wood, p. 150, 152.
Basal: belonging or attached to the
Base: that extremity of any organ by which it is attached to its support.
Bast, Bast-fibres, p. 147.
Beaked: ending in a prolonged narrow tip.
Bearded: see *barbate. Beard* is sometimes used popularly for awn, more commonly for long or stiff hairs of any sort.
Bell-shaped: of the shape of a bell, as the corolla of Harebell, fig. 207, p. 102.
Berry: a fruit pulpy or juicy throughout, as a grape; p. 127.
Bí- (or *Bis*), in compound words: twice; as

Bulblets: small bulbs, borne above ground, as on the stems of the bulb-bearing Lily and on the fronds of Cistopteris bulbifera and some other Ferns; p. 46.
Bulb-scales, p. 50.
Bullate: appearing as if blistered or bladdery (from *bulla,* a bubble).

Cadúcous: dropping off very early, compared with other parts; as the calyx in the Poppy Family, falling when the flower opens.
Cæspitose, or *Céspitose:* growing in turf-like patches or tufts, like most sedges, &c.
Cálcarate: furnished with a spur (*calcar*), as the flower of Larkspur, fig. 183, and Violet, fig. 181.
Calcéolate or *Cálceiform:* slipper-shaped, like one petal of the Lady's Slipper.
Cállose: hardened; or furnished with callosities or thickened spots.
Cálycine: belonging to the calyx.
Calýculate: furnished with an outer accessory calyx (*calyculus*) or set of bracts looking like a calyx, as in true Pinks.
Calýptra: the hood or veil of the capsule of a Moss.
Calýptriform: shaped like a calyptra or candle-extinguisher.
Calyx: the outer set of the floral envelopes or leaves of the flower; p. 85.
Cambium and *Cambium-layer,* p. 154.
Campánulate: bell-shaped; p. 102, fig. 207.
Campylótropous, or *Campylótropal;* curved ovules and seeds of a particular sort; p. 123, fig. 271.
Campylospérmous: applied to fruits of Umbelliferæ when the seed is curved in at the edges, forming a groove down the inner face; as in Sweet Cicely.
Canalículate: channelled, or with a deep longitudinal groove.
Cáncellate: latticed, resembling lattice-work.
Canéscent: grayish-white; hoary, usually because the surface is covered with fine white hairs. *Incanous* is whiter still.
Capilláceous, Cápillary: hair-like in shape; as fine as hair or slender bristles.
Cápitate: having a globular apex, like the head on a pin; as the stigma of Cherry, fig. 213; or forming a head, like the flower-cluster of Button-bush, fig. 161.
Capitéllate: diminutive of capitate; as the stigmas of fig. 255.
Capítulum (a little head): a close rounded dense cluster or head of sessile flowers; p. 80, fig. 161.
Capréolate: bearing tendrils (from *capreolus,* a tendril).
Capsule: a pod; any dry dehiscent seed-vessel; p. 131, fig. 305, 306.
Cápsular: relating to, or like a capsule.
Carína: a keel; the two anterior petals of a papilionaceous flower, which are combined to form a body shaped somewhat like the keel (or rather the prow) of a vessel; p. 105, fig. 218, *k.*
Cárinate: keeled; furnished with a sharp ridge or projection on the lower side.
Carióṕsis, or *Caryópsis:* the one-seeded fruit or grain of Grasses, &c., p. 130.
Cárneous: flesh-colored; pale red.
Cárnose: fleshy in texture.
Cárpel, or *Carpídium:* a simple pistil, or one of the parts or leaves of which a compound pistil is composed; p. 117.
Cárpellary: pertaining to a carpel.

Carpology: that department of Botany which relates to fruits.

Cárpophore: the stalk or support of a fruit or pistil within the flower; as in fig. 276–278.

Cartiláginous, or *Cartilagíneous:* firm and tough, like cartilage, in texture.

Cáruncle: an excrescence at the scar of some seeds; as those of Polygala.

Carúnculate: furnished with a caruncle.

Caryophylláceous: pink-like: applied to a corolla of 5 long-clawed petals; fig. 200.

Catkin: a scaly deciduous spike of flowers, an ament; p. 81.

Caudate: tailed, or tail-pointed.

Caudex: a sort of trunk, such as that of Palms; an upright rootstock; p. 37.

Caulèscent: having an obvious stem; p. 36.

Caúlicle: a little stem, or rudimentary stem; p. 6.

Caúline: of or belonging to a stem (*caulis,* in Latin), p. 36.

Cell (diminutive *Cellule*): the cavity of an anther, ovary, &c., p. 113, 119; one of the elements or vesicles of which plants are composed; p. 140, 142.

Céllular tissue of plants; p. 142. *Cellular Bark,* p. 152.

Cellulose, p. 159.

Centrífugal (inflorescence): produced or expanding in succession from the centre outwards; p. 82. The radicle is centrifugal, when it points away from the centre of the fruit.

Centrípetal: the opposite of centrifugal; p. 79, 83.

Cereal: belonging to corn, or corn-plants.

Cérnuous: nodding; the summit more or less inclining.

Chaff: small membranous scales or bracts on the receptacle of Compositæ; the glumes, &c. of Grasses.

Chaffy: furnished with chaff, or of the texture of chaff.

Chaláza: that part of the ovule where all the parts grow together; p. 122.

Channelled: hollowed out like a gutter; same as *canaliculate.*

Character: a phrase expressing the essential marks of a species, genus, &c. which distinguish it from all others; p. 180.

Chartáceous: of the texture of paper or parchment.

Chlórophyll: the green grains in the cells of the leaf, and of other parts exposed to the light, which give to herbage its green color; p. 155.

Chrómule: coloring matter in plants, especially when not green, or when liquid.

Cícatrix: the scar left by the fall of a leaf or other organ.

Cíliate: beset on the margin with a fringe of *cilia,* i. e. of hairs or bristles, like the eyelashes fringing the eyelids, whence the name.

Cinéreous, or *Cineráceous:* ash-grayish; of the color of ashes.

Círcinate: rolled inwards from the top, like a crosier, as the shoots of Ferns; p. 76, fig. 154; the flower-clusters of Heliotrope, &c.

Circumscissile, or *Circumcissile:* divided by a circular line round the sides, as the pods of Purslane, Plantain, &c.; p. 133, fig. 298, 311.

Circumscription: the general outline of a thing.

Cirrhíferous, or *Cirrhose:* furnished with a tendril (Latin, *cirrhus*); as the Grape-vine. *Cirrhose* also means resembling or coiling like tendrils, as the leaf-stalks of Virgin's-bower; p. 37.

Class, p 175, 177.

Classification, p. 173.

18 *

Cláthrate: latticed; same as *cancellate.*
Clávate: club-shaped; slender below and thickened upwards.
Claw: the narrow or stalk-like base of some petals, as of Pinks; p. 102, fig. 200
Climbing: rising by clinging to other objects; p. 37.
Club-shaped: see *clavate.*
Clustered: leaves, flowers, &c. aggregated or collected into a bunch.
Clýpeate: buckler-shaped.
Coádunate: same as *connate;* i. e. united.
Coaléscent: growing together.
Coárctate: contracted or brought close together.
Coated Bulbs, p. 46.
Cobwebby: same as *arachnoid;* bearing hairs like cobwebs or gossamer.
Coccus (plural *cocci*): anciently a berry; now mostly used to denote the carpels of a dry fruit which are separable from each other, as of Euphorbia.
Cochleáriform: spoon-shaped.
Cóchleate: coiled or shaped like a snail-shell.
Cœlospérmous: applied to those fruits of Umbelliferæ which have the seed hollowed on the inner face, by the curving inwards of the top and bottom; as in Coriander.
Coherent, in Botany, is usually the same as *connate;* p. 104.
Collective fruits, p. 133.
Collum or *Collar:* the neck or line of junction between the stem and the root.
Columélla: the axis to which the carpels of a compound pistil are often attached, as in Geranium (fig. 278), or which is left when a pod opens, as in Azalea and Rhododendron.
Column: the united stamens, as in Mallow, or the stamens and pistils united into one body, as in the Orchis family, fig. 226.
Columnar: shaped like a column or pillar.
Coma: a tuft of any sort (literally, a head of hair); p. 135, fig. 317.
Cómose: tufted; bearing a tuft of hairs, as the seeds of Milkweed; fig. 317.
Cómmissure: the line of junction of two carpels, as in the fruit of Umbelliferæ, such as Parsnip, Caraway, &c.
Common: used as "general," in contradistinction to "partial"; e. g. "common involucre," p. 81.
Cómplanate: flattened.
Compound leaf, p. 64. *Compound pistil,* p. 118. *Compound umbel,* &c., p. 81.
Complete (flower), p. 89.
Complicate: folded upon itself.
Compressed: flattened on two opposite sides.
Condúplicate: folded upon itself lengthwise, as are the leaves of Magnolia in the bud, p. 76.
Cone: the fruit of the Pine family; p. 133, fig. 314.
Cónfluent: blended together; or the same as *coherent.*
Confórmed: similar to another thing it is associated with or compared to; or closely fitted to it, as the skin to the kernel of a seed.
Congésted, Conglómerate: crowded together.
Cónjugate: coupled; in single pairs.
Connate: united or grown together from the first.

Cup-shaped: same as cyathiform, or near it.
Cúpule: a little cup; the cup to the acorn of the Oak, p. 130, fig. 299.
Cúpulate: provided with a cupule.
Cúspidate: tipped with a sharp and stiff point.
Cut: same as incised, or applied generally to any sharp and deep division.
Cúticle: the skin of plants, or more strictly its external pellicle.
Cyáthiform: in the shape of a cup, or particularly of a wine-glass.
Cýcle: one complete turn of a spire, or a circle; p. 73.
Cýclical. rolled up circularly, or coiled into a complete circle.
Cyclósis: the circulation in closed cells, p. 167.
Cylindraceous: approaching to the
Cylíndrical form; as that of stems, &c., which are round, and gradually if at all tapering.
Cýmbæform, or *Cymbiform:* same as boat-shaped.
Cyme: a cluster of centrifugal inflorescence, p 82, fig. 165, 167.
Cýmose: furnished with cymes, or like a cyme.

Deca- (in composition of words of Greek derivation): ten; as
Decágynous: with 10 pistils or styles. *Decándrous:* with 10 stamens.
Deciduous: falling off, or subject to fall, said of leaves which fall in autumn, and of a calyx and corolla which fall before the fruit forms.
Declined: turned to one side, or downwards, as the stamens of Azalea nudiflora.
Decompound: several times compounded or divided; p 67, fig. 138.
Decumbent: reclined on the ground, the summit tending to rise; p. 37.
Decurrent (leaves): prolonged on the stem beneath the insertion, as in Thistles.
Decússate: arranged in pairs which successively cross each other; fig. 147.
Definite: when of a uniform number, and not above twelve or so.
Deflexed: bent downwards.
Deflorate: past the flowering state, as an anther after it has discharged its pollen.
Dehiscence: the mode in which an anther or a pod regularly bursts or splits open; p. 132.
Dehiscent: opening by regular dehiscence.
Deliquescent: branching off so that the stem is lost in the branches, p. 25.
Deltoid: of a triangular shape, like the Greek capital Δ.
Demersed: growing below the surface of water.
Dendroid, Dendritic: tree-like in form or appearance.
Dentate: toothed (from the Latin *dens,* a tooth), p. 61, fig. 113.
Denticulate: furnished with denticulations, or very small teeth: diminutive of the last.
Depauperate (impoverished or starved): below the natural size.
Depressed: flattened, or as if pressed down from above; flattened vertically.
Descending: tending gradually downwards.
Determinate Inflorescence, p. 81, 83.
Dextrorse: turned to the right hand.
Di- (in Greek compounds): two, as
Diádelphous (stamens): united by their filaments in two sets; p. 111, fig. 227.
Diándrous: having two stamens, p. 112.
Diagnosis. a short distinguishing character, or descriptive phrase.

Diáphanous: transparent or translucent.
Dichlamýdeous (flower): having both calyx and corolla.
Dichótomous: two-forked.
Diclínous: having the stamens in one flower, the pistils in another; p. 89, fig. 176, 177.
Dicóccous (fruit): splitting into two *cocci*, or closed carpels.
Dicotylédonous (embryo): having a pair of cotyledons; p. 16, 137.
Dicotyledonous Plants, p. 150, 182.
Didymous: twin.
Didýnamous (stamens); having four stamens in two pairs, one pair shorter than the other, as in fig. 194, 195.
Diffuse: spreading widely and irregularly.
Dígitate (fingered): where the leaflets of a compound leaf are all borne on the apex of the petiole; p. 65, fig. 129.
Dígynous (flower): having two pistils or styles, p. 116.
Dímerous: made up of two parts, or its organs in twos.
Dimídiate: halved; as where a leaf or leaflet has only one side developed, or a stamen has only one lobe or cell; fig. 239.
Dimorphous: of two forms.
Diœcious, or *Dioícous:* where the stamens and pistils are in separate flowers on different plants; p. 89.
Dipétalous: of two petals. *Diphýllous:* two-leaved. *Dípterous:* two-winged.
Disciform or *Disk-shaped:* flat and circular, like a disk or quoit.
Disk: the face of any flat body; the central part of a head of flowers, like the Sunflower, or Coreopsis (fig. 224), as opposed to the *ray* or margin; a fleshy expansion of the receptacle of a flower; p. 125.
Dissected: cut deeply into many lobes or divisions.
Dissépiments: the partitions of an ovary or a fruit; p. 119.
Dístichous: two-ranked; p. 73.
Distinct: uncombined with each other; p. 102.
Diváricate: straddling; very widely divergent.
Divided (leaves, &c.): cut into divisions extending about to the base or the mid rib; p. 62, fig. 125.
Dodeca- (in Greek compounds): twelve; as
Dodecágynous: with twelve pistils or styles.
Dodecandrous: with twelve stamens.
Dolabriform: axe-shaped.
Dorsal: pertaining to the back (*dorsum*) of an organ.
Dorsal Suture, p. 117.
Dotted Ducts, p. 148.
Double Flowers, so called: where the petals are multiplied unduly; p. 85, 98.
Downy: clothed with a coat of soft and short hairs.
Drupe: a stone-fruit; p. 128, fig. 285.
Drupaceous: like or pertaining to a drupe.
Ducts: the so-called vessels of plants; p. 146, 148.
Dumose: bushy, or relating to bushes.
Duramen: the heart-wood, p. 153.
Dwarf: remarkably low in stature.

E-, or *Ex-*, at the beginning of compound words, means destitute of; as *ecostate*, without a rib or midrib; *exalbuminous*, without albumen, &c.
Eared: see *auriculate;* p. 59, fig. 96.
Ebrácteate; destitute of bracts.
Echínate: armed with prickles (like a hedgehog). *Echínulate:* a diminutive of it.
Edentate: toothless.
Effete: past bearing, &c.; said of anthers which have discharged their pollen.
Eglandulose: destitute of glands.
Eláters: threads mixed with the spores of Liverworts.
Ellipsoidal: approaching an elliptical figure.
Elliptical: oval or oblong, with the ends regularly rounded; p. 58, fig. 88.
Emárginate: notched at the summit; p. 60, fig. 108.
Émbryo: the rudimentary undeveloped plantlet in a seed; p. 6, fig. 9, 12, 26, 31 – 37, &c., and p. 136. *Embryo-sac,* p. 139.
Emersed: raised out of water.
Endecágynous: with eleven pistils or styles. *Endecándrous:* with eleven stamens.
Éndocarp: the inner layer of a pericarp or fruit; p. 128.
Éndochrome: the coloring matter of Algæ and the like.
Endógenous Stems, p. 150. *Endogenous Plants,* p. 150.
Endosmose: p. 168.
Éndosperm: another name for the albumen of a seed.
Éndostome: the orifice in the inner coat of an ovule.
Ennea-: nine. *Enneágynous:* with nine petals or styles.
Enneándrous: with nine stamens.
Ensiform: sword-shaped; as the leaves of Iris, fig. 134.
Entire: the margins not at all toothed, notched, or divided, but even; p. 61.
Ephemeral: lasting for a day or less, as the corolla of Purslane, &c.
Epi-, in composition: upon; as
Épicarp: the outermost layer of a fruit; p. 128.
Epidermal: relating to the *Epidérmis*, or the skin of a plant; p. 152, 155.
Epigœous: growing on the earth, or close to the ground.
Epígynous: upon the ovary; p. 105, 111.
Epipétalous: borne on the petals or the corolla.
Epiphýllous: borne on a leaf.
Epiphyte: a plant growing on another plant, but not nourished by it; p. 34.
Epiphýtic or *Epiphýtal:* relating to *Epiphytes;* p. 34.
Episperm: the skin or coat of a seed, especially the outer coat.
Equal: same as *regular;* or of the same number or length, as the case may be, of the body it is compared with.
Equally pinnate: same as abruptly pinnate; p. 65.
Équitant (riding straddle); p. 68, fig. 133, 134.
Erose: eroded, as if gnawed.
Eróstrate: not beaked.
Essential Organs of the flower, p 85.
Estivátion: see *œstivation.*
Etiolated: blanched by excluding the light, as the stalks of Celery.
Evergreen: holding the leaves over winter and until new ones appear, or longer.
Exalbúminous (seed): destitute of albumen; p. 186.

Fléxuose, or *Fléxuous:* bending gently in opposite directions, in a zigzag way.
Floating: swimming on the surface of water.
Flóccose: composed, or bearing tufts, of woolly or long and soft hairs.
Flora (the goddess of flowers): the plants of a country or district, taken together, or a work systematically describing them; p. 3.
Floral: relating to the blossom
Floral Envelopes: the leaves of the flower; p. 85, 99
Floret: a diminutive flower; one of the flowers of a head (or of the so-called compound flower) of Compositæ, p. 106.
Flower: the whole organs of reproduction of Phænogamous plants; p. 84.
Flower-bud: an unopened flower.
Flowering Plants, p. 177. *Flowerless Plants*, p. 172, 177.
Foliáceous: belonging to, or of the texture or nature of, a leaf (*folium*).
Fóliose: leafy; abounding in leaves.
Fóliolate: relating to or bearing leaflets (*foliola*).
Fóllicle: a simple pod, opening down the inner suture; p. 131, fig. 302.
Follícular: resembling or belonging to a follicle.
Food of Plants, p. 160.
Foramen: a hole or orifice, as that of the ovule; p. 122.
Fornix: little arched scales in the throat of some corollas, as of Comfrey.
Fórnicate: over-arched, or arching over.
Fóveate: deeply pitted. *Fovéolate:* diminutive of *foveate*.
Free: not united with any other parts of a different sort; p. 103.
Fringed: the margin beset with slender appendages, bristles, &c.
Frond: what answers to leaves in Ferns; the stem and leaves fused into one body, as in Duckweed and many Liverworts, &c.
Frondescence: the bursting into leaf.
Fróndose: frond-bearing; like a frond: or sometimes used for leafy.
Fructification: the state of fruiting. Organs of, p. 76.
Fruit: the matured ovary and all it contains or is connected with; p. 126.
Frutéscent: somewhat shrubby; becoming a shrub (*frutex*).
Fruticulose: like a small shrub. *Frúticose:* shrubby; p. 36.
Fugacious: soon falling off or perishing.
Fulvous: tawny; dull yellow with gray.
Funículus: the stalk of a seed or ovule; p. 122.
Funnel-form, or *Funnel-shaped:* expanding gradually upwards, like a funnel or tunnel; p. 102.
Fúrcate: forked.
Furfuráceous: covered with bran-like fine scurf.
Furrowed: marked by longitudinal channels or grooves.
Fuscous: deep gray-brown.
Fúsiform: spindle-shaped; p. 32.

Gáleate: shaped like a helmet (*galea*); as the upper sepal of the Monkshood fig. 185, and the upper lip of the corolla of Dead-Nettle, fig. 209.
Gamopétalous: of united petals; same as *monopetalous*, and a better word; p. 102.
Gamophýllous: formed of united leaves. *Gamosépalous:* formed of united sepals.
Gelatine, p. 165.

Géminate: twin; in pairs; as the flowers of Linnæa.
Gemma: a bud.
Gemmation: the state of budding, or the arrangement of parts in the bud.
Gémmule: a small bud; the buds of Mosses; the plumule, p. 6.
Genículate: bent abruptly, like a knee (*genu*), as many stems.
Genus: a kind; a rank above species; p. 175, 176.
Generic Names, p. 178.
Geographical Botany: the study of plants in their geographical relations, p. 3.
Germ: a growing point; a young bud; sometimes the same as embryo; p. 136.
Germen: the old name for ovary.
Germination: the development of a plantlet from the seed; p. 5, 137.
Gibbous: more tumid at one place or on one side than the other.
Glabrate: becoming glabrous with age, or almost glabrous.
Glabrous: smooth, i. e. having no hairs, bristles, or other pubescence.
Gladiate: sword-shaped; as the leaves of Iris, fig. 134.
Glands: small cellular organs which secrete oily or aromatic or other products: they are sometimes sunk in the leaves or rind, as in the Orange, Prickly Ash, &c.; sometimes on the surface as small projections; sometimes raised on hairs or bristles (*glandular hairs, &c.*), as in the Sweetbrier and Sundew. The name is also given to any small swellings, &c., whether they secrete anything or not.
Glandular, Glandulose: furnished with glands, or gland-like.
Glans (*Gland*): the acorn or mast of Oak and similar fruits.
Glaucescent: slightly glaucous, or bluish-gray.
Glaucous: covered with a *bloom*, viz. with a fine white powder that rubs off, like that on a fresh plum, or a cabbage-leaf.
Globose: spherical in form, or nearly so. *Glóbular:* nearly globose.
Glochídiate (hairs or bristles): barbed; tipped with barbs, or with a double hooked point.
Glómerate: closely aggregated into a dense cluster.
Glómerule: a dense head-like cluster; p. 83.
Glossology: the department of Botany in which technical terms are explained.
Glumaceous: glume-like, or glume-bearing.
Glume: Glumes are the husks or floral coverings of Grasses, or, particularly, the outer husks or bracts of each spikelet.
Glumelles: the inner husks, or paleæ, of Grasses.
Gluten: a vegetable product containing nitrogen; p. 165.
Granular: composed of grains. *Granule:* a small grain.
Growth, p 138.
Grumous or *Grumose:* formed of coarse clustered grains.
Guttate: spotted, as if by drops of something colored.
Gymnocárpous: naked-fruited.
Gymnospérmous: naked-seeded; p. 121.
Gymnospérmæ, or *Gymnospermous Plants*, p. 184.
Gynándrous: with stamens borne on, i. e. united with, the pistil; p. 111, fig. 226.
Gynœcium: a name for the pistils of a flower taken altogether.
Gýnobase: a particular receptacle or support of the pistils, or of the carpels of a compound ovary, as in Geranium, fig. 277, 278.

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Gýnophore: a stalk raising a pistil above the stamens, as in the Cleome Family, p. 276.
Gyrate: coiled in a circle: same as *circinate.*
Gyrose: strongly bent to and fro.

Habit: the general aspect of a plant, or its mode of growth.
Habitat: the situation in which a plant grows in a wild state.
Hairs: hair-like projections or appendages of the surface of plants.
Hairy: beset with hairs, especially longish ones.
Halberd-shaped, or *Halberd-headed:* see *hastate.*
Halved: when appearing as if one half of the body were cut away.
Hamate or *Hamose:* hooked; the end of a slender body bent round.
Hámulose: bearing a small hook; a diminutive of the last.
Hastate or *Hastile:* shaped like a halberd; furnished with a spreading lobe on each side at the base; p. 59, fig. 97.
Heart-shaped: of the shape of a heart as commonly painted; p. 58, fig. 90.
Heart-wood: the older or matured wood of exogenous trees; p. 153.
Helicoid: coiled like a *helix* or snail-shell.
Helmet: the upper sepal of Monkshood in this shape, fig. 185, &c.
Hemi- (in compounds from the Greek): half; e. g. *Hemispherical,* &c.
Hémicarp: half-fruit, or one carpel of an Umbelliferous plant.
Hemítropous or *Hemítropal* (ovule or seed): nearly same as *amphitropous,* p. 123.
Hepta- (in words of Greek origin): seven; as,
Heptágynous: with seven pistils or styles.
Heptámerous: its parts in sevens. *Heptándrous:* having seven stamens.
Herb, p. 20.
Herbaceous: of the texture of common herbage; not woody; p. 36.
Herbarium: the botanist's arranged collection of dried plants; p. 201.
Hermaphrodite (flower): having both stamens and pistils in the same blossom; same as *perfect;* p. 89.
Heterocárpous: bearing fruit of two sorts or shapes, as in Amphicarpæa.
Heterógamous: bearing two or more sorts of flowers as to their stamens and pistils; as in Aster, Daisy, and Coreopsis.
Heteromórphous: of two or more shapes.
Heterótropous, or *Heterótropal* (ovule): the same as *amphitropous;* p. 123.
Hexa- (in Greek compounds): six; as
Hexágonal: six-angled. *Hexágynous:* with six pistils or styles.
Hexámerous: its parts in sixes. *Hexándrous:* with six stamens.
Hexápterous: six-winged.
Hilar: belonging to the hilum.
Hilum: the scar of the seed; its place of attachment; p. 122, 135.
Hippocrépiform: horseshoe-shaped.
Hirsute: hairy with stiffish or beard-like hairs.
Hispid: bristly; beset with stiff hairs. *Hispídulous* is a diminutive of it.
Hoary: grayish-white; see *canescent,* &c.
Homógamous: a head or cluster with flowers all of one kind, as in Eupatorium.
Homogéneous: uniform in nature; all of one kind.
Homomállous (leaves, &c.): originating all round a stem, but all bent or curved round to one side.

Insertion: the place or the mode of attachment of an organ to its support; p. 72.
Intercellular Passages or *Spaces*, p. 143, fig. 341.
Internode: the part of a stem between two nodes; p. 42.
Interruptedly pinnate: pinnate with small leaflets intermixed with larger ones, as in Water Avens.
Intrafoliaceous (stipules, &c.): placed between the leaf or petiole and the stem.
Introrse: turned or facing inwards, i. e. towards the axis of the flower; p. 113.
Inverse or *Inverted:* where the apex is in the direction opposite to that of the organ it is compared with.
Involucel: a partial or small involucre; p. 81.
Involúcellate: furnished with an involucel.
Involúcrate: furnished with an involucre.
Involucre: a whorl or set of bracts around a flower, umbel, or head; p. 79.
Involute, in vernation, p. 76: rolled inwards from the edges.
Irregular Flowers, p. 91.

Jointed: separate or separable at one or more places into pieces; p. 64, &c.

Keel: a projecting ridge on a surface, like the keel of a boat; the two anterior petals of a papilionaceous corolla; p. 105, fig. 217, 218, *k*.
Keeled: furnished with a keel or sharp longitudinal ridge.
Kernel of the ovule and seed, p. 122, 136.
Kidney-shaped: resembling the outline of a kidney; p. 59, fig. 100.

Labéllum: the odd petal in the Orchis Family.
Labiate: same as *bilabiate* or two-lipped; p. 105.
Laciniate: slashed; cut into deep narrow lobes (called *laciniæ*).
Lactescent: producing milky juice, as does the Milkweed, &c.
Lácunose: full of holes or gaps.
Lævigate: smooth as if polished.
Lámellar or *Lamellate:* consisting of flat plates (*lamellæ*).
Lámina: a plate or blade: the blade of a leaf, &c., p 54.
Lanate: woolly; clothed with long and soft entangled hairs.
Lanceolate: lance-shaped; p. 58, fig. 86.
Lanuginous: cottony or woolly.
Latent buds: concealed or undeveloped buds; p. 26, 27.
Lateral: belonging to the side.
Latex: the milky juice, &c. of plants.
Lax: loose in texture, or sparse; the opposite of crowded.
Leaf, p. 49. *Leaf-buds,* p. 20, 27.
Leaflet: one of the divisions or blades of a compound leaf; p. 64.
Leaf-like: same as *foliaceous*.
Leathery: of about the consistence of leather; coriaceous.
Legume: a simple pod, dehiscent into two pieces, like that of the Pea, p. 131, fig. 303; the fruit of the Pea Family (*Leguminosæ*), of whatever shape.
Legumine, p. 165.
Leguminous: belonging to legumes, or to the Leguminous Family.
Lenticular: lens-shaped; i. e. flattish and convex on both sides.

Lépidote: leprous; covered with scurfy scales.
Liber: the inner, fibrous bark of Exogenous plants; p. 152.
Ligneous, or *Lignose:* woody in texture.
Ligulate: furnished with a ligule; p. 106.
Lígule: the strap-shaped corolla in many Compositæ, p. 106, fig. 220; the little membranous appendage at the summit of the leaf-sheaths of most Grasses.
Limb: the blade of a leaf, petal, &c.; p. 54, 102.
Linear: narrow and flat, the margins parallel; p. 58, fig. 85.
Líneate: marked with parallel lines. *Lineolate:* marked with minute lines.
Língulate, *Linguiform:* tongue-shaped.
Lip: the principal lobes of a bilabiate corolla or calyx, p. 105; the odd and peculiar petal in the Orchis Family.
Lobe: any projection or division (especially a rounded one) of a leaf, &c.
Locéllus (plural *locelli*): a small cell, or compartment of a cell, of an ovary or anther.
Lócular: relating to the cell or compartment (*loculus*) of an ovary, &c.
Loculicídal (dehiscence): splitting down through the middle of the back of each cell; p. 132, fig. 305.
Locústa: a name for the spikelet of Grasses.
Lóment: a pod which separates transversely into joints; p. 131, fig. 304.
Lomentáceous: pertaining to or resembling a loment.
Lórate: thong-shaped.
Lúnate: crescent-shaped. *Lunulate:* diminutive of *lunate.*
Lýrate: lyre-shaped; a pinnatifid leaf of an obovate or spatulate outline, the end-lobe large and roundish, and the lower lobes small, as in Winter-Cress and Radish, fig. 59.

Mace: the aril of the Nutmeg; p. 135.
Máculate: spotted or blotched.
Male (flowers): having stamens but no pistil.
Mámmose: breast-shaped.
Marcescent: withering without falling off.
Marginal: belonging to the edge or margin.
Marginate: margined, with an edge different from the rest.
Masked: see *personate.*
Median: belonging to the middle.
Medúllary: belonging to, or of the nature of pith (*medulla*); pithy.
Medullary Rays: the silver-grain of wood; p. 151.
Medullary Sheath: a set of ducts just around the pith; p. 151.
Membranaceous or *Mémbranous:* of the texture of membrane; thin and more or less translucent.
Meníscoid: crescent-shaped.
Méricarp: one carpel of the fruit of an Umbelliferous plant.
Merismatic: separating into parts by the formation of partitions within.
Mésocarp: the middle part of a pericarp, when that is distinguishable into three layers; p. 128.
Mesophlœum: the middle or green bark.

Micropyle: the closed orifice of the seed; p. 135.
Midrib: the middle or main rib of a leaf; p. 55.
Milk-Vessels: p. 148.
Miniate: vermilion-colored.
Mitriform: mitre-shaped; in the form of a peaked cap.
Monadélphous: stamens united by their filaments into one set; p. 111.
Monándrous (flower): having only one stamen; p. 112.
Moníliform: necklace-shaped; a cylindrical body contracted at intervals.
Monochlamýdeous: having only one floral envelope, i. e. calyx but no corolla, as Anemone, fig. 179, and Castor-oil Plant, fig. 178.
Monocotylédonous (embryo): with only one cotyledon; p. 16, 137.
Monocotyledonous Plants, p. 150, 192.
Monœcious, or *Monoícous* (flower): having stamens or pistils only; p. 90.
Monógynous (flower): having only one pistil, or one style; p. 116.
Monopétalous (flower): with the corolla of one piece; p. 101.
Monophýllous: one-leaved, or of one piece; p. 102.
Monosépalous: a calyx of one piece; i. e. with the sepals united into one body; p. 101.
Monospérmous: one-seeded.
Monstrosity: an unnatural deviation from the usual structure or form.
Morphology: the department of botany which treats of the forms which an organ (say a leaf) may assume; p. 28.
Múcronate: tipped with an abrupt short point (*mucro*); p. 60, fig. 111.
Mucrónulate: tipped with a minute abrupt point; a diminutive of the last.
Multi-, in composition: many; as
Multangular: many-angled. *Multicípital:* many-headed, &c.
Multifarious: in many rows or ranks. *Múltifid:* many-cleft; p. 62.
Multilócular: many-celled. *Multisérial:* in many rows.
Multiple Fruits, p. 133.
Múricate: beset with short and hard points.
Múriform: wall-like; resembling courses of bricks in a wall.
Muscology: the part of descriptive botany which treats of Mosses (i. e. *Musci*).
Múticous: pointless; beardless; unarmed.
Mycélium: the spawn of Fungi; i. e. the filaments from which Mushrooms, &c. originate.

Nápiform: turnip-shaped; p. 31, fig. 57.
Natural System: p. 195.
Naturalized: introduced from a foreign country, but growing perfectly wild and propagating freely by seed.
Navícular: boat-shaped, like the glumes of most Grasses.
Necklace-shaped: looking like a string of beads; see *moniliform.*
Nectar: the honey, &c. secreted by glands, or by any part of the corolla.
Nectaríferous: honey-bearing; or having a nectary.
Nectary: the old name for petals and other parts of the flower when of unusual shape, especially when honey-bearing. So the hollow spur-shaped petals of Columbine were called nectaries; also the curious long-clawed petals of Monkshood, fig. 186, &c.

Orthótropous or *Orthótropal* (ovule or seed): p. 122, 135, fig. 270, 274.
Osseous: of a bony texture.
Oval: broadly elliptical; p. 88.
Óvary: that part of the pistil containing the ovules or future seeds; p. 86, 116.
Óvate: shaped like an egg with the broader end downwards, or, in plane surfaces, such as leaves, like the section of an egg lengthwise; p. 58, fig. 89.
Óvoid: ovate or oval in a solid form.
Óvule: the body which is destined to become a seed; p. 86, 116, 122.

Palea (plural *paleæ*): chaff; the inner husks of Grasses; the chaff or bracts on the receptacle of many Compositæ, as Coreopsis, fig. 220, and Sunflower.
Paleaceous: furnished with chaff, or chaffy in texture.
Palmate: when leaflets or the divisions of a leaf all spread from the apex of the petiole, like the hand with the outspread fingers; p. 167, fig. 129, &c.
Palmately (veined, lobed, &c.): in a palmate manner; p. 57, 63, 65.
Pandúriform: fiddle-shaped (which see).
Pánicle: an open cluster; like a raceme, but more or less compound; p. 81, fig. 163.
Panicled, Paniculate: arranged in panicles, or like a panicle.
Papery: of about the consistence of letter-paper.
Papilionaceous: butterfly-shaped; applied to such a corolla as that of the Pea and the Locust-tree; p. 105, fig. 217.
Papílla (plural *papillæ*): little nipple-shaped protuberances.
Papíllate, Papíllose: covered with papillæ.
Pappus: thistle-down. The down crowning the achenium of the Thistle, and other Compositæ, represents the calyx; so the scales, teeth, chaff, as well as bristles, or whatever takes the place of the calyx in this family, are called the pappus; fig. 292–296, p. 130.
Parallel-veined, or *nerved* (leaves): p. 55, 56.
Paráphyses: jointed filaments mixed with the antheridia of Mosses.
Parénchyma: soft cellular tissue of plants, like the green pulp of leaves.
Paríetal (placentæ, &c.): attached to the walls (*parietes*) of the ovary or pericarp; p. 119, 120.
Parted: separated or cleft into parts almost to the base; p. 62.
Partial involucre, same as an *involucel*: *partial petiole,* a division of a main leaf stalk or the stalk of a leaflet: *partial peduncle,* a branch of a peduncle *partial umbel,* an umbellet, p. 81.
Patent: spreading; open. *Patulous:* moderately spreading.
Pauci-, in composition: few; as *pauciflorous,* few-flowered, &c.
Pear-shaped: solid obovate, the shape of a pear.
Péctinate: pinnatifid or pinnately divided into narrow and close divisions, like the teeth of a comb.
Pedate: like a bird's foot; palmate or palmately cleft, with the side divisions again cleft, as in Viola pedata, &c.
Pedately cleft, lobed, &c.: cut in a pedate way.
Pédicel: the stalk of each particular flower of a cluster; p. 78, fig. 156.
Pédicellate, Pédicelled: furnished with a pedicel.

