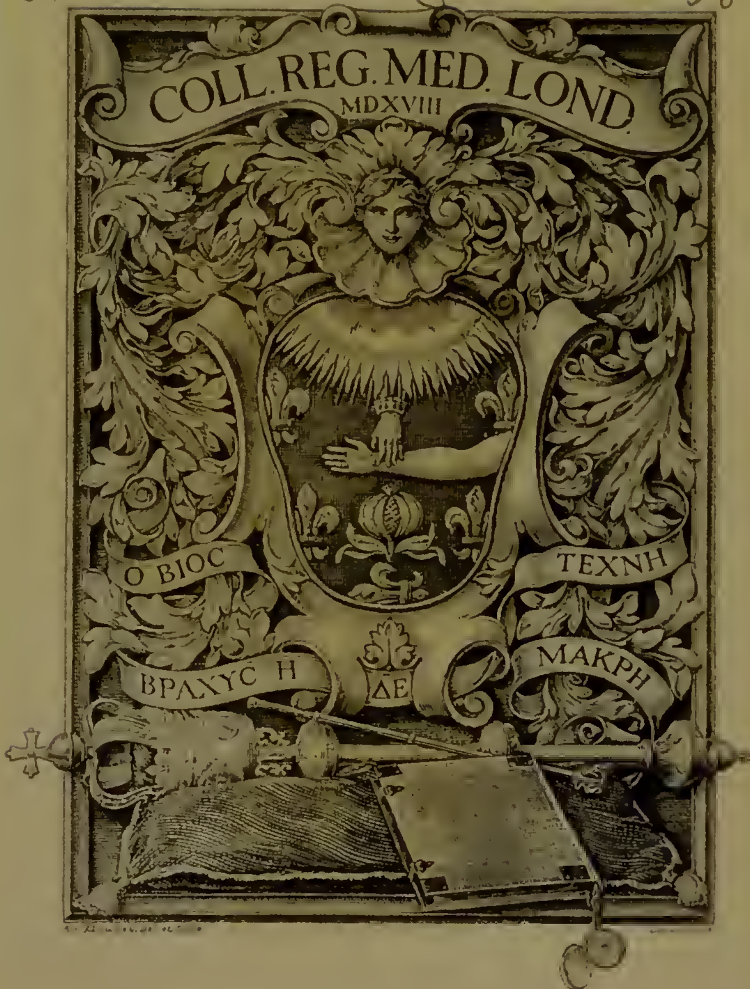
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1832.

ELEMENTS OF BOTANY.

ELEMENTS OF BOTANY

AND

VEGETABLE PHYSIOLOGY,

INCLUDING THE CHARACTERS OF THE

NATURAL FAMILIES OF PLANTS,

WITH ILLUSTRATIVE FIGURES.

BY A. RICHARD, M.D.

TRANSLATED FROM THE FOURTH EDITION

BY W. MACGILLIVRAY, A.M.

WILLIAM BLACKWOOD, EDINBURGH; AND
T. CADELL, STRAND, LONDON.
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TO

ROBERT GRAHAM, M.D., F.R.S.E.

REGIUS PROFESSOR OF BOTANY IN THE UNIVERSITY OF EDINBURGH,

THIS TRANSLATION

OF THE

"NOUVEAUX ELEMENS DE BOTANIQUE" OF M. A. RICHARD,

IS RESPECTFULLY INSCRIBED

BY HIS OBEDIENT SERVANT,

W. MACGILLIVRAY.

THE

TRANSLATOR'S PREFACE.