Péduncle: a flower-stalk, whether of a single flower or of a flower-cluster; p. 78.
Péduncled, Pedúnculate: furnished with a peduncle.
Peltate: shield-shaped: said of a leaf, whatever its shape, when the petiole is attached to the lower side, somewhere within the margin; p. 59, fig. 102, 178.
Pendent: hanging. *Pendulous:* somewhat hanging or drooping.
Penícillate: tipped with a tuft of fine hairs, like a painter's pencil; as the stigmas of some Grasses.
Penta- (in words of Greek composition): five; as
Pentágynous: with five pistils or styles; p. 116.
Pentámerous: with its parts in fives, or on the plan of five.
Pentándrous: having five stamens; p. 112. *Pentástichous:* in five ranks.
Pepo: a fruit like the Melon and Cucumber; p. 128.
Perennial: lasting from year to year; p. 21.
Perfect (flower): having both stamens and pistils; p. 89.
Perfóliate: passing through the leaf, in appearance; p. 67, fig. 131, 132.
Pérforate: pierced with holes, or with transparent dots resembling holes, as an Orange-leaf.
Périanth: the leaves of the flower generally, especially when we cannot readily distinguish them into calyx and corolla; p. 85.
Péricarp: the ripened ovary; the walls of the fruit; p. 127.
Pericárpic: belonging to the pericarp.
Périchæth: the cluster of peculiar leaves at the base of the fruit-stalk of Mosses.
Perichætial: belonging to the perichæth.
Perigónium, Perigóne: same as *perianth.*
Perigýnium: bodies around the pistil; applied to the closed cup or bottle-shaped body which encloses the ovary of Sedges, and to the bristles, little scales, &c. of the flowers of some other Cyperaceæ.
Perígynous: the petals and stamens borne on the calyx; p. 104, 111.
Perípheric: around the outside, or periphery, of any organ.
Périsperm: a name for the albumen of a seed (p. 136).
Péristome: the fringe of teeth, &c. around the orifice of the capsule of Mosses.
Persístent: remaining beyond the period when such parts commonly fall, as the leaves of evergreens, and the calyx, &c. of such flowers as remain during the growth of the fruit.
Pérsonate: masked; a bilabiate corolla with a projection, or *palate*, in the throat, as of the Snapdragon; p. 106, fig. 210, 211.
Petal: a leaf of the corolla; p. 85.
Petaloid: petal-like; resembling or colored like petals.
Pétiole: a footstalk of a leaf; a leaf-stalk, p. 54.
Petioled, Petiolate: furnished with a petiole.
Petiólulate: said of a leaflet when raised on its own partial leafstalk.
Phænógamous, or *Phanerógamous:* plants bearing flowers and producing seeds; same as Flowering Plants; p. 177, 182.
Phyllódium (plural *phyllodia*): a leaf where the blade is a dilated petiole, as in New Holland Acacias; p. 69.
Phyllotáxis, or *Phyllotaxy:* the arrangement of leaves on the stem; p. 71.
Physiological Botany, Physiology, p. 3.

Phyton: a name used to designate the pieces which by their repetition make up a plant, theoretically, viz. a joint of stem with its leaf or pair of leaves.

Pilíferous: bearing a slender bristle or hair (*pilum*), or beset with hairs.

Pílose: hairy; clothed with soft slender hairs.

Pinna: a primary branch of the petiole of a bipinnate or tripinnate leaf, as fig. 130, p. 66.

Pínnule: a secondary branch of the petiole of a bipinnate or tripinnate leaf; p. 66.

Pínnate (leaf): when the leaflets are arranged along the sides of a common petiole; p. 65, fig. 126–128.

Pinnately lobed, cleft, parted, divided, &c., p. 63.

Pinnátifid: same as pinnately cleft; p. 63, fig. 119.

Pistil: the seed-bearing organ of the flower; p. 86, 116.

Pistillídium: the body which in Mosses, Liverworts, &c. answers to the pistil.

Pitchers, p. 51, fig. 79, 80.

Pith: the cellular centre of an exogenous stem; p. 150, 151.

Pitted: having small depressions or pits on the surface, as many seeds.

Placénta: the surface or part of the ovary to which the ovules are attached; p. 118.

Plaited (in the bud); p. 76, fig. 150; p. 110, fig 225.

Plane: flat, outspread.

Plicate: same as *plaited.*

Plumose: feathery; when any slender body (such as a bristle of a pappus) is beset with hairs along its sides, like the plumes or the beard on a feather.

Plúmule: the little bud or first shoot of a germinating plantlet above the cotyledons; p. 6, fig. 5; p. 137.

Pluri-, in composition: many or several; as

Plurifoliolate: with several leaflets; p. 66.

Pod: specially a legume, p. 131; also applied to any sort of capsule.

Pódosperm: the stalk of a seed.

Pointless: destitute of any pointed tip, such as a *mucro, awn, acumination,* &c.

Pollen: the fertilizing powder of the anther; p. 86, 114.

Pollen-mass: applied to the pollen when the grains all cohere into a mass, as in Milkweed and Orchis.

Poly- (in compound words of Greek origin): same as *multi-* in those of Latin origin, viz. many; as

Polyadélphous: having the stamens united by their filaments into several bundles; p. 112.

Polyándrous: with numerous (more than 20) stamens (inserted on the receptacle); p. 112.

Polycotylédonous: having many (more than two) cotyledons, as Pines; p. 17, 137, fig. 45, 46.

Polýgamous: having some perfect and some separated flowers, on the same or on different individuals, as the Red Maple.

Polýgonal: many-angled.

Polýgynous: with many pistils or styles; p. 116.

Polýmerous: formed of many parts of each set.

Polymórphous: of several or varying forms.

Polypétalous: when the petals are distinct or separate (whether few or many), p. 103.

Race: a marked variety which may be perpetuated from seed ; p. 174.
Raceme: a flower-cluster, with one-flowered pedicels arranged along the sides of a general peduncle ; p. 78, fig. 156.
Racemose: bearing racemes, or raceme-like.
Rachis: see *rhachis.*
Radial: belonging to the ray.
Rádiate, or *Radiant:* furnished with ray-flowers ; p. 107
Rádical: belonging to the root, or apparently coming from the root.
Rádicant: rooting, taking root on or above the ground, like the stems of Trumpet-Creeper and Poison-Ivy.
Rádicels: little roots or rootlets.
Radicle: the stem-part of the embryo, the lower end of which forms the root ; p. 6, fig. 4, &c. ; p. 137.
Rameal: belonging to a branch. *Ramose:* full of branches (*rami*).
Rámulose: full of branchlets (*ramuli*).
Raphe: see *rhaphe.*
Ray: the marginal flowers of a head (as of Coreopsis, p. 107, fig. 219) or cluster (as of Hydrangea, fig. 167), when different from the rest, especially when ligulate, and diverging (like rays or sunbeams) ; the branches of an umbel, which diverge from a centre ; p. 79.
Receptacle: the axis or support of a flower ; p. 86, 124 ; the common axis or support of a head of flowers ; fig. 230.
Reclined: turned or curved downwards ; nearly recumbent.
Recurved: curved outwards or backwards.
Redúplicate (in æstivation) : valvate with the margins turned outwards, p. 109.
Reflexed: bent outwards or backwards.
Refracted: bent suddenly, so as to appear broken at the bend.
Regular: all the parts similar ; p. 89.
Réniform: kidney-shaped ; p. 58, fig. 100.
Repánd: wavy-margined ; p. 62, fig. 115.
Répent: creeping, i. e. prostrate and rooting underneath.
Réplum: the persistent frame of some pods (as of Prickly Poppy and Cress), after the valves fall away.
Reproduction, organs of: all that pertains to the flower and fruit ; p. 76.
Resúpinate: inverted, or appearing as if upside down, or reversed.
Reticulated: the veins forming network, as in fig. 50, 83.
Retroflexed: bent backwards ; same as *reflexed.*
Retúse: blunted ; the apex not only obtuse, but somewhat indented ; p. 60, fig. 107.
Révolute: rolled backwards, as the margins of many leaves ; p. 76.
Rhachis (the backbone) : the axis of a spike, or other body ; p. 78.
Rhaphe: the continuation of the seed-stalk along the side of an anatropous ovule (p. 123) or seed ; fig. 273, *r*, 319 and 320, *b*.
Rháphides: crystals, especially needle-shaped ones, in the tissues of plants.
Rhizóma: a rootstock ; p. 40, fig. 64 – 67.
Rhombic: in the shape of a rhomb. *Rhomboidal:* approaching that shape.
Rib: the principal piece, or one of the principal pieces, of the framework of a leaf, p. 55 ; or any similar elevated line along a body.

Ring: an elastic band on the spore-cases of Ferns.
Ríngent: grinning; gaping open; p. 102, fig. 209.
Root, p. 28.
Root-hairs, p. 31, 149.
Rootlets: small roots, or root-branches; p. 29.
Rootstock: root-like trunks or portions of stems on or under ground; p. 40.
Rosaceous: arranged like the petals of a rose.
Rostéllate: bearing a small beak (*rostellum*).
Róstrate: bearing a beak (*rostrum*) or a prolonged appendage.
Rósulate: in a regular cluster of spreading leaves, resembling a full or double rose, as the leaves of Houseleek, &c.
Rótate; wheel-shaped: p. 101, fig. 204, 205.
Rotund: rounded or roundish in outline.
Rudimentary: imperfectly developed, or in an early state of development.
Rúgose: wrinkled, roughened with wrinkles.
Rúminated (albumen): penetrated with irregular channels or portions filled with softer matter, as a nutmeg.
Rúncinate: coarsely saw-toothed or cut, the pointed teeth turned towards the base of the leaf, as the leaf of a Dandelion.
Runner: a slender and prostrate branch, rooting at the end, or at the joints, as of a Strawberry, p. 38.

Sac: any closed membrane, or a deep purse-shaped cavity.
Ságittate: arrowhead-shaped; p. 59, fig. 95.
Salver-shaped, or *Salver-form:* with a border spreading at right angles to a slender tube, as the corolla of Phlox, p. 101, fig. 208, 202.
Samára: a wing-fruit, or key, as of Maple, p. 5, fig. 1, Ash, p. 131, fig. 300, and Elm, fig. 301.
Sámaroid: like a samara or key-fruit.
Sap: the juices of plants generally. Ascending or crude sap; p. 161, 168. Elaborated sap, that which has been digested or assimilated by the plant; p. 162, 169.
Sárcocarp: the fleshy part of a stone-fruit, p. 128.
Sarmentáceous: bearing long and flexible twigs (*sarments*), either spreading or procumbent.
Saw-toothed: see *serrate.*
Scábrous: rough or harsh to the touch.
Scaláriform: with cross-bands, resembling the steps of a ladder.
Scales: of buds, p. 22, 50; of bulbs, &c., p. 40, 46, 50.
Scaly: furnished with scales, or scale-like in texture; p. 46, &c.
Scandent: climbing; p. 37.
Scape: a peduncle rising from the ground, or near it, as of the stemless Violets, the Bloodroot, &c.
Scápiform: scape-like.
Scar of the seed, p. 135. *Leaf-scars,* p. 21.
Scárious or *Scariose:* thin, dry, and membranous.
Scóbiform: resembling sawdust.

Scórpioid or *Scorpioidal:* curved or circinate at the end, like the tail of a scorpion, as the inflorescence of Heliotrope.
Scrobículate: pitted; excavated into shallow pits.
Scurf, Scurfiness: minute scales on the surface of many leaves, as of Goosefoot, Buffalo-berry, &c.
Scútate: buckler-shaped.
Scutéllate, or *Scutélliform:* saucer-shaped or platter-shaped.
Sécund: one-sided; i. e. where flowers, leaves, &c. are all turned to one side.
Secúndine: the inner coat of the ovule; p. 124.
Seed, p. 134. *Seed-coats,* p. 134. *Seed-vessel,* p. 127.
Segment: a subdivision or lobe of any cleft body.
Ségregate: separated from each other.
Semi- (in compound words of Latin origin): half; as
Semi-adherent, as the calyx or ovary of Purslane, fig. 214. *Semicordate:* half-heart-shaped. *Semilunar:* like a half-moon. *Semiovate:* half-ovate, &c.
Seminal: relating to the seed. *Seminíferous:* seed-bearing.
Sempérvirent: evergreen.
Sepal: a leaf or division of the calyx; p. 85.
Sépaloid: sepal-like. *Sepaline:* relating to the sepals.
Separated Flowers: those having stamens or pistils only; p. 89.
Septate: divided by partitions (*septa*).
Séptenate: with parts in sevens.
Septicídal: where a pod in dehiscence splits through the partitions, dividing each into two layers; p. 132, fig. 306.
Septíferous: bearing the partition.
Septífragal: where the valves of a pod in dehiscence break away from the partitions; p. 132.
Septum (plural *septa*): a partition, as of a pod, &c.
Sérial, or *Seriate:* in rows; as *biserial,* in two rows, &c.
Seríceous: silky; clothed with satiny pubescence.
Serótinous: happening late in the season.
Serrate, or *Serrated:* the margin cut into teeth (*serratures*) pointing forwards; p 61, fig. 112.
Sérrulate: same as the last, but with fine teeth.
Sessile: sitting; without any stalk, as a leaf destitute of petiole, or an anther destitute of filament.
Seta: a bristle, or a slender body or appendage resembling a bristle.
Setáceous: bristle-like. *Sétiform:* bristle-shaped.
Setígerous: bearing bristles. *Setose:* beset with bristles or bristly hairs.
Sex: six; in composition. *Sexangular:* six-angled, &c.
Sheath: the base of such leaves as those of Grasses, which are
Sheathing: wrapped round the stem.
Shield-shaped: same as *scutate,* or as *peltate,* p. 59.
Shrub, p. 21.
Sígmoid: curved in two directions, like the letter S, or the Greek *sigma.*
Silículose: bearing a silicle, or a fruit resembling it.
Sílicle: a pouch, or short pod of the Cress Family; p. 133.
Silíque: a longer pod of the Cress Family; p. 133, fig. 310.

Station: the particular place, or kind of situation, in which a plant naturally occurs.

Stéllate, Stéllular: starry or star-like; where several similar parts spread out from a common centre, like a star.

Stem, p. 36, &c.

Stemless: destitute or apparently destitute of stem.

Sterile: barren or imperfect; p. 89.

Stigma: the part of the pistil which receives the pollen; p. 87.

Stigmátic, or *Stígmatose:* belonging to the stigma.

Stipe (Latin *stipes*) · the stalk of a pistil, &c., when it has any; the stem of a Mushroom.

Stipel: a stipule of a leaflet, as of the Bean, &c.

Stipéllate: furnished with stipels, as the Bean and some other Leguminous plants.

Stípitate: furnished with a stipe, as the pistil of Cleome, fig. 276.

Stípulate: furnished with stipules.

Stipules: the appendages one each side of the base of certain leaves; p. 69.

Stolons: trailing or reclined and rooting shoots; p. 37.

Stoloníferous: producing stolons.

Stomate (Latin *stoma,* plural *stomata*): the breathing-pores of leaves, &c.; p. 156.

Strap-shaped: long, flat, and narrow; p 106.

Striate, or *Striated:* marked with slender longitudinal grooves or channels (Latin *striæ*).

Strict: close and narrow; straight and narrow.

Strigíllose, Strígose: beset with stout and appressed, scale-like or rigid bristles.

Strobiláceous: relating to, or resembling a

Stróbile: a multiple fruit in the form of a cone or head, as that of the Hop and of the Pine; fig. 314, p. 133.

Stróphiole: same as *caruncle.* *Strophiolate:* furnished with a strophiole.

Struma: a wen; a swelling or protuberance of any organ.

Style: a part of the pistil which bears the stigma; p. 86.

Stylopódium: an epigynous disk, or an enlargement at the base of the style, found in Umbelliferous and some other plants.

Sub-, as a prefix: about, nearly, somewhat; as *subcordate,* slightly cordate: *subserrate,* slightly serrate: *subaxillary,* just beneath the axil, &c., &c.

Súberose: corky or cork-like in texture.

Subclass, p. 177, 183. *Suborder,* p. 176. *Subtribe,* p. 177.

Súbulate: awl-shaped; tapering from a broadish or thickish base to a sharp point; p. 68.

Succulent: juicy or pulpy.

Suckers: shoots from subterranean branches; p. 37.

Suffrutéscent: slightly shrubby or woody at the base only; p. 36.

Sugar, p. 163.

Sulcate: grooved longitudinally furrows.

Supernumerary Buds: p. 26.

Supérvolute: plaited and convolute in bud; p. 110, fig. 225.

Supra-axillary: borne above the axil, as some buds; p. 26, fig. 52.

Supra-decompound: many times compounded or divided.

Súrculose: producing suckers, or shoots resembling them.
Suspended: hanging down. Suspended ovules or seeds hang from the very summit of the cell which contains them; p. 122, fig. 269.
Sútural: belonging or relating to a suture.
Súture: the line of junction of contiguous parts grown together; p. 117.
Sword-shaped: vertical leaves with acute parallel edges, tapering above to a point; as those of Iris, fig. 133.
Symmetrical Flower: similar in the number of parts of each set; p. 89.
Synántherous, or *Syngenesious:* where stamens are united by their anthers; p. 112, fig. 229.
Syncárpous (fruit or pistil): composed of several carpels consolidated into one.
System, p. 195.
Systematic Botany: the study of plants after their kinds; p. 3.

Taper-pointed: same as *acuminate;* p. 60, fig. 103.
Tap-root: a root with a stout tapering body; p. 32.
Tawny: dull yellowish, with a tinge of brown.
Taxónomy: the part of Botany which treats of classification.
Tégmen: a name for the inner seed-coat.
Tendril: a thread-shaped body used for climbing, p. 38: it is either a branch, as in Virginia Creeper, fig. 62; or a part of a leaf, as in Pea and Vetch, fig. 127.
Térete: long and round; same as *cylindrical,* only it may taper.
Términal: borne at, or belonging to, the extremity or summit.
Terminólogy: the part of the science which treats of technical terms; same as *glossology.*
Térnate: in threes; p. 66. *Ternately:* in a ternate way.
Testa: the outer (and usually the harder) coat or shell of the seed; p. 134.
Tetra- (in words of Greek composition): four; as,
Tetracóccous: of four cocci or carpels.
Tetradýnamous: where a flower has six stamens, two of them shorter than the other four, as in Mustard, p. 92, 112, fig. 188.
Tetrágonal: four-angled. *Tetrágynous:* with four pistils or styles; p. 116.
Tetrámerous: with its parts or sets in fours.
Tetrándrous: with four stamens; p. 112.
Theca: a case; the cells or lobes of the anther.
Thorn: see *spine;* p. 39.
Thread-shaped: slender and round, or roundish like a thread; as the filament of stamens generally.
Throat: the opening or gorge of a monopetalous corolla, &c., where the border and the tube join, and a little below.
Thyrse or *Thyrsus:* a compact and pyramidal panicle; p. 81.
Tómentose: clothed with matted woolly hairs (*tomentum*).
Tongue-shaped: long, flat, but thickish, and blunt.
Toothed: furnished with teeth or short projections of any sort on the margin, used especially when these are sharp, like saw-teeth, and do not point forwards; p. 61, fig. 113.
Top-shaped: shaped like a top, or a cone with its apex downwards.

Tórose, Tórulose: knobby; where a cylindrical body is swollen at intervals.
Torus: the receptacle of the flower; p. 86, 124.
Tree, p. 21.
Tri-, in composition: three; as
Triadélphous: stamens united by their filaments into three bundles; p. 112.
Triándrous: where the flower has three stamens; p. 112.
Tribe, p. 176.
Trichótomous: three-forked. *Tricóccous:* of three cocci or roundish carpels.
Trícolor: having three colors. *Tricóstate:* having three ribs.
Tricúspidate: three-pointed. *Tridéntate:* three-toothed.
Triénnial: lasting for three years.
Trifárious: in three vertical rows; looking three ways.
Trífid: three-cleft; p. 62.
Trifóliate: three-leaved. *Trifóliolate:* of three leaflets; p. 66.
Trifúrcate: three-forked. *Trígonous:* three-angled, or triangular.
Trígynous: with three pistils or styles; p. 116. *Tríjugate:* in three pairs (*jugi*).
Trilóbed, or *Trilobate:* three-lobed; p. 62.
Trilócular: three-celled, as the pistils or pods in fig. 225–227.
Trímerous: with its parts in threes, as Trillium, fig. 189.
Trinérvate: three-nerved, or with three slender ribs.
Triœcious: where there are three sorts of flowers on the same or different individuals; as in Red Maple.
Tripártible: separable into three pieces. *Tripártite:* three-parted; p. 62.
Tripétalous: having three petals; as in fig. 189.
Triphýllous: three-leaved; composed of three pieces.
Tripínnate: thrice pinnate; p. 66. *Tripinnátifid:* thrice pinnately cleft; p. 64.
Triple-ribbed, Triple-nerved, &c.: where a midrib branches into three near the base of the leaf, as in Sunflower.
Triquétrous: sharply three-angled; and especially with the sides concave, like a bayonet.
Trisérial, or *Triseriate:* in three rows, under each other.
Tristíchous: in three longitudinal or perpendicular ranks.
Tristigmátic, or *Tristígmatose:* having three stigmas.
Trisúlcate: three-grooved.
Tritérnate: three times ternate; p. 67.
Trivial Name: the specific name.
Trochlear: pulley-shaped.
Trumpet-shaped: tubular, enlarged at or towards the summit, as the corolla of Trumpet-Creeper.
Truncate: as if cut off at the top; p. 60, fig. 106.
Tube, p. 102.
Trunk: the main stem or general body of a stem or tree.
Tuber: a thickened portion of a subterranean stem or branch, provided with eyes (buds) on the sides; as a potato, p. 43, fig. 68.
Túbercle: a small excrescence.
Tubercled, or *Tuberculate:* bearing excrescences or pimples.
Túberous: resembling a tuber. *Tuberíferous:* bearing tubers.
Túbular: hollow and of an elongated form; hollowed like a pipe.

Veined, Veiny: furnished with evident veins. *Veinless:* destitute of veins.
Veinlets: the smaller ramifications of veins.
Velate: furnished with a veil.
Velútinous: velvety to the touch.
Venation: the veining of leaves, &c.; p. 55.
Vénose: veiny; furnished with conspicuous veins.
Ventral: belonging to that side of a simple pistil, or other organ, which looks towards the axis or centre of the flower; the opposite of dorsal; as the
Ventral Suture, p. 117.
Véntricose: inflated or swelled out on one side.
Vénulose: furnished with veinlets.
Vermícular: shaped like worms.
Vernation: the arrangement of the leaves in the bud; p. 75.
Vérnicose: the surface appearing as if varnished.
Vérrucose: warty; beset with little projections like warts.
Vérsatile: attached by one point, so that it may swing to and fro, as the anthers of the Lily and Evening Primrose; p. 113, fig. 234.
Vertex: same as the *apex.*
Vértical: upright; perpendicular to the horizon, lengthwise.
Vérticil: a whorl; p. 71. *Verticillate:* whorled; p. 71, 75, fig. 148.
Vésicle: a little bladder. *Embryonal Vesicle*, p. 139. *Vesicular:* bladdery.
Vessels: ducts, &c.; p. 146, 148.
Véxillary, Vexillar: relating to the
Vexíllum: the standard of a papilionaceous flower; p. 105, fig. 218, *a*.
Víllose: shaggy with long and soft hairs (*villosity.*)
Vimíneous: producing slender twigs, such as those used for wicker-work.
Vine: any trailing or climbing stem; as a Grape-vine.
Viréscent, Viridescent: greenish; turning green.
Vírgate: wand-shaped, as a long, straight, and slender twig.
Viscous, Viscid: having a glutinous surface.
Vitta (plural *vittæ*): the oil-tubes of the fruit of Umbelliferæ.
Vóluble: twining, as the stem of Hops and Beans; p. 37.

Wavy: the surface or margin alternately convex and concave; p. 62.
Waxy: resembling beeswax in texture or appearance.
Wedge-shaped: broad above, and tapering by straight lines to a narrow base; p. 58, fig. 94.
Wheel-shaped: see *rotate;* p. 102, fig. 204, 205.
Whorl, Whorled: when leaves, &c. are arranged in a circle round the stem; p. 71, 75, fig. 148.
Wing: any membranous expansion. *Wings* of papilionaceous flowers, p. 105
Winged: furnished with a wing; as the fruit of Ash and Elm, fig. 300, 301.
Wood, p. 145. *Woody:* of the texture or consisting of wood.
Woody Fibre, or *Wood-Cells*, p. 146.
Woolly: clothed with long and entangled soft hairs; as the leaves of Mullein.

THE END.

FIELD, FOREST, AND GARDEN

BOTANY.

PREFACE.

This book is intended to furnish botanical classes and beginners generally with an easier introduction to the plants of this country than is the *Manual*, and one which includes the common cultivated as well as the native species. It is made more concise and simple, 1. by the use of somewhat less technical language; 2. by the omission, as far as possible, of the more recondite and, for the present purpose, less essential characters; and also of most of the obscure, insignificant, or rare plants which students will not be apt to meet with or to examine, or which are quite too difficult for beginners; such as the Sedges, most Grasses, and the crowd of Golden Rods, Asters, Sunflowers, and the like, which require very critical study. On the other hand, this small volume is more comprehensive than the Manual, since it comprises the common herbs, shrubs, and trees of the Southern as well as the Northern and Middle States, and all which are commonly cultivated or planted, for ornament or use, in fields, gardens, pleasure-grounds, or in house-culture, including even the conservatory plants ordinarily met with.

It is very desirable that students should be able to use exotic as well as indigenous plants in analysis; and a scientific acquaintance with the plants and flowers most common around us in garden, field, and green-house, and which so largely contribute to our well-being and enjoyment, would seem to be no less important than in the case of our native plants. If it is worth while so largely to assemble around us ornamental and useful trees, plants, and flowers, it is certainly well to know what they are and what they are like. To students in agricultural schools and colleges this kind of knowledge will be especially important.

One of the main objects of this book is to provide cultivators, gardeners, and amateurs, and all who are fond of plants and flowers, with a simple guide to a knowledge of their botanical names and structure. There is, I believe, no sufficient work of this kind in the English language, adapted to our needs, and available even to our botanists and botanical teachers, — for whom the only recourse is to a botanical library beyond the reach and means of most of these, and certainly quite beyond the reach of those whose needs I have here endeavored to supply, so far as I could, in this small volume. The great difficulties of the undertaking have been to keep the book within the proper compass, by a rigid exclusion of all extraneous and unnecessary matter, and to determine what plants, both native and exotic, are common enough to demand a place in it, or so uncommon that they may be omitted. It is very unlikely that I can have chosen wisely in all cases and for all parts of the country, and in view of the different requirements of botanical students on the one hand and of practical cultivators on the other, — the latter commonly caring more for made varieties, races, and crosses, than for species, which are the main objects of botanical study. But I have here brought together, within less than 350 pages, brief and plain botanical descriptions or notices of 2,650 species, belonging to 947 genera; and have constructed keys to the natural families, and analyses of their contents, which I hope may enable students, who have well studied the *First Lessons*, to find out the name, main characters, and place of any of them which they will patiently examine in blossom and, when practicable, in fruit also. If the book answers its purpose reasonably well, its shortcomings as regards cultivated plants may be made up hereafter. As to the native plants omitted, they are to be found, and may best be studied, in the *Manual of the Botany of the Northern United States*, and in Chapman's *Flora of the Southern United States*.

This book is designed to be the companion of the *First Lessons in Botany*, which serves as grammar and dictionary; and the two may be bound together into one compact volume, forming a comprehensive *School Botany*.

For the account of the Ferns and the allied families of Cryptogamous Plants I have to record my indebtedness to Professor D. C. Eaton of Yale College. These beautiful plants are now much cultivated by amateurs; and the means here so fully provided for studying them will doubtless be appreciated.

HARVARD UNIVERSITY HERBARIUM,
Cambridge, Massachusetts, August 29, 1868.

ANALYTICAL KEY

TO THE

NATURAL ORDERS OR FAMILIES.

Plants producing true flowers and seeds. . . . SERIES I. PHÆNOGAMOUS OR FLOWERING, p. 33

Not producing flowers, propagated by spores. . . . . . SERIES II. CRYPTOGAMOUS OR FLOWERLESS, p. 359

SERIES I. PHÆNOGAMOUS OR FLOWERING PLANTS.

With wood in a circle or in concentric annual circles or layers around a central pith; netted-veined leaves; and parts of the flower mostly in fives or fours. (See p. 33.) CLASS I. EXOGENOUS OR DICOTYLEDONOUS PLANTS, p. 13

With wood in separate threads scattered through the diameter of the stem, not in a circle, no ers · leaves mostl arallel-veined; and parts of the flower almost al-

Class I. EXOGENOUS OR DICOTYLEDONOUS PLANTS.

With pistil of the ordinary sort, the ovules in a closed ovary. (Cotyledons a pair.) . . . Subclass I. ANGIOSPERMOUS, p. 33

With both calyx and corolla, the latter of wholly separate petals. . . . . . . I. POLYPETALOUS DIVISION, p. 14

With both calyx and corolla, the latter united more or less into one piece. . . . II. MONOPETALOUS DIVISION, p. 20

Without corolla, i. e. with only one sort of floral envelope, or even none at all. . . . III. APETALOUS DIVISION, p. 24

Without proper pistil, the ovules naked on a scale or on the end of a short axis: cotyledons often more than two in a whorl. . . . . Subclass II. GYMNOSPERMOUS, p. 27

Class II. ENDOGENOUS OR MONOCOTYLEDONOUS PLANTS.

With flowers on a spadix or fleshy spike, perianth none or not corolla-like, and no glumes. I. SPADICEOUS DIVISION, p. 28

With flowers not on a spadix, and perianth or part of it more or less corolla-like. . II. PETALOIDEOUS DIVISION, p. 28

With flowers enveloped by glumes (chaffy bracts), and no manifest perianth. . . . III. GLUMACEOUS DIVISION, p. 30

Series II. CRYPTOGAMOUS OR FLOWERLESS PLANTS.

Having stems with woody matter in them, also in the leaves. . . Class III. ACROGENOUS PLANTS, or ACROGENS, p. 30

(The lower classes, of cellular plants, destitute of woody matter, including Mosses, Lichens, Sea-Weeds, and Fungi, are here omitted.)

I. POLYPETALOUS DIVISION OF EXOGENS.

A. *Stamens more than* 10, *and more than twice the number of the sepals or divisions of the calyx.*

Stamens monadelphous, united with the base of the corolla: anthers kidney-shaped, one-celled. . . MALLOW FAMILY, 70
Stens monadelphous at base: anthers two-celled: leaves twice pinnate. . . . . MIMOSA F. 99
Stens lphous at base: anthers two- ell d: leves not pinnate.
Leaves with joint between ple and ald, wih is translucent-dotted. . . . . Citrus, RUE F. 81
Leaves without a joint and not translucent- dotd. . . . . CAMELLIA F. 75
Stamens not monadelphous.
Pistils ms, but hd over each other and cohering in a mass on a l ng ptacle. . . . . MAGNOLIA F. 42
Pistils several nd in lws in a top-shaped tple. . . . . Nelumbium, WATER-LILY F. 46
Pistils mus and pte, at least their ovaries, but concealed in a hollow fshy receptacle,
Which bears sepals or bracts over its surface: leaves simple, opposite. . . . . . . CALYCANTHUS F. 130
Which is naked and ties an inferior ovary: leaves ale, compound. . . . . Rose, ROSE F. 115
Pistils mus or ome than one, separate, on the receptacle.
S tans borne on the calyx. ROSE F. 115
Stamens rbe on the receptacle.
Leaves centrally tple: aquatic herb. . . . . Brasenia, WATER-LILY F. 46
Leaves peltate nar the margin: woody ller. . . . . MOONSEED F. 44
Leaves not peltate, quite entire: res or shrubs.
Spicy-anise-scented: petals numerous: seed solitary. . . . . Illicium, MAGNOLIA F. 42
Unpleasantly ned when bruised: petals 6 in 2 ranks: seds several. . . . . CUSTARD-APPLE F. 43
Leaves not peltate: hbs, or if woody-stemmed the leaves are compound. . . . . CROWFOOT F. 33
Pistil as to cary one below but 3- lld or horned at the top.
Not fleshy plants: petals unequal, cut or cleft: pod 1-celled, eed. . . . . MIGNONETTE F. 57
Not fleshy: pod several-celled, several-seeded. . . . . Nigella, CROWFOOT F. 33
Fly plants: petals equal, narrow, entire . . . . FIG-MARIGOLD F. 156

Stamens in 5 sets, one on the base of each petal: calyx imbricated in the bud: no stipules.
Ovary superior, 5-celled. . . . . CAMELLIA F. 75
Ovary partly inferior, becoming one-celled and one-seeded. . . . . . . STORAX F. 220
Stamens separate: leaves alternate, mostly with stipules. . . . . PEAR F. 117
Stamens separate: leaves opposite or some of them scattered: no stipules.
Calyx-tube or cup wholly adherent to the 3–5-celled ovary. . . . . . . SAXIFRAGE F. 131
Calyx-cup extended beyond the free or adherent few–many-celled ovary. . . LOOSESTRIFE F. 149

B. *Stamens not exceeding* 10, *or if so not more than twice the number of the petals or divisions of the calyx.*

1. *Calyx free from the two or more separate or nearly separate ovaries.*
Woody twiners, with dioecious flowers, separate stamens opposite as many petals, and few pistils. . . . MOONSEED F. 44
Woody trees, with [illegible] flowers, [illegible] stamens, and many pistils in a head, in fruit scattered in a spike. MAGNOLIA F. 42
Trees, with dioecious or polygamous (rarely perfect) flowers, pinnate leaves, and few winged fruits. . . . . . . QUASSIA F. 83
Trees, with dioecious or herbs with perfect flowers: leaves pinnate, [illegible] dotted, strong-scented or aromatic. . . RUE F. 81
Herbs or shrubs: leaves not dotted: flowers chiefly perfect.
Succulent or fleshy plants: pistils, petals, and sepals all equal in number. . . . . ORPINE F. 137
Not succulent nor fleshy-thickened.
Stamens inserted on the calyx: leaves alternate. . . . . ROSE F. 115, & SAXIFRAGE F. 131
Stamens inserted on a disk adhering to bottom of the calyx: leaves opposite, compound. See Staphylea, SOAPBERRY F. 88
Stamens inserted on the receptacle. . . . . CROWFOOT F. 33

2. *Calyx free from the single (simple or compound) ovary; i. e. ovary superior.*
Stamens of the same number as the petals and opposite them.
Anthers opening by uplifted valves: ovary simple, 1-celled. . . BARBERRY F. 44
Anthers opening lengthwise.
Ovary 1-celled, 1-ovuled: styles 5. . . . . LEADWORT F. 222
Ovary 1-celled, with several ovules on a central placenta.
Style and stigma only one: calyx persistent. . . PRIMROSE F. 222
Style or stigma cleft or lobed. . PURSLANE F. 69

Ovary 5-celled, with several ovules in each cell. . . . . STERCULIA F. 75
Ovary 2-celled, with a pair of erect ovules in each cell. . . . . VINE F. 85
Ovary 2–4-celled, with one erect ovule in each cell. . . . . BUCKTHORN F. 86

Stamens ... of the same number as the petals alternate with them, ... more ... fewer.
Leaves opposite, with pellucid and dark dots, ... entire: calyx ... t ... . ST. JOHN'S WORT F. 61
Leaves ... with large ... pellucid dots: leaves alternate or ... ound. . . . . RUE F. 81
Leaves not opposite with ... pellucid dots.

Ovary simple, as shown by the style, ... and single parietal placenta. . . . . PULSE F. 94
Ovary ... simple, 1-celled, 1-seeded: style ... . Fumaria, FUMITORY F. 49
Ovary compound, as shown by the number of cells, placentæ, styles, or stigmas.
With 2 parietal placentæ, but 2-celled by a partition between: stamens ... tetradynamous. . . . . MUSTARD F. 51
With 2 parietal placentæ and 1-celled: ... stamens 6, separate, not tetradynamous. . . . . . . CAPER F. 56
With 2 parietal placentæ, and 1-celled: stamens 6 in 2 sets. . . . . FUMITORY F. 49
With 3 (rarely 5) parietal placentæ, and 1-celled: stamens not 6.
Stamens inserted on the calyx, or with 5 ... of ... stamen-like bodies. . . . SAXIFRAGE F. 131
Stamens on the long stalk of the ovary: ... filaments. . . . . PASSION-FLOWER F. 157
Stamens on the receptacle.
Flower irregular: style 1. VIOLET F. 58
Flower regular: styles ... .
Styles or their ... twice as many as the placentæ: leaves gl... and-bristly. . . . SUNDEW F. 59
Styles as many as the placentæ: leaves ... ed or ... ed. . . . . . TAMARISK F. 63
Style and stigma one: stamens 5: leaves ... . PITTOSPORUM F. 57
Style and stigma one, or ... stigmas 3: stamens not 5. . . . . ROCK-ROSE F. 60
With one cell, one erect ovule, and 3 styles or stigmas. . . . . CASHEW F. 84
With one cell and many ovules on a central placenta. . . . . PINK F. 63
With two cells and several or many ovules in the centre, but becoming 1-celled.
Stamens 2 or 3 on the receptacle. . . . . WATER-WORT F. 63
Stamens 4–12, on the calyx. LOOSESTRIFE F. 149

With two cells and a single ing ovle in each cell.
Flowers irregular : tms 6 or 8, lhus or I ms : anthers opening at the apex. . . . . POLYGALA F. 92
Flowers lgr, with narrow tals : shrubs or trees. . . . . . . WITCH-HAZEL F. 140
With alte ple leaves ad 4 tms with anthers. . . . . OLIVE F. 279
With opte des nd 2 (rarely 3 or 4) stamens. . . . .

With more than two cells, or wn nly wo cells with 2 or more ovules in each cell.
Seeds ery ms in each of he 3–5 cells of he pod : tyle 1 : stamens on the receptacle. . . HEATH F. 210
Seeds m, or few on a stalk bursting out of the pod : style 1 : stamens on the calyx. LOOSESTRIFE F. 149
Seeds indefinitely mus : sty ds 2 or m, or plitting into 2 : stamens on the calyx. . SAXIFRAGE F. 131
Seeds eal or few, at at the ms 3–12 in each cell.
Shrubs, with ple leaves of 3 or 5 lts, and a dry pd. . . . . BLADDERNUT F. 89
Herbs, wth alternate or radical ads of 3 or more lts : wr regular. . Oxalis, } GERANIUM F. 77
Herbs, wth ple alternate des : fwer irregular. . . . . . Impatiens, }
Shrubs, with simple ads : eds in a pulpy aril. . . . . STAFF-TREE F. 87

Seeds and ovules only ne or two in ah cell.
Tree, wth twe pinnate leaves, nd nrs within he the of ned fts. . . . . . MELIA F. 84
Shrubs or herbs, with tns ls only at b, nd td 1 aes. }
Herbs, wth alternate leaves, mstly of gnt tse nd dr, no endrils wn climbing : } GERANIUM F. 77
stamens separate. . . . .
Herbs, with alternate and compound insipid leaves, climbing by a hook or tendril in the flower-cluster. . . . . Cardiospermum, SOAPBERRY F. 88
Herbs (or one species shrubby), with simple and entire scentless leaves, and stamens often slightly monadelphous at the base. . . . . FLAX F. 77
Shrubs or trees : leaves not aromatic-scented : stamens separate.
Leaves simple, not lobed : fruit a small berry. . . . . HOLLY F. 218
Leaves simple, not lobed : fruit a colored pod : seeds in a red pulpy aril. . STAFF-TREE F. 87
Leaves simple, palmately-lobed or cleft, opposite. . . . . MAPLE F. 89
Leaves compound, pinnate or digitate. . . . . SOAP-BERRY F. 88

II. MONOPETALOUS DIVISION OF EXOGENS.

A. *Calyx with its tube adherent to the ovary, i. e. superior, or ovary inferior.*

Flowers collected in a head which is provided with a calyx-like involucre: anthers syngenesious, i. e. united into a tube or ring around the style, only 4 or 5. . . . . COMPOSITE FAMILY, 179

Flowers not involucrate, or when in an involucrate head having the anthers separate.

Tendril-bearing herbs: leaves alternate: flowers monœcious or diœcious. . . . . . GOURD F. 158

Not tendril-bearing: flowers commonly perfect, at most polygamous.

Stamens free from the corolla, or at most lightly cohering with its very base.

Flowers irregular: stamens with the 5 anthers and sometimes the filaments also united. . . . LOBELIA F. 208

Flowers regular: herbs, with some milky juice: stamens only as many as the lobes of the corolla. CAMPANULA F. 209

Flowers regular: shrubs, or evergreen and trailing: stamens twice as many as lobes of corolla. WHORTLEBERRY F. 211

Stamens borne on the tube of the corolla and fewer than its lobes, viz.

One to three: ovary sometimes 3-celled, but the fruit only 1-celled and 1-seeded. . . . . . VALERIAN F. 177

Four, two of them shorter: ovary 3-celled, but two cells empty: fruit one-seeded. Linnæa, HONEYSUCKLE F. 169

Four, one longer and one shorter pair: ovary one-celled: fruit very many-seeded. . . . . . GESNERIA F. 228

Stamens borne on the corolla, twice or more than twice the number of its lobes, more or less monadelphous or 5-adelphous: leaves alternate. . . . . STORAX F. 220

Stamens borne on the tube of the corolla, just as many as its lobes: leaves opposite or whorled. . . . . CINCHONA F. 173

With stipules, entire. . . . . MADDER F. 173

Without stipules, entire, in whorls: ovary 2-celled: fruit twin, 2-seeded. . . . .

Without true stipules, often toothed or compound, chiefly opposite: flowers not in a proper head. HONEYSUCKLE F. 169

Without stipules, often toothed or cut: flowers in an involucrate head: ovary 1-celled, 1-seeded. . . TEASEL F. 178

B. *Calyx free from the ovary, i. e. inferior, or ovary superior.*

Corolla more or less irregular.

Stamens 10 or 5, distinct: anthers opening by a hole at the apex of each cell: ovary 5-celled. . . HEATH FAMILY, 210

Stamens 10, (monadelphous or diadelphous): anthers opening lengthwise: ovary 1-celled. . . . . PULSE F. 94

Stamens 8 or 6, monadelphous or (diadelphous): anthers opening by a hole at the apex: ovary 2-celled. . . POLYGALA F. 92

Stamens 6, diadelphous: the middle anther of each set 2-celled, the other two 1-celled: ovary 1-celled. . . FUMITORY F. 49

Stamens (with anthers) 5.

Ovary deeply 4-lobed, making 4 seed-like fruits or pieces. . . . . Echium, BORAGE F. 254

Ovary not divided: fruit (usually a pod) many-seeded.

Calyx urn-shaped, enclosing the pod, which is 2-celled, the top separating as a lid. Hyoscyamus, NIGHTSHADE F. 265

Calyx 5-cleft or 5-parted: pod 2-valved. . . . . Verbascum, &c., FIGWORT F. 229

Stamens (with anthers) 4 or 2.

Ovary 1-celled with a central placenta, bearing several or many seeds: stamens 2. . . . . . BLADDERWORT F. 225

Ovary 1-celled with 2 or 4 parietal placentæ: stamens 4, didynamous.

Leafless plants, brownish or yellowish, never green, with scales in place of foliage. . . . BROOM-RAPE F. 228

Leafy plants, with ordinary foliage.

Not climbing: seeds minute, wingless. . . . . GESNERIA F. 228

Climbing: seeds winged. . . . . BIGNONIA F. 226

Ovary 2-celled, many-seeded: pod becoming very long: many flat and winged seeds: woody climbers or trees. BIGNONIA F. 226

Ovary 4-celled (but stigmas only 2): many flat and more or less large seeds, filled by the embryo: herbs. . SESAMUM F. 227

Ovary 2-celled, many-seeded or few-seeded, the placenta in the axis.

Seeds few or several in each cell, flat and borne on hook-like projections of the placentæ, or globular on a cartilaginous ring: no albumen. . . . . ACANTHUS F. 239

Seeds many or few in each cell, not borne on hooks, &c.: embryo in albumen. . . . . FIGWORT F. 229

Ovary 2–4 celled, rarely 1-celled, with only a single ovule or seed in each cell, not lobed. . . . . . . VERVAIN F. 241

Ovary 4-lobed, making 4 seed-like pieces or nutlets around the single style. . . . . MINT F. 243

Ga ... gr.

t ... more numerous than the divisions of the ... la. ... e, from the ... in of the bases of the ... als, some

of the ... ing, ... ed as ... may be ... ght.

... s ... ie ... pie, or ... e ... y ... n, ... 1-celled. . . . . MIMOSA F. 99

Leaves ... ly compound, of 3 ... s: ... y 5- ... ed: ... s 0, ... s at the ... ... lis, GERANIUM F. 77

... s simple, in one ... pd, ... y, very ... s - ... ls as ... y as ... s of the ... a. ORPINE F. 137

Leaves ... le or ... bed or ... s ... s: ... s kidney-shaped, 1-celled. . MALLOW F. 70

Leaves ... le, not ... bed or divided, nor ... y: ... s 2- ... ed: pistil ... d, ... e ... n 1-celled.

Stamens on the ... ple, free or ... y ... e from the ... a: an ... s ... y ... ning at the end. HEATH F. 210

Stamens on the ... a or ... y so: ... s opening ... e: ... s or ... s.

F ... s ... s or diœcious: ... s ... e: styles 4, ... h 2-lobed. . . . . . . EBONY F. 219

Flowers perfect: ... s ... e or less ... s or ... 5 ... d.

Base of the ... k ... t with the ... e of the ... y. . . . . STORAX F. 220

... x ... lly ... e from the ... y. . . . . CAMELLIA F. 75

S ... s (with ...) as ... y as the ... s or divisions of the corolla and opposite them.

S ... s or ... s 5: ... y 1-celled: ... le ... d ... ed solitary. . . . . LEADWORT F. 222

Style and stigma only ... e.

... s: ovary 1-celled with a central placenta: ... s few or ... y. . . . . PRIMROSE F. 222

... s or ... : ... y 5-celled: fruit 1 – fe ... d: petal-like ... s ... e with the anthers. SAPODILLA F. 220

S ... s (with ...) as ... y as the lobes or parts of the corolla ... d ... e with ... m.

... il one and simple, with one parietal placenta: fruit a ... e or l ... ment: leaves twice ... pie. . . . . MIMOSA F. 99

Pistils as ... y as the l ... s of the corolla, separate: fl ... y ... ls. . . . . ORPINE F. 137

Pistils ... al or ... y as to the ... y, or ovaries deeply ... d, the l ... s or ... s ... ing so many separate

little ... d fruits or ... , but all ... d one ... n style.

... s or ... s ... s in a ... p or ... al in a circle. . . . . NOLANA F. 266

... s or ... s only 4 ... d the ... e of the ... n ... e.

... tic ... ps, with ... e leaves. . . . . Mentha, &c., MINT F. 243

Not ... ic, with ... e ... d ... ly ... h leaves. . . . BORAGE F. 254

Two or three 2-ovuled or four one-ovuled cells : seeds large : mostly twiners. CONVOLVULUS F. 262
Two or rarely more many-ovuled cells : seeds numerous.
Styles 2, or rarely 3, or two-cleft. . . . . . WATERLEAF F. 258
Style and stigma only one. . . . . NIGHTSHADE F. 265
Leaves none : leafless parasitic twiners, destitute of green herbage. . . . DODDER F. 263
Stamens fewer than the lobes or divisions of the corolla,
Four, mostly didynamous.
Ovary 2-celled, with usually many ovules in each cell. . . . . FIGWORT F. 229
Ovary 2-celled, with few or several ovules in each cell : seeds flat, on hooks. . ACANTHUS F. 239
Ovary 2 – 4-celled, with a single ovule in each cell. . . . . VERVAIN F. 241
Two only with anthers, and two sterile ones : ovary deeply lobed. . . . Lycopus, MINT F. 243
Two, exserted : herbs, or some exotic species are low shrubby plants. . . Veronica, FIGWORT F. 229
Two, occasionally three : shrubs, trees, or woody twiners. . . . . OLIVE F. 279

III. APETALOUS DIVISION OF EXOGENS.

A. *Flowers not in catkins.*

Ovary 2 – 6-celled, its cells containing numerous ovules.
Six-celled, the tube of the calyx coherent with its surface or the lower part of it : lobes of the calyx 3. . . . [illegible]RT F. 282
Four-celled, the tube of calyx coherent with its surface : lobes of calyx and stamens 4. Ludwigia, EVENING P[illegible]SE F. 141
Five-celled, free from the calyx : stamens 10. . . . . Penthorum, [illegible]E F. 137
Three-celled, free from the calyx of 5 sepals white inside : stamens 3. . . . . Mollugo, PINK F. 63
Two-celled or four-celled, free from but enclosed in the cup-shaped calyx : stamens 4. . Ammannia, LOOSESTRIFE F. 149
Two-celled, many pistils in a head : no calyx : flowers monoecious. Tree. . . . Liquidambar, [illegible]L F. 140
Ovary 1 – 2-celled, several-ovuled on one side of a basal placenta. . . . . Cuphea, [illegible]FE F. 149

Ovary or ovaries one-celled, with numerous or several ovules, on parietal placentæ.

Calyx coherent: placentæ 2. . . . . Chrysosplenium, SAXIFRAGE F. 131

Calyx free, of 2 sepals: placentæ 2. . . . . Bocconia, POPPY F. 48

Calyx free, of 4 or more sepals: placentæ 1. . . . . CROWFOOT F. 33

Ovary one-celled, with several or many ovules from the bottom or on a central placenta, free from the calyx.

Flowers surrounded by dry scarious or colored bracts: pod opening by a transverse line above the base. . . AMARANTH F. 286

Flowers without colored bracts: pod splitting from the top. . . . . CHICKWEED F. 64

Ovary or separate ovaries one-celled, with one or sometimes two or three ovules.

Woody plants, parasitic on trees, dioecious. . . . . MISTLETOE F. 292

Woody or partly woody climbers by their leafstalks. . . . . Clematis, CROWFOOT F. 33

Trees or shrubs, not climbing.

Leaves pinnate, aromatic, their stalks mostly prickly: pistils more than one. . . . . . Zanthoxylum, RUE F. 81

Leaves pinnate, not aromatic nor prickly: pistil one. . . . . Fraxinus, OLIVE F. 279

Leaves simple, beset with silvery (rarely coppery) scurf or scurfy down. . . . . OLEASTER F. 292

Leaves simple, not silvery-scurfy,

Aromatic or spicy-scented: calyx mostly corolla-like: anthers opening by uplifted valves. . . . . LAUREL F. 290

Aromatic-scented: no proper calyx: anthers not opening by valves. . . . . SWEET-GALE F. 305

Not aromatic: juice milky: stamens in clusters: flowers in a closed receptacle, which becomes pulpy. . Fig, FIG F. 296

Not aromatic, and juice not milky: the leaves

Palmately lobed and veined, with sheathing stipules: no evident calyx.e . . . . . . PLANE-TREE F. 300

Mostly toothed, feather-veined, sometimes also with ribs from the base: calyx free from the ovary. . ELM F. 296

Entire: calyx corolla-like and free from the ovary: flowers perfect. . . . . MEZEREUM F. 291

Entire (rarely toothed): tube of calyx coherent with ovary: flowers dioeciously polygamous

Ovary and fruit pear-shaped: stigma terminal . . . . SANDALWOOD F. 292

Ovary globular or oval: stigma running down one side of the awl-shaped style. . Nyssa, DOGWOOD F. 167

Herbs, with sheathing stipules above the tumid joints of the stem: leaves alternate. . . . . . . BUCKWHEAT F. 287

Herbs, with the stipules if any not in the form of sheaths.

Pistils numerous or several: calyx commonly corolla-like: stipules none. . . . . CROWFOOT F. 33

Pistils 3 or 4 : calyx as well as corolla n: flowers perfect, in a spike. . . . . . . LIZARD'S-TAIL F. 293
Pistils 1 – 4, lnd by the point lyx : leaves ite, pi ne or 1 bed, with stipules. . (Dn, &c., ROSE F. 115
Pistil only one, with 2 hairy styles or stigmas : leaves palmately pod or cleft : flowers dis. . . HEMP F. 297
Pistil only n: leaves ple.
lyx corolla-like (white), its tant with the ovary : fls perfect : leaves nate. . SANDALWOOD F. 292
Calyx ile, fe from the oxy, but the be of its ube hardening and sit as a
ring to the thin be, king a ort of n-like fruit : style and stigma simple. . FOUR-O'CLOCK F. 23
Calyx gi, ms colored or corolla like : ed ly.
Style or stigma ne and ple : flrs monœcious or diœc' ms. . . . . . . NETTLE FAMILY, 296
Styles or stigmas 2 or 3, or 2 – 3-cleft : flwrs nly perfect.
Flowers crowded with dry and ms bs. . . . . AMARANTH F. 286
Fls without ited and ms bts.
Leaves hdly nte, in thd, cleft, or 1 bd. . . . . . . GOOSEFOOT F. 284
Leaves p, entire. . . . . CHICKWEED F. 64
Calyx none, : ept as an adherent ring to the oxy, without lobes : tic. . . WATER-MILFOIL F. 140
Ovary 2 – 10-celled, with ne or two ds in ah cell.
Aic rh, with 3 ld n-like litle fits in the xils of the leaves or bracts. . . . . WATER-MILFOIL F. 140
Herbs, shrubs, rarely trees, with ms frs, 3- led oxry and ld pod : the ots and ds ngle
or a pair hanging fm the summit of the ell : jnce ily, : ept in the Box, &c. . . . . . SPURGE F. 23
Herbs, with tout hollow m, pet flrs, and 10- led ovary, becoming rie. . . . . . POKEWEED F. 284
Shrubs or tes, with 2-celled ovary, and winged fruit (samara or key),
Of two keys, jnd at thir be and winged fom the apex. . . . . MAPLE F. 89
Of a igle ky, wgd from the px or almost all rnd . leaves pinnate. . . Fraxinus, OLIVE F. 279
Of a single ky, thin-winged all rnd : leaves ple. . . . . ELM F. 296
Shrubs or tes with gs 2 – 4-celled fit, no ilky j ui, ad
Perfect or ms ids flowers : ms 4 or 5 : eds et. . . . . BUCKTHORN F. 86
Perfect fles : ms bt 2, white : seeds ing. . . Fothergilla, WITCH-HAZEL F. 140

I. SPADICEOUS DIVISION OF ENDOGENS.

Trees or woody plants with simple trunk, caudex, or stock: leaves persistent, long-petioled, fan-shaped and plaited or pinnate: spadix branched: floral envelopes of 3 or 6 parts. . . . . PALM F. 316

Immersed aquatics, branching and leafy. . . . . PONDWEED F. 316

Small or minute free-floating aquatics, with no distinction of stem and foliage. . . . . DUCKWEED F. 316

Reed-like or Flag-like marsh herbs, with linear and sessile nerved leaves.

Flowers crowded in the spike or head: no distinct perianth. . . . . CAT-TAIL F. 318

Flowers with a 6-parted perianth. . . . . Acorus, ARUM F. 317

Terrestrial or marsh-plants, with leaves of distinct blade and petiole, the veins netted. . . . . ARUM F. 317

II. PETALOIDEOUS DIVISION OF ENDOGENS.

Pistils more than one, mostly numerous, separate or nearly so: perianth of 3 green sepals and 3 colored petals: leaves mostly netted-veined between the ribs. . . . . WATER-PLANTAIN F. 319

Pistil only one as to the ovary.

Perianth adherent to the ovary, or superior, i. e. ovary inferior.

Flowers dioecious: stems twining: leaves with distinct petiole and blade, the veins or veinlets netted. . . . . YAM F. 335

Flowers dioecious or polygamous: aquatic herbs: flowers from a spathe. . . . . FROG'S-BIT F. 321

Flowers perfect.

Anthers only one or two, borne on or united with the style or stigma: flower irregular. . . . . ORCHIS F. 323

Antner only one, embracing the slender style but not united with it, 2-celled: flower irregular. . . . . GINGER F. 328

Anther only one, free from the style, one-celled: flower irregular. . . . . ARROWROOT F. 328

Anthers 5 (one abortive filament without any anther): flower somewhat irregular. . . BANANA F. 328
Anthers 3, turned outwards: filaments either separate or monadelphous. . . . . . . IRIS F. 332
Anthers 6, all the stamens being perfect.
Epiphytes or air-plants, except the Pine-Apple. . . . . PINE-APPLE F. 329
Terrestrial plants, chiefly from bulbs or corms, some from tubers, fibrous roots, or rootstocks. AMARYLLIS F. 329
Perianth free from the ovary, or very nearly so.
Epiphytes or air-plants, with dry and often scurfy leaves. . . . . Tillandsia, PINE-APPLE F. 329
Aquatic herbs: flowers irregular as to the (corolla-like) perianth or stamens, or both. . . . PICKEREL-WEED F. 322
Terrestrial herbs or sometimes woody plants, not rush-like or grass-like.
Perianth of green sepals and colored petals which are entirely different.
Styles or sessile stigmas 3, separate: petals 3, not equal: leaves netted-veined. . . Trillium, LILY F. 337
Style and stigma one: petals 3 or 2, equal. . . . . SPIDERWORT F. 350
Perianth with all 6 (in one instance only 4) parts colored alike or nearly so.
Anthers one-celled: plants mostly climbing by tendrils on the petiole. . . . SMILAX F. 336
Anthers 2-celled. . . . . LILY F. 337
Terrestrial or aquatic rush-like or grass-like plants, with small regular flowers,
Not in a simple scaly-bracted head: perianth glumaceous. . . . . RUSH F. 349
In a simple spike or raceme: flowers bractless, perfect: perianth herbaceous. . ARROW-GRASS F. 319
In a simple scaly-bracted head on a scape: leaves all from the root.
Perianth yellow, the inner divisions or petals with claws: flowers perfect: pod
1-celled, many-seeded, the placentae parietal. . . . . YELLOW-EYED GRASS F. 351
Perianth white or whitish: flowers monoecious or dioecious: pod 2-3-celled, 2-3-seeded. . . PIPEWORT F. 352

III. GLUMACEOUS DIVISION OF ENDOGENS.

Ovary 3-celled or 1-celled with 3 parietal placentæ, becoming a pod, 3 – many-seeded: flowers with a regular perianth of six glumaceous sepals. In structure of the flower most like the Lily Family; but the glumaceous perianth and the herbage unite this division. . . . . RUSH F. 349

Ovary 1-celled, 1-ovuled, in fruit an akene or grain. True glumaceous plants; the glumes being bracts.

Glumes single, bearing a flower in the axil. . . . . SEDGE F. 352

Glumes in pairs, an outer pair for the spikelet, an inner pair for each flower. . . . . . . GRASS F. 353

ACROGENOUS CRYPTOGAMOUS PLANTS.

With many-jointed stems and no leaves, except the united scales or teeth that form a sheath or ring at each joint: spore-cases in a terminal head or spike. . . . . HORSETAIL F. 359

With ample leaves often compound, all from a rootstock or trunk, and bearing the minute spore-cases. . . . . . FERN F. 360

With scale-shaped, linear, or awl-shaped and wholly simple leaves thickly set on the leafy stems: spore-cases in the axil of some of them. . . . . CLUB-MOSS F. 372

KEY TO THOSE ENDOGENS WHICH FROM THEIR FOLIAGE MIGHT BE MISTAKEN FOR EXOGENS.

Flowers placed on a spadix, and with a prominent spathe. . . . . ARUM F. 317

Flowers not on a spadix: pistils several or many: calyx and corolla distinctly different. WATER-PLANTAIN F. 319

Flowers not on a spadix: pistil only one.

Calyx adherent with the ovary: flowers dioecious or polygamous.

Small plants, twining: small flowers in racemes, spikes, or panicles. . . . . YAM F. 335

Aquatic plants: flowers from a spathe. . . . . FROG'S-BIT F. 321

Calyx free from the ovary.

Aquatic herbs: flowers more or less irregular, from a sort of spathe. . . . PICKEREL-WEED F. 322

Terrestrial herbs, not climbing: anthers 2-celled. . . . . Trillium, &c., LILY F. 337

Terrestrial and mostly climbing shrubs or herbs, with tendrils on the petiole: anthers one-celled. . . SMILAX F. 336

SERIES I.

FLOWERING OR PHÆNÓGAMOUS PLANTS:

THOSE which fructify by means of stamens and pistils, and produce true seeds.

CLASS I. DICOTYLÉDONOUS OR EXÓGENOUS PLANTS: Distinguished by having the wood or woody matter of the stem all in a circle between pith and bark, and in yearly layers when the stem is more than one year old: also the embryo with a pair of cotyledons or seed leaves (or several in Pines, &c.). Generally known at once by having netted-veined leaves. Parts of the flower seldom in threes, most commonly in fives or fours. See Lessons, p. 183. This class includes all our ordinary trees and shrubs, and the greater part of our herbs.

SUBCLASS I. ANGIOSPERMOUS: including all of the class which have their seeds in a pericarp, or their ovules in a closed ovary, i. e. all except the Pine and Cycas families.

I. POLYPETALOUS DIVISION. Includes the families which have, at least in some species, both calyx and corolla, the latter with their petals separate, i. e. not at all united into one body. Yet some plants of almost all these families have apetalous flowers.

1. RANUNCULACEÆ, CROWFOOT FAMILY.

Not perfectly distinguished by any one or two particular marks, but may be known, on the whole, by having an acrid watery juice (not milky or colored), numerous stamens, and usually more than one pistil, all the parts of the flower separate from each other, and inserted on the receptacle. The bulk of the seed is albumen, the embryo being very small. The plants are herbs, or a few barely shrubby. Many are cultivated for ornament. The following are the common genera, with their chief distinctions.

§ 1. *Sepals valvate* or *with their edges turned inward in the bud. Petals none or minute. Pistils many,* 1-*seeded, becoming akenes. Leaves opposite: the plants mostly climbing by their leaf-stalks.*

1. CLEMATIS. Sepals commonly 4, sometimes several, petal-like. Akenes tipped with the persistent style or a part of it.

§ 2. *Sepals imbricated in the bud. Not climbing, nor woody except in* 8 *and one of* 20.

* *Pistils and akenes several or many in a head,* 1-*seeded.*

+– *Petals none: sepals petal-like.*

2. HEPATICA. Involucre close to the flower, exactly imitating a 3-leaved calyx. Sepals 6 or more, oblong, resembling petals. Pistils 12–20. Stemless low perennials, with rounded 3-lobed leaves and 1-flowered scapes.
3. ANEMONE. Involucre of 2 or more opposite or whorled green leaves much below the flower. Sepals 4–20. Pistils very many in a close head (or fewer in one speeies), forming pointed or tailed akenes.
4. THALICTRUM. Involucre none, and stem-leaves all alternate, except in one species intermediate between this genus and Anemone. Sepals 4 or more. Pistils 4–15, forming several-angled or grooved akenes. Perennials, with small flowers in panicles or umbels, most of them diœcious, and with ternately compound or decompound leaves.

+– +– *Petals and sepals both conspicuous,* 5 *or more. Akenes naked, short-pointed.*

5. ADONIS. Petals and sepals naked, no pit or appendage at the base. Akenes in a head or short spike.
6. MYOSURUS. Sepals with a spur at the base underneath. Petals on a slender claw, which is hollow at its apex. Akenes in a long tail-shaped spike.
7. RANUNCULUS. Sepals naked. Petals with a little pit or a scale on the short claw. Akenes in a head.

* * *Pistils several,* 2-*ovuled, becoming* 1–2-*seeded pods or berries.*

8. ZANTHORHIZA. Sepals 5, deciduous after flowering. Petals 5, small, 2-lobed, on a claw. Stamens 5–10. Little pods 1-seeded. Undershrub, with yellow wood and roots.
9. HYDRASTIS. Sepals 3, falling when the flower opens. Petals none. Fruit berry-like. Low perennial.

* * * *Pistils several, few, or one, forming several-seeded pods or rarely berries.*

+– *Sepals* (4 or 5) *falling when the flower opens, petal-like. Petals minute, and with claws, or none. Stamens numerous, white. Leaves ternately decompound.*

10. ACTÆA. Pistil only one, becoming a berry. Flowers in a short and thick raceme or cluster.
11. CIMICIFUGA. Pistils 1–8, becoming pods in fruit. Flowers in long racemes.

+– +– *Sepals not falling when the flower opens, in* 15 *and* 20 *persistent even till the fruit matures, in all the others petal-like and deciduous.*

++ *Petals none at all: flowers regular.*

12. CALTHA. Sepals 5–9. Pods several. Leaves simple and undivided, rounded.

++ ++ *Petals* 5 *or more inconspicuous nectar-bearing bodies, very much smaller than the sepals: flower regular.*

13. TROLLIUS. Sepals 5–many. Petals with a little hollow near the base. Pods sessile. Leaves palmately parted and lobed.
14. COPTIS. Sepals 5–7. Petals club-shaped and tubular at the top. Pods raised on slender stalks! Leaves with 3 leaflets.
15. HELLEBORUS. Sepals 5, persistent, enlarging and turning green after flowering! Petals hollow and 2-lipped. Leaves palmately or pedately divided.
16. NIGELLA. Sepals 5. Petals 2-lobed. Pods 3–5 or more united below into one! Annuals, with finely dissected leaves.

++ ++ ++ *Petals large hollow spurs projecting between the sepals: flower regular.*

17. AQUILEGIA. Sepals 5. Pistils about 5, with slender styles, and forming narrow pods. Perennials, with ternately compound or decompound leaves.

++ ++ ++ ++ *Petals* 2 *or* 4, *much smaller than the* 5 *unequal sepals: i. e. the flower irregular and unsymmetrical. Leaves palmately lobed or parted. Pods* 1–5.

18. DELPHINIUM. Upper sepal spurred; the spur enclosing the spurs of the upper pair of petals: lower pair of petals spurless or wanting.
19. ACONITUM. Upper sepals in the form of a hood or helmet, covering the two very long-clawed and peculiar little petals.

++ ++ ++ ++ ++ *Petals large and flat, of ordinary shape. Sepals herbaceous and persistent! Flowers large, regular.*

20. PÆONIA. A fleshy disk surrounds the base of the 2 or more pistils, which form leathery pods in fruit. Seeds large, rather fleshy-coated. Perennials, with compound or decompound leaves: one species shrubby.

§ 1. *Long hairy styles form feathery tails to the akenes, like those of Virgin's Bower: fl. large, purple, in early spring. The genus* PULSATILLA *of some authors.*

A. Pulsatílla, PASQUE-FLOWER, of Europe. Cult. in some flower-gardens; has the root-leaves finely thrice-pinnately divided or cut; otherwise much like the next.

A. pàtens, var. **Nuttalliàna,** WILD P. On the plains N. W.; the handsome purple or purplish flower (2′ or more across when open) rising from the ground on a low soft-hairy stem (3′–6′ high), with an involucre of many very narrow divisions; the leaves from the root appearing later, and twice or thrice-ternately divided and cut.

§ 2. *Short styles not making long tails, but only naked* or *hairy tips.*

* *Garden* ANEMONIES, *from S Eu., with tuberous roots and very large flowers.*

A. coronària, with leaves cut into many fine lobes, and 6 or more broad oval sepals, also

A. horténsis, with leaves less cut into broader wedge-shaped divisions and lobes, and many longer and narrow sepals, — are the originals of the showy, mostly double or semi-double, great-flowered GARDEN ANEMONIES, of all colors, red in the wild state, — not fully hardy, treated like bulbs.

* * *Wild species, smaller-flowered.*

+ *Pistils very many, forming a dense woolly head in fruit: leaves of the involucre long-petioled, compound: flowers of* 5 *small greenish-white sepals, silky beneath: stem* 2°–3° *high.*

A. cylíndrica, LONG-FRUITED A. Involucre several-leaved surrounding several long naked peduncles; fl. late in spring (in dry soil N. & W.), followed by a cylindrical head of fruit.

A. Virginiàna, VIRGINIAN A. Involucre 3-leaved; peduncles formed in succession all summer, the middle or first one naked, the others bearing 2 leaves (involucel) at the middle, from which proceed two more peduncles, and so on: head of fruit oval or oblong. Common in woods and meadows.

+ + *Pistils fewer, not woolly in fruit: flower* 1′ or *more broad.*

A. Pennsylvànica, PENNSYLVANIAN A. Stem 1° high, bearing an involucre of 3 wedge-shaped 3-cleft and cut sessile leaves, and a naked peduncle, then 2 or 3 peduncles with a pair of smaller leaves at their middle, and so on; fl. white, in summer. (Lessons, fig. 179.) Alluvial ground, N. & W.

A. nemoròsa, WOOD A. Stem 4′–10′ high, bearing an involucre of 3 long-petioled leaves of 3 or 5 leaflets, and a single short-peduncled flower; sepals white, or purple outside. Woodlands, early spring.

4. THALÍCTRUM, MEADOW-RUE. (Old name, of obscure derivation.) The following are the common wild species, in woodlands and low grounds.

§ 1. *Flowers perfect, few, in an umbel: resembling an Anemone: sepals* 5–10.

T. anemonoìdes, RUE-ANEMONE. A very smooth and delicate little plant, growing with Wood Anemone, which it resembles in having no stem-leaves except those that form an involucre around the umbel of white (rarely pinkish) flowers, appearing in early spring; leaflets roundish, 3-lobed at the end, long-stalked; ovaries many-grooved, and with a flat-topped sessile stigma: otherwise it would rank as an Anemone.

§ 2. *Flowers mostly diœcious and not handsome, small, in loose compound panicles; the* 4 or 5 *sepals falling early: stigmas slender: akenes several-grooved and angled: leaves ternately decompound* (Lessons, fig. 138), *all alternate; the uppermost not forming an involucre.*

T. dioicum, EARLY MEADOW-RUE. Herb glaucous, 1°–2° high; flowers greenish, in early spring; the yellowish linear anthers of the sterile plant hanging on long capillary filaments: leaves all on general petioles. Rocky woods.

T. purpuràscens, PURPLISH M. Later, often a little downy, 2°–4°

high; stem-leaves not raised on a general petiole; flowers greenish and purplish; anthers short-linear, drooping on capillary and upwardly rather thickened filaments.

T. Cornùti, Tall M. Herb 4°–8° high; stem-leaves not raised on a general petiole; flowers white, in summer; anthers oblong, not drooping; the white filaments thickened upwards. Low or wet ground.

5. ADÒNIS. (The red-flowered species fabled to spring from the blood of Adonis, killed by a wild boar.) Stems leafy; leaves finely much cut into very narrow divisions. Cult. from Europe for ornament

A. autumnàlis, Pheasant's-eye A. ① Stems near 1° high, it or the branches terminated by a small flower, of 5–8 scarlet or crimson petals, commonly dark at their base. Has run wild in Tennessee.

A. vernàlis, Spring A. ♃ Stems about 6′ high, bearing a large showy flower, of 10–20 lanceolate light-yellow petals, in early spring.