ALTHOUGH Botany has long been a favourite study in this country, it has generally been presented under the least attractive aspect. Catalogues of Plants, and Elementary Works intended chiefly to render intelligible an almost interminable vocabulary, have formed the staple materials of the science; while the more interesting and instructive departments have been overlooked, or have been merely introduced in the form of occasional notices. The present Work, besides imparting the usual information respecting the terms employed in designating the various organs of plants, affords a more satisfactory knowledge of their structure and relations than any of indigenous origin. The study of Natural Families is at length beginning to assume some degree of popularity among us; and, although more difficult at first, so as even to be hardly attainable without a previous examination of species by the

Linnæan method, must ultimately become prevalent, as it alone affords a real knowledge of the structure and mutual relations of plants. The success with which the elementary work of M. RICHARD has met on the Continent, bears testimony to its merits; and although a work, on a different plan, but having a similar object, has lately appeared in this country, it is conceived that its utility has been in no degree diminished. It is true that a translation has already been presented to the public, but that now offered will be seen to be, if not on a different plan, yet of a different character. When two commodities, intended for the gratification of the same want, are offered to the purchaser, he ought to be thankful that a choice has been afforded him.

The Translation is as direct and literal as was judged consistent with the differences of idiom between the languages, and the peculiarities of French and English authorship. The Illustrative Figures, which, in the original, were placed at the end of the volume, have, in the Translation, been dispersed through the Work, so that the reader can glance his eye from the definition to the illustration, without danger of losing sight of the relation which the one bears to the other. Some Notes have been added, having reference chiefly to the Medical and Economical Uses of Plants. The wood-engravings have been carefully executed by Mr W. W. Christie.

These are all the explanations which seem to be necessary, more especially as the Author has some valuable remarks in his Prefaces; and, while the Translator is sensible of the merits of the Original, he hopes his efforts may not have proved ineffectual in conveying the import of all that it contains, in a manner perfectly intelligible to the English reader.

ADVERTISEMENT

TO THE FOURTH EDITION.

THE Fourth Edition of our ELEMENTS OF BOTANY AND VEGETABLE PHYSIOLOGY, which we this day publish, we have improved as much as we could, with the view of endeavouring in some degree to justify the increasing success which the work obtains. Independently of the changes and additions which we have made in the different chapters, and particularly in those which treat of the structure of monocotyledonous stems, the general organization of the flower, the structure of the pollen, the action of that substance during fecundation, that of the ovule previous to impregnation, &c., we have especially to mention the important addition of the characters of all the families of the vegetable kingdom. The number of families which we here present amounts to a hundred and sixty-two. It might have been still greater had we intended to include all the families which have been successively established or proposed since the publication of the *Genera Plantarum* of Jussieu. But not only have we united to other already established families, a considerable number of those which have been newly proposed, but we have also thought, that, in an elementary work, we might without disadvantage, omit some families as yet too imperfectly known, either in their general characters, or in the genera of which they ought to consist, or, lastly, in the place which they ought to occupy in the series of natural orders. We are anxious to make this remark, that we may not be accused of not having spoken in this work of several recently proposed families.