6. MYOSÙRUS, MOUSETAIL (which the name means in Greek). ①

M. mínimus. An insignificant little plant, wild or run wild along streams from Illinois S., with a tuft of narrow entire root-leaves, and scapes 1′–3′ high, bearing an obscure yellow flower, followed by tail-like spike of fruit of 1′–2′ long, in spring and summer.

7. RANÚNCULUS, CROWFOOT, BUTTERCUP. (Latin name for a little frog, and for the Water Crowfoots, living with the frogs.) A large genus of wild plants, except the double-flowered varieties of three species cult in gardens for ornament. (Lessons, p. 183, fig. 358–361.)

§ 1. *Aquatic; the leaves all or mostly under water, and repeatedly dissected into many capillary divisions: flowering all summer.*

R. aquàtilis, White Water-Crowfoot. Capillary leaves collapsing into a tuft when drawn out of the water; petals small, white, or only yellow at the base, where they bear a spot or little pit, but no scale: akenes wrinkled crosswise.

R. divaricàtus, Stiff W. Like the last, but less common; the leaves stiff and rigid enough to keep their shape (spreading in a circular outline) when drawn out of water.

R. multífidus, Yellow W. Leaves under water much as those of the White Water Crowfoots, or rather larger; but the bright yellow petals as large as those of Common Buttercups, and, like them, with a little scale at the base. (Formerly named R. Purshii, &c.)

§ 2. *Terrestrial, many in wet places, but naturally growing with the foliage out of water: petals with the little scale at the base, yellow in all the wild species.*

* *Akenes not prickly nor bristly nor striate on the sides.* ♃

+ Spearwort Crowfoots; *growing in very wet places, with mostly entire and narrow leaves: fl. all summer.*

R. alismæfòlius. Stems ascending, 1°–2° high; leaves lanceolate or the lowest oblong; flower fully ½′ in diameter; akenes beaked with a straight and slender style.

R. Flámmula. Smaller than the last, and akenes short-pointed; rare N., but very common along borders of ponds and rivers is the

Var. **réptans,** or Creeping S., with slender stems creeping a few inches in length; leaves linear or spatulate, seldom 1′ long; flower only ¼′ broad.

+ + Small-flowered Crowfoots; *in wet or moist places, with upper leaves 3-parted or divided, and very small flowers, the petals shorter or not longer than the calyx: fl. spring and summer.*

R. abortìvus, Small-flowered C. Very smooth and slender, 6′–2° high; root-leaves rounded, crenate; akenes in a globular head. Shady places, along watercourses.

R. sceleràtus, Cursed C. So called because the juice is very acrid and blistering; stouter than the last and thicker-leaved, equally smooth, even the root-leaves lobed or cut; akenes in an oblong or cylindrical head. In water or very wet places.

R. recurvàtus, Hook-styled C. Hairy, 1° - 2° high; leaves all 3-cleft and long-petioled, with broad wedge-shaped 2 - 3-lobed divisions; akenes in a globular head, with long recurved styles. Woods.

R. Pennsylvànicus, Bristly C. Bristly hairy, coarse and stout, 2° - 3° high; leaves all 3-divided; the divisions stalked, again 3-cleft, sharply cut and toothed; akenes in an oblong head, tipped with a short straight style. Along streams.

+ + + Buttercups or Common Crowfoots, *with bright yellow corolla, about 1' in diameter, much larger than the calyx; leaves all once and often twice 3 - 5-divided or cleft, usually hairy; head of akenes globular.*

++ *Natives of the country, low or spreading.*

R. fasciculàris, Early B Low, about 6' high, without runners, on rocky hills in early spring; root-leaves much divided, somewhat pinnate; petals rather narrow and distant; akenes scarcely edged, slender-beaked.

R. rèpens, Creeping B. Everywhere common in very wet or moist places, flowering in spring and summer; immensely variable; stem soon ascending, sending out some prostrate stems or runners in summer; leaves more coarsely divided and cleft than those of the last; petals obovate; akenes sharp-edged and stout-beaked.

++ ++ *Introduced weeds from Europe, common in fields, &c., especially E.: stem erect: leaves much cut.*

R. bulbòsus, Bulbous B. Stem about 1° high from a solid bulbous base nearly as large as a hickory nut; calyx reflexed when the very bright yellow and showy large corolla expands, in late spring.

R. àcris, Tall B. Stem 2° - 3° high, no bulbous base; calyx only spreading when the lighter yellow corolla expands, in summer. Commoner than the last, except E. A full double-flowered variety is cult. in gardens, forming golden-yellow balls or buttons.

+ + + + Garden Ranunculuses. *Besides the double variety of the last, the choice Double Ranunculuses of the florist come from the two following.*

R. Asiàticus, of the Levant; with 3-parted leaves and flowers nearly 2' broad, resembling Anemonies, yellow, or of various colors. Not hardy N.

R. aconitifòlius, of Eu., taller, smooth, with 5-parted leaves, and smaller white flowers, the full double called Fair Maids of France.

* * *Akenes striate or ribbed down the sides.* ①

R. Cymbalària, Sea-side Crowfoot. A little plant, of sandy shores of the sea and Great Lakes, &c., smooth, with naked flowering stems 2' - 6' high, and long runners; leaves rounded and kidney-shaped, coarsely crenate; flowers small, in summer.

8. ZANTHORHÌZA, SHRUB YELLOW-ROOT. (Name composed of the two Greek words for *yellow* and *root.*) Only one species,

Z. apiifòlia. A shrubby plant, 1° - 2° high, with deep yellow wood and roots (used by the Indians for dyeing), pinnate leaves of about 5 cut-toothed or lobed leaflets, and drooping compound racemes of small dark or dull-purple flowers, in early spring, followed by little 1-seeded pods: grows in damp, shady places along the Alleghanies.

9. HYDRÁSTIS, ORANGE-ROOT, YELLOW PUCCOON. (Name from the Greek, probably meaning that the root or juice of the plant is drastic.) ♃ A single species,

H. Canadénsis. Low, sending up in early spring a rounded 5 - 7-lobed root-leaf, and a stem near 1° high, bearing one or two alternate smaller leaves above, just below the single small flower. The 3 greenish sepals fall from the bud, leaving the many white stamens and little head of pistils; the latter grow pulpy and produce a crimson fruit resembling a raspberry. Rich woods, from New York, W. & S.

16. NIGÉLLA, FENNEL-FLOWER. (Name from the black seeds.) ① Garden plants from Eu. and Orient; with leafy stems, the leaves finely divided, like Fennel; known by having the 5 ovaries united below into one 5-styled pod. Seeds large, blackish, spicy; have been used as a substitute for spice or pepper.

N. Damascèna, COMMON F. or RAGGED-LADY. Flower bluish, rather large, surrounded and overtopped by a finely-divided leafy involucre, like the other leaves; succeeded by a smooth inflated 5-celled pod, in which the lining of the cells separates from the outer part.

N. satìva, NUTMEG-FLOWER. Cult. in some old gardens; has coarser leaves, and smaller rough pods.

17. AQUILÈGIA, COLUMBINE. (From *aquila*, an eagle, the spurs of the petals fancied to resemble talons.) ♃ Well-known, large-flowered ornamental plants: flowers in spring and early summer, usually nodding, so that the spurs ascend.

* *North American species, with long straight spurs to the corolla.*

A. Canadénsis, WILD C. Flowers about 2′ long, scarlet and orange, or light yellow inside, the petals with a very short lip or blade, and stamens projecting. Common on rocks.

A. Skínneri, MEXICAN C., is taller, later, and considerably larger-flowered than the last, the narrower acute sepals usually tinged greenish; otherwise very similar. Cult.

A. cærùlea, LONG-SPURRED C., native of the Rocky Mountains, lately introduced to gardens, and worthy of special attention; has blue and white flowers, the ovate sepals often 1½′, the very slender spurs 2′ long, the blade of the petals (white) half the length of the (mostly blue) sepals, spreading.

* * *Old World species, with hooked or incurved spurs to the corolla.*

A. vulgàris, COMMON GARDEN C. Cult. in all gardens, 1° – 3° high, many-flowered; spurs rather longer than the blade or rest of the petal; pods pubescent. Flowers varying from blue to purple, white, &c., greatly changed by culture, often full double, with spur within spur, sometimes all changed into a rosette of plane petals or sepals.

A. glandulòsa, GLANDULAR C. A more choice species, 6′ – 1° high, with fewer very showy deep blue flowers, the blade of the petals white or white-tipped and twice the length of the short spurs; pods and summit of the plant glandular-pubescent.

A. Sibírica, SIBERIAN C. Equally choice with the last, and like it; but the spurs longer than the mostly white-tipped short blade, as well as the pods, &c. smooth.

18. DELPHÍNIUM, LARKSPUR. (From the Latin name of the dolphin, alluding to the shape of the flower.) The familiar and well-marked flower of this genus is illustrated in Lessons, p. 91, 94, fig. 183, 184, 192.

* *Garden annuals from Eu., with only the 2 upper petals, united into one body, one pistil, and leaves finely and much divided: fl. summer and fall.*

D. Consòlida, FIELD L. Escaped sparingly into roadsides and fields, flowers scattered on the spreading branches, blue, varying to pink or white; pod smooth.

D. Ajàcis, ROCKET L. More showy, in gardens, and with similar flowers crowded in a long close raceme, and downy pods; spur shorter: some marks on the front of the united petals were fancied to read AIAI = Ajax.

* * *Perennials, with 4 separate petals and 2 – 5, mostly 3 pistils.*

D. grandiflòrum, GREAT-FL. L. of the gardens, from Siberia and China, is 1° – 2° high, with leaves cut into narrower linear divisions; blue flowers, 1½′ or more across, with ample oval sepals, and the 2 lower petals rounded and entire. Various in color, also double-flowered; summer.

D. cheilánthum, of which D. FORMÒSUM, SHOWY L., is one of the various garden forms, also Siberian, is commonly still larger-flowered, deep blue, with lower petals also entire or nearly so; the mostly downy leaves have fewer and lanceolate or wedge-lanceolate divisions; is now much mixed and crossed with others: summer.

D. azùreum, Azure L. Wild S. & W., often downy, 1° – 3° high, with narrow linear divisions to the leaves, and a spike-like raceme of rather small, azure, pale-blue, or sometimes white flowers, in spring; sepals and 2-cleft lower petals oblong. Var. with full-double flowers in gardens: summer.

D. tricórne, Dwarf Wild L. Open woods from Penn. W. & S.: about 1° high from a branched tuberous root; has broader linear lobes to the leaves, and a loose raceme of few or several rather large showy flowers, deep blue or sometimes white, in spring; sepals and cleft lower petals oblong; pods strongly diverging.

D. exaltàtum, Tall Wild L., is the wild species (from Penn. W. & S.) most resembling the next, 3° – 5° high, but the less handsome flowers and panicled racemes hoary or downy: fl. summer.

D. elàtum, Bee Larkspur. Cult. from Eu.: 3° – 6° high, with broad leaves 5 – 7-cleft beyond the middle, and the divisions cut into sharp lobes or teeth; many flowers (in summer) in a long wand-like raceme, blue or purplish; the 2-cleft lower petals prominently yellowish-bearded in the common garden form. There are many varieties and mixtures with other species, some double-flowered.

19. ACONÌTUM, ACONITE, WOLFSBANE, MONKSHOOD. (Ancient name.) ♃ Root thick, tuberous or turnip-shaped, a virulent poison and medicine. Leaves palmately divided or cleft and cut-lobed. Flowers showy: the large upper sepal from its shape is called the *casque* or *helmet*. Under it are two long-stalked queer little bodies which answer for petals. See Lessons, p. 92, fig. 185, 186, 193. The following are all cult. from Eu. for ornament, except the first: fl. summer.

A. uncinàtum, Wild A. or Monkshood. Stem slender, 3° – 5°, erect, but bending over above, as if inclined to climb; leaves cleft or parted into 3 – 5 ovate or wedge-lanceolate cut-toothed lobes; flowers loosely panicled, blue; the roundish helmet nearly as broad as high, its pointed visor turned down. Low grounds, from Penn. S. & W.

A. variegàtum, Variegated A. Erect; leaves divided to the base into rather broad-lobed and cut divisions; flowers in a loose panicle or raceme, blue and often variegated with white or whitish; the helmet considerably higher than wide, its top curved forward, its pointed visor ascending or horizontal.

A. Napéllus, True Monkshood or Officinal Aconite. Erect, from a turnip-shaped root; leaves divided to the base and then 2 – 3 times cleft into linear lobes; flowers crowded in a close raceme, blue (also a white variety); helmet broad and low.

A. Anthora, a low species, with very finely divided leaves, and crowded yellow flowers, the broad helmet rather high, occurs in some old gardens.

20. PÆÒNIA, PÆONY. (Ancient name, after a Greek physician, *Pæon.*) ♃ Well-known large-flowered ornamental plants, cult. from the Old World. Leaves ternately decompound. Roots thickened below.

* *Herbs, with single-flowered stems, in spring, and downy pods.*

P. officinàlis, Common P. Very smooth, and with large coarsely divided green leaves; the great flowers red, white, &c., single or very double.

P. peregrìna, of Eu., in the gardens called P. parodóxa, has leaves glaucous and more or less downy beneath, and smaller flowers than the last, rose-red, &c., generally full double, and petals cut and fringed.

P. tenuifòlia, Slender-leaved P. of Siberia, is low, with early crimson-red flowers, and narrow linear divisions to the leaves.

* * *Herbs, with several-flowered stems, in summer, and smooth pods.*

P. albiflòra, White-fl. or Fragrant P., or Chinese P. Very smooth about 3° high, with bright green foliage, and white or rose-colored, often sweet-scented, rather small flowers, single, also double, and with purple varieties.

* * * *Shrubby : fl. in spring and early summer.*

P. Moùtan, TREE PÆONY, of China. Stems 2° – 3° high; leaves pale and glaucous, ample; flowers very large (6′ or more across), white with purple base, or rose-color, single or double; the disk, which in other species is a mere ring, in this forms a thin-fleshy sac or covering, enclosing the 5 or more ovaries, but bursting, and falling away as the pods grow.

2. MAGNOLIACEÆ, MAGNOLIA FAMILY.

Trees or shrubs, with aromatic bitter bark, simple mostly entire alternate leaves, and solitary flowers; the sepals and petals on the receptacle and usually in threes, but together occupying more than two ranks, and imbricated in the bud; pistils and mostly the stamens numerous, the latter with adnate anthers (Lessons, p. 113, fig. 233); and seeds only 1 or 2 in each carpel; the embryo small in albumen.

I. Stipules to the leaves forming the bud-scales, and falling early. Flowers perfect, large. Stamens and pistils many on a long receptacle or axis, the carpels imbricated over each other and cohering into a mass, forming a sort of cone in fruit. These are the characters of the true Magnolia Family, of which we have two genera.

1. LIRIODENDRON. Sepals 3, reflexed. Corolla bell-shaped, of 6 broad greenish-orange petals. Stamens almost equalling the petals, with slender filaments, and long anthers opening outwards. Carpels thin and scale-form, closely packed over each other, dry in fruit, and after ripening separating and falling away from the slender axis; the wing-like portion answering to style; the small seed-bearing cell at the base and indehiscent. Leaf-buds flat: stipules free from the petiole.
2. MAGNOLIA. Sepals 3. Petals 6 or 9. Stamens short, with hardly any filaments: anthers opening inwards. Carpels becoming fleshy in fruit and forming a red or rose-colored cone, each when ripe (in autumn) splitting down the back and discharging 1 or 2 coral-red berry-like seeds, which hang on extensile cobwebby threads. Stipules united with the base of the petiole, falling as the leaves unfold.

II. Stipules none. Here are two Southern plants which have been made the representatives of as many small orders.

3. ILLICIUM. Flowers perfect. Petals 9 – 30. Stamens many, separate. Pistils several in one row, forming a ring of almost woody little pods.
4. SCHIZANDRA. Flowers monœcious. Petals mostly 6. Stamens 5, united into a disk or button-shaped body, which bears 10 anthers on the edges of the 5 lobes. Pistils many in a head, which lengthens into a spike of scattered red berries.

1. LIRIODÉNDRON, TULIP-TREE (which is the meaning of the botanical name in Greek). Only one species,

L. Tulipífera. A tall, very handsome tree, in rich soil, commonest W., where it, or the light and soft lumber (much used in cabinet-work), is called WHITE-WOOD, and even POPLAR; planted for ornament; fl. late in spring, yellow with greenish and orange. Leaves with 2 short side-lobes, and the end as if cut off.

2. MAGNÒLIA. (Named for the botanist *Magnol.*) Some species are called UMBRELLA-TREES, from the way the leaves are placed on the end of the shoots; others, CUCUMBER-TREES, from the appearance of the young fruit.

* *Native trees of this country, often planted for ornament.*

M. grandiflòra, GREAT-FLOWERED MAGNOLIA of S., half-hardy in the Middle States. The only perfectly evergreen species; splendid tree with

1. **ASÍMINA,** PAPAW of U. S. (Creole name.) Petals greenish or yellowish, becoming dark dull purple as they enlarge; the 3 inner small. Pistils few in the centre of the globular head of anthers, making one or more large, oblong, pulpy fruits, sweet and eatable when over-ripe in autumn. Flowers in early spring preceding the leaves.

A. tríloba, COMMON PAPAW (wholly different from the true Papaw of W. Ind.), is a shrub or small tree, wild W. & S. and sometimes planted, with obovate-lanceolate leaves, and banana-shaped fruit 3′ – 4′ long.

A. parviflòra is a small-flowered, and **A. grandiflòra** a large-flowered species of S. E. States, both small-fruited, and **A. pygmæa** is a dwarf one with nearly evergreen leaves far South.

4. MENISPERMACEÆ, MOONSEED FAMILY.

Woody or partly woody twiners, with small diœcious flowers; their sepals and petals much alike, and one before the other (usually 6 petals before as many sepals); as many or 2 – 3 times as many stamens; and 2 – 6 pistils, ripening into 1-seeded little stone-fruits or drupes; the stone curved, commonly into a wrinkled or ridged ring; the embryo curved with the stone. Leaves palmate or peltate: no stipules. Anthers commonly 4-lobed.

1. COCCULUS. Sepals, petals, and stamens each 6.
2. MENISPERMUM. Sepals and petals 6 or 8. Stamens in sterile flowers 12 – 20.

1. **CÓCCULUS.** (Name means a little berry.) Only one species in U. S.

C. Carolinus, CAROLINA C. Somewhat downy; leaves ovate or heart shaped, entire or sinuate-lobed; flowers greenish, in summer; fruits red, as large as peas. From Virginia S. & W.

2. **MENISPÉRMUM,** MOONSEED. (Name from the shape of the stone of the fruit.) Only one species,

M. Canadénse, CANADIAN MOONSEED. Almost smooth; leaves peltate near the edge; flowers white, in late summer; fruits black, looking like small grapes.

5. BERBERIDACEÆ, BARBERRY FAMILY.

Known generally by the perfect flowers, having a petal before each sepal, and a stamen before each petal, with anthers opening by a pair of valves like trap-doors, hinged at the top (Lessons, p. 114, fig. 236), and a single simple pistil. But No. 6 has numerous stamens, 5 and 6 have more petals than sepals, and the anthers of 2 and 6 open lengthwise, in the ordinary way. There are commonly bracts or outer sepals behind the true ones. All blossom in spring, or the true Barberries in early summer.

* *Shrubs or shrubby: stamens 6 : berry few-seeded.*

1. BERBERIS. Flowers yellow, in racemes: petals with two deep-colored spots at the base. Leaves simple, or simply pinnate. Wood and inner bark yellow. Leaves with sharp bristly or spiny teeth.
2. NANDINA. Flowers white, in panicles: anthers opening lengthwise. Leaves twice or thrice pinnate.

* * *Perennial herbs.*

+ *With one to three twice or thrice ternately compound leaves.*

3. EPIMEDIUM. Stamens 4. Petals 4 hollow spurs or hoods. Pod several seeded. Leaflets with bristly teeth.

4. CAULOPHYLLUM. Stamens 6. Petals 6 broad and thickish bodies much shorter than the sepals. Ovary bursting or disappearing early, leaving the two ovules to develop into naked berry-like, or rather drupe-like, spherical seeds on thick stalks.

+ + *With simply 2 – 9-parted leaves, and solitary white flowers: sepals falling when the blossom opens. Seeds numerous, parietal. Pistils rarely more than one!*

5. JEFFERSONIA. Flower on a scape, rather preceding the 2-parted root-leaves. Petals (oblong) and stamens mostly 8. Fruit an ovate pod, opening by a cross-line half-way round, the top forming a conical lid. Seeds with an aril on one side.

6. PODOPHYLLUM. Flower in the fork between the two peltate 5 – 9-parted leaves: root-leaf single and peltate in the middle, umbrella-like. Petals 6 – 9, large and broad. Stamens usually 12 – 18. Fruit an oval, large and sweet, eatable berry; the seeds imbedded in the pulp of the large parietal placenta.

1. BÉRBERIS, BARBERRY. (Old Arabic name.) The two sorts or sections have sometimes been regarded as distinct genera.

§ 1. TRUE BARBERRY; *with simple leaves, clustered in the axil of compound spines.*

B. vulgàris, COMMON B. of Eu. Planted, and run wild in thickets and by roadsides; has drooping many-flowered racemes, and oblong red and sour berries; leaves obovate-oblong, fringed with closely-set bristly teeth, with a joint in the very short petiole (like that in an orange-leaf), clustered in the axils of triple or multiple spines, which answer to leaves of the shoot of the previous season (see Lessons, p. 51, fig. 78).

B. Canadénsis, WILD B. In the Alleghanies from Virginia S., and rarely cult., a low bush, with few-flowered racemes, oval red berries, and less bristly or toothed leaves.

§ 2. MAHONIA; *with pinnate and evergreen leaves, spiny-toothed leaflets, and clustered racemes of early spring flowers: berries blue or black with a bloom. Planted for ornament.*

B. Aquifòlium, HOLLY B. or MAHONIA, from Oregon, &c., rises to 3° – 4° high; leaflets 5 – 9, shining, finely reticulated.

B. rèpens, CREEPING or LOW M., from Rocky Mountains, is more hardy, rises only 1° or less, and has rounder, usually fewer, pale or glaucous leaflets.

B. nervòsa, also called GLUMÀCEA, from the husk-like long and pointed bud-scales at the end of the stems, which rise only a few inches above the ground; leaflets 11 – 21, along the strongly-jointed stalk, lance-ovate, several-ribbed from the base. Also from Oregon.

B. Japónica, JAPAN M., tall, rising fully 6° high, the rigid leaflets with only 3 or 4 strong spiny teeth on each side, is coming into ornamental grounds.

2. NANDÌNA. (The native Japanese name.) A single species, viz.

N. doméstica. Cult. in cool greenhouse, &c., from Japan: very compound large leaves: the berries more ornamental than the blossoms.

3. EPIMÈDIUM, BARREN-WORT. (Old Greek name, of uncertain meaning.) Low herbs, with neat foliage: cult. for ornament.

E. Alpìnum, of European Alps, has a panicle of odd-looking small flowers; the yellow petals not larger than the reddish sepals.

E. macrànthum, LARGE-FLOWERED E. of Japan, with similar foliage, has large white flowers with very long-spurred petals.

4. CAULOPHÝLLUM, COHOSH. The only species of the genus is

C. thalictroìdes, BLUE COHOSH. Wild in woods, with usually only one stem-leaf and that close to the top of the naked stem (whence the name of the genus, meaning *stem-leaf*), and thrice ternate, but, having no common petiole, it looks like three leaves; and there is a larger and more compound radical leaf, with a long petiole. The leaves are glaucous and resemble those of *Thalictrum* (as the specific name indicates), but the leaflets are larger. Seeds very hard, with a thin blue pulp.

5. JEFFERSÒNIA, TWIN-LEAF. (Named for *Thomas Jefferson.*)

J. diphýlla, sometimes called RHEUMATISM-ROOT. Wild in rich woods, W. & S., sometimes cult.; the pretty white flower and the leaves both long-stalked, from the ground, appearing in early spring.

6. PODOPHÝLLUM, MAY-APPLE, or MANDRAKE. (Name means *foot-leaf*, the 5 – 7-parted leaf likened to a webbed-foot.)

P. peltàtum. Wild in rich soil: the long running rootstocks (which are poisonous and medicinal) send up in spring some stout stalks terminated by a large, 7 – 9-lobed, regular, umbrella-shaped leaf (i. e. peltate in the middle), and some which bear two one-sided leaves (peltate near their inner edge), with a large white flower nodding in the fork. The sweet pulpy fruit as large as a pullet's egg, ripe in summer: rarely 2 or more to one flower.

6. NYMPHÆACEÆ, WATER-LILY FAMILY.

Aquatic perennial herbs, with the leaves which float on the surface of the water or rise above it mostly peltate or roundish-heart-shaped, their margins inrolled in the bud, long-petioled; axillary 1-flowered peduncles; sepals and petals hardly ever 5, the latter usually numerous and imbricated in many rows. The genera differ so widely in their botanical characters that they must be described separately. One of them is the famous Amazon Water-Lily, VICTORIA REGIA, with floating leaves 3 feet or more in diameter, and the magnificent flowers almost in proportion; while the dull flowers of Water-shield are only half an inch long.

1. BRASENIA. Sepals and petals each 3 or 4, narrow, and much alike, dull purple. Stamens 12 – 18: filaments slender. Pistils 4 – 18, forming indehiscent 1 – 3-seeded pods. All the parts separate and persistent. Ovules commonly on the dorsal suture! Embryo, &c. as in Water-Lily.
2. NELUMBIUM. Sepals and petals many and passing gradually into each other, deciduous. Stamens very many, on the receptacle, the upper part of which is enlarged into a top-shaped body, bearing a dozen or more ovaries, each tipped with a flat stigma and separately immersed in as many hollows. (Lessons, p. 126, fig. 284.) In fruit these form 1-seeded nuts, resembling small acorns. The whole kernel of the seed is embryo, a pair of fleshy and farinaceous cotyledons enclosing a plumule of 2 or 3 rudimentary green leaves.
3. NYMPHÆA. Sepals 4, green outside. Petals numerous, many times 4, passing somewhat gradually into the numerous stamens (Lessons, p. 99, fig. 198): both organs grow attached to the globular many-celled ovary, the former to its sides which they cover, the latter borne on its depressed summit. Around a little knob at the top of the ovary the numerous stigmas radiate as in a poppy-head, ending in long and narrow incurved lobes. Fruit like the ovary enlarged, still covered by the decaying persistent bases of the petals: numerous seeds cover the partitions. Ripe seeds each in an arillus or bag open at the top. (Lessons, p. 135, fig. 318.) Embryo, like that of Nelumbium on a very small scale, but enclosed in a bag, and at the end of the kernel, the rest of which is mealy albumen.
4. NUPHAR. Sepals usually 6 or 5, partly green outside. Petals many small and thickish bodies inserted under the ovary along with the very numerous short stamens. Ovary naked, truncate at the top, which is many-rayed by stigmas, fleshy in fruit: the internal structure as in Nymphæa, only there is no arillus to the seeds.

1. BRASÈNIA, WATER-SHIELD. (Name unexplained.) One species,

B. peltàta. In still, rather deep water: stems rising to the surface, slender, coated with clear jelly, bearing floating oval centrally-peltate leaves ($2' – 3'$ long), and purplish small flowers, produced all summer.

2. NELÚMBIUM, NELUMBO. (Ceylonese name.) Rootstocks interrupted and tuberous, sending up, usually out of water, very long petioles and

S. rùbra, Red-flowered Trumpet-Leaf of S. States: sometimes cult. in greenhouses. Leaves trumpet-shaped, slender, a foot long, with a narrow wing and an erect ovate pointed hood; flower crimson-purple.

S. Drummòndii, Great Trumpet-Leaf of Florida: sometimes cult. Leaves much like the last, but 2° or 3° long, upper part of the tube and the roundish erect hood variegated and purple-veiny; and the deep-purple flower very large.

S. psittacìna, Parrot Pitcher-Plant of S. States, and rarely cult. Leaves short and spreading, with a narrow tube, a broad wing, and an inflated globular hood, which is incurved over the mouth of the tube, spotted with white; flower purple.

S. variolàris, Spotted Trumpet-Leaf of S. States. Leaves erect, trumpet-shaped, white-spotted above, longer than the scape, with a broad wing, and an ovate hood arching over the orifice; flower yellow.

S. flàva, Yellow Trumpet-Leaf of S. States: cult. more commonly than the rest, as a curiosity, and almost hardy N. Leaves trumpet-shaped, 2° long, erect, yellowish or purple-veiny, with a narrow wing, and an erect roundish but pointed hood, a tall scape, and yellow flower.

8. PAPAVERACEÆ, POPPY FAMILY.

Herbs with milky or colored juice, regular flowers, a calyx mostly of 2 sepals which fall when the blossom opens, petals twice or 3–5 times as many, numerous stamens on the receptacle, and a compound 1-celled ovary, with 2 or more parietal placentæ. Fruit a pod, many-seeded. Juice narcotic, as in Poppy (opium), or acrid. No. 5 has watery juice, with the odor of muriatic acid, and the calyx like a cap or lid; No. 7 has no petals and few seeds.

* *Petals crumpled in the flower-bud, which droops on its peduncle before opening.*

1. PAPAVER. Stigmas united into a many-rayed circular body which is closely sessile on the ovary. Pod globular or oblong, imperfectly many-celled by the projecting placentæ which are covered with numberless seeds, opening only by pores or chinks at the top. Juice white.
2. STYLOPHORUM. Stigma 3–4-lobed, raised on a style. Pod ovoid, bristly, opening from the top into 3 or 4 valves, leaving the thread-like placentæ between them. Juice yellow.
3. CHELIDONIUM. Stigma 2-lobed, almost sessile. Pod linear, with 2 placentæ, splitting from below into 2 valves. Juice orange.

* * *Petals more or less crumpled in the bud, which is erect before opening.*

4. ARGEMONE. Stigma 3–6-lobed, almost sessile. Sepals and oblong pod prickly; the latter opening by valves from the top, leaving the thread-like placentæ between. Juice yellow.
5. ESCHSCHOLTZIA. Sepals united into a pointed cap which falls off entire. Receptacle or end of the flower-stalk dilated into a top-shaped body, often with a spreading rim. Stigmas 4–6, spreading, unequal; but the placentæ only 2. Pod long and slender, grooved. Juice colorless.

* * * *Petals not crumpled in the bud, which does not droop.*

6. SANGUINARIA. Sepals 2: but the petals 8–12. Stigma 2-lobed, on a short style. Pod oblong, with 2 placentæ. Juice orange-red.

* * * * *Petals none. Flowers in panicles, drooping in the bud.*

7. BOCCONIA. Sepals 2, colored. Stigma 2-lobed. Pod few-seeded. Juice reddish.

1. PAPÀVER, POPPY. (Ancient name.) We have no truly wild species: the following are from the Old World.

* *Annuals, flowering in summer: cult. and weeds of cultivation.*

P. somníferum, Opium Poppy. Cult. for ornament, especially double-flowered varieties, and for medical uses. Smooth, glaucous, with clasping and wavy leaves, and white or purple flowers.

P. Rhœas, Corn Poppy of Eu. Low, bristly, with almost pinnate leaves, and deep red or scarlet flowers with a dark eye, or, when double, of various colors; pod obovate.

P. dùbium, Long-headed P. Leaves with their divisions more cut than the last; flowers smaller and lighter red, and pod oblong-clavate: run wild in fields in Penn.

* * *Perennial: cult. for ornament: flowering in late spring.*

P. orientàle, Oriental P. Rough-hairy, with tall flower-stalks, almost pinnate leaves, and a very large deep-red flower, under which are usually some leafy persistent bracts. Var. bracteàtum, has these bracts larger, petals still larger and deeper red, with a dark spot at the base.

2. STYLÓPHORUM, CELANDINE POPPY. (Name means *style-bearer*, expressing a difference between it and Poppy and Celandine.) ♃

S. diphýllum. From Penn. W. in open woods; resembling Celandine, but low, and with far larger (yellow) flowers, in spring.

3. CHELIDÒNIUM, CELANDINE. (From the Greek word for the *Swallow.*) ② ♃

C. màjus, the only species, in all gardens and moist waste places; 1° – 4° high, branching, with pinnate or twice pinnatifid leaves, and small yellow flowers in a sort of umbel, all summer; the pods long and slender.

4. ARGEMÒNE, PRICKLY POPPY. (Meaning of name uncertain.) ①

A. Mexicàna, Mexican P. Waste places and gardens. Prickly, 1° – 2° high; leaves sinuate-lobed, blotched with white; flowers yellow or yellowish, pretty large, in summer. Var. albiflòra has the flower larger, sometimes very large, white; cult. for ornament.

5. ESCHSCHÓLTZIA. (Named for one of the discoverers, *Eschscholtz*, the name easier pronounced than written.) ①

E. Califòrnica, Californian annual, now common in gardens; with pale dissected leaves, and long-peduncled large flowers, remarkable for the top-shaped dilatation at the base of the flower, on which the extinguisher-shaped calyx rests: this is forced off whole by the opening petals. The latter are bright orange-yellow, and the top of the receptacle is broad-rimmed. Var. Douglásii wants this rim, and its petals are pure yellow, or sometimes white; but the sorts are much mixed in the gardens; and there are smaller varieties under different names.

6. SANGUINÀRIA, BLOOD-ROOT. (Name from the color of the juice.) ♃

S. Canadénsis, the common and only species; wild in rich woods, handsome in cultivation. The thick red rootstock in early spring sends up a rounded-reniform and palmate-lobed veiny leaf, wrapped around a flower-bud: as the leaf comes out of ground and opens, the scape lengthens, and carries up the handsome, white, many-petalled flower.

7. BOCCÒNIA. (Named in honor of an Italian botanist, *Bocconi.*) ♃

B. cordàta, Cordate B., from China, the only hardy species; a strong root sending up very tall leafy stems, with round-cordate lobed leaves, which are veiny and glaucous, and large panicles of small white or pale rose-colored flowers, late in summer.

9. FUMARIACEÆ, FUMITORY FAMILY.

Like the Poppy Family in the plan of the flowers; but the 4-petalled corolla much larger than the 2 scale-like sepals, also irregular and closed, the two inner and smaller petals united by their spoon-shaped tips, which enclose the anthers of the 6 stamens in two sets, along with the stigma: the middle anther of each set is 2-celled, the lateral ones 1-celled. Delicate or tender and very smooth herbs, with colorless and inert juice, and much dissected or compound leaves.

* *Corolla heart-shaped or 2-spurred at base: pod several-seeded.*

1. DICENTRA. Petals slightly cohering with each other. Seeds crested.
2. ADLUMIA. Petals all permanently united into one slightly heart-shaped body, which encloses the small pod. Seeds crestless. Climbing by the very compound leaves.

* * *Corolla with only one petal spurred at base.*

3. CORYDALIS. Ovary and pod slender, several-seeded. Seeds crested.
4. FUMARIA. Ovary and small closed fruit globular, 1-seeded.

1. DICÉNTRA (meaning two-spurred in Greek). Commonly but wrongly named DICLȲTRA or DIÉLYTRA. ♃ Fl. in spring.

* *Wild species, low, with delicate decompound leaves and few-flowered scapes sent up from the ground in early spring.*

D. Cucullària, DUTCHMAN'S BREECHES. Common in leaf-mould in woods N. Foliage and flowers from a sort of granular-scaly bulb; corolla white tipped with yellow, with the two diverging spurs at the base longer than the pedicel.

D. Canadénsis, CANADIAN D. or SQUIRREL-CORN. With the last N. Separate yellow grains, like Indian corn, in place of a scaly bulb; the corolla narrower and merely heart shaped at base, white or delicately flesh-colored, sweet-scented; inner petals much crested at tip.

D. exímia is rarer, wild along the Alleghanies, occasionally cult., has coarser foliage, and more numerous flowers than the last, pink-purple, and produced throughout the summer, from tufted scaly rootstocks.