We have sometimes judged it expedient to unite several families into one; and on this subject we must also say a few words. In the present state of science, we think there is more reason for diminishing the number of genera and families, than for increasing it. A glance at the changes which have taken place in botany since the establishment of the method of natural families, will be sufficient to shew the truth of this observation. For some time after the publication of the *Genera Plantarum* of Jussieu, that work, which even now is one of the most splendid monuments that have been reared to botany, while it is also, to the person who attentively studies it, a source of the most profound and positive knowledge, was considered as an invariable rule for characterizing the genera, as well as the families resulting from their approximation in groups. But the progress which has been made in botanical science, a more attentive examination of the structure of the seed and fruit, and the advantages which it affords for the arrangement of the genera and families, have induced great changes in the study of botany. The cultivators of that science became sensible of the necessity of penetrating still deeper into the organization of the different parts of the flower, and in particular of the ovary, the seed, and the fruit, which, it was perceived, would furnish the most important characters for determining the natural affinities of plants. The genera placed together in each of of the hundred natural orders presented in the *Genera Plantarum* were therefore submitted anew to examination ; and from this more precise analysis, which was directed especially towards the most essential organs, necessarily resulted the discovery of a great number of characters, resemblances and differences, which had previously passed unnoticed. The new impulse thus given to the study of plants, rendered it necessary to introduce modifications both in the circumscription of the genera, the number of which was soon more than doubled, and in that of the families themselves. But in this early period of the new era of botany, it was natural that observers, discovering every day a multitude of new modifications which had escaped the notice of their predecessors, should be more struck with the differences which they observed between the genera and families, than with the new relations which analysis disclosed. In fact, at this period, the genera, or the species that had been minutely analyzed according to the principles of the new school, were as yet too few and too unconnected not to present in some measure great dissimilarities; and, as but too often happens in the study of the sciences, facts which were as yet but special and unconnected were too hastily generalized: Whence arose the great number of new genera and families which were successively established, and which soon doubled that of the *Genera Plantarum*. But the impulse had been given, and the true path had been pointed out. The analytical investigation which is successively directed to the daily increasing number of plants, and the discoveries of travellers, who daily arrive with new types of organization, must gradually fill up many of the gaps by which the groups already established are separated. During the first period, each new analysis brought to light a new modification of vegetable organization, and became in some measure a separate type. But now when observations have greatly accumulated, analogous facts have arranged themselves around those previously known; and through the diversified modifications which each of them presents, shades of insensible gradation have in some measure connected them with each other, and have formed that so rarely interrupted chain of which all accurate observers have recognised the existence among the productions of nature. In this new state of things, we are daily witnessing the disappearance of the precise and strictly defined characters which were at first imagined to exist, both between the species which compose the genera, and between the genera associated in families. It necessarily results from this, that as the differences disappear, the sections or divisions which had been founded upon them ought to be dispensed with ; and, as we have already said, the necessary result of the continued advance of botanical science, must be a great diminution both in the number of the genera at present established, and in that of the groups or families which have been formed by their association. But for this new observations are still required. If we have sometimes refused to admit the ideas of others, we have done so from conviction, under the influence of a discriminating caution, and not with the selfish and perverse desire of substituting our own ideas for those of our predecessors.

In the arrangement or general disposition of the families, we have followed the series presented by M. de Jussieu, in which we have scarcely made any change. It is of little importance what method is followed, provided the natural and obvious affinities that exist among the different families be duly respected. For every person qualified to judge in this matter, seems to be now convinced of the impossibility of retaining the natural relations in a linear series, without frequent interruptions; and whether we adopt, as a basis to the divisions that may be established in it, the insertion, which was chosen by Jussieu for that purpose, or the adherence or non-adherence of the ovary, as I have attempted in my *Medical Botany*, numerous exceptions will every now and then interfere to interrupt the continuity of the system.

In characterizing the families themselves, we have in general preferred the name first imposed, not admitting that a mere change in the termination of the name is sufficient to transfer to another author the honour of having established a family. To this name we have added the synonyms of the family, or the names of those which we think should be united to it. All our characters, with the exception of a very small number of which we could not procure the materials, have been taken from nature, and not unfrequently a careful analysis of the genera of each family has induced us to modify the characters which had previously been given of it. We have not judged it expedient, in an elementary work, to present these characters in their full extent, although we have omitted nothing that might serve to distinguish the different families with precision; and as the fruit and the seed generally afford the most important characters, their description always forms part of the general character of each family.

To the general characters we have subjoined some observations, respecting the affinities and differences of each family viewed in relation to those which are placed near it, the divisions or tribes which have been proposed in it or the families which ought to be united to it. We have also taken care to mention the principal genera of which it is composed.

To enable beginners to direct their attention to the most distinct families, and especially to those of which they may readily find examples in nature, we have marked with an asterisk, all the families which contain genera that form part of the Flora of France *.

Those persons who, intending to follow the medical profession, study botany for the purpose of obtaining a knowledge of the characters, and medical properties of all the plants employed in medicine, or of all the medicines derived from the vegetable kingdom, will find all that it is necessary for the medical practitioner to know of this department of natural history, in our *Medical Botany* †.

In concluding this notice, we here renew the expression of our gratitude to the professors who have done us the honour of recommending our book to their pupils, and more especially to MM. Desfontaines, Professor at the *Jardin du Roi*; Guiart, Professor in the *Ecole de Pharmacie*; Delile, Professor to the Medical Faculty of Montpellier; and Nestler, Professor to the Medical Faculty of Strasburg.

* In the translation, the asterisks have been attached to the families of which members occur in the British Flora.—Tr.

† *Botanique Medicale*, or natural and medical history of all the medicaments, aliments and poisons derived from the vegetable kingdom, 2 vols. 8vo. Paris.

PREFACE

TO THE FIRST EDITION.

The work which we this day publish, under the title of *New Elements of Botany applied to Medicine*, has been anxiously looked for by students of Botany, and especially by the numerous pupils who attend the Medical Lectures in Paris. Many of them long ago requested my father to publish the elementary lectures of Botany which he delivered; but other occupations, and especially the direction which he had given to his labours, the principal object of which was the improvement of the philosophical part of the science, prevented the execution of the project. By his advice, and in some measure under his direction, I undertook the task, the results of which I now lay before the public. I have not concealed from myself its numerous difficulties, the composition of an elementary work being far from easy. Yet I am somewhat disposed to think, that he who would attempt to present the elements of a science with simplicity, precision and perspicuity, would do well to commence the task before he had forgotten the obstacles which he himself had met with, that he might thus be enabled to smooth the way for those whom he might be desirous of directing in the same science.

Having for several years performed the duties of Botanical Demonstrator to the Medical Faculty of Paris, my principal object has been to simplify the elements of the science. In composing this work, I have been desirous of removing from botany the useless and vague hypotheses, and the tedious details with which it has often been cumbered. Intending my book principally for the instruction of young persons qualifying themselves for the medical profession, and aware of the number and importance of the studies necessary to be undertaken by them, among which botany occupies a distinguished rank, I have confined myself to the most essential principles of that science, to those by the aid of which they might easily arrive at an accurate knowledge of the plants employed in medical practice.

What, in fact, is the object which the student of medicine has in view, when he enters upon the study of Botany? He is not desirous of embracing the whole extent of that science; but merely wishes to become acquainted with its fundamental principles, and to know by what means he may be enabled to distinguish the different plants which are useful to man, as affording remedies to his diseases, or as satisfying his wants.

In fact, Botany is an inexhaustible source of efficacacious remedies to the physician who is possessed of the knowledge requisite for enabling him to avail himself of its treasures. No class of natural bodies affords so many useful medicaments. Now, what medical man, anxious to exercise his art in a manner worthy of its importance, can, without some misgivings, prescribe to his patients plants which he scarcely knows by name, which he has never seen in the recent state, and which he cannot distinguish even from those to which they have no affinity, because he has not studied their characters? He is like the surgeon, who, in performing an operation, is all the while ignorant of the organs which his instrument is dividing. The physician in this case, not only shews himself to be unworthy of the high opinion which may have been conceived of him, but by his culpable inexperience renders himself liable to approve of errors the most prejudicial, and to sanction mistakes the most fatal to suffering humanity.

Who in fact has not heard of the many poisonings caused by the ignorance of herbarists, who, in place of a salutary plant, have administered one possessed of deleterious properties? If the physician to whom the care of a patient so situated is intrusted, should possess the necessary knowledge of Botany, he could discover the gross blunder of the herbarist, and prevent its fatal effects; or at least, knowing the deleterious action of the plant employed, he might in time administer the remedies calculated to neutralize it.

Thus, for example, the hemlock has often been taken for another umbelliferous plant possessed of beneficial qualities, and to which it bears some resemblance in its external characters, although essentially differing in the organs of fructification.