* * *Cultivated exotic, taller and coarser, leafy-stemmed, many-flowered.*

D. spectábilis, SHOWY D. or BLEEDING HEART. From N. China, very ornamental through spring and early summer, with ample Peony-like leaves, and long drooping racemes of bright pink-red heart-shaped flowers (1′ long): the two small sepals fall off in the bud.

2. ADLÚMIA, CLIMBING FUMITORY. (Named in honor of a *Mr. Adlum.*) ② The only species is

A. cirrhósa. Wild in low shady grounds from New York W. & S. and cult.; climbing over bushes or low trees, by means of its 2–3-pinnately compound delicate leaves, the stalks of the leaflets acting like tendrils; flowers flesh-colored, panicled, all summer.

3. CORȲDALIS. (Greek name for Fumitory.) Our species are leafy-stemmed, ① or ②, wild in rocky places, fl. spring and summer.

C. glaùca, PALE CORYDALIS. Common, 6′–3° high, very glaucous, with the whitish flowers variegated with yellow and pink, a short and rounded spur, and erect pods.

C. flàvula, YELLOWISH C. From Penn. S. & W.: has the flowers pale yellow, with the tips of the outer petals wing-crested; seeds sharp-edged: otherwise like the next.

C. aùrea, GOLDEN C. From Vermont W. & S. Low and spreading; flowers golden-yellow with a longish spur, and crestless tips, hanging pods, and smooth blunt-edged seeds.

4. FUMÀRIA, FUMITORY. (Name from *fumus*, smoke.) ① Low, leafy-stemmed, with finely cut compound leaves.

F. officinàlis, COMMON F. Common in old gardens, waste places, and dung-heaps; a delicate small weed, with a close spike of small pinkish crimson-tipped flowers, in summer.

12. DENTARIA. Pods, &c. as in the preceding. Seed-stalks broad and flat. Stem 2–3-leaved in the middle, naked below, springing from a horizontal scaly-toothed or irregular fleshy rootstock.
13. LUNARIA. Pods oval or oblong, large and very flat, stalked above the calyx. Seeds winged, 2-rowed in each cell. Flowers pretty large, purple.
14. DRABA. Pods round-oval, oblong or linear, flat. Seeds wingless, 2-rowed in each cell. Flowers small, white in the common species.

++ ++ ++ ++ *Pod short, flattish parallel to the broad partition. Flowers yellow, small.*

15. CAMELINA. Pods turgid, obovate or pear-shaped.

++ ++ ++ ++ ++ *Pod short, very much flattened contrary to the narrow partition; the valves therefore deeply boat-shaped. Flowers white, small.*

16. CAPSELLA. Pods obovate-triangular, or triangular with a notch at the top.

* * *Seeds or the ovules single or sometimes 2 in each cell. Pods short and flat.*

+ *Corolla irregular, the petals being very unequal.*

17. IBERIS. Flowers in short and flat-topped clusters, white or purple; the two petals on the outer side of the flower much larger than the others. Pods scale-shaped, roundish or ovate, much flattened contrary to the very narrow partition, notched at the wing-margined top.

+ + *Corolla regular, small.*

18. LEPIDIUM. Pods scale-shaped, much flattened contrary to the very narrow partition, often notched or wing-margined at the top. Flowers white.
19. ALYSSUM. Pods roundish, flattened parallel to the broad partition. Seeds flat, commonly wing-margined. Flowers yellow or white.

§ 2. *Fruit indehiscent, wing-like, 1-seeded.*

20. ISATIS. Flowers yellow. Fruit 1-celled, 1-seeded, resembling a small samara or ash-fruit.

§ 3. *Fruit fleshy, or when ripe and dry corky, not opening by valves, 2–many-seeded.*

21. CAKILE. Fruit jointed in the middle; the two short joints 1-celled, 1-seeded. Seed oblong.
22. RAPHANUS. Fruit several-seeded, with cellular matter or with constrictions between the spherical seeds.

1. BRÁSSICA, CABBAGE, MUSTARD, &c. (Ancient Latin name of Cabbage. Botanically the Mustards rank in the same genus.) ① ② Cult. from Eu., or run wild as weeds; known by their yellow flowers, beak-pointed pods, and globose seeds, the cotyledons wrapped round the radicle.

B. oleràcea, CABBAGE. The original is a sea-coast plant of Europe, with thick and hard stem, and pretty large pale yellow flowers; the leaves very glabrous and glaucous; upper ones entire, clasping the stem, not auricled at the base: cult. as a biennial, the rounded, thick, and fleshy, strongly veined leaves collect into a head the first year upon the summit of a short and stout stem. — Var. BROCCOLI is a state in which the stem divides into short fleshy branches, bearing clusters of abortive flower-buds. — Var. CAULIFLOWER has the nourishing matter mainly concentrated in short imperfect flower-branches, collected into a flat head. — Var. KOHLRABI has the nourishing matter accumulated in the stem, which forms a turnip-like enlargement above ground, beneath the cluster of leaves. — KALE is more nearly the natural state of the species, the fleshy leaves not forming a head.

B. campéstris, of the Old World; like the last, but with brighter flowers; the lower leaves pinnatifid or divided and rough with stiff hairs, and the upper auricled at the base, is represented in cultivation by the Var. COLZA or RAPE, with small annual root, cult. for the oil of the seed. — Var. TURNIP (B. NAPUS); cult. as a biennial, for the nourishment accumulated in the napiform white root. — Var. RUTABAGA or SWEDISH TURNIP, has a longer and yellowish root.

B. Sinipástrum, or **Sinàpis arvénsis,** CHARLOCK. A troublesome weed of cultivation in grainfields, annual, with the somewhat rough leaves barely toothed or little lobed, and nearly smooth pods spreading in a loose raceme, the seed-bearing part longer than the conical (usually empty) beak.

B. (or **Sinàpis**) **alba,** WHITE MUSTARD. Cult. and in waste places, annual; the leaves all pinnatifid and rough-hairy; pods spreading in the raceme, bristly, the lower and turgid few-seeded portion shorter than the 1-seeded stout and flattened beak; seeds large, pale brown.

B. (or **Sinàpis**) **nigra,** BLACK MUSTARD. Cult. and in waste places; leaves less hairy and less divided than the last; pods erect in the raceme or spike, smooth, short, 4-sided (the valves having a strong midrib), and tipped with the short empty conical base of a slender style; seeds dark brown, smaller, and more pungent than in the last.

2. SISÝMBRIUM, HEDGE MUSTARD. (The ancient Greek name.)

S. officinàle, COMMON H. ① Coarse weed in waste places, with branching stems, runcinate leaves, and very small pale yellow flowers, followed by awl-shaped obscurely 6-sided pods close pressed to the axis of the narrow spike.

S. canéscens, HOARY H. or TANSY-MUSTARD. ① Commonly only S. & W., hoary, with finely cut twice-pinnatifid leaves, minute yellowish flowers, and oblong-club-shaped 4-sided pods on slender horizontal pedicels.

3. NASTÚRTIUM, WATER-CRESS, HORSERADISH, &c. (Name from *nasus tortus*, convulsed nose, from the pungent qualities.) Here are combined a variety of plants, widely different in appearance: the following are the commonest.

* *Nat. from Eu.: the white petals twice the length of the calyx.* ♃

N. officinàle, WATER-CRESS. Planted or run wild in streamlets, spreading and rooting, smooth, with pinnate leaves of 3 – 11 roundish or oblong leaflets; fl. all summer; pods broadly linear, slightly curved upwards on their spreading pedicels. Young plants eaten.

N. Armoràcia, HORSERADISH. Planted or run wild in moist soil; with very large oblong or lanceolate leaves, chiefly from the ground, crenate, rarely cut or pinnatifid; pods globular, but seldom seen. The long deep root is a familiar condiment.

* * *Indigenous species, in wet places: petals yellow or yellowish.*

N. palústre, MARSH-CRESS. A very common homely weed, erect, 1° – 3° high, with pinnatifid or lyrate leaves of several oblong cut-toothed leaflets, small yellowish flowers, and small oblong or ovoid pods.

N. sessiliflòrum, like the last, but with less lobed leaves, very minute sessile flowers, and longer oblong pods, is common from Illinois S. And there are 2 or 3 more in some parts, especially S.

4. HÉSPERIS, ROCKET. (Greek for *evening*, the flowers being then fragrant.) ♃

H. matronàlis, COMMON or DAME R. Tall and rather coarse plant in country gardens, from Eu., inclined to run wild in rich shady soil; with oblong or lanceolate toothed leaves, and rather large purple flowers, in summer, followed by (2′ – 4′) long and slender pods.

5. MALCÒLMIA. (Named for *W. Malcolm*, an English gardener.)

M. marítima, MAHON STOCK, called VIRGINIA STOCK in England, but comes from the shores of the Mediterranean: a garden annual, not much cult., a span high, with pale green oblong or spatulate nearly entire leaves, and pretty pink-red flowers changing to violet-purple, also a white var. (much smaller than those of true Stock); pods long and slender.

6. MATTHÌOLA, STOCK or GILLIFLOWER. (Named for the early naturalist, *Matthioli*.) Cult. garden or house plants, from Eu., hoary-leaved, much prized for their handsome and fragrant, pretty large, pink, reddish, or white flowers, of which there are very double and showy varieties.

M. incàna, COMMON STOCK. ♃ Stout stem becoming almost woody: not hardy at the N.

M. ánnua, TEN-WEEK STOCK. ① Probably only an herbaceous variety of the last; flowers usually not double.

7. CHEIRANTHUS, WALLFOWER. (*Cheiri* is the Arabic name.) Like Stocks, but slightly if at all hoary, and the flowers orange, brown-reddish, or yellow. ♃

C. Cheiri, COMMON WALLFLOWER. Cult. from S. Eu., not hardy N., a much-prized house-plant; stem woody, crowded with the narrow and pointed entire leaves.

8. ERÝSIMUM. (Name from Greek, and meaning to draw blisters, from the acridity.)

E. ásperum, WESTERN WALLFLOWER. Wild from Ohio W. & S.; like the wild state of the Wallflower, with bright yellow or orange flowers, but the seeds are different, and the long pods quite square in the cross-section; the leaves somewhat toothed and hoary. ② ♃

E. cheiranthoides, TREACLE-MUSTARD or WORMSEED MUSTARD. A rather insignificant annual, wild or run wild in waste moist places, with slender branches, lanceolate almost entire leaves, and small yellow flowers, followed by shortish and obscurely 4-sided pods on slender spreading pedicels.

9. BARBARÈA, WINTER-CRESS. (The Herb of Santa Barbara.) Different from the last genus in the seeds, divided leaves, and in the general aspect. Leaves used by some as winter salad, but bitterish. ② ♃

B. vulgàris, COMMON W. or YELLOW ROCKET. Smooth, common in old gardens and other rich soil, with green lyrate leaves, and bright yellow flowers, in spring and summer; pods erect, crowded in a dense raceme, much thicker than their pedicels.

B. prǽcox, EARLY W. or SCURVY-GRASS. Cult. from Penn. S. for early salad, beginning to run wild, probably a variety of the last, with more numerous and narrower divisions to the leaves; the less erect pods scarcely thicker than their pedicels.

10. ÁRABIS, ROCK-CRESS. (Name from Arabic.) Fl. spring and summer. Leaves mostly simple and undivided.

* *Wild species, on rocks, &c.: flowers white or whitish, not showy.* ②

A. lyràta, LOW R. A delicate, low, nearly smooth plant, with a cluster of lyrate root-leaves; stem-leaves few and narrow; bright white petals rather conspicuous; pods slender, spreading.

A. hirsùta, HAIRY R. Strictly erect, 1° – 2° high; stem-leaves many and sagittate; small greenish-white flowers and narrow pods erect.

A. lævigàta, SMOOTH R. Erect, 1° – 2° high, glaucous; upper leaves sagittate; flowers rather small; pods 3′ long, very narrow and not very flat, recurving; seeds winged.

A. Canadénsis, CANADIAN or SICKLEPOD R. Tall, growing in ravines; stem-leaves pointed at both ends, pubescent; petals whitish, narrow; pods 3′ long, scythe-shaped, very flat, hanging; seeds broadly winged.

* * *Wild, on river banks: flowers pink-purple, rather showy.* ② ♃

A. hesperidoides, ROCKET R. Smooth, erect, 1° – 3° high; with rounded or heart-shaped long-petioled root-leaves, ovate-lanceolate stem-leaves (2′ – 6′ long), the lower on a winged petiole or with a pair of small lateral lobes; petals long-clawed; pods spreading, narrow; seeds wingless. Banks of the Ohio and S. W.

* * * *Garden species: flowers white, showy.* ♃

A. alpìna, ALPINE R., and its variety? A. ÁLBIDA, from Eu., low and tufted, hairy or soft-downy, are cult. in gardens; fl. in early spring.

11. CARDAMÌNE, BITTER-CRESS. (Ancient Greek name.) ♃

C. hirsùta, SMALL B. A low and branching insignificant herb, usually not hairy, with slender fibrous root, pinnate leaves, the leaflets angled or toothed, and small white flowers, followed by narrow upright pods: common in moist soil, fl spring and summer.

18. LEPÍDIUM, PEPPERGRASS. (A Greek word, meaning *little scale*, from the pods.) Our common species have incised or pinnatifid leaves, and very small white or whitish flowers. ①

L. Virgínicum, WILD P. A common weed by roadsides, with petals, and usually only 2 stamens; the little pods orbicular and scarcely margined at the notched top; seeds flat, the radicle against the edge of the cotyledons.

L. ruderàle, introduced from Europe, is much less common, more branched, with no petals, smaller scarcely notched pods, and turgid seeds, the radicle against the back of one of the cotyledons.

L. satìvum, GARDEN P. Cult. as a cress, has petals, and the larger ovate pods are winged and slightly notched at the top.

19. ALÝSSUM, MADWORT. (Name refers to being a fancied remedy for canine madness.) Cult. for ornament; from Eu.

A. marítimum, SWEET ALYSSUM. A spreading little plant, from Europe, fl. all summer in gardens, or in the greenhouse in winter, green or slightly hoary, with lanceolate or linear entire leaves tapering at the base, and small white honey-scented flowers, in at length elongated racemes, the round little pods with a single seed in each cell. A variety much used for borders has paler and white-edged leaves.

A. saxàtile, ROCK A. Low, hoary-leaved, with abundant bright yellow flowers, in spring; cult. from Europe. ♃

20. ÌSATIS, WOAD. (Name of obscure derivation.) ② One common species of Eu.,

I. tinctòria, DYER'S WOAD. Rather tall, glabrous and glaucous, with the stem-leaves lanceolate and entire, sessile and somewhat sagittate; the racemes of small yellow flowers panicled, succeeded by the hanging samara-like closed pods; fl. in early summer. Old gardens, formerly cult. for a blue dye.

21. CAKÌLE, SEA-ROCKET. (An old Arabic name.) ① ②

C. Americàna, AMERICAN S. A fleshy herb, wild on the shore of the sea and Great Lakes, with obovate wavy-toothed leaves, and purplish flowers.

22. RÁPHANUS, RADISH. (Ancient Greek name, said to refer to the rapid germination of the seeds.) ① ② All from the Old World.

R. satìvus, RADISH. Cult. from Eu.; with lyrate lower leaves, purple and whitish flowers, and thick and pointed closed pods; the seeds separated by irregular fleshy false partitions: cult. for the tender and fleshy pungent root· inclined to run wild.

R. caudàtus, RAT-TAIL R., from India, lately introduced into gardens, rather as a curiosity, is a probable variety of the Radish, with the narrow pod a foot or so long, eaten when green.

R. Raphanístrum, WILD R. or JOINTED CHARLOCK. Troublesome weed in cult. fields, with rough lyrate leaves, yellow petals changing to whitish or purplish, and narrow long-beaked pods, which are divided across between the several seeds, so as to become necklace-form.

11. CAPPARIDACEÆ, CAPER FAMILY.

In our region these are herbs, resembling *Cruciferæ*, but with stamens not tetradynamous and often more than 6, no partition in the pod (which is therefore 1-celled with two parietal placentæ), and kidney-shaped seeds, the embryo rolled up instead of folded together: the leaves commonly palmately compound, and the herbage bitter and nauseous instead of pungent. But in warm regions the Cress-like pungency sometimes appears, as in *capers*, the pickled flower-buds of CÁPPARIS SPINOSA, of the Levant. This and its near relatives are trees or shrubs.

1. CLEOME. Calyx 4-cleft. Petals 4. Stamens 6, on a short thickened receptacle. Ovary and many-seeded pod in ours raised above the receptacle on a long stalk. Style very short or none. Usually an appendage on one side of the receptacle.
2. GYNANDROPSIS. Sepals 4. Stamens borne on the long stalk of the ovary far above the petals. Otherwise as in No. 1.
3. POLANISIA. Sepals 4. Stamens 8 – 32. Ovary and pod sessile or short-stalked on the receptacle. Style present. Otherwise nearly as No. 1.

1. CLEÒME. (From a Greek word meaning *closed*, the application not obvious.) ①

C. púngens. Tall (2° – 4° high), clammy-pubescent, with little spines or prickly points (whence the name) in place of stipules, about 7 broadly lanceolate leaflets, but the bracts simple and ovate or heart-shaped, and a raceme of large and handsome flowers, with long-clawed pink or purple petals and declined stamens. Cult. from S. America, for ornament, and run wild S.

C. integrifòlia, much smaller, very smooth, with 3 leaflets and the pink petals without claws, is wild in Nebraska, &c., and lately introduced to gardens.

2. GYNANDRÓPSIS. (Greek-made name, meaning that the stamens appear to be on the pistil.) (Lessons, p. 125, fig. 276.)

G. pentaphýlla. Nat. from Carolina S. from West Indies, is a clammy-pubescent weed, with 5 leaflets to the leaves and 3 to the bracts; the white petals on claws.

3. POLANÍSIA. (Greek-made name, meaning *many-unequal*, referring to the stamens.)

P. gravèolens. A heavy-scented (as the name denotes), rather clammy, low herb, with 3 oblong leaflets, and small flowers with short white petals, about ll scarcely longer purplish stamens, and a short style; fl. summer. Wild on gravelly shores, from Conn. W.

12. RESEDACEÆ, MIGNONETTE FAMILY.

Herbs, with inconspicuous flowers in spikes or racemes; represented by the main genus,

1. RESÈDA, MIGNONETTE, &c. (From a Latin word, *to assuage*, from supposed medical properties.) Calyx 4 – 7-parted, never closed even in the bud. Petals 4 – 7, unequal, cleft or notched, those of one side of the flower appendaged within. Stamens 10 – 40, borne on a sort of disk dilated on one side of the flower. Ovary and pod composed of 3 – 6 carpels united not quite to the top into a 3 – 6-lobed or 3 – 6-horned 1-celled pistil which opens at the top long before the seeds are ripe. The seeds are numerous, kidney-shaped, on 3 – 6 parietal placentæ. Leaves alternate.

R. odoràta, Common Mignonette. Cult. (from N. Africa) as an annual, for the delicious scent of the greenish-white flowers; the anthers orange; petals 6, the posterior ones cut into several fine lobes; stems low; some leaves entire and oblong, others 3-lobed.

R. Lutèola, Dyer's M. or Weld. Nat. along roadsides, tall, with lanceolate entire leaves, and a long spike of yellowish flowers; petals 4.

13. PITTOSPORACEÆ, PITTOSPORUM FAMILY.

A small family of shrubs and trees, belonging mostly to the southern hemisphere, in common cultivation represented only by one house-plant, a species of

1. PITTÓSPORUM. (Name means *pitchy seed* in Greek, the seeds being generally covered with a sticky exudation.) Flowers regular, of 5 sepals, 5 petals, and 5 stamens; the claws of the petals sometimes slightly united. ovary one-celled with three parietal placentæ, a single style and stigma. Fruit a globular woody pod, many-seeded.

P. Tobìra, Common P. A low tree, cultivated as a house-plant (from Japan), with obovate and retuse evergreen leaves crowded at the end of the branches, which are terminated by a small sessile umbel of white fragrant flowers, produced in winter.

14. VIOLACEÆ, VIOLET FAMILY.

Commonly known only by the principal genus of the order, viz.

1. **VIOLA,** VIOLET. (Ancient Latin name.) Sepals 5, persistent. Petals 5, more or less unequal, the lower one with a sac or spur at the base. (Lessons, p. 91, fig. 181, 182.) Stamens 5, short: the very broad flat filaments conniving and slightly cohering around the pistil, which they cover, all but the end of the style and the (usually one-sided) stigma, bearing the anthers on their inner face, two of these spurred at the base. Ovary and pod 1-celled, with 3 parietal placentæ, containing several rather large seeds.— Herbs, with stipules to the alternate leaves, and 1-flowered peduncles.

* Stemless Violets, *with leaves and peduncles all from creeping or subterranean rootstocks, there being no proper ascending stems: all flowering in spring, also producing inconspicuous flowers and most of the fruitful pods, all summer, concealed among the leaves.*

+ *Garden species, from Europe: fragrant.*

V. odoràta, Sweet Violet. Cult. from Eu., the tufts spreading by creeping runners: leaves rounded heart-shaped, more or less downy; flowers purple-blue (violet-color) varying to bluish and white, single or in cultivation commonly full double. Hardy; while the Italian Violet, the variety used for winter-blooming, with leaves smoother and brighter green and flowers paler or grayish-blue, is tender northward.

+ + *Wild species: slightly sweet-scented or scentless.*

++ *Flowers blue or violet-color.*

V. Selkírkii, Selkirk's V. Small, only 2′ high, the rounded heart-shaped leaves spreading flat on the ground; the flower large in proportion, its thick spur nearly as long as the beardless petals: on shady banks, only N.

V. sagittàta, Arrow-leaved V. One of the commonest and earliest; leaves varying from oblong-heart-shaped to ovate and often rather halberd-shaped, the earlier ones on short and margined petioles; flower large in proportion; spur short and sac-shaped, as in all the following.

V. cucullàta, Common Blue V. The tallest and commonest of the blue violets, in all low grounds, with matted fleshy and scaly-toothed rootstocks, erect and heart-shaped or kidney-shaped obscurely serrate leaves, with the sides at the base rolled in when young, on long petioles; flowers sometimes pale or variegated with white.

V. palmàta, Hand-leaf V., is a variety of the last, with the leaves, or all the later ones, 3 – 7-cleft or parted; common southward.

V. pedàta, Bird-foot V. Grows in sandy or light soil, from a short and thick or tuber-like rootstock; the leaves all cut into linear divisions or lobes; the flower large, beardless, usually light violet-color: sometimes the two upper petals deep dark violet, like a pansy.

V. delphinifòlia, Larkspur-leaved V., takes the place of the preceding in prairies, &c. W. and is like it, but has the lateral petals bearded.

++ ++ *Flowers (small) white, the lower petal purplish-veined.*

V. blànda, Sweet White V. Very common, with faintly sweet-scented flowers, all the petals beardless; leaves rounded heart-shaped or kidney-shaped.

V. primulæfòlia, Primrose-leaved V. Common S., between the last and next, has oblong or ovate leaves.

V. lanceolàta, Lance-leaved V. Commonest S., has lanceolate leaves tapering into long petioles, and beardless petals.

the bristles of the outer rows very slowly turn inwards, so that their glands help to hold the prey!

D. longifòlia, LONGER-LEAVED S. In very wet bogs or shallow water, with spatulate-oblong leaves, some of them erect, on long petioles.

D. brevifòlia, SHORT-LEAVED S. In wet sand, only at the S.; small; scape only 2′ – 5′ high, few-flowered; leaves short, wedge-shaped.

* * *Flowers rose-purple: no blade to the leaf.*

D. filifòlia, THREAD-LEAVED S. In wet sandy soil near the coast, from Plymouth, Mass., to Florida; leaves erect, thread-shaped; scape 6′ – 12′ high, from a bulb-like base; flowers handsome, $\frac{1}{2}$′ or more broad.

2. DIONÆA, VENUS'S FLY-TRAP. (Named for the mother of Venus.) ♃ Only one species,

D. muscípula. Grows only in sandy bogs near Wilmington, N. Car., but kept in conservatories as a great curiosity. (See Lessons, p. 52, fig. 81, for the leaves, and the way they catch insects!) Flowers white, borne in an umbel-like cyme on a scape 1° high, in spring.

16. CISTACEÆ, ROCK-ROSE FAMILY.

Shrubby or low herbaceous plants, with regular flowers; a persistent calyx of 5 sepals, two of them exterior and resembling bracts; the petals and stamens on the receptacle; the style single or none; ovary 1-celled with 3 or 5 parietal placentæ (Lessons, fig. 261), bearing orthotropous ovules. Represented in greenhouses by one showy species, CISTUS LADANIFERUS of Europe (not common), and in sandy woods and fields by the following wild plants.

1. HELIANTHEMUM. Petals 5, crumpled in the bud, fugacious (falling at the close of the first day). Stamens and ovules many in the complete flower: placentæ 3. Style none or short.
2. HUDSONIA. Petals as in the last. Calyx narrow. Stamens 9 – 30. Style slender. Ovules few.
3. LECHEA. Petals 3, persistent, not longer than the calyx. Stamens 3 – 12. Style none. Pod partly 3-celled, 6-seeded.

1. HELIANTHEMUM, FROSTWEED. (Name from Greek words for *sun* and *flower*, the blossoms opening only in sunshine. Popular name, from crystals of ice shooting from the cracked bark at the root late in the autumn.) Low, yellow-flowered, in sandy or gravelly soil. ♃

H. Canadénse, CANADIAN or COMMON F. Common, and the only one N.; has lance-oblong leaves hoary beneath; flowers produced all summer, some with showy corolla 1′ broad and many stamens; others small and clustered along the stem, with inconspicuous corolla and 3 – 10 stamens; the latter produce small few-seeded pods.

H. corymbòsum, only along the coast S., is downy all over, with smaller flowers clustered at the top of the stem, and larger ones long-peduncled.

H. Caroliniànum, grows only S., is hairy, with green leaves, the lower obovate and clustered; flowers all large-petalled and scattered, in spring.

2. HUDSÒNIA. (For an English botanist, *William Hudson*.) Heath-like little shrubs, 6′ – 12′ high, nearly confined to sandy shores of the ocean and Great Lakes, with minute downy leaves closely covering the branches, and small yellow flowers, opening in sunshine, in spring and summer.

H. ericoìdes, HEATH-LIKE H. Greenish; leaves awl-shaped; flowers peduncled. From New Jersey N.

H. tomentòsa, DOWNY H. Hoary with soft down; leaves oblong or oval and close pressed; peduncles short or hardly any. From New Jersey to Maine and Lake Superior.

3. **LÉCHEA,** PINWEED. (For *Leche*, a Swedish botanist.) Small, homely herbs, with inconspicuous greenish or purplish flowers, and pods about the size of a pin's head, whence the popular name: common in sterile soil; fl. summer and autumn. ♃

L. màjor, LARGER P. Stem upright, hairy, 1° – 2° high; leaves elliptical, mucronate; flowers densely clustered. Borders of sterile woodlands.

L. mìnor, SMALLER P. Stems low, 6′ – 18′ high, often straggling, minutely hairy; leaves linear; flowers loosely racemed on the branches. Open sterile ground.

17. HYPERICACEÆ, ST. JOHN'S-WORT FAMILY.

Distinguished from all other of our plants by the opposite and entire simple and chiefly sessile leaves, punctate with translucent and commonly some blackish dots, perfect flowers with the stamens (usually many and more or less in 3 or 5 clusters) inserted on the receptacle, and a pod either 1-celled with parietal placentæ or 3 – 5-celled (see Lessons, p. 120, fig. 260, 262, 263), filled with many small seeds. Juice resinous and acrid. All here described are wild plants of the country.

* *No glands between the stamens. Petals convolute in the bud.*

1. ASCYRUM. Sepals 4; the outer pair very broad, the inner small and narrow. Petals 4, yellow. Stamens many. Ovary 1-celled.
2. HYPERICUM. Sepals and (yellow) petals 5. Stamens many, rarely few.

* * *Large gland between each of the 3 sets of stamens. Petals imbricated in the bud.*

3. ELODES. Sepals and erect flesh-colored. Petals 5. Stamens 9 to 12, united in 3 sets. Ovary 3-celled. Flowers axillary.

1. **ÁSCYRUM,** ST. PETER'S-WORT. (Greek name means without roughness, being smooth plants.) Leafy-stemmed, woody at the base, with 2-edged branches; wild in pine barrens, &c., chiefly S. Fl. summer. ♃

* *A pair of bractlets on the pedicel: styles short.*

A. Crux-Ándreæ, ST. ANDREW'S CROSS. From New Jersey to Illinois & S.; stems spreading; leaves thinnish, narrow-oblong and tapering to the base; flowers rather small, with narrow pale yellow petals and only 2 styles.

A. stans, COMMON ST. PETER'S-WORT. From New Jersey S.; stems 2° – 3° high; leaves thickish, closely sessile, oval or oblong; flowers larger, with obovate petals and 3 or 4 styles.

* * *No bractlets on the pedicel: styles longer than ovary.*

A. amplexicaùle, CLASPING-LEAVED S. Only found S., with erect stems many times forking above, and closely sessile heart-shaped leaves; styles 3.

2. **HYPÉRICUM,** ST. JOHN'S–WORT. (Ancient name, of uncertain derivation.) Fl. in summer, in all ours yellow.

* *Shrubs or perennial herbs: stamens very many.*

+– *Styles 5 (rarely more) united below into one: pod 5-celled.*

H. pyramidàtum, GREAT-FL. S. Herb, 2° – 4° high, with ovate-oblong partly-clasping leaves, and large flowers, the petals rather narrow, 1′ long, and 5 clusters of stamens. River-banks N. & W.

H. Kalmiànum, KALM'S S. Low shrub, with glaucous oblanceolate leaves and rather large flowers. N. W.: rare, except at Niagara Falls.

+– +– *Styles 3 partly united, or at first wholly united to the top into one (see* Lessons, p. 118, fig. 256): *sepals leafy, spreading.*

++ *Shrubby, deciduous-leaved, both Northern and Southern.*

H. prolíficum, SHRUBBY S. Like the last, but leaves scarcely glaucous, lance-oblong or linear; pod 3-celled.

++ ++ *Shrubby, evergreen or nearly so, only Southern.*

H. fasciculàtum, FASCICLED S. Leaves narrow-linear and small, and with shorter ones clustered in the axils; pod narrow. Wet pine barrens.

H. myrtifòlium, MYRTLE-LEAVED S. Leaves heart-shaped and partly clasping, thick, glaucous; pod conical. Wet pine barrens.

H. aùreum, GOLDEN S. Leaves oblong with a narrow base, glaucous beneath; thick; flowers mostly single, very large (2′ broad), orange-yellow; pod ovate. River-banks towards the mountains.

H. nudiflòrum, NAKED-CLUSTERED S. Shrubby and evergreen S., less so in Virginia, &c., has 4-angled branches, oblong pale leaves, and a peduncled naked cyme of rather small flowers; pods conical.

++ ++ ++ *Herbaceous, simple-stemmed, Northern & Western.*

H. sphærocàrpon, SPHERICAL-FRUITED S. About 2° high; leaves diverging, oblong-linear (2′ long), obtuse; flowers numerous, small, in a naked flat cyme; sepals ovate; pod globular, 1-celled. Rocky banks, W.

H. adprèssum, UPRIGHT-LEAVED S. A foot high; leaves ascending, lanceolate, often acute; flowers few and rather small; sepals narrow; pod oblong, partly 3-celled. Low grounds, Pennsylvania to Rhode Island.

H. ellípticum, ELLIPTICAL-LEAVED S. Barely 1° high; leaves spreading, oblong, thin; flowers rather few in a nearly naked cyme, pale; the pod purple, oblong-oval, obtuse, 1-celled. Wet soil, N.

+ + + *Styles* 3 *wholly separate* (*see* Lessons, fig. 255): *herbs.*

++ *Ovary and pod 3-celled: petals black-dotted: styles mostly diverging.*

H. perforàtum, COMMON S. The only one not indigenous, nat. from Eu., a troublesome weed in fields, &c.; spreads by runners from the base; upright stems branching; leaves oblong or linear-oblong, with pellucid dots; flowers rather large in open leafy cymes; the deep yellow petals twice the length of the lanceolate acute sepals. The juice is very acrid.

H. corymbòsum, CORYMBED S. Common N. in moist ground; stem 2° high, sparingly branched; leaves oblong, slightly clasping, having black as well as pellucid dots; flowers rather small, crowded; petals light yellow and black-lined as well as dotted; sepals oblong; styles not longer than the pod.

H. maculàtum, SPOTTED S. Common S. has somewhat heart-shaped or more clasping leaves, lanceolate sepals, and very long and slender styles: otherwise like the last.

++ ++ *Ovary 1-celled: stem strict: leaves ascending, acute, closely sessile, short.*

H. angulòsum, ANGLED S. Wet pine-barrens from New Jersey S. Stem sharply 4-angled (1° – 2° high), smooth; leaves ovate or lance-oblong; flowers scattered along the ascending branches of the cyme, small, copper-yellow; styles slender.

H. pilòsum, HAIRY S. Wet pine-barrens S. Stem terete, and with the lance-ovate leaves roughish-downy; styles short.

* * *Annual, low and slender, small-flowered herbs: stamens 5 – 12: ovary and brown-purple pod strictly 1-celled: styles 3, separate: sepals narrow, erect: petals narrow.*

+ *Leaves conspicuous and spreading: flowers in cymes.*

H. mùtilum, SMALL S. Slender, much branched and leafy up to the flowers; leaves partly clasping, thin, 5-nerved, ovate or oblong; petals pale yellow. Everywhere in low grounds.

H. Canadénse, CANADIAN S. Stem and branches strictly erect; leaves linear or lanceolate, 3-nerved at the base; petals copper-yellow. Wet sandy soil.

+ + *Leaves erect, awl-shaped or scale-like and minute: flowe very small and scattered along the numerous bushy and wiry slender braches.*

H. Drummóndii, DRUMMOND'S S. In dry barrens, W. Illinois and S., with linear-awl-shaped leaves, short-pedicelled flowers, and pods not longer than the calyx.

H. Saròthra, ORANGE-GRASS or PINE-WEED. Common in dry sterile soil, with minute awl-shaped appressed scales for leaves, flowers sessile on the wiry branches, and slender pods much exceeding the calyx.

* *Calyx with a scaly cup or set of bracts at its base: styles* 2.

1. DIANTHUS. Calyx cylindrical, faintly many-striate. Petals without a crown. Seeds attached by the face: embryo in the albumen and nearly straight!

* * *Calyx naked at base: seeds attached by the edge: embryo curved.*

2. LYCHNIS. Styles 5, rarely 4. Calyx not angled, but mostly 10-nerved.
3. SILENE. Styles 3. Calyx not angled, mostly 10-nerved.
4. VACCARIA. Styles 2. Calyx pyramidal, becoming 5-wing-angled.
5. SAPONARIA. Styles 2. Calyx cylindrical or oblong, not angled, 5-toothed Pod 4-valved at the top.
6. GYPSOPHILA. Styles 2. Calyx bell-shaped, 5-cleft, or thin and delicate below the sinuses. Pod 4-valved. Flowers small and panicled, resembling those of Sandwort, &c.

II. CHICKWEED FAMILY, &c. Petals spreading, without claws, occasionally wanting. Sepals (4 or 5) separate or united only at base, or rarely higher up. Flowers small, compared with the Pink Family, and the plants usually low and spreading or tufted.

* *Without stipules, generally with petals: pod several-seeded.*

7. SAGINA. Styles and valves of the pod as many as the sepals and alternate with them (4 or 5). Petals entire or none. Small plants.
8. CERASTIUM. Styles as many as the sepals and opposite them (5). Petals notched at the end or 2-cleft, rarely none. Pod mostly elongated, opening at the top by 10 teeth.
9. STELLARIA. Styles fewer than the sepals (3 or sometimes 4) and opposite as many of them. Petals 2-cleft, or sometimes none. Pod globular or ovoid, splitting into twice as many valves as there are styles.
10. ARENARIA. Styles (commonly only 3) fewer than the sepals and opposite as many of them. Petals entire, rarely none. Pod globular or oblong, splitting into as many or twice as many valves as there are styles.