There is another great advantage which the physician finds in the study of Botany, and which is the power of substituting by other more common or more easily procured plants, those which are usually employed, but do not grow in the country in which he resides, or are of too high a price. In fact, he may often in this manner make advantageous substitutions, when the study of the natural families has disclosed to him the principles by which he ought to be guided. Thus, he will know that all the individuals of the same species possess essentially the same medicinal properties; that the species of the same genus agree more or less in their virtues; and that in many cases all the genera of a natural family of plants are similar in their mode of action. Possessed of this knowledge, he may substitute for a genus of the family of Cruciferæ, some other which may be more easily procured, because all the genera of that extensive family contain an acrid and stimulating essential oil, which gives them a tonic and anti-scorbutic property, common to almost all the species. The same remark applies to the families of Labiatæ, Gramineæ, Malvaceæ, and many others.

But he will also learn that there are certain families, equally natural as to their botanical characters, in which these substitutions are not practicable, or at least cannot be made without the most scrupulous attention. Thus, in the family of Solaneæ, beside the Potato, we find the Mandrake; near the White Mullein, the Henbane and Nightshade. In like manner, he will find among the Euphorbiaceæ substances which differ so much in their properties, that while some afford articles of food or useful medicines, others are powerful poisons. For example, that family contains the Cascarilla and the Manihoc, which form the principal food of the Indians of Guyana; and beside these, the genus *Euphorbia*, the *Hura*, and others, whose milky, acrid and burning juice may become a violent poison. What we have said of the Solaneæ and Euphorbiaceæ is equally true of many other families. In short, the study of Botany will disclose to the physician the natural families of plants in which all the genera possess the same properties, those in which similar properties occur in certain genera, and those in which each genus is possessed of different properties, and in which all the species are often deleterious.

The difficulties connected with the study of Botany are often exaggerated. Young persons in particular, who are qualifying themselves for the medical profession, are apt to be discouraged by the first obstacles which they encounter, without making the least effort to surmount them. Almost always prejudiced against the science, they do not give themselves the trouble of studying it, or study it in so superficial a manner, and with so little method, that for several years they employ a part of their time in acquiring nothing but vague and uncertain ideas. It were easy to demonstrate by daily experience, that the little success thus obtained, depends upon the false idea which they have formed of the science, and the bad method which they have adopted in studying it.

Some, in fact, imagining Botany to consist merely of a knowledge of the names of plants, and especially of those employed in medicine, pay no regard to the characters peculiar to each of those plants, or the signs by which they may be known and distinguished. The consequence is, that although they may have learned a great number of names, they have no real knowledge of the plants, and are unable to distinguish them from each other. They are like persons who in learning a language, get by heart a great number of words, without knowing their meaning.

Others again, without having attentively studied the fundamental principles, wish directly to find out and distinguish the different plants, in the works in which they are described. But at every step they are stopped by difficulties which they are unable to surmount. Whence, in fact, are derived the characters by means of which a plant may be known and distinguished from those to which it is more or less related? Is it not from the organs of plants, and the numerous modifications which they experience? Now it is clear, that to be able to recognise a plant in a description, one must know the meaning of the terms employed. Nearly fifty-thousand species of plants are known at the present day; yet three or four well selected words are often sufficient to characterize a plant, and distinguish it from all the rest. The meaning attached to these words ought therefore to be fixed and unalterable, and he who is desirous of studying Botany must, in the first place, render himself familiar with the import of the terms employed in describing each modification of organs.

What, then, is the best method of studying Botany, especially for a person who, like the medical student, can only devote a portion of his time to it? We shall briefly state that which experience has shewn to be the surest, as well as the most rapid.

1. The organs of plants are not very numerous, for which reason the substantive nouns by which they are represented may easily be retained by the dullest memory. The first thing to be done then, is to learn the meaning attached to the words stem, leaf, root, calyx, corolla, &c.

2. These organs may undergo various modifications which the botanist expresses by adjectives appended to

the substantive. Thus to the word *stem* are added the adjectives *herbaceous, woody, simple, branched, erect, recumbent, cylindrical, pentagonal, &c.* to denote that it is green and tender, or solid and hard like wood; destitute of branches or furnished with them; standing upright, or lying along the ground, &c. Most of the adjectives employed in botanical language are in common use for designating other objects. Thus, every one readily perceives what is meant by a *cylindrical, tetragonal,* or *pentagonal* stem. There are some, however, which, being peculiar to the language of Botany, require to be defined before they can be properly understood. To these, therefore, the student ought to pay particular attention.

3. When one has become acquainted with the names of the different organs of a plant, and understands the expressions by which their various modifications are represented, he has only to make choice of a system and to study it. By consulting a work in which plants are methodically arranged, he will be able to find the name of any plant that may come in his way, although he has never seen it before. Now this is the principal object of him who studies Botany. That science does not in fact consist of a mere mechanical knowledge of the names of the different plants. The botanist is he who, by means of the fundamental principles of the science, which rest exclusively upon the structure, the form, and the uses of the various organs,

is able, when he chooses, to find the name of a plant which he did not previously know.

Such is the course which we have followed in the exposition of the fundamental principles of Botany, which we now offer to the public. It was not our intention to write a complete treatise on general Botany, or on vegetable physics, for on these subjects there are already excellent works which might be pointed to as models. Our principal object was to present to the medical student, a simple and easy account of the elements of a science of so great utility to him, but which he unfortunately too often neglects. Agreeably to the plan which we proposed to ourselves, we have refrained from entering upon the more minute details of the science, our wish having been only to render more easy the study of a science so useful to some, so agreeable to all who attach themselves to it, and to which we have devoted our whole time.

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ELEMENTS OF BOTANY.

INTRODUCTION.

Botany is that part of Natural History to which peculiarly belongs the study of vegetables, and by which we learn to know, to distinguish, and to arrange them. This science does not, as some have ignorantly supposed, consist in the mere knowledge of the names given to the different species of plants, but also takes cognizance of the laws which preside over their general organization, and examines the forms and functions of their organs, and the relations by which they are connected with each other.

Botany, viewed with reference to its most important applications, also makes known to us the salutary or noxious properties of plants, and the advantages which may be derived from them in domestic economy, the arts, and the practice of medicine.

So extensive a science necessarily requires to be divided into several distinct branches, for the purpose of facilitating its study; and this, in fact, has been done.

1. Thus Botany *, properly so called, is that part of the science which considers vegetables in a general manner, and as objects distinct from each other, which are to be examined, described and arranged. This branch is itself divided into three others :

* *Botany*, in Latin *Botanice*, *Res herbaria*, from βοτανη, a plant.

Glossology *, or the knowledge of the terms necessary for designating the various organs of plants, and their numerous modifications. This part consists of the language of botany, with which, on account of its extreme importance, the student ought first to render himself familiar.

Taxonomy †, or the application of the general laws of classification to the vegetable kingdom. To this branch belong the different classifications that have been proposed for the methodical arrangement of plants.

Phytography ‡, or the art of describing plants:

2. The second branch of Botany is named VEGETABLE PHYSICS, or Organic Botany. It considers vegetables as organized and living beings, discloses their internal structure, and explains the mode of action peculiar to each of their organs, and the alterations which they may undergo, whether in their structure or in their functions. Hence arise there secondary divisions in vegetable physics:

Organography §, or the description of the organs, of their form, their position, their structure, and their connections.

Vegetable Physiology, or the study of the functions peculiar to each of the organs.

Vegetable Pathology, which makes us acquainted with the various alterations or diseases by which plants may be affected.

3. The third branch of general Botany, which considers the relations that exist between man and vegetables, is named the APPLICATION OF BOTANY. It is subdivided into

* *Glossology*, from γλοσσα, a word, tongue or language, and λογος, a discourse or doctrine.

† *Taxonomy*, from ταξις, order, method, and νομος, a law or rule:—law of classification.

‡ *Phytography*, from φυτον, a plant, and γραφω, to write or describe:—the art of describing plants.