* * *With scarious stipules between the leaves, conspicuous and entire petals, and a many-seeded* 3 – 5-*valved pod.*

11. SPERGULARIA. Styles usually 3. Leaves opposite.
12. SPERGULA. Styles 5, as many as the sepals and alternate with them. Leaves in whorls.

* * * *Without petals: the fruit (utricle)* 1-*seeded and indehiscent.*

13. ANYCHIA. Sepals 5, nearly distinct. Stamens 2 – 5. Stigmas 2, sessile. Stipules and flowers minute.
14. SCLERANTHUS. Sepals (5) united below into an indurated cup, narrowed at the throat where it bears 5 or 10 stamens, enclosing the small utricle. Styles 2. Stipules none.

* * * * *Without petals, but the* 5 *sepals white and petal-like inside: stipules obscure if any: fruit a* 3-*celled many-seeded pod.*

15. MOLLUGO. Stamens generally 3, on the receptacle. Stigmas 3. Pod 3-valved, the partitions breaking away from the seed-bearing axis and adhering to the middle of the valves.

1. DIÁNTHUS, PINK. (Greek name, meaning Jove's own flower.) All but the first species cultivated for ornament: fl. summer.

* *Flowers sessile and many in a close cluster, with long and narrow-pointed bracts under the calyx, except in the last.*

D. Armèria, Deptford Pink of Europe, has got introduced into fields in a few places; a rather insignificant plant, somewhat hairy, narrow-leaved, with very small scentless flowers; petals rose-color with whitish dots. ①

D. barbàtus, Sweet William or Bunch Pink, of Europe, with thinnish oblong-lanceolate green leaves, and a very flat-topped cluster of various-colored flowers, the petals sharply toothed, abounds in all country gardens; the many double-flowered varieties are more choice. ♃

D. Carthusianòrum, Carthusians' Pink, from Eu., has linear leaves, slender stems, and a dense cluster of small flowers; bracts ovate or oblong, abruptly awn-tipped, brown, shorter than the calyx; petals merely toothed, short, usually dark purple or crimson: now rather scarce in gardens. ♃

* * *Flowers single at the ends of the branches: leaves narrow and often grass-like, rather rigid, glabrous and glaucous, usually without any evident veins.*

D. Chinénsis, China or Indian Pink, has lanceolate leaves, less rigid and greener than any of the following, and linear acute scales or bracts as long as the calyx; the large petals toothed or cut, of various colors, red, purple, violet, &c. The garden var. Heddewigii is a more glaucous and large-flowered form, lately introduced. ① ②

D. Caryophýllus, Clove Pink, the parent of all the sorts of Carnation, &c., has the stems almost woody below, very glaucous long-linear leaves; the scales under the calyx very short and broad; petals merely toothed, of various colors. Scarcely hardy N. ♃

D. plumàrius, Pheasant's-eye or Plumed Pink. A low, hardy species, making broad tufts, with small very glaucous leaves, sending up flower-stems in early summer, the white or pink or variegated petals cut into a fringe of slender lobes. ♃

D. supérbus, is taller, less tufted, and later-flowered; the large petals entirely dissected into delicate almost capillary divisions. ♃

2. LÝCHNIS. (Greek name for *lamp*, the down of the Mullein Lychnis having been used for wicking.) All from the Old World: fl. summer.

§ 1. *Calyx with long leaf-like lobes: petals naked.* ①

L. Githàgo, Corn-Cockle. A weed in grain-fields, hairy, with long linear leaves, and long-peduncled showy red-purple flowers; in fruit the calyx-lobes falling off; the black seeds injurious to the grain.

§ 2. *Calyx without long leaf-like lobes: petals crowned with a 2-cleft little scale or pair of teeth on the base of the blade or at the top of the claw.* ♃

L. coronària, Mullein-Lychnis or Mullein Pink. Cult. in gardens; the flower crimson and like that of Corn-Cockle; but teeth of the calyx short and slender; plant white-cottony; leaves oval or oblong. ② ♃

L. Flos-Jòvis, Jupiter's L. Less common in gardens, downy-hairy or cottony and whitish; leaves lance-oblong; flowers many and smaller, in a head-like long-peduncled cluster, reddish-purple; petals obcordate.

L. Chalcedónica, Maltese-Cross or Scarlet L. Very common in country-gardens; tall, rather hairy and coarse, with lance-ovate partly clasping green leaves, and a very dense flat-topped cluster of many smallish flowers; the bright scarlet or brick-red petals deeply 2-lobed.

L. grandiflòra, Large-flowered L. Cult. from China; smooth, with oblong green leaves tapering to both ends, and the branches bearing single or scattered short-peduncled flowers, which are 2′ or 3′ across; the red or scarlet petals fringe-toothed at the end.

L. Viscària, Viscid L. Rather scarce in gardens; smooth, but the slender stem glutinous towards the top; leaves linear; flowers many in a narrow raceme-like cluster, rather small; calyx tubular or club-shaped; petals pink-red, slightly notched: also a double-flowered variety.

L. Flos-cùculi, Cuckoo L. Ragged Robin is the double-flowered variety, in gardens; slightly downy and glutinous, with lanceolate leaves, and an open panicle of pink-red petals, these cleft into 4 narrow-linear lobes.

L. diùrna, Day-blooming L. Double-flowered form also called Ragged Robin in the gardens; smoothish or soft-hairy; leaves oblong or lance-ovate, the upper ones pointed; flowers scattered or somewhat clustered on the branches, rose-red.

L. vespertìna, Evening-blooming L. A weed in some waste grounds, like the last, and more like the Night-flowering Catchfly; but has 5 styles and a more ovate enlarging calyx; the flowers are commonly diœcious, white, and open after sunset, the root biennial. But a full double-flowering variety in gardens is perennial, day-flowering, and is a white sort of Ragged Robin.

3. SILÈNE, CATCHFLY. (Both names refer to the sticky exudation on stems and calyx of several species, by which small insects are often caught.) Besides the following, some other wild or cultivated species are met with, but not common. Fl. mostly all summer.

* *All over sticky-hairy: naturalized from Europe.* ①

S. noctiflòra, NIGHT-FLOWERING C. Tall coarse weed in cult. or waste grounds; lower leaves spatulate, upper lanceolate and pointed; flowers single or in loose clusters terminating the branches, with awl-shaped calyx-teeth and white or pale rosy 2-parted petals, opening at nightfall or in cloudy weather.

* * *Smooth, a part of each of the upper joint of stem glutinous: flowers small.* ①

S. Armèria, SWEET-WILLIAM C. In old gardens or running wild, from Europe; stem about 1° high, branching into flat-topped cymes of many flowers, which are rather showy; calyx club-shaped; petals notched, bright pink, or a white variety, opening only in sunshine; leaves lance-ovate, glaucous.

S. antirrhìna, SLEEPY C. Wild in sandy or gravelly soil; stem slender, 6′–20′ high, rather simple; flowers very small, panicled; calyx ovoid; petals rose-color, obcordate, opening only at midday in sunshine; leaves lanceolate or linear.

* * * *Somewhat sticky-pubescent, at least the calyx, which is oblong, tubular, or club-shaped: wild species, with red or pink showy flowers.* ♃

S. Pennsylvánica, PENNSYLVANIAN C. or WILD PINK. In gravelly soil; stems 4′–8′ high, bearing 2 or 3 pairs of lanceolate leaves and a cluster of short-stalked middle-sized flowers, in spring; petals pink-red, wedge-shaped, slightly notched.

S. Virgínica, VIRGINIAN C. or FIRE PINK. In open woods W. & S.; 1°–2° high; leaves spatulate or lanceolate; flowers few, peduncled; the pretty large bright crimson-red petals 2-cleft.

S. régia, ROYAL C. Prairies, &c., from Ohio S.; like the last, but 3° high, with lance-ovate leaves, numerous short-peduncled flowers in a narrow panicle, and narrower scarlet-red petals scarcely cleft.

* * * * *Not sticky: calyx inflated and bladdery: petals rather small, white.* ♃

S. stellàta, STARRY CAMPION. Wild on wooded banks; stem slender, 2°–3° high; leaves in whorls of 4, lance-ovate, pointed; flowers in a long and narrow panicle; petals cut into a fringe.

S. inflàta, BLADDER CAMPION. Wild in fields E., but nat. from Eu., glaucous or pale and very smooth, 1° high, with ovate-lanceolate or oblong leaves, and an open cyme of flowers; the bladdery calyx veiny; petals 2-cleft.

4. VACCÁRIA, COW-HERB. (Name from Latin *vacca*, a cow.) ①

V. vulgàris, COMMON C. In gardens or running wild near them, from Eu.; smooth, 1°–2° high, with pale lanceolate partly clasping leaves, and a loose open cyme of flowers; petals pale red, naked, not notched; fl. summer.

5. SAPONÁRIA, SOAPWORT. (Latin and common names from the mucilaginous juice of the stem and root forming a lather.) From Europe.

S. officinàlis, COMMON S. or BOUNCING BET. A rather stout, 1°–2° high, nearly smooth herb, in gardens, and running wild by roadsides; leaves 3–5-ribbed, the lower ovate or oval, upper lanceolate; flowers rather large, clustered; petals pale rose-color or almost white, notched at the end. The double-flowered is most common. ♃

6. GYPSÓPHILA. (From Greek words meaning lover of *gypsum* or *chalk*, growing on calcareous rocks.) Plants with the small and often panicled flowers and foliage of Arenaria or Stellaria, but the sepals united into a cup as in the true Pink Family, usually by their thin white edges, however, so that to a casual glance they may appear distinct. Cult. in choicer gardens, from Eu. and the East, ornamental, especially for dressing cut flowers, &c. Fl. all summer.

G. paniculàta, PANICLED G. Very smooth, pale, 1°–2° high; with lance-linear leaves, and branches repeated forking into very loose and light cymes, bearing innumerable very small and delicate white flowers. ♃

G. élegans, ELEGANT G. Less tall or low, loosely spreading; with lanceolate leaves, much larger (½′ broad) and fewer flowers, white or slightly rosy. ①

A. diffùsa, SPREADING S. Shady grounds S. Plant soft-downy; stems prostrate, 1° or more long; leaves lanceolate; peduncles lateral, 1-flowered; petals shorter than the sepals or none. ♃

* * *Petals conspicuous, longer than the calyx, white.* ♃

A. lateriflòra, SIDE-FLOWERING S. Gravelly shores and banks N. Plant minutely downy; stem erect, 3′ – 10′ high, sparingly branching; peduncles few-flowered, soon becoming lateral by the farther growth of the leafy stem; leaves oval or oblong.

A. strícta. Rocky or shady banks N. Tufted, smooth, 4′–6′ high; stems crowded with slender almost bristle-form leaves; flowers several in a terminal open cyme; sepals sharp-pointed.

A. squarròsa, PINE-BARREN S. In sand, coast of New Jersey and S. Densely tufted on a deep root, 3′ – 5′ high; leaves much crowded, short, awl-shaped, smooth; the flowering branches or few-flowered peduncles glandular; sepals obtuse.

A. Grœnlándica, MOUNTAIN S. On rocky summits of mountains and N. E. coast. Densely tufted, soft; leaves thread-form; flowering stems 2′ – 4′ high, few-flowered, the flowers large in proportion; petals notched at the end.

A. peploìdes, SEA SANDWORT, in sands of sea-shore N., is large, with very fleshy ovate leaves, and axillary flowers.

11. SPERGULÁRIA, SAND SPURREY. (Name from likeness to *Spergula.*) A sort of Sandworts with scaly-membranaceous stipules, and reddish flowers, produced all summer: chiefly maritime. ① ♃ ?

S. rùbra. The field form of this is common in sand or gravel, along roads and paths, E., quite away from salt water; smoothish, prostrate in tufts; leaves thread-shaped; pod and pink-red corolla hardly exceeding the calyx; seeds rough, wingless, half-obovate.

S. salìna. Larger and more fleshy, only in brackish sands; with short peduncles, pale corolla, pod longer than the calyx, and rough obovate-rounded (winged or wingless) seeds.

S. mèdia. Like the last, in salt marshes and sands, but with longer peduncles and smooth seeds.

12. SPÉRGULA, SPURREY. (Latin *spargere,* to scatter, i. e. its seeds.)

S. arvénsis, CORN S. Stems 1° or so high; bearing several thread-shaped leaves in the whorls, and terminating in a panicle of white flowers. A weed in grain-fields, cult. in Europe as a forage plant, sheep being fond of it: fl. summer. ①

13. ANÝCHIA FORKED CHICKWEED. (Name of obscure meaning.) ①

A. dichótoma, a common little herb; in shady places it is smooth and erect, 6′ – 10′ high, with repeatedly forking long-jointed very slender stems, minute short-stalked greenish flowers in the forks, and oval or oblong leaves: in dry or parched soil it is spreading on the ground, short-jointed, narrower-leaved, often pubescent, the flowers more clustered and nearly sessile: all summer.

14. SCLERÁNTHUS, KNAWEL. (From Greek words meaning *hard* and *flower,* referring to the indurated tube of the calyx.)

S. ànnuus, our only species, is nat. from Eu. in gravelly grounds, around gardens, &c., a very pale little herb, 3′ – 5′ high, very much branched and spreading, with short awl-shaped leaves, and greenish small flowers clustered or sessile in the forks, in late summer and autumn.

15. MOLLÙGO, CARPET-WEED. (An old Latin name for some soft plant.) ①

M. verticillàta. A very common, small, prostrate and spreading little weed, in waste gravelly soil, gardens, &c., with spatulate leaves and 1-flowered pedicels in clusters or whorls at the joints; the sepals white inside; stamens 3 · 4. all summer.

21. PORTULACACEÆ, PURSLANE FAMILY.

Succulent-leaved herbs, with 2 sepals and 5 petals, the stamens sometimes many, sometimes few, and then one before each petal; ovary 1-celled, becoming a pod, with many or few kidney-shaped seeds on a central placenta, or on slender seed-stalks from the base. Seeds as in the Pink Family.

1. PORTULACA. Stamens more numerous than the petals. Style cleft into several slender divisions. Lower part of the ovary and many-seeded pod united with the bottom of the calyx; the upper part when mature falling off as a lid. Flowers opening only once, in sunshine.
2. TALINUM. Stamens more numerous than the petals. Style 3-lobed at the summit. Calyx free from the ovary, deciduous. Pod 3-valved, many-seeded. Flowers opening only once, in sunshine.
3. CALANDRINIA. Stamens numerous. Style 3-cleft at the summit. Calyx free from the ovary, persistent, enclosing the 3-valved many-seeded pod. Flowers opening only once, in sunshine.
4. CLAYTONIA. Stamens 5, one attached to the base of each petal. Style 3-cleft at the summit. Calyx persistent, free from the few-seeded pod. Flowers usually opening for more than one day.

1. PORTULÁCA, PURSLANE. (Old Latin name for Purslane.) Leafy and branching, low and spreading, with fleshy sessile leaves; fl. all summer. (Lessons, p. 103, fig. 214.) ①

P. oleràcea, Common P. Very smooth, with prostrate stems, obovate or wedge-form leaves, and small sessile flowers opening only in bright sunshine and for a short time; the petals pale yellow. The commonest garden weed, sometimes used as a pot-herb.

P. pilòsa, Hairy P. Wild far S., has linear terete leaves, with a tuft of beard-like hairs in the axils, and rather large pink flowers.

P. grandiflòra, Great-flowered P., is probably a variety of the last, from South America, commonly cult. for ornament; the large very showy flowers brilliant purple, crimson, red, sometimes white or yellow, or with light centre, of many shades or variations.

2. TALÌNUM. (Name unexplained.) One wild species in some places.

T. teretifòlium, Terete-leaved T. Low and smooth, with thick and fleshy root, short stems bearing crowded linear terete leaves, and a slender naked peduncle, many-flowered; petals rose-purple. Serpentine rocks, Pennsylvania, and rarer west and south: fl. all summer. ♃

3. CALANDRÍNIA. (Named for a Swiss botanist, *Calandrini.*) Cultivated for ornament in choice gardens: fl. all summer.

C. díscolor. Cult. as an annual, from Chili; very glabrous, making a rosette of fleshy spatulate leaves at the root (these glaucous above and tinged with purple beneath), and sending up a naked flower-stem, bearing a raceme of large rose-purple flowers, 2′ in diameter.

C. Menzièsii, Menzies' C. Low, spreading, leafy-stemmed annual, from Oregon and California, with bright green and tender lance-spatulate leaves, and crimson flowers (nearly 1′ broad) in a short leafy raceme.

4. CLAYTÒNIA, SPRING BEAUTY. (Named for *John Clayton,* an early botanist in Virginia.) Low, smooth herbs: ours producing only a pair of stem leaves and a short raceme of flowers.

* *Stem simple from a round tuber: leaves separate: fl. early spring.* ♃

C. Virgínica, Narrow-leaved S. In moist woods, one of the prettiest spring flowers; petals rose-color with pink veins; leaves linear-lanceolate.

C. Caroliniàna, Broader-leaved S. In rich woods; commonest N. and along the Alleghanies, smaller than the other, with oblong-spatulate or lance-oblong leaves only 1′ or 2′ long.

* * *Stem-leaves united into one usually rounded blade or cup underneath the small and whitish flowers: fl. summer.* ①

C. perfoliàta occurs in some gardens, from Oregon and California; small, of no beauty; root-leaves tufted, spatulate or lanceolate.

22. MALVACEÆ, MALLOW FAMILY.

Known by the monadelphous numerous stamens, their tube connected with the base of the petals, kidney-shaped 1-celled anthers (Lessons, p. 114, fig. 238), the calyx valvate and the corolla convolute in the bud. Herbs or shrubs, with alternate palmately-veined and often lobed leaves, evident stipules, and regular flowers, the true sepals and the petals 5. There is commonly an involucre of several bracts, resembling an outer calyx. Seeds kidney-shaped: the leafy cotyledons crumpled or doubled up, in some mucilaginous albumen. Innocent plants, mucilaginous, with a very tough fibrous bark.

§ 1. *Anthers all borne in a cluster at the top of the short tube of filaments.*

* *Ovaries numerous and separate, crowded in a head, in fruit becoming little 1-seeded pods or akenes. Involucre conspicuous as a sort of outer calyx. Herbs.*

1. MALOPE. Involucre of 3 ovate or heart-shaped leaves. Annuals.
2. KITAIBELIA. Involucre of 6 – 9 ovate and pointed leaves united at the base. Perennial.

* * *Ovaries several or many united in a ring around an axis, in fruit commonly falling away separately, each 1-seeded. Ours are all herbs.*

+- *Stigmas running down the side of the slender styles.*

3. ALTHÆA. Involucre of 6 – 9 bracts united at the base. Axis of the fruit not projecting nor enlarged.
4. LAVATERA. Involucre of 3 – 6 more united bracts. Axis of the fruit overtopping the carpels.
5. MALVA. Involucre of only 3 separate bracts. Petals obcordate, otherwise entire. Carpels beakless.
6. CALLIRRHOE. Involucre of 1 – 3 bracts or none. Petals wedge-shaped and truncate, denticulate or cut-fringed at the end. Carpels with a sort of beak at the summit.
7. NAPÆA. Involucre none. Flowers diœcious!

+- +- *Stigmas capitate or truncate at the apex of the styles.*

8. ANODA. Involucre none. Fruit depressed, very flat and star-shaped, the sides of the numerous carpels evanescent: seed nearly horizontal.
9. SIDA. Involucre none. Fruit separating into 5 or more closed carpels, or each 2-valved at the apex: seed hanging.

* * * *Ovaries and cells of the fruit 2 – several-seeded.*

10. ABUTILON. Involucre none. Carpels each 3 – several-seeded.
11. MODIOLA. Involucre of 3 bractlets. Carpels each 2-seeded, with a cross partition between the upper and lower seed.

§ 2. *Anthers borne along the outside of the tube of filaments. Ovary and fruit 3 – several-celled: stigmas capitate. Involucre present. Herbs, shrubs, or trees.*

* *Involucre of several or many bracts.*

12. MALVAVISCUS. Branches of the style and stigmas 10, twice as many as the cells of the ovary. Petals not separating and spreading. Fruit berry-like: cells 1-seeded.
13. KOSTELETZKYA. Branches of the style and stigmas 5. Pod 5-celled; the cells single-seeded.
14. HIBISCUS. Branches of the style or stigmas and cells of the ovary 5. Pod 5-celled, loculicidal; the cells many-seeded.

* * *Involucre of 3 large and heart-shaped leaf-like bracts.*

15. GOSSYPIUM. Styles united into one: stigmas 3 – 5, as many as the cells of the pod. Seeds numerous, bearing cotton.

flowers $1\frac{1}{2}'$ in diameter, the petals pale rose-color or white, striped with dark purple or violet veins. ①

M. sylvéstris, HIGH M. Gardens and roadsides; $2^{\circ}-3^{\circ}$ high, branching, with rather sharply 5–7-lobed leaves, and purple-rose-colored flowers rather smaller, than in the last; fruit wrinkled-veiny. ② ♃

M. Alcea. Gardens; $2^{\circ}-4^{\circ}$ high, hairy, with stem-leaves parted almost to the base into 3–5 divisions which are again 3–5-cleft or cut-toothed; and showy flowers in clusters or terminal racemes; corolla deep rose-color, $1\frac{1}{2}'-2'$ broad; fruit smooth, minutely wrinkled-veiny. ♃

M. moschàta, MUSK M. Gardens, and escaped to roadsides, $1^{\circ}-2^{\circ}$ high, rather hairy, with the herbage faintly musk-scented, leaves about thrice parted or cut into slender linear lobes, and short-peduncled flowers somewhat clustered or racemed; corolla $1\frac{1}{2}'$ broad, rose-color or white; fruit downy.

6. CALLÍRRHOË. (A Greek mythological name, applied to N. American plants.) Species chiefly farther W. and S., becoming rather common in choice gardens. Flowers crimson, mauve, or red-purple, very showy, produced all summer.

* *Root thick, often turnip-shaped, farinaceous: stems roughish-hairy or smoothish.* ♃

C. triangulàta. Dry prairies from Wisconsin S.; stems erect, 2° high; leaves triangular, halberd-shaped, or the lowest heart-shaped, the upper cut-lobed or 3–5-cleft; flowers somewhat panicled and short-peduncled; involucre as long as the calyx; corolla $1\frac{1}{2}'$ or less in diameter; carpels of the fruit even on the back, tipped with a short point.

C. involucràta. Wild from plains of Nebraska S., and cult. for ornament; stems spreading on the ground, $1^{\circ}-3^{\circ}$ long; stipules conspicuous; leaves rounded, 5-parted or cleft and cut-lobed, shorter than the axillary peduncles; involucre shorter than the calyx; corolla $2'$ or more broad; carpels of the fruit reticulated, tipped with a flat and inconspicuous beak.

C. Papàver. Wild in rich woodlands from Georgia to Texas, and sparingly cult.; stems short, ascending, few-leaved; leaves 3–5-parted with lance-linear divisions, or the lowest rather heart-shaped and cleft into oblong lobes; axillary peduncles very (often 1°) long; involucre of 1–3 bracts or none; corolla $2'$ or more broad; carpels of the fruit wrinkled or reticulated and with a stout incurved beak.

C. digitàta. Wild in prairies of Arkansas and Texas; 1° high; leaves mostly from the root, 5–7-parted into long linear sometimes 2–3-cleft divisions; peduncles long and slender; involucre none; corolla $1\frac{1}{2}'-2'$ broad, the petals fringe-toothed at the end; fruit nearly as in the last.

* * *Root slender or tapering: herbage smooth.* ① ②

C. pedàta. Wild in E. Texas; not rare cult.; stem erect, $1^{\circ}-5^{\circ}$ high, leafy; leaves rounded, 3–7-lobed or parted and the wedge-shaped divisions cleft or cut; peduncles slender, longer than the leaves; involucre none; corolla about $1\frac{1}{2}'$ broad, the petals minutely eroded at the end; carpels of the fruit smooth and even on the back, and with a stout conspicuous beak.

7. NAPÆA, GLADE-MALLOW. (From Greek name for *glade* or *nymph of the groves.*) Only one species,

N. dioica. In valleys, chiefly in limestone districts of Penn., Virginia, and W. A rather coarse, roughish herb; stem $4^{\circ}-7^{\circ}$ high; leaves 9–11-parted and their lobes cut and toothed, the lowest often 1° in diameter; flowers small, in panicled corymbs, in summer.

8. ÁNODA. (Origin of the name obscure.) Low herbs from Mexico, Texas, &c., sparingly cult. for ornament. Stems, &c. hirsute: peduncles long and slender, 1-flowered. Fruit in the form of a many-rayed star, supported by the spreading 5-rayed calyx: when ripe the rim of each carpel falls away with the seed it embraces, the sides or partitions disappearing. ①

A. hastàta has mostly halberd-shaped leaves, and blue or violet corolla only $1'-1\frac{1}{2}'$ in diameter; lobes of the calyx ovate, scarcely pointed.

A. cristàta has mostly triangular or obscurely halberd-shaped and toothed leaves, and purple or rose-colored corolla 2′ in diameter; lobes of the calyx triangular, taper-pointed.

9. SÌDA. (Ancient name, of obscure meaning.) Mostly rather small-flowered or weedy herbs, with 5 – 12 styles and carpels: fl. summer and autumn.

* *Peduncles axillary, 1-flowered: corolla yellow.*

S. spinòsa. So named from the little pointed projection or tubercle at the base of the petiole, but which can hardly be called a spine; stems much branched, 10′ – 20′ high; leaves lance-ovate, serrate, minutely soft-downy; peduncles very short; flower very small; pod ovate, of 5 carpels, each splitting at top into 2 points. A common weed S. of New York. ①

S. rhombifòlia. But the leaves are hardly rhombic, usually lance-oblong, short-petioled, serrate, pale and whitish downy beneath; stems 1° – 3° high, much branched; peduncles rather long; flower small; fruit of 10 or 12 one-pointed carpels. A weed only S. ①

S. Elliòttii. Nearly smooth, 1° – 4° high; leaves linear or lanceolate, serrate, short-petioled; flower 1′ broad, on a short peduncle; fruit of 10 – 12 nearly blunt carpels. Woodlands S. ♃

* *Peduncles bearing a corymb of several white flowers from the upper axils.*

S. Napæa. Smooth; stem simple, 4° - 7° high; leaves rounded, 5-cleft, the lobes toothed and taper-pointed; corolla about 1′ broad; styles and cells of the pod 10. Wild in S. Penn. and Virg. Cult. in old gardens. ♃

10. ABÙTILON, INDIAN MALLOW. (Origin of name obscure.) Resembles Sida, but cells more than one-seeded; flowers usually larger.

A. Avicénnæ, Velvet-Leaf. Cult. soil and old gardens, 3° – 5° high; leaves roundish heart-shaped, taper-pointed, soft-velvety; peduncles shorter than petiole, 1 – 3-flowered; corolla orange-yellow; fruit of 12 – 15 united hairy carpels with spreading beaks. Fl. autumn. ①

A. striàtum, Striped Abutilon. Cult. in greenhouses, &c. from Brazil; a tall shrub, very smooth, with rounded heart-shaped 3-lobed leaves, the lobes very taper-pointed, and pretty large solitary flowers hanging on a very long and slender peduncle; corolla not spreading open, orange-colored, with deeper or brownish veining or stripes.

11. MODÌOLA. (The shape of the depressed fruit likened to the Roman measure *modiolus.*) Procumbent or spreading, small-flowered, weedy plants.

M. multífida. Virginia and S., in low grounds; leaves 3 – 7-cleft and cut, or the earlier ones rounded and undivided; flowers red, ½′ broad; fruit hairy at the top. ② ♃

12. MALVAVÍSCUS. (Name composed of *Malva*, Mallow, and *viscus*, birdlime, from the glutinous pulp of the berry-like fruit.) Shrubby plants, with showy scarlet flowers, of peculiar appearance, the petals not expanding, but remaining convolute around the lower part of the slender projecting and soon twisted column, held together as it were by a little side-lobe near the base of the inner edge.

M. arbòreus, the common West India species, cult. in some hot-houses, has heart-shaped leaves longer than broad, and yellowish fruit.

M. Drummòndii, of Texas, if housed in winter flowers all summer in open ground, is soft-downy, with more rounded and somewhat 3-lobed leaves, and scarlet fruit.

13. KOSTELÉTZSKYA. (Named for a Bohemian botanist, *Kosteletzsky.*) Like Hibiscus, only the cells of ovary and fruit 1-seeded. Fl. summer.

K. Virgínica, Virginian K. In and near salt marshes, from New York and New Jersey S.: roughish-hairy, 2° – 5° high; leaves heart-shaped or mostly 3-lobed, often halberd-shaped; flowers somewhat racemed or panicled, rose-purple, 1′ – 2′ broad. ♃

14. HIBÍSCUS, ROSE-MALLOW. (Ancient name, of obscure origin.) Flowers showy, usually large, in summer and autumn.

* *Tall shrubs or even trees, exotics.*

H. Syrìacus, TREE H. or SHRUBBY ALTHÆA, of gardens and grounds, common, native of the Levant: nearly smooth, with wedge-ovate and 3-lobed leaves, and short-peduncled flowers in their axils, in autumn, about 3′ broad, purple, rose-color, white, &c., often double.

H. Rosa-Sinénsis. CHINA H. or ROSE OF CHINA. Cult. in conservatories, from East Indies (where the splendid corollas, which stain black, are used to black shoes): very smooth, with bright green ovate and pointed somewhat toothed leaves, and very showy flowers on slender peduncles, 4′ or 5′ broad, scarlet-red (rarely rose-purple or even white), often double.

* * *Herbs, with persistent and regular 5-lobed calyx, and a short pod.*

+ *Wild species, but sometimes cultivated, tall and large.* ♃

H. coccíneus, GREAT RED H. or ROSE-MALLOW. Marshes from Carolina S.; very smooth, 4° – 7° high, with leaves 5-parted or deeply cleft into long lanceolate and taper-pointed divisions, and bright-red corolla 6′ – 11′ broad, the petals narrowed below.

H. militàris, HALBERD-LEAVED R. Low grounds from Pennsylvania and Illinois S.; smooth, 3° – 4° high, with ovate or heart-shaped toothed or 3-lobed leaves, some of them halberd-shaped, and slender-peduncled flowers, with inflated calyx, and flesh-colored corolla 4′ – 5′ broad.

H. Moscheùtos, SWAMP R. Common in brackish marshes and up the larger rivers; 3° – 7° high, soft-downy; the ovate pointed and often 3-lobed leaves hoary beneath, generally smooth above; peduncles slender; corolla 4′ – 6′ broad, pale rose or white, with or without a darker centre; pod smooth.

H. grandiflòrus, LARGE-FL. R. Swamps, from Illinois and Carolina S.; like the last, but leaves soft-downy both sides, and pod velvety-hairy.

H. aculeàtus, PRICKLY or ROUGH R. Swamps only S.; rough with stiff bristles and bristly points, 2° – 6° high; leaves 3 – 5-cleft and the divisions mostly toothed; flowers short-peduncled; leaves of the involucre often forked; corolla yellow with a purple centre, 4′ broad; pod bristly.

+ + *Exotic low species, in gardens or cultivated grounds.* ①

H. Triònum, BLADDER KETMIA or FLOWER-OF-AN-HOUR. Rather hairy, 1° – 2° high, with the leaves toothed, or the upper 3-parted into lanceolate lobes, the middle lobe much longest; calyx inflated and bladdery; corolla about 2′ broad, sulphur-yellow with a blackish eye, open only in midday sunshine.

* * * *Herbs, with calyx splitting down one side, and generally falling off at once, and with long or narrow pyramidal or angled pod: natives of East Indies.*

H. esculéntus, OKRA or GUMBO. Nearly smooth, with rounded heart-shaped 5-lobed toothed leaves, greenish-yellow flowers on slender peduncle (involucre falling early), and narrow pods 3′ or 4′ long, which are very mucilaginous, and when green cooked and eaten, or used to thicken soups: cult. S. ①

H. Mànihot. Smoothish, with leaves 5 – 7-parted into long narrow divisions; the large and showy corolla pale yellow with a dark eye; the leaves of the involucre hairy and soon falling off: introduced or cult. S. W. ♃

15. GOSSÝPIUM, COTTON. (Name given by Pliny, from the Arabic.) Plants now diffused over warm countries, most valuable for the wool on the seeds: the species much mixed up.

G. herbàceum, COMMON COTTON. Cult. S. Leaves with 5 short and roundish lobes; petals pale yellow or turning rose-color, purple at base. ①

G. Barbadénse, BARBADOES OR SEA-ISLAND C. Cult. on the coast S. Inclining to be shrubby at base; branches black-dotted; leaves with 5 longer lance-ovate and taper-pointed lobes; leaves of the involucre with very long and slender teeth; petals yellowish or whitish with purple base.

G. arbòreum, TREE C. Cult. S., only for curiosity, has 5 – 7 nearly lanceolate and taper-pointed lobes to the leaves, leaves of involucre slightly toothed, and a purple corolla with a darker centre.

each cell. The petals themselves are commonly more or less united at their base; they are 5 or sometimes 6 or even more in number in natural flowers, and in cultivated plants apt to be increased by doubling.

* *Exotics, from China, Japan, &c.: some of the inner stamens entirely separate: commonly there is a gradation from bracts to sepals and petals.*

1. CAMELLIA. Numerous separate inner stamens within the ring or cup formed by the united bases of the very numerous outer stamens. Style 3-5-cleft. Seeds large, usually single in each cell of the thick and woody pod. Leaves evergreen, serrate.
2. THEA. Separate interior stamens only as many as the petals (5 or 6): otherwise nearly like Camellia: flowers less showy; bracts under the calyx inconspicuous.

* * *Natives of Southeastern States: stamens all united at the base.*

3. GORDONIA. Stamens in 5 clusters, one attached to the base of each petal. Style columnar: stigma 5-rayed. Seeds several, more or less winged. Leaves coriaceous or thickish.
4. STUARTIA. Stamens uniformly united by a short ring at the base of the filaments. Seeds 2 in each cell, wingless. Leaves thin and deciduous.

1. CAMÉLLIA. (Named for *G. Camellus* or *Kamel,* a missionary to China in the 17th century.)

C. Japónica, JAPAN CAMELLIA, with oval or oblong pointed and shining leaves, and terminal or nearly terminal flowers, simple or double, red, white, or variegated, of very many varieties, is the well-known and only common species; fl. through the winter, hardy only S.

2. THÈA, TEA-PLANT. (The Chinese name.) Genus too slightly different from Camellia. Shrubs, natives of China and Japan, sparingly cult. for ornament.

T. víridis, GREEN or COMMON T. Leaves oblong or broadly lanceolate, much longer than wide; the white flowers (1′ or more broad) nodding on short stalks in their axils.

T. Bohèa, BOHEA T. Leaves smaller and broader in proportion; probably a mere variety of the other.

3. GORDÒNIA. (Named for *Dr. Gordon* and another Scotchman of the same name.)

G. Lasiánthus, LOBLOLLY BAY. A handsome shrub or small tree, in swamps near the coast from Virginia S., with evergreen and smooth lance-oblong leaves tapering to the base and minutely serrate, and showy white flowers 2′-3′ across, in spring and summer, on a slender peduncle; the stamens short, on a 5-lobed cup.

G. pubéscens, also called FRANKLÍNIA, after *Dr. Franklin.* Grows only in Georgia and Florida; a tall, ornamental shrub or small tree, with thinner and deciduous leaves whitish downy beneath, as are the sepals and (white) petals, and longer style and filaments, the latter in 5 distinct parcels one on the base of each petal.

4. STUÁRTIA. (Named for *John Stuart,* the *Lord Bute* at the time of the American Revolution.) Ornamental shrubs, with thin leaves and handsome white flowers 2′ or 3′ across, in late spring or early summer, wild in shady woods of Southern States.