§ *Organography*, from οργανον, an organ, and γραφω, to write or describe: —the description of organs. *Terminology* is synonymous, but being composed of a Latin and Greek word, is inadmissible.

Agricultural Botany, or the application of Botany to the cultivation of plants and the improvement of the soil; *Medical Botany*, or the application of botanical knowledge to the determination of plants which may be useful as furnishing medicines, and of which the medical practitioner may avail himself in the treatment of diseases; and, lastly, *Economical Botany*, the object of which is to make known the uses to which plants may be applied in the arts, or in domestic economy.

Botany being the science to which peculiarly belongs the study of vegetables, it is necessary that, in treating of it, we should first give an idea of the objects to which this name is applied.

Vegetables or *Plants* (in Latin *vegetabilia*, *plantæ;* in Greek *φυτα, βοτάναι*), are organized and living beings, destitute of sensibility and voluntary motion *, but possessing irritability, which is a common character of all organized beings. It is by this property, in virtue of which they contract and move under the influence of certain agents, that organized beings resist the action of the external causes which continually tend to destroy them.

It is extremely difficult to trace with precision the line of demarcation by which vegetables are separated from ani-

* Although vegetables are destitute of voluntary motion, some of them execute a very perceptible kind of locomotion or alteration of place: for example, the species of the genus orchis, and the colchicum. In fact, the root of most of the orchises presents two fleshy tubercles, situated one beside the other, at the base of the stem. One of these tubercles, after giving rise to the stem, of which it contained the germ in its interior, fades, shrivels, and is ultimately decomposed; but in proportion as it disappears, a third tubercle is developed near the second one, which still contains the rudiment of next year's stem, and when the latter has performed its office, takes the place of this second tubercle. As the development of a new tubercle takes place each year successively on one of the sides of the old tubercles, it will easily be understood that each new stem as it is developed will be found at a certain distance from its predecessor. The same phenomenon happens nearly in the same manner in colchicum, only that its bulb continually tends to sink deeper into the ground.

mals. Linnæus, in his usual aphoristic manner, has said: *Minerals grow; vegetables grow and live; animals grow, live, and feel;* in other words, minerals increase in size; vegetables, besides increasing in size, are possessed of life; animals, together with the faculty of increasing in size, and the possession of life, are endowed with sensibility. This distinction, which is indeed decided enough, when we compare a rock-crystal with an oak, or an oak with a man, gradually disappears when we compare together the objects which form the lowest members of these three great series. In fact, it is very difficult to say in what certain species of polypi differ essentially from certain algæ; for the essential character which is attributed to animals, sensibility or the consciousness of existence, and the faculty of moving, diminish, and at length entirely disappear, in the lowest classes of the animal kingdom. Besides, many observers agree in considering as constant the transformation of certain plants into animals, and vice versa. M. Agardh, a celebrated algologist, and a Professor of the University of Lund, in Sweden, has published a curious dissertation on the metamorphoses of the algæ. This alleged transformation, however, appears to be merely the result of inaccurate observation.

But, when we overlook for a moment the facts which thus form a transition between the two great divisions of organized beings, we find decided differences between animals and vegetables. Thus, in animals which are possessed of the faculty of moving, there exists a system of contractile fibres, the alternate relaxation and tension of which determine the motions of the animal. These are the muscular fibres. In vegetables there is nothing of this kind, all their fibres being in a manner inert and inexcitable. Besides, there is nothing in them like a nervous system, although an ingenious experimenter has, in this respect, compared them to animals. In the latter, the substances which are to serve for nutrition are first absorbed at the exterior, and remain during a certain time in a particular cavity, where they undergo a suitable elaboration before they are taken up by the chyliferous vessels, which carry them into the torrent of the circulation; but in vegetables nutrition is effected in a more simple manner, the absorbed matters are directly conveyed to all parts of the plant, without undergoing any previous alteration; so that, in them, we find neither intestinal canal nor stomach, there being no digestion to be performed.

Vegetables differ further from animals in respect to the progress of their fluids. In animals, in fact, there is a true circulation, in other words, the blood or nutritious fluid sets out from a point where it receives its impulse, is distributed to all parts of the body, where, in its course, it deposits the principles destined for their nutrition, and finally returns to the point from whence it set out. But in vegetables there is no true circulation: the nutritious fluids traverse the plant, but are not impelled by a heart, which, in animals, forms a point from which the blood set out, and to which it finally returns.

Animals always feed on organized substances, animal or vegetable. In plants, on the contrary, nutrition is effected by means of inorganic substances, such as gases, water and salts, which are applied for the development of their parts. Again, vegetables are destitute of lungs, and consequently of respiration. Although there is in them an exhalation of the gases which have been absorbed, and which have not been used for nutrition, the nature of these ejected gases is very different in the two great classes of organized beings. Thus, in animals it is carbonic acid that is exhaled, while in vegetables it is oxygen. Vegetables are further distinguished from animals by their chemical composition, carbon predominating in the former, and azote in the latter.

It were easy to extend this comparison between vegetables and animals; but enough has already been said to make known the principal differences which exist between them.

Anatomical investigation shews us that vegetables are composed of simple and similar elementary parts, which, combining in various ways, constitute the *organs* properly so called. We now proceed to examine these elementary parts, the study of which constitutes Vegetable Anatomy.

ELEMENTARY PARTS OF VEGETABLES, OR VEGETABLE ANATOMY.

When the internal structure of a vegetable is examined with the naked eye, and more especially when it is viewed by the aid of a powerful lens, or a microscope, it is found to be composed of thin transparent cells, extremely minute, varying in form, sometimes regular, sometimes irregular, and of tubes or cylindrical vessels, which are isolated or collected into bundles. Such are the two principal forms under which the elementary parts that enter into the composition of vegetables present themselves, and to which the names of *cellular tissue* and *vascular tissue* have been given.

Of the Cellular Tissue.

The first modification of the elementary tissue of vegetables is the *Cellular* or *Areolar Tissue* (Fig. 1. 2.) It is composed of cellules, which are in mutual contact, and whose form depends in general upon the resistance with which they meet. Some authors have compared them to the light froth which forms on soap-water, when that fluid is agitated. It has been generally supposed that the walls

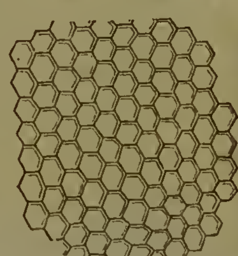
Fig. 1.

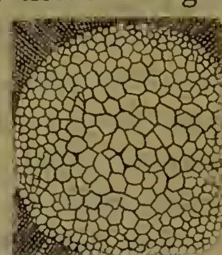
Fig. 2.

of two contiguous cellules are common to both; but Malpighi advanced the opinion that they were composed of distinct vesicles, which he named utricles. Professor Sprengel of Halle, in 1802, and many other distinguished physiologists, have made observations which confirm this opinion. The cellules may be separated from each other without being torn, which proves that each of them forms a kind of small vesicle, having distinct walls of its own, and that wherever two cells are in contact, the membrane which separates them is formed of two laminæ, which belong to each cell respectively. The recent inquiries of M. Du Trochet and Professor Amici confirm this opinion. The separation of the vesicles which form the cellular tissue, may be effected by simple maceration in water, as was done by Professor Link, or by boiling in nitric acid. Sometimes, however, the walls of the cellules are so intimately united that it is almost impossible to separate them.

When the formation and development of the cellular tissue in vegetables are observed, it is clearly seen to be composed of cells, which are at first separated, but which, in the progress of their development, finally adhere more or less to each other. In fact, with the aid of the microscope, there are perceived in the vesicles of the cellular tissue corpuscules of an oval or rounded form, generally of a green colour, but exhibiting all possible tints, according to the walls in which they are observed. These corpuscules impart