S. Virgínica, grows in the low country from Virginia S.; shrub 8°-12° high, with finely serrate leaves soft-downy underneath, pure white petals, purple stamens, one style, and a roundish pod.

S. pentágyna, belongs to the mountains S. of Virginia, and in cult. is hardy N.; has smoother leaves and rather larger very handsome flowers, their petals jagged-edged and tinged with cream-color, the sepals often reddish outside, 5 separate styles, and a 5-angled pointed pod.

26. LINACEÆ, FLAX FAMILY.

A small family, represented here only by the main genus,

1. **LÍNUM,** FLAX. (The classical Greek and Latin name.) Flowers (see Lessons, p. 89, fig. 174, 175, and p. 93, fig. 191) usually opening for only one day, and in sunshine, regular and symmetrical; the persistent sepals, deciduous petals, slightly monadelphous stamens, and mostly the styles 5, but the latter are sometimes fewer, occasionally partly united: ovary and pod with as many 2-seeded cells as there are styles, or mostly twice as many and one-seeded, each cell being divided more or less by a false partition. Seeds with a mucilaginous coat and a large straight oily embryo. Leaves simple, nearly sessile, and entire. Fl. all summer.

* *Wild species, annuals or scarcely perennials, with small yellow flowers.*

L. Virginiànum, the commonest WILD FLAX, in dry woods, 2° high, with spreading or recurving terete branches at the summit of the stem; the leaves oblong or lanceolate, only the lower spatulate and opposite; flowers scattered; styles separate; pod little larger than a pin's head.

L. striàtum, also common, mostly in boggy grounds, like the first; but has the branches shorter, scattered along the stem, and sharply 4-angled with intermediate grooves (whence the name); most of the stem-leaves opposite and oblong; flowers more crowded.

L. sulcàtum, much less common, in dry soil, also has grooved (upright) branches, but the leaves are linear and scattered; flowers and pods twice as large; sepals sharp-pointed, 3-nerved and with rough glandular margins; styles united half-way up.

* * *Cultivated, hardy, herbaceous, with 5 styles and largish handsome flowers.*

L. usitatíssimum, COMMON FLAX. Cult. from Old World, and inclined to run wild in fields; with narrow lanceolate leaves, corymbose rich blue flowers, and pointed sepals. ①

L. perénne, PERENNIAL FLAX. Cult. from Eu. in some varieties, for ornament, wild beyond the Mississippi; less tall than the foregoing, narrower-leaved; sepals blunt; petals sky-blue, sometimes pale, at least towards the base. ♃

L. grandiflòrum, LARGE-FL. RED FLAX. Cult. as an annual, from North Africa; 1° high, with linear or lanceolate leaves, and showy crimson-red flowers. ① ♃

* * * *Cultivated in conservatories, shrubby, with 3 styles and large flowers.*

L. trígynum, of India, has rather large elliptical leaves, and a succession of large and showy bright-yellow flowers.

27. GERANIACEÆ, GERANIUM FAMILY.

As now received a large and multifarious order, not to be characterized as a whole in any short and easy way, including as it does Geraniums, Nasturtiums, Wood-Sorrels, Balsams, &c., which have to be separately described.

§ 1. *Flowers regular and symmetrical: sepals persistent. Herbs.*

1. OXALIS. Sepals and petals 5, the former imbricated, the latter convolute in the bud. Stamens 10, monadelphous at base, the alternate ones shorter. Styles 5, separate on a 5-celled ovary, which becomes a membranaceous several-seeded pod. Juice sour and watery. Leaves commonly of three obcordate or two-lobed leaflets, which droop at nightfall. Flowers usually open only in sunshine.
2. LIMNANTHES. Sepals and petals 5, the former valvate, the latter convolute in the bud. Glands on the receptacle 5. Stamens 10, separate at the base. Style 1, five-lobed at the apex, rising from the centre of a deeply five-lobed ovary, which in fruit becomes 5 separate thickish and wrinkled akenes. Leaves pinnate; the leaflets cut or cleft.

3. FLŒRKEA. Sepals, small petals, stigmas, and lobes of the ovary 3; and stamens 6: otherwise like Limnanthes.
4. GERANIUM. Sepals and petals 5, the former imbricated, the latter commonly convolute in the bud. Glands on the receptacle 5, alternate with the petals. Stamens 10, monadelphous at the base, the alternate filaments shorter, but usually bearing anthers. Style 5-cleft. Ovary 5-celled, 5-lobed, the lobes separating when ripe into 5 two-ovuled but one-seeded carpels or little pods, which remain hanging by their long naked recurving styles as these split off, from below upwards, from a long central beak or axis. (Lessons, p. 125, fig. 277, 278.) Leaves with stipules Herbage scented.
5. ERODIUM. Stamens with anthers only 5. Styles when they split off from the beak bearded inside, often twisting spirally: otherwise as Geranium.

§ 2. *Flowers somewhat irregular, Geranium-like. Shrubby or fleshy-stemmed.*

6. PELARGONIUM. Sepals and petals 5; the base of one sepal extends downward on one side the pedicel forming a narrow tube or adherent spur, and the two petals on that side of the flower differ from the rest more or less in size or shape. Stamens with anthers fewer than 10, commonly 7. Pistil, &c. as in Geranium. Herbage scented. Leaves with stipules.

§ 3. *Flowers very irregular, spurred, also unsymmetrical. Tender herbs.*

7. TROPÆOLUM. Sepals 5, united at the base, and in the upper side of the flower extended into a long descending spur. Petals 5, or sometimes fewer, usually with claws: the two upper more or less different from the others and inserted at the mouth of the spur. Stamens 8, unequal or dissimilar; filaments usually turned downwards and curving. Ovary of 3 lobes surrounding the base of a single style, in fruit becoming 3 thick and fleshy closed separate carpels, each containing a single large seed. Herbs, climbing by their long leafstalks; the watery juice with the pungent odor and taste of Cress. Leaves alternate: stipules none or minute. Peduncles axillary, one-flowered.
8. IMPATIENS. Sepals and petals similarly colored, the parts belonging to each not readily distinguished. There are 3 small outer pieces, plainly sepals, on one side of the flower; then, on the other side, a large hanging sac contracted at the bottom into a spur or little tail; within are two small unequally 2-lobed petals, one each side of the sac. Stamens 5, short, conniving or lightly cohering around and covering the 5-celled ovary, which in fruit becomes a several-seeded pod: this bursts elastically, flying in pieces at the touch, scattering the seeds, separating into 5 twisting valves and a thickish axis. Style none. Seeds rather large. Erect, branching, succulent-stemmed herbs, with simple leaves and no stipules.

1. ÓXALIS, WOOD-SORREL. (Name from Greek words meaning *sour-salt*, from the oxalates or "salt-of-sorrel" contained in the juice.)

* *Native species, flowering through the summer: leaflets broadly obcordate.*

O. stricta, YELLOW W. Extremely common in waste or cultivated soil and open woodlands; stems 3′–12′ high, leafy; slender peduncles bearing an umbel of 2–6 small yellow flowers, followed by slender pods. ① ♃

O. Acetosélla, TRUE W. Common in mossy woods N.; the leafstalks and 1-flowered scapes 2′–4′ high from a creeping scaly-toothed rootstock; flower rather large, white with delicate reddish veins. ♃

O. violàcea, VIOLET W. Common S., rarer N., in rocky or sandy soil; leafstalks and slender scape from a scaly bulb, the flowers several in an umbel, middle-sized, violet. ♃

* * *Cultivated in conservatories, from Cape of Good Hope.*

O. Bówiei, a stemless species, with a small bulb on a spindle-shaped root; leafstalks and few-flowered scapes 6′–10′ high; broad obcordate leaflets almost 2′ long; petals deep rose-color, 1′ long.

O. speciòsa is more hairy; leaflets obovate and scarcely notched, commonly crimson underneath, only 1′ long; scapes short, 1-flowered; petals 1½′ long, pink-red with a yellowish base.

O. flàva, from a strong bulb sends up to the surface a short scaly stem, bearing thick flattish leafstalks and short 1-flowered scapes; the leaflets 6–10 and linear; petals nearly 1′ long, yellow, often edged with reddish.

§ 1. *Leaves peltate and fleshy, the 5 lobes entire: stems trailing.*

P. peltàtum, Ivy-leaved P. Generally smooth, the leaf fixed towards the middle, with or without a darkish zone; flowers pink or varying to white.

§ 2. *Leaves round and crenate, very obscurely many-lobed and with a deep narrow sinus: petals all of one color (scarlet, pink, or varying to white), the two upper a little narrower than the others: stems erect, shrubby and succulent. The two species greatly mixed.*

P. zonàle, Horse-shoe P. So called from the dark horse-shoe mark or zone, which however is not always present; smoothish; petals narrowish.

P. ínquinans, Staining or Scarlet P. In the unmixed state is soft-downy and clammy, the leaves without the zone; petals broadly obovate, originally intense scarlet.

§ 3. *Leaves rounded, moderately if at all lobed: branches scarcely succulent: petals never scarlet, the two upper more or less larger than the three lower.*

* *Leaves sweet-scented, velvety or soft-downy: flowers small: stems or branches herbaceous or half herbaceous, spreading or straggling.*

P. capitàtum, Rose-scented P. Softly hairy, with the rose-scented leaves moderately lobed, the lobes short and broad; peduncle bearing many sessile flowers in a head; petals rose-purple, barely $\frac{1}{2}'$ long.

P. tomentòsum, Peppermint P. Densely soft-hairy; branches long and thickish; leaves rather large, round-heart-shaped and with 5 – 7 open lobes, velvety-hairy both sides; flowers on long pedicels in panicled umbels, insignificant; petals white, the 3 lower a little longer than the calyx.

P. odoratissimum, Nutmeg-scented P. Branches slender and straggling, from a very short scaly stem or base; leaves rounded and crenate, soft-velvety, small; flowers on short pedicels, very small; petals white, scarcely exceeding the calyx.

* * *Leaves not sweet-scented: flowers large, pink, purple, white, &c., the two upper petals longer and broader than the three lower and streaked or spotted: shrubby and erect. (All much mixed.)*

P. cucullàtum, Cowled P. Soft-hairy, the rounded kidney-shaped leaves cupped, soft-downy.

P. cordàtum, Heart-leaved P. Like the last or less hairy, with flat ovate-heart-shaped leaves.

P. angulòsum, Maple-leaved P. Harsher-hairy; the leaves rigid, inclined to be lobed, truncate or even wedge-shaped at the base (scarcely ever heart-shaped), sharply toothed.

§ 4. *Leaves decidedly lobed or cut, in some species compound or decompound,*

* *Smooth and pale or glaucous, rounded, palmately 5 – 7-cleft.*

P. grandiflòrum, Great-flowered P. Shrubby; peduncles bearing about 3 large flowers, with white petals $1\frac{1}{2}'$ long, the two upper larger and elegantly veined or variegated with pink or rose-color.

* * *Silky-hoary, pinnately veined and somewhat pinnatifid.*

P. trícolor, Three-colored P. Low, rather shrubby; the long-petioled small leaves lance-oblong; peduncles bearing 2 or 3 showy flowers; the three lower petals white, the two upper crimson, with a dark spot at their base, and rather smaller, $\frac{1}{2}'$ long: not common.

* * * *Soft-hoary or velvety, palmately 3-parted, small: no obvious stipules.*

P. exstipulàtum, Penny-Royal P. Low, rather shrubby; leaves with the sweet scent of Penny-Royal or Bergamot, $\frac{1}{2}'$ wide, the lobes wedge-shaped and cut-toothed; flowers small and insignificant, white.

* * * * *Hairy, roughish, or downy: leaves more or less pinnatifid or pinnately compound or the main lobes or divisions pinnatifid, balsamic or strong-scented: stipules present.*

P. quercifòlium, Oak-leaved P. Shrubby, hairy and glandular; leaves deeply sinuate-pinnatifid, with wavy-toothed blunt lobes (the lowest ones largest, making a triangular-heart-shaped outline), often dark-colored along the middle, unpleasantly scented; petals purple or pink, the two upper (1' long) much longest.

P. gravèolens, Heavy-scented P. Shrubby and hairy like the last; leaves palmately 5 – 7-lobed or parted and the oblong lobes sinuate-pinnatifid; petals shorter.

P. Rádula, Rough P. Shrubby, rough and hairy above with short bristles; the balsamic or mint-scented leaves palmately parted and the divisions pinnately parted or again cut into narrow linear lobes, with revolute margins; peduncles short, bearing few small flowers; petals rose-color striped or veined with pink or purple.

P. fúlgidum, Brilliant P. Shrubby and succulent-stemmed, downy; leaves mostly 3-parted, with the lateral divisions wedge-shaped and 3-lobed, the middle one oblong and cut-pinnatifid; calyx broad in the throat; petals obovate, scarlet, often with dark lines, ½' long.

P. tríste, Sad or Night-scented P. Stem succulent and very short from a tuberous rootstock, or none; leaves pinnately decompound, hairy; petals dull brownish-yellow with darker spots, sweet-scented at night.

7. TROPÆOLUM, NASTURTIUM or INDIAN CRESS. (Name from a Greek word for *a trophy*, the foliage of the common sort likened to a group of shields.) Cult. from South America, chiefly Peru, for ornament, and the pickled fruits used as a substitute for capers, having a similar flavor and pungency: fl. all summer, showy.

T. màjus, Common N. Climbing high, also low and scarcely climbing; leaves roundish and about 6-angled, peltate towards the middle; petals much longer than calyx, varying from orange to scarlet and crimson, pointless, entire or a little jagged at the end, and the 3 lower and longer-clawed ones fringed at the base: also a full double variety. ①

T. minus, Smaller N. Smaller; petals paler yellow and with a pointed tip. Now less common than the preceding, but mixed with it. ①

T. tuberòsum, Tuberous N. Less common; leaves with 5 rather deep lobes; petals entire, orange, scarcely longer than the heavy-spurred orange-red calyx; tubers edible. ♃

T. peregrinum, Canary-bird Flower. Climbing high; leaves deeply 5 – 7-lobed and cut; spur hooked or curved; petals light yellow, the 2 upper lobed, the 3 lower small and fringed. ①

8. IMPÁTIENS, TOUCH-ME-NOT, JEWEL-WEED, BALSAM. (Name from the sudden bursting of the pod when touched.) Ours are all tender and succulent-stemmed annuals: fl. all summer.

I. pállida, Pale T. Wet ground and moist shady places, commonest N., 1° – 4° high, branched; leaves alternate, oval; flowers panicled, pale yellow dotted with brownish-red (rarely spotless), the sac broader than long and tipped with a short incurved spur.

I. fúlva, Spotted T. Commoner S.; has smaller orange-colored flowers spotted with reddish-brown, sac longer than broad and tapering into an inflexed spur (spots and spur rarely wanting).

I. Balsámina, Garden Balsam, from India. Low, with crowded lanceolate leaves, the lower opposite, a cluster of large and showy short-spurred flowers in their axils, on short stalks, of very various shades (from white to red and purple); the finer sorts full double.

28. RUTACEÆ, RUE FAMILY.

Known by the transparent dots or glands (resembling punctures) in the simple or compound leaves, containing a pungent or acrid bitter-aromatic volatile oil; and stamens only as many or twice as many (or in Orange and Lemon more numerous), inserted on the base of a receptacle (or a glandular disk surrounding it) which sometimes elevates more or less the single compound pistil or the 2 – 5 more or less separate carpels. Leaves either opposite or alternate, in ours mostly alternate, without stipules. Flowers only in No. 2 irregular. Many species are medicinal.

§ 1. *Perennial, strong-scented, hardy (exotic) herbs: flowers perfect: stamens* 8 *or* 10: *ovary* 4 – 5-*lobed*, 4 – 5-*celled: seeds several.*

1. RUTA. Sepals and petals 4 or 5, short, the latter roundish and arching. Stamens twice as many as the petals. Style 1. Pod globular and many-seeded. Leaves decompound.
2. DICTAMNUS. Sepals and petals 5; the latter long and lanceolate, on short claws, the lower one declining, the others ascending. Stamens 10; the long filaments declining and curved, partly glandular. Styles 5, nearly separate. Ovary a little elevated, deeply 5-lobed, in fruit becoming 5 flattened rough-glandular 2 – 3-seeded pods, each splitting when ripe into 2 valves, which divide into an outer and an inner layer. Leaves pinnate.

§ 2. *Shrubs or trees, hardy, with polygamous, diœcious, or sometimes perfect, small (greenish or whitish) flowers: stamens* 4 *or* 5, *as many as the petals: seeds single or in pairs.*

* *Indigenous: leaves pinnate or of* 3 *leaflets, deciduous.*

3. ZANTHOXYLUM. Flowers diœcious. Pistils 2 – 5; their styles slightly cohering; the ovaries separate, ripening into rather fleshy at length dry and 2-valved little pods. Seed black, smooth and shining. Prickly trees or shrubs: leaves pinnate.
4. PTELEA. Flowers polygamous. Pistil a 2-celled ovary tipped with a short style, forming a 2-celled 2-seeded and rounded wing-fruit or samara, in shape like that of the Elm. Not prickly: leaflets 3.

* * *Exotic: leaves simple and entire, evergreen.*

5. SKIMMIA. Flowers polygamous or perfect. Ovary 2 – 5-celled, with a single ovule from the top of each cell, in fruit becoming a red berry or drupe.

§ 3. *Shrubs or trees, exotic, not hardy, with sweet-scented foliage and perfect flowers, having numerous* (20 – 60) *stamens.*

6. CITRUS. Petals 4 – 8, usually 5, thickish. Filaments irregularly united more or less. Ovary many-celled, encircled at the base by a conspicuous disk (see Lessons, p. 125, fig. 281), in fruit becoming a thick-rinded many-seeded large berry. Branches usually spiny. Leaves evergreen, apparently simple, but with a joint between the blade and the (commonly winged or margined) petiole, showing that the leaf is a compound one reduced to the end-leaflet.

1. RÙTA, RUE. (The ancient name.) Natives of the Old World. ♃

R. gravéolens, Common Rue. Cult. in country gardens; a bushy herb, woody or almost shrubby at the base, with bluish-green and strongly dotted oblong or obovate small leaflets, the terminal one broader and notched at the end, and corymbs of greenish-yellow flowers, produced all summer; the earliest blossom has the parts in fives, the rest in fours. Plant very acrid, sometimes even blistering the skin.

2. DICTÁMNUS, FRAXINELLA. (Ancient Greek name.) Native of Southern Europe. ♃

D. Fraxinélla. Cult. for ornament; herb with an almost woody base, viscid-glandular, and with a strong aromatic scent; the leaves likened to those of Ash on a smaller scale (whence the common name) of 9 – 13 ovate and serrate leaflets; the large flowers in a terminal raceme, in summer, in one variety pale purple with redder veins, another white.

3. ZANTHÓXYLUM, PRICKLY ASH. (Name composed of two Greek words, meaning *yellow wood.*) Bark, leaves, and little fleshy pods very pungent and aromatic.

Z. Americànum, Northern P. or Toothache-tree. Rocky woods and banks N.; a prickly shrub or small tree, with leaves downy when young, of 9 – 11 ovate or oblong leaflets; the greenish flowers in axillary clusters, in

30. MELIACEÆ, MELIA FAMILY.

Trees, chiefly with pinnately compound dotless leaves, stamens twice as many as the petals and united up to or beyond the anthers into a tube, and a several-celled ovary with a single style; almost all tropical, — represented in Florida and farther south by SWIETÈNIA MAHOGANI, the MAHOGANY-TREE, and by an exotic shade-tree at the South, viz.

1. **MÈLIA.** (Old Greek name of the Ash, transferred to a widely different tree.) Calyx 5 – 6-parted. Petals 5 or 6, linear-spatulate. Filaments united into a cylindrical tube with a 10 – 12-cleft mouth, enclosing as many anthers. Fruit a globose berry-like drupe, with a bony 5-celled stone, and a single seed in each cell. Flowers in large compound panicles.

M. Azédarach, PRIDE-OF-INDIA or CHINA-TREE. A favorite shade-tree at the S., 30° – 40° high, with twice pinnate smooth leaves, ovate and pointed toothed leaflets, of a deep green color, and numerous fragrant lilac-colored flowers, in spring, succeeded by the yellowish fruit.

31. ANACARDIACEÆ, CASHEW FAMILY.

Trees or shrubs, with resinous or acid, sometimes poisonous, often colored or milky juice; alternate leaves without stipules; small flowers with sepals, petals, and stamens 5; and a 1-celled 1-ovuled ovary bearing 3 styles or stigmas, — represented by the genus

1. **RHÚS,** SUMACH. (Ancient name.) Flowers polygamous or diœcious, sometimes perfect, whitish or greenish, in terminal or axillary panicles. Stamens inserted under the edge or between the lobes of a flattened disk in the bottom of the calyx. Fruit a small dry or berry-like drupe, the solitary seed on a curved stalk rising from the bottom of the cell. (The astringent leaves of some species are used for dyeing and tanning, those of R. CORIARIA in S. Europe for morocco leather. The juice of some Japanese species yield their famous lacquer; the fruit of another a sort of wax.)

§ 1. *Cultivated from Europe, with simple entire leaves: not poisonous.*

R. Cótinus, SMOKE-TREE or VENETIAN SUMACH. Shrub 5° – 9° high, smooth, with obovate leaves on slender petioles, loose panicles of flowers in early summer, followed rarely by little half-heart-shaped fruits: usually most of the flowers are abortive, while their pedicels lengthen, branch, and bear long plumy hairs, making large and light, feathery or cloud-like bunches, either greenish or tinged with red, which are very ornamental. The same or one very like it is wild in Alabama.

§ 2. *Native species, with compound leaves of* 3 – 31 *leaflets.*

* *Poisonous to the touch for most people, the juice resinous: flowers in slender axillary panicles, in summer: fruit smooth, white or dun-color.*

R. Toxicodéndron, POISON IVY or POISON OAK. Common in low grounds, climbing by rootlets over rocks, &c., or ascending trees; leaflets 3, rhombic-ovate, often sinuate or cut-lobed, rather downy beneath. A vile pest.

R. venenàta, POISON SUMACH, P. ELDER, or P. DOGWOOD. In swampy ground; shrub 6° – 18° high, smooth, with pinnate leaves of 7 – 13 obovate entire leaflets, and very slender panicles. More virulent than the foregoing.

* * *Not poisonous: fruit red and beset with reddish hairs, very acid.*

+ *Leaves pinnate: flowers whitish, in large and very compact terminal panicles, in early summer, succeeded by a compact mass of crimson fruit.*

R. týphina, STAGHORN SUMACH. Shrub or tree, on hillsides, &c., 10° – 30° high, with resinous-milky juice, brownish-yellow wood, velvety-hairy branches and stalks, and large leaves of 11 – 31 lance-oblong pointed and serrate leaflets. Worthy to be planted for ornament.

R. glàbra, SMOOTH S. Shrub 2° – 12° high, in rocky places, like the last, but smooth, the leaflets whitened beneath. — Var. LACINIATA, in Penn., has the leaflets cut into narrow irregular lobes: planted for ornament.

R. copallìna, DWARF S. Shrub 1° – 5° high, in rocky or sandy ground, spreading by subterranean shoots; with downy stalks or branches, petioles winged or broadly margined between the 9 – 21 oblong or lance-ovate oblique leaflets, which are thickish and shining above; juice resinous.

+ + *Leaves of* 3 *cut-lobed leaflets: flowers light yellow, in spring before the leaves appear, diœcious, in small scaly-bracted and catkin-like spikes.*

R. aromàtica, FRAGRANT S. A straggling bush in rocky places, from Vermont W. & S., with the small rhombic-ovate leaflets pubescent when young, aromatic-scented.

32. VITACEÆ, VINE FAMILY.

Woody plants, climbing by tendrils, with watery and often acid juice, alternate leaves, deciduous stipules, and small greenish flowers in a cyme or thyrsus; with a minutely 4 – 5-toothed or almost obsolete calyx; petals valvate in the bud and very deciduous; the stamens as many as the petals and opposite them; a 2-celled ovary with a pair of ovules rising from the base of each cell, becoming a berry containing 1 – 4 bony seeds. Tendrils and flower-clusters opposite the leaves.

1. VITIS. Calyx very short, a fleshy disk connecting it with the base of the ovary and bearing the petals and stamens.
2. AMPELOPSIS. Calyx minutely 5-toothed: no disk. Petals expanding before they fall. Leaflets 5.

1. VITIS, GRAPE-VINE. (The classical Latin name.) Fl. in late spring.

§ 1. TRUE GRAPES. *Petals and stamens* 5, *the former lightly cohering at the top and thrown off without expanding: the base of the very short and truncate calyx filled with the disk, which rises into* 5 *thick lobes or glands between the stamens: leaves simple, rounded and heart-shaped, usually* 3 – 5*-lobed.*

* *Flowers all perfect, somewhat fragrant: exotic.*

V. vinífera, EUROPEAN GRAPE. Cult. from immemorial time, from the East, furnishing the principal grapes of our greenhouses, &c.; some varieties nearly hardy N.: leaves green, cottony only when very young.

* * *Flowers more or less polygamous (some plants inclined to produce only staminate flowers), exhaling a fragrance like that of Mignonette: native species.*

+ *Bark of stem early separating in loose strips: panicles compound and loose.*

V. Labrùsca, NORTHERN FOX-GRAPE, the original of the CATAWBA, ISABELLA, and furnishing most of the American table and wine grapes; common in moist grounds N. & W.: leaves and young shoots very cottony, even the adult leaves retaining the cottony wool underneath, the lobes separated by roundish sinuses; fruit large, with a tough musky pulp when wild, dark purple or amber-color, in compact clusters.

V. æstivàlis, SUMMER GRAPE. Common N. & S.; leaves green above, and with loose cobwebby down underneath, the lobes with roundish open sinuses; clusters slender; fruit smaller and earlier than in the foregoing, black with a bloom, pleasant. Original of the CLINTON GRAPE, &c.

V. cordifòlia, WINTER or FROST GRAPE. Common on banks of streams: leaves never cottony, green both sides, thin, heart-shaped, little lobed, but coarsely and sharply toothed; clusters loose; fruit small, bluish or black with a bloom, very sour, ripe after frosts. Var. RIPÀRIA, the common form along river-banks W. has broader and more cut or lobed leaves.

+ + *Bark of stem close and smooth, pale.*

V. vulpìna, MUSCADINE, BULLACE, or FOX-GRAPE of the South. River-banks from Maryland and Kentucky S.: leaves rather small, round in outline, seldom and slightly lobed, glossy and mostly smooth both sides, the margin cut into coarse and broad teeth; clusters small; fruit large, $\frac{1}{2}' - \frac{3}{4}'$ in diameter, purple, thick-skinned, musky, or pleasant-flavored, ripe in early autumn: the original of the SCUPPERNONG GRAPE, &c.

§ 2. CISSUS. *Petals and* stamens 4 or 5, *the former opening regularly: disk thick and broad,* 4 – 5-*lobed: flowers mostly perfect: berries not larger than peas, not eatable.*

* *Wild species S. & W., smooth, usually with* 5 *stamens and petals.*

V. indivìsa, a species with simple leaves like those of a true Grape, heart-shaped or ovate, pointed, coarsely-toothed, but not lobed; flower-clusters small and loose; style slender.

V. bipinnàta, a bushy or low-climbing plant, with few tendrils, and decompound leaves, the small leaflets cut-toothed.

* * *Exotic species, with mostly* 4 *stamens and petals.*

V. heterophỳlla, from Japan, a form with the leaves blotched or variegated with white (small, thin, variously 3 – 5-lobed), and small blue berries, is hardy in gardens; cult. for the variegated foliage.

V. díscolor, from Java, cult. in hothouses, for its splendid foliage; leaves lance-oblong with a heart-shaped base, crimson underneath, velvety-lustrous and dark-green shaded with purple or violet, or often mottled with white, on the upper surface, the shoots reddish.

2. AMPELÓPSIS, VIRGINIA-CREEPER. (Name from Greek words, meaning *like the Vine:* indeed, it is hardly distinct enough from the second section of *Vitis.*)

A. quinquefòlia, the only genuine species: in all low grounds, climbing extensively, sometimes by rootlets as well as by the tendrils, the latter specially fitted for ascending walls and trunks, to which they attach themselves firmly by sucker-like disks at the tip of their branches (Lessons, p. 38, figs. 62, 63); leaflets 5, digitate, lance-oblong, cut-toothed, changing to crimson in autumn; flowers cymose, in summer; berries small, black or bluish.

33. RHAMNACEÆ, BUCKTHORN FAMILY.

Shrubs or trees, of bitterish and astringent properties, with simple chiefly alternate leaves and small flowers; well marked by the stamens of the number of the valvate sepals (4 or 5) and alternate with them, i. e. opposite the petals, inserted on a disk which lines the calyx-tube and often unites it with the base of the ovary, this having a single erect ovule in each of the (2 – 5) cells. Branches often thorny: stipules minute or none: flowers often apetalous or polygamous. Petals commonly hooded or involute around the stamen before it. (Lessons, p. 126, fig. 282, 283.)

* *Calyx free from the ovary.*

1. BERCHEMIA. Twining climbers, with straight-veined leaves. Petals 5, without claws, rather longer than the stamens. Disk thick, nearly filling the bottom of the calyx. Ovary 2-celled, becoming a 2-celled small stone-fruit, with purple and thin pulp.
2. RHAMNUS. Erect shrubs or trees, with loosely-veined leaves. Petals 4 or 5, with short claws. Stamens short. Ovary 2 – 4-celled, becoming a black berry-like fruit, containing 2 – 4 cartilaginous seed-like nutlets, which are grooved on the back, as is the contained seed. Cotyledons foliaceous.
3. FRANGULA. Like Rhamnus, but with straight-veined leaves; the nutlets not grooved but convex on the back: cotyledons thick.

Represented both as to native and cultivated plants by two genera:

1. CELASTRUS. Flowers polygamous or diœcious. Petals and stamens 5, on the edge of a concave disk which lines the bottom of the calyx. Filaments and style rather slender. Pod globular, berry-like, but dry. Leaves alternate.
2. EUONYMUS. Flowers perfect, flat; the calyx-lobes and petals (4 or 5) widely spreading. Stamens mostly with short filaments or almost sessile anthers, borne on the surface of a flat disk which more or less conceals or covers the ovary. Pod 3–5-lobed, generally bright-colored. Leaves opposite: branchlets 4-sided.

1. CELÁSTRUS, STAFF-TREE. (Old Greek name, of obscure meaning and application.)

C. scàndens, Climbing Bitter-sweet or Wax-work. A twining high-climbing shrub, smooth, with thin ovate-oblong and pointed finely serrate leaves, racemes of greenish-white flowers (in early summer) terminating the branches, the petals serrate or crenate-toothed, and orange-colored berry-like pods in autumn, which open and display the seeds enclosed in their scarlet pulpy aril: wild in low grounds, and planted for the showy fruit.

2. EUÓNYMUS, SPINDLE-TREE. (Old Greek name, means *of good repute.*) Shrubs not twining, with dull-colored inconspicuous flowers, in small cymes on axillary peduncles, produced in early summer; the pods in autumn ornamental, especially when they open and display the seeds enveloped in their scarlet pulpy aril.

* *Leaves deciduous, finely serrate: style short* or *nearly none.*

+– *North American species: anthers sessile* or *nearly* so.

E. atropurpùreus, Burning-bush or Spindle-tree. Tall shrub, wild from New York W. & S., and commonly planted; with oval or oblong petioled leaves, flowers with rounded dark dull-purple petals (generally 4), and smooth deeply 4-lobed red fruit, hanging on slender peduncles.

E. Americànus, American Strawberry-bush. Low shrub, wild from New York W. & S., and sometimes cult.; with thickish ovate or lance-ovate almost sessile leaves, usually 5 greenish-purple rounded petals, and rough-warty somewhat 3-lobed fruit, crimson when ripe. Var. obovàtus, with thinner and dull obovate or oblong leaves, has long and spreading or trailing and rooting branches.

+– +– *Exotic: anthers raised on evident filaments.*

E. Europæus, European Spindle-tree. Occasionally planted, but inferior to the foregoing; a rather low shrub, with lance-ovate or oblong short-petioled leaves, about 3-flowered peduncles, 4 greenish oblong petals, and a smooth 4-lobed red fruit, the aril orange-color.

* * *Leaves evergreen, serrulate: filaments and style rather slender.*

E. Japónicus, Japan S. Planted S. under the name of Chinese Box, there hardy, but is a greenhouse plant N.; has obovate shining and bright green leaves (also a form with white or yellowish variegation), several-flowered peduncles, 4 obovate whitish petals, and smooth globular pods.

35. SAPINDACEÆ, SOAPBERRY FAMILY.

Trees, shrubs, or one or two herbaceous climbers, mostly with compound or lobed leaves, and unsymmetrical flowers, the stamens sometimes twice as many as the petals or lobes of the calyx, but commonly rather fewer, when of equal number alternate with the petals; these imbricated in the bud, inserted on a disk in the bottom of the calyx and often coherent with it: ovary 2–3-celled, sometimes 2–3-lobed, with 1–3 (or in Staphylea several) ovules in each cell. The common plants belong to the three following suborders.

I. BLADDER-NUT FAMILY; has perfect and regular flowers, stamens as many as the petals, several bony seeds with a straight embryo in scanty albumen, and opposite compound leaves both stipulate and stipellate.

1. STAPHYLEA. Erect sepals, petals, and stamens 5; the latter borne on the margin of a fleshy disk which lines the bottom of the calyx. Styles 3, slender, separate or lightly cohering: ovary strongly 3-lobed, in fruit becoming a bladdery 3-lobed 3-celled and several-seeded large pod. Shrubs, with pinnately compound leaves of 3 or 5 leaflets.

II. SOAPBERRY FAMILY PROPER; has flowers often polygamous or diœcious, and more or less irregular or unsymmetrical, only 1 or 2 ovules, ripening but a single seed in each cell of the ovary, the embryo coiled or curved, without albumen. No stipules.

* *Leaves alternate. Pod bladdery-inflated, except in No. 4.*

2. CARDIOSPERMUM. Herbs, with twice ternate and cut-toothed leaves, climbing by hook-like tendrils in the flower-clusters. Sepals 4, the inner pair larger. Petals 4, each with an appendage on the inner face, that of the two upper large and petal-like, of the two lower crest-like and with a deflexed spur or process, raised on a claw. Disk irregular, enlarged into two glands, one before each lower petal. Stamens 8, turned towards the upper side of the flower away from the glands, the filaments next to them shorter. Styles or stigmas 3, short: ovary triangular, 3-celled, with a single ovule rising from the middle of each cell. Fruit a large and thin bladdery 3-lobed pod: seeds bony, globose, with a scale-like heart-shaped aril adherent to the base.
3. KŒLREUTERIA. Small tree, with pinnate leaves. Sepals 5. Petals 3 or 4 (the place of the others vacant), each with a small 2-parted scale-like appendage attached to its claw. Disk enlarging into a lobe before each petal. Stamens 5 – 8, declined: filaments hairy. Style single, slender: ovary triangular, 3-celled, with a pair of ovules in each cell. Pod bladdery, 3-lobed, 3-celled.
4. SAPINDUS. Trees, with abruptly pinnate leaves. Sepals and petals each 5, or rarely 4; the latter commonly with a little scale or appendage adhering to the short claw. Stamens mostly 8, equal. Style single: ovary 3-lobed, 3-celled, with a single ovule in each cell. Fruit mostly a globular and fleshy 1-celled berry (the other cells abortive), filled with a large globular seed, its coat crustaceous: cotyledons thick and fleshy.

* * *Leaves opposite, of 5 – 9 digitate leaflets. Pod leathery, not inflated.*

5. ÆSCULUS. Trees or shrubs. Calyx 5-lobed or 5-toothed. Petals 4 or 5, more or less unequal, on claws enclosed in the calyx, not appendaged. Stamens 7, rarely 6 or 8: filaments slender, often unequal. Style single, as also the minute stigma: ovary 3-celled, with a pair of ovules in each cell. Fruit a leathery pod, splitting at maturity into 3 valves, ripening 1 – 3 very large, chestnut-like, hard-coated seeds: the kernel of these consists of the very thick cotyledons firmly joined together, and a small incurved radicle.

III. MAPLE FAMILY; has flowers generally polygamous or diœcious, and sometimes apetalous, a mostly 2-lobed and 2-celled ovary, with a pair of ovules in each cell, ripening a single seed in each cell of the winged fruit. Embryo with long and thin cotyledons, coiled or crumpled. (See Lessons, p. 5, fig. 1 – 3, &c.) Leaves opposite: no stipules.

6. ACER. Trees, or a few only shrubs, with palmately-lobed or even parted leaves. Calyx mostly 5-cleft. Petals as many or none, and stamens 3 – 8 or rarely more, borne on the edge of the disk. Styles or stigmas 2, slender. Fruit a pair of samaras or key-fruits, united at the base or inner face and winged from the back. Occasionally the ovary is 3-celled and the fruit 3-winged.
7. NEGUNDO. Trees, with pinnate leaves of 3 – 7 leaflets, and diœcious very small flowers, without petals or disk; the calyx minute: stamens 4 or 5. Fruit, &c. of Acer.

1. STAPHYLÈA, BLADDER-NUT. (Name from a Greek word for a bunch of grapes, little applicable.)

S. trifòlia, American B. Shrub 8° – 10° high, with greenish striped branches, 3 ovate pointed serrate leaflets, deciduous stipules, and hanging raceme-like clusters of white flowers at the end of the branchlets of the season, in spring, followed by the large bladdery pods. Low ground, common N. & W.

S. pinnàta, European B., occasionally planted, is very similar, but has five leaflets.

2. CARDIOSPÉRMUM, BALLOON-VINE, HEART-SEED. (The latter is a translation of the Greek name.)

C. Halicàcabum, the common species, wild in the S. W. States, is cult. in gardens, for the curious inflated pods; it is a delicate herb, climbing over low plants or spreading on the ground, with small white flowers, in summer.

3. KŒLREUTÈRIA. (Named for *Kœlreuter*, a German botanist.)

K. paniculàta, a small tree from China, planted in ornamental grounds; has pinnate leaves of numerous thin and coarsely toothed or cut leaflets, and a terminal ample branched panicle of small yellow flowers, in summer, followed by the bladdery pods.

4. SAPÍNDUS, SOAPBERRY. (*Sapo Indus*, i. e. Indian soap, the berries used as a substitute for soap.)

S. marginàtus, wild S. & W.: a small tree, with 8 – 20 broadly lanceolate falcate leaflets on a wingless but often margined common stalk, and small white flowers in panicles, in summer, the whitish berries as large as bullets.

5. ÆSCULUS, HORSE-CHESTNUT, BUCKEYE. (Ancient name of an Oak or other mast-bearing tree, applied to these trees on account of their large chestnut-like seeds. These, although loaded with farinaceous nourishment, are usually rendered uneatable, and even poisonous, by a bitter narcotic principle.) Flowers in a terminal crowded panicle, in late spring or early summer.

§ 1. True Horse-Chestnuts: *natives of Asia, with broad and spreading petals on short claws, and fruit more or less beset with prickly points.*

Æ. Hippocàstanum, Common H. Tall fine tree, with 7 leaflets, and large flowers of 5 petals, white, and spotted with some purple and yellowish; stamens 7, declined: of late there is a double-flowered variety.

Æ. rubicúnda, Red H. Less tall, flowering even as a shrub, with brighter green leaves of 5 – 7 leaflets, flowers with 4 rose-red petals not so spreading, and mostly 8 stamens less declined. Probably a hybrid between Horse-Chestnut and some red Buckeye.

§ 2. *Californian, with 4 broad spreading petals on rather slender claws.*

Æ. Califórnica, Californian H. Low tree, of 5 slender-stalked leaflets, and a long very compact raceme-like panicle of small white or rosy-tinged flowers; stamens 5 – 7, slender; fruit large, with some rough points.

§ 3. Buckeyes: *of Atlantic U. S., with 4 erect and smaller petals on slender claws.*

Æ. parviflòra, Small Buckeye. Wild in the upper country S., and planted N.; shrub 3° – 9° high, with 5 – 7 leaflets soft downy underneath, slender raceme-like panicle 1° long, and capillary stamens very much longer than the narrow white petals; flowering N. as late as midsummer; fruit smooth; seeds small, almost eatable.

Æ. glàbra, Fetid or Ohio Buckeye. W. of the Alleghanies; tall tree, with 5 nearly smooth leaflets, a short panicle, stamens moderately longer than the somewhat uniform pale yellow petals, and fruit prickly roughened like that of Horse-Chestnut.

Æ. flàva, Yellow or Sweet Buckeye. W. & S.; tree or shrub, with 5 – 7 smooth or smoothish leaflets, a short dense panicle, oblong calyx, and

deeply 5-lobed leaves silvery-white and when young downy beneath, the narrow lobes coarsely cut and toothed; flowers greenish, in earliest spring, without petals; fruit woolly when young, but soon smooth, 2′ – 3′ long including the great diverging wings.

A. rùbrum, Red or Swamp M. Rather small tree, in wet grounds, with soft white wood, reddish twigs, moderately 3 – 5-lobed leaves whitish beneath, the middle lobe longest, all irregularly serrate; flowers scarlet, crimson, or sometimes yellowish (later than in the foregoing species); fruit smooth, with the slightly spreading wings 1′ or less in length, often reddish.

7. NEGÚNDO, ASH-LEAVED MAPLE, BOX-ELDER. (Obscure or unmeaning name.)

N. aceroìdes. A handsome, rather small tree, common from Penn. S. & W., with light green twigs, and drooping clusters of small greenish flowers, in spring, rather earlier than the leaves, the fertile ones in drooping racemes, the oblong fruits half the length of the very veiny wing; leaflets ovate, pointed, coarsely toothed, very veiny. A variety with white-variegated leaves is lately cult. for ornament.

36. POLYGALACEÆ, POLYGALA FAMILY.

Bitter, some of them medicinal plants, represented mainly, and here wholly, by the genus

1. POLÝGALA, MILKWORT. (Name from Greek words, meaning *much milk;* but the plants have no milky juice at all; they are thought to have been so named from a notion that in pasturage they increased the milk of cows.) Flowers remarkably irregular, in outward appearance as if papilionaceous like those of the next family, but really of a quite different structure. Calyx persistent, of 5 sepals; three of them small, viz. two on the lower, and one on the upper, side of the blossom; and one on each side called *wings* which are larger, colored, and would be taken for petals. Within these, on the lower side, are three petals united into one body, the middle one keel-shaped and often bearing a crest or appendage. Stamens 8 or sometimes 6; their filaments united below into a split sheath, separating above usually in two equal sets, concealed in the hooded middle petal: anthers 1-celled, opening by a hole at the top. Style curved and commonly enlarged above or variously irregular. Ovary 2-celled, with a single ovule hanging from the top of each cell, becoming a small flattish 2-seeded pod. Seed with an appendage at the attachment (*caruncle*): embryo straight, with flat cotyledons in a little albumen. Leaves simple, entire, without stipules. Our native species are numerous, mostly with small or even minute flowers, and are rather difficult to study. The following are the commonest.

§ 1. *Native species, low herbs, mostly smooth.*

* *Flowers yellow, some turning green in drying, in dense spikes or heads: leaves alternate. Growing in low or wet places in pine-barrens, S. E. Fl. summer.*

+– *Numerous short spikes or heads in a corymb.*

P. cymòsa. Stem 1° – 3° high, branching at top into a compound corymb of spikes; leaves linear, acute, the uppermost small; no caruncle to the seed. From North Carolina S.

P. ramòsa. Stem 6′ – 12′ high, more branched; lowest leaves obovate or spatulate, upper ones lanceolate; a caruncle at base of seed. Delaware and S.

+– +– *Short and thick spike or head single: root-leaves clustered.*

P. lùtea, Yellow Bachelor's-Button of S. Stem 5′ – 12′ high; lower leaves spatulate or obovate, upper lanceolate; flowers bright orange.

P. nàna. Stems 2′ – 4′ high, in a cluster from the spatulate or linear root-leaves; flowers lighter yellow.

* * *Flowers purple or rose-color, in a single dense spike terminating the stem or branches: no subterranean flowers. Fl. all summer.* ①

+— *Leaves all alternate, narrow.*

P. incarnàta. From Penn. W. & S.; stem slender, 6′ – 12′ high; leaves minute and awl-shaped; the three united petals extended below into a long and slender tube, the crest of the middle one conspicuous.

P. sanguínea. Sandy damp ground: stem 4′ – 8′ high, leafy to the top; leaves oblong-linear; flowers bright rose-purple (sometimes pale or even white), in a thick globular at length oblong head or spike, without pedicels.

P. fastigiàta. Pine-barrens from New Jersey S.; slender, 4′ – 10′ high, with smaller narrow-linear leaves, and oblong dense spike of smaller rose-purple flowers, on pedicels as long as the pod; bracts falling off.

P. Nuttàllii. Sandy soil, from coast of Mass. S.; lower than the foregoing; flowers rather looser in more cylindrical spikes, greenish-purple; awl-shaped bracts remaining on the axis after the flowers or fruits have fallen.

+— +— *Leaves all or all the lower ones in whorls of four.*

P. cruciàta. Low grounds: stems 3′ – 10′ high, 4-angled, and with spreading branches; leaves linear or spatulate, mostly in fours; spike thick and short, nearly sessile, its axis rough with persistent bracts where the flowers have fallen; wings of the flower broad-ovate or heart-shaped, bristly-pointed.

P. brevifòlia. Sandy bogs from Rhode Island S.: differs from the last only in more slender stems, narrower leaves, those on the branches alternate, the spike stalked, and wings of the flower lance-ovate and nearly pointless.

* * * *Flowers (all summer) greenish-white or scarcely tinged with purple, very small, in slender spikes, none subterranean: leaves linear, the lower in whorls of four or five.* ①

P. verticillàta. Very common in dry sterile soil; stem 5′ – 10′ high, much branched; all the leaves of the main stem whorled.

P. ambigua. In similar places and very like the last, chiefly S. & W., more slender; only the lowest leaves whorled; flowers more scattered and often purplish-tinged, in long-peduncled spikes.

* * * * *Flowers white, small (in late spring) in a close spike terminating simple tufted stems which rise from a perennial root, none subterranean: leaves numerous, all alternate.* ♃

P. Sénega, Seneca Snakeroot. A medicinal plant, commoner W., 5′ – 12′ high, with lanceolate or oblong, or even lance-ovate short leaves, cylindrical spike, round-obovate wings, and small crest.

P. álba. Common only far W. & S. W.; more slender than the last, with narrow-linear leaves, more tapering long-peduncled spike, and oval wings.

* * * * * *Flowers rose-purple in a raceme, or single, largish: leaves alternate.*

P. grandiflòra. Dry soil S.; pubescent, with branching stems 1° high, lanceolate leaves, crestless flowers scattered in a loose raceme (in late summer), bright purple turning greenish. ♃

P. polýgama. Sandy barrens, with tufted and very leafy stems 5′ – 8′ high, linear-oblong or oblanceolate leaves, and many-flowered racemes of handsome rose-purple flowers, their crest conspicuous; also on short underground runners are some whitish very fertile flowers with no evident corolla. Fl. all summer. ②

P. paucifòlia, Fringed Polygala, sometimes called Flowering Wintergreen. Light soil in woods, chiefly N.: a delicate little plant, with stems 3′ – 4′ high, rising from long and slender runners or subterranean shoots, on which are concealed inconspicuous fertile flowers; leaves few and crowded at the summit, ovate, petioled, some of them with a slender-peduncled showy flower from the axil, of delicate rose-red color (rarely a white variety), almost an inch long, with a conspicuous fringed crest and only 6 stamens; in spring. ♃

§ 2. *Shrubby species of the conservatory, from the Cape of Good Hope.*

P. oppositifòlia, with opposite sessile heart-shaped and mucronate leaves, of a pale hue, and large and showy purple flowers, with a tufted crest.

P. myrtifòlia, has crowded alternate oblong or obovate leaves, on short petioles, and showy purple flowers 1′ long, with a tufted crest.

37. LEGUMINOSÆ, PULSE FAMILY.

Distinguished by the *papilionaceous* corolla (Lessons, p. 105, fig. 217, 218), usually accompanied by 10 monadelphous or diadelphous or rarely distinct stamens (Lessons, p. 112, fig. 227, 228), and the *legume* (Lessons, p. 131, fig. 303, 304). These characters are combined in the proper Pulse Family. In the two other great divisions the corolla becomes less papilionaceous or wholly regular. Alternate leaves, chiefly compound, entire leaflets, and stipules are almost universal in this great order.

I. PULSE FAMILY PROPER. Flower (always on the plan of 5, and stamens not exceeding 10) truly papilionaceous, i. e. the standard outside of and in the bud enwrapping the other petals, or only the standard present in Amorpha. (For the terms used to denote the parts of this sort of corolla see Lessons, p. 105.) Sepals united more or less into a tube or cup. Leaves never twice compound.

A. *Stamens monadelphous* or *diadelphous.*

§ 1. *Herbs, shrubs, or one a small tree, never twining, trailing, nor tendril-bearing, with leaves simple or of 3 or more digitate leaflets, monadelphous stamens, and the alternate five anthers differing in size and shape from the other five: pod usually several-seeded.*

1. LUPINUS. Leaves of several leaflets, in one species simple: stipules adherent to the base of the petiole. Flowers in a long thick raceme. Calyx deeply 2-lipped. Corolla of peculiar shape, the sides of the rounded standard being rolled backwards, and the wings lightly cohering over and enclosing the narrow and incurved scythe-shaped or sickle-shaped keel. Pod flat. Mostly herbs.
2. CROTALARIA. Leaves in our species simple, and with foliaceous stipules free from the petiole but running down on the stem. Calyx 5-lobed. Keel scythe-shaped, pointed. Stamens with the tube of filaments split down on the upper side. Pod inflated. Ours herbs.
3. GENISTA. Leaves simple and entire: stipules very minute or none. Calyx 5-cleft. Keel oblong, nearly straight, blunt, turned down when the flower opens. Pod mostly flat. Low shrubby plants.
4. CYTISUS. Leaves of one or three leaflets, or the green branches sometimes leafless: stipules minute or wanting. Calyx 2-lipped or 5-toothed. Keel straight or somewhat curved, blunt, soon turned down. Style incurved or even coiled up after the flower opens. Pod flat. Seeds with a fleshy or scale-like appendage (*strophiole*) at the scar. Low shrubby plants.
5. LABURNUM. Leaves of three leaflets: stipules inconspicuous or wanting. Calyx with 2 short lips, the upper lip notched. Keel incurved, not pointed. Ovary and flat pod somewhat stalked in the calyx. Seeds naked at the scar. Trees or shrubs, with golden yellow flowers in long hanging racemes.

§ 2. *Herbs, never twining nor tendril-bearing, with leaves of 3 leaflets (rarely more but then digitate), their margins commonly more or less toothed (which is remarkable in this family): stipules conspicuous and united with the base of the petiole* (Lessons, p. 69, fig. 136): *stamens diadelphous: pod 1–few-seeded, never divided across into joints.*

* *Leaves pinnately 3-foliolate, as is seen by the end leaflet being jointed with the common petiole above the side leaflets.*

6. TRIGONELLA. Herbage odorous. Flowers (in the common cult. species) single and nearly sessile in the axil of the leaves. Pod elongated, oblong or linear, tapering into a long-pointed apex.
7. MEDICAGO. Flowers small, in spikes, heads, &c. Corolla short, not united with the tube of stamens. Pod curved or coiled up, at least kidney-shaped.
8. MELILOTUS. Herbage sweet-scented. Flowers small, in slender racemes. Corolla as in Medicago. Pod small, but exceeding the calyx, globular, wrinkled, closed, 1–2-seeded.

++ ++ *Pod indehiscent, very thick, 1-3-seeded. Calyx with a long, thread-shaped or stalk-like tube. Leaves abruptly pinnate: stipules united with the petiole at base.*

20. ARACHIS. Annual. Leaflets 4, straight-veined. Flowers small, yellow, in axillary heads or spikes. Calyx with one narrow lobe making a lower lip, the upper lip broad and 4-toothed. Keel incurved and pointed. Stamens monadelphous, 5 anthers longer and fixed by near their base, the alternate ones short and fixed by their middle. Ovary at the bottom of the very long and stalk-like tube of the calyx, containing 2 or 3 ovules: when the long style and the calyx with the rest of the flower falls away, the forming pod is protruded on a rigid deflexed stalk which then appears, and is pushed into the soil where it ripens into the oblong, reticulated, thick, coriaceous fruit, which contains the 1-3 large and edible seeds; the embryo composed of a pair of very thick and fleshy cotyledons and an extremely short nearly straight radicle.

++ ++ ++ *Pod continuous, i. e. not in joints, at length opening, 2-several-seeded.*

a. *Leaves abruptly pinnate: plants not twining. (Flowers in ours yellow.)*

21. SESBANIA. Herbs, with many pairs of leaflets, and minute or early deciduous stipules. Flowers in axillary racemes, or sometimes solitary. Calyx short, 5-toothed. Standard rounded, spreading: keel and style incurved. Pod usually intercepted internally with cellular matter or membrane between the seeds.

22. CARAGANA. Shrubs, with mostly fascicled leaves of several pairs of leaflets, and a little spiny tip in place of an end leaflet: stipules minute or spiny. Flowers solitary or 2-3 together on short peduncles. Calyx bell-shaped or short-tubular, 5-toothed. Standard nearly erect with the sides turned back: the blunt keel and the style nearly straight. Pod linear, several-seeded.

b. *Leaves odd-pinnate: stems not twining.*

1. *Anthers tipped with a little gland or blunt point.*

23. INDIGOFERA. Herbs, or sometimes shrubby, when pubescent the close-pressed hairs are fixed by the middle. Flowers rose-color, purple, or white, in axillary racemes or spikes, mostly small. Calyx 5-cleft. Standard roundish, often persistent after the rest of the petals have fallen: keel with a projection or spur on each side. Pod oblong, linear, or of various shapes, commonly with membranous partitions between the seeds.

2. *Anthers blunt and pointless.*

24. TEPHROSIA. Herbs, with obliquely parallel-veined leaflets often silky beneath, and white or purple flowers (2 or more in a cluster) in racemes; the peduncles terminal or opposite the leaves Calyx 5-cleft or 5-toothed. Standard rounded, silky outside. Style incurved, rigid: stigma with a tuft of hairs. Pod linear, flat, several-seeded.

25. ROBINIA. Trees or shrubs, with netted-veined leaflets furnished with stipels, and often with sharp spines or prickles for stipules. Flowers large and showy, white or rose-color, in axillary racemes. Base of the leafstalk hollow and covering the axillary bud of the next year. Calyx 5-toothed, the two upper teeth partly united. Standard large, turned back: keel incurved, blunt. Ovary stalked in the calyx. Pod broadly linear, flat, several-seeded, margined on the seed-bearing edge, the valves thin.

26. COLUTEA. Shrubs, not prickly, and no stipels to the leaflets: the flowers rather large, yellow or reddish, in short axillary racemes. Calyx 5-toothed. Standard rounded, spreading: keel strongly incurved, blunt, on long united claws. Style incurved, bearded down one side. Pod raised out of the calyx on a stalk of its own, thin and bladdery-inflated, flattish on the seed-bearing side, several-seeded.

27. ASTRAGALUS. Herbs, without stipels, and with white, purple, or yellowish rather small flowers in spikes, heads, or racemes: peduncles axillary. Corolla narrow: standard erect, mostly oblong. Style and stigma smooth and beardless. Pod commonly turgid or inflated and within more or less divided lengthwise by intrusion of the back or a false partition from it.

(SWAINSONA, SUTHERLANDIA, and CLIANTHUS, plants from Australia, New Zealand, and South Africa, with showy flowers and bladdery-inflated pods (like Colutea), are sometimes cult. in conservatories, but are not common enough to find a place here.)

c. *Leaves odd-pinnate: stems twining: stipels obscure: stipules small.*

28. WISTARIA. Woody, high-climbing, with numerous leaflets, and large showy bluish flowers, in hanging terminal dense racemes. Calyx with 2 short teeth on the upper and longer ones on the lower side. Standard large, roundish, turned back: keel merely incurved, blunt. Pod knobby, several-seeded.

29. APIOS. Herbs, twining over bushes, with 5 – 7 leaflets, and sweet-scented chocolate-purple flowers, in dense and short racemes: peduncles axillary. Calyx with 2 upper very short teeth, and one longer lower one, the side teeth nearly wanting. Standard very broad, turned back: keel long and scythe-shaped, strongly incurved, or at length coiled. Pod linear, flat, almost straight, several-seeded.

d. *Leaves of 3 leaflets (pinnately 3-foliolate) or rarely one, commonly stipellate.*

1. *Shrubby, or from a woody base: wings and sometimes keel small and inconspicuous.*

30 ERYTHRINA. Stem, branches, and even the leafstalks usually prickly. Flowers large and showy, usually red, in racemes. Calyx without teeth. Standard elongated: wings often wanting or so small as to be concealed in the calyx; keel much shorter than the standard, sometimes very small. Pod stalked in the calyx, linear, knobby, usually opening only down the seed-bearing suture. Seeds scarlet.

2. *Herbs, mostly twiners, with wings and keel in ordinary proportion.*

= *Flowers not yellow: seeds or at least the ovules several: leaflets stipellate.*

31. PHASEOLUS. Keel of the corolla coiling into a ring or spiral, usually with a tapering blunt apex: standard rounded, turned back or spreading. Style coiled with the keel, bearded down the inner side: stigma oblique or lateral. Pod linear or scimetar-shaped. Flowers usually clustered on the knotty joints of the raceme. Stipules striate, persistent.

32. DOLICHOS. Keel of the corolla narrow and bent inwards at a right angle, but not coiling. Style bearded under the terminal stigma. Stipules small. Otherwise nearly as Phaseolus.

33. GALACTIA. Keel straightish, blunt, as long as the wings: standard turned back. Style naked. Calyx of 4 pointed lobes, upper one broadest. Pod flattened, mostly linear. Flowers clustered on the knotty joints of the raceme: flower-buds taper-pointed. Stipules and bracts small or deciduous.

34. AMPHICARPÆA. Keel and very similar wings nearly straight, blunt: the erect standard partly folded around them. Style naked. Calyx tubular, 4-toothed. Flowers small; those in loose racemes above often sterile, their pods when formed scimetar-shaped and few-seeded; those at or near the ground or on creeping branches very small and without manifest corolla, but very fertile, making small and fleshy, obovate or pear-shaped, mostly subterranean pods, ripening one or two large seeds. Bracts rounded and persistent, striate, as are the stipules.

35. CENTROSEMA. Keel broad, incurved, nearly equalling the wings: standard large and rounded, spreading, and with a spur-like projection behind. Calyx short, 5-cleft. Style bearded only at the tip around the stigma. Pod long, linear, with thickened edges bordered by a raised line on each side. Flowers showy. Stipules, bracts, and bractlets striate, persistent.

36. CLITORIA. Keel small, shorter than the wings, incurved, acute: standard much larger than the rest of the flower, notched at the end, erect. Calyx tubular, 5-toothed. Style bearded down the inner side. Pod oblong-linear, flattish, not bordered. Flowers large and showy, 1 – 3 on a peduncle. Stipules, bracts, and bractlets persistent, striate.

37. HARDENBERGIA. Keel small, much shorter than the wings, incurved, blunt: standard large in proportion, rounded, spreading. Calyx short 5-toothed, the 2 upper teeth united. Style short, naked. Pod linear, not bordered. Flowers rather small, in racemes. Stipules and bracts small, striate, mostly deciduous. Leaflets mostly single.

38. KENNEDYA. Keel incurved, blunt or acute, mostly equalling or exceeding the wings: standard broad, spreading. Calyx 5-lobed: 2 upper lobes partly united. Style naked. Pod linear, not bordered. Flowers showy, red, single or few on the peduncle. Bracts and stipules striate.

= = *Flowers yellow (sometimes purple-tinged outside): ovules only 2: pod 1 – 2-seeded.*

39. RHYNCHOSIA. Keel of the corolla incurved at the apex: standard spreading. Calyx 4 – 5-parted or lobed. Pod short and flat. Flowers small. Leaves mostly soft-downy and resinous-dotted, sometimes of a single leaflet.

§ 4. *Herbs, with abruptly pinnate leaves, the common petiole terminated by a tendril, by which the plant climbs or supports itself, or in many low species the tendril reduced to a mere bristle or tip, or in* Cicer, *which has toothed leaflets, an odd leaflet commonly takes its place: peduncles axillary: stamens almost always diadelphous. Cotyledons very thick, so that they remain underground in germination, as in the Pea.*

* *Leaflets entire or sometimes toothed at the apex: radicle bent on the cotyledons: style inflexed: pod flat or flattish.*

40. PISUM. Lobes of the calyx leafy. Style rigid, dilated above and the margins reflexed and joined together so that it becomes flattened laterally, bearded down the inner edge. Pod several-seeded: seeds globose. Flowers large. Leaflets only 1 – 3 pairs.
41. LATHYRUS. Lobes of the calyx not leafy. Style flattened above on the back and front, bearded down one face. Pod several-seeded. Seeds sometimes flattish. Leaflets few or several pairs.
42. VICIA. Style slender, bearded or hairy only at the apex or all round the upper part. Pod 2 – several-seeded. Seeds globular or flattish. Leaflets few or many pairs.
43. LENS. Lobes of the calyx slender. Style flattish on the back, and minutely bearded down the inner face. Pod 1 – 2-seeded. Seeds flattened, lenticular. Flowers small.

* * *Leaflets toothed all round, and usually an odd one at the end in place of a tendril: style incurved, naked: radicle of the embryo almost straight.*

44. CICER. Calyx 5-parted. Pod turgid oblong, not flattened, 2-seeded. Seeds large, irregularly rounded-obovate, pointed. Peduncle mostly 1-flowered.

B. *Stamens separate to the base. (Plants not twining nor climbing.)*

§ 1. *Leaves simple or of 3 digitate leaflets.*

45. CHORIZEMA. Somewhat shrubby, with simple and spiny-toothed leaves, scarcely any stipules, and orange or copper-red flowers. Standard rounded kidney-shaped: keel straight, much shorter than the wings. Pod ovoid, turgid, several-seeded.
46. BAPTISIA. Herbs, with simple entire sessile leaves and no stipules, or mostly of 3 leaflets with deciduous or persistent stipules. Flowers yellow, blue, or white. Standard erect, with the sides turned back, about equalled by the oblong and straightish wings and keel. Pod inflated, coriaceous, stalked in the calyx, many-seeded.
47. THERMOPSIS. Pod scarcely stalked, linear, flat. Otherwise as Baptisia.

§ 2. *Leaves odd-pinnate.*

48. CLADRASTIS. Trees, with large leaflets, no obvious stipules, and hanging terminal panicles of white flowers. Standard turned back: the nearly separate straightish keel-petals and wings oblong, obtuse. Pod short-stalked in the calyx, linear, very flat, thin, marginless, 4 – 6-seeded. Base of the petioles hollow and covering the axillary leaf-buds of the next year.
49. SOPHORA. Trees, shrubs, or herbs, with numerous leaflets, and mostly white or yellow flowers in terminal racemes or panicles. Keel-petals and wings oblong, obtuse, usually longer than the broad standard. Pod commonly stalked in the calyx, terete, several-seeded, fleshy or almost woody, hardly ever opening, but constricted across into mostly 1-seeded portions.

II. BRASILETTO FAMILY.

Flowers more or less irregular, but not papilionaceous: when they seem to be so the petal answering to the standard will be found to be *within* instead of outside of the other petals. Stamens 10 or fewer, separate. The leaves are sometimes twice pinnate, which is not the case in the true Pulse Family. Embryo of the seed straight, the radicle not turned against the edge of the cotyledons.

§ 1. *Leaves simple and entire. Corolla appearing as if papilionaceous.*

50. CERCIS. Trees, with rounded heart-shaped leaves, minute early deciduous stipules, and small but handsome red-purple flowers in umbel-like clusters on old wood, earlier than the leaves, rather acid to the taste. Calyx short,

1. LUPÌNUS, LUPINE. (Old Latin name, from *lupus*, a wolf, because Lupines were thought to destroy the fertility of the soil.)

* *Wild species of Atlantic States, in sandy soil: fl. in spring.* ♃

L. perénnis, Wild L. Somewhat hairy; with erect stem 1° – 1½° high, 7 – 11 spatulate oblong or oblanceolate green leaflets, and a long raceme of showy purplish-blue (rarely pale) flowers, in late spring.

L. villòsus, One-leaved L. Silky-downy, with short spreading or ascending stems, oblong or lance-oblong simple leaves, and a dense raceme of blue, purple, or rose-colored flowers. Near the coast, from North Carolina S.

* * *Cultivated for ornament: fl summer.*

L. polyphýllus, Many-leaved L., is the principal hardy perennial species of the gardens, from Oregon and California, 3° – 4° high, rather hairy, with 13 – 15 lanceolate or oblanceolate leaflets, and a very long dense raceme of blue, sometimes purple, variegated, or even white flowers, in June. ♃

L. mutàbilis, cult. as an annual, from South America, is tall, very smooth throughout, with about 9 narrow-oblong blunt leaflets, and very large sweet-scented violet-purple flowers (or a white variety), with yellow and a little red on the standard.

L. densiflòrus, of California (where there are many fine Lupines), 1° – 2° high, is well marked by the numerous white flowers forming distinct and separate whorls in the long raceme. ①

L. àlbus, of Eu., which the ancients cultivated as pulse, has the several obovate-oblong leaflets smooth above, but hairy beneath, white flowers alternate in the raceme, and large smooth pods. ①

L. hirsùtus, cult. in old gardens, from Eu., is clothed with soft white hairs; the leaflets spatulate-oblong; flowers in loose whorls in the raceme, blue, with rose-color and white varieties; pods very hairy. ①

L. lùteus, the old Yellow L. of the gardens, from Eu., silky-hairy, rather low; with yellow flowers in whorls crowded in a dense spike. ①

2. CROTALÀRIA, RATTLEBOX. (From Greek word for *a rattle*, the seeds rattling in the coriaceous inflated pod.) Native, in sandy soil: fl. yellow, in summer.

C. sagittàlis. Low, 3′ – 6′ high, branching, beset with rusty-colored spreading hairs, with nearly sessile oval or lance-oblong leaves, and 2 or 3 flowers on the peduncle. ①

C. ovàlis. Spreading, rough with appressed hairs; leaves short-petioled, oval, oblong, or lanceolate; peduncle with 3 – 6 scattered flowers. ♃

3. GENÍSTA, WOAD-WAXEN, WHIN. (Celtic word: *little bush.*)

G. tinctòria, Dyer's W. or Green-weed. Nat. from Eu. in sterile soil E., especially in Mass.: low and undershrubby, not thorny, with lanceolate leaves, and bright yellow rather small flowers somewhat racemed at the end of the striate-angled green branches, in early summer.

4. CÝTISUS. (Ancient Greek name, after an island where it grows.) The following are the only species generally cultivated.

C. (or **Sarothàmnus**) **scopàrius,** Scotch Broom. Shrub, from Europe, 3° – 5° high, smooth, with long and tough erect angled and green branches, bearing small leaves, the lower short-petioled and with 3 obovate leaflets, the upper of a single sessile leaflet, and in the axils large and showy golden yellow flowers on slender pedicels; calyx with 2 short and broad lips; style and stamens slender, held in the keel, but disengaged and suddenly starting upward when touched (as when bees alight on the deflexed keel), the style coiling spirally; pod hairy on the edges. Hardy in gardens N.; running wild in Virginia: fl. early summer.

Irish Broom, so called, but is from Portugal, is another species, not hardy here. Spanish Broom is Spartium junceum, of another genus.

C. Canariénsis, from the Canary Islands, is cultivated in conservatories; a shrub with crowded slender branches, soft-hoary leaves of 3 very small obovate leaflets, and small yellow sweet-scented flowers, produced all winter.

5. LABÚRNUM. (Ancient Latin name. Genus separated from Cytisus from the different appearance, and the seeds destitute of strophiole or appendage at the scar.)

L. vulgàre, COMMON LABURNUM, GOLDEN-CHAIN, or BEAN-TREFOIL-TREE of Europe. Planted for ornament, a low tree, with smooth green bark, slender-petioled leaves of 3 oblong leaflets (2′ – 3′ long), and pretty large showy golden-yellow flowers hanging in long racemes, in late spring; pods with one thicker edge.

6. TRIGONÉLLA. (Old name, from Greek word for *triangular*, from the shape of the corolla or the seeds.) Low herbs. T. CÆRÙLEA is the plant used in Switzerland for imparting the flavor like that of Melilot to certain kinds of cheese.)

T. Fœnum-Græcum, FENUGREEK. Occasionally cult. in gardens, in Europe a forage and popular medicinal plant, strong-scented; with wedge-oblong leaflets, one or two nearly sessile small flowers in the axils, yellowish or whitish corolla, and a linear long-pointed and somewhat curved pod 2′ – 4′ long, with veiny sides. ①

7. MEDICÀGO, MEDICK. (The old name of Lucerne, because it came to the Greeks from *Media.*) All natives of the Old World: a few have run wild here. Fl. all summer.

* *Flowers violet-purple or bluish.* ♃

M. satìva, LUCERNE or SPANISH TREFOIL. Cultivated for green fodder, especially S.: stems erect, 1° – 2° high, from a long deep root; leaflets obovate-oblong; racemes oblong; pod several-seeded, linear, coiled about 2 turns.

* * *Flowers yellow.* ① ②

M. lupulìna, BLACK MEDICK, NONESUCH. A weed or pasture plant, in dry or sandy fields, &c.: low, spreading, downy, with wedge-obovate leaflets, roundish or at length oblong heads or spikes of small flowers, and little kidney-shaped 1-seeded pods turning black when ripe.

M. maculàta, SPOTTED M. Waste sandy places, S. & E.: spreading or trailing; with broadly inversely heart-shaped leaflets marked with a dark spot, 3 – 5-flowered peduncles, and a flat pod compactly coiled three or more turns, its thickish edge beset with a double row of curved prickles.

M. denticùlata, like the last, but rarer, with pod of looser coils, sharp edge, and mostly shorter prickles.

M. scutellàta, SNAIL MEDICK, BEEHIVE. Cult. occasionally in gardens for its curious pods, which are pretty large, coiled up like a snail-shell, in many turns, smooth and even.

8. MELILÒTUS, MELILOT, SWEET CLOVER. (From Greek words for *honey* and *Lotus*, i. e. *Sweet Lotus:* foliage sweet-scented, especially in drying.) Natives of the Old World; somewhat cult. in gardens, &c., and running wild in waste or cultivated ground: fl. all summer. ① ②

M. àlba, WHITE M., BOKHARA or TREE CLOVER. Tall, 3° – 6° high, branching, with obovate or oblong leaflets truncately notched at the end, and loose racemes of white flowers. Has been cult. for green fodder.

M. officinàlis, YELLOW M. Less tall, 2° – 3° high, with merely blunt leaflets and yellow flowers.

9. TRIFÒLIUM, CLOVER, TREFOIL. (Latin name: *three leaflets.*)

* *Low, insignificant weeds, nat. from Europe in dry waste fields, &c.* ①

+ *Flowers yellow, in round heads, produced through late summer and autumn, reflexed and turning chestnut-brown, dry and papery with age.*

T. agràrium, YELLOW HOP-C. Smoothish, 6′ – 12′ high, with obovate-oblong leaflets all nearly sessile on the end of the petiole; heads rather large.

T. procùmbens, LOW HOP-C. Smaller, spreading, rather downy, the wedge-obovate leaflets notched at the end, the middle one at a little distance from the others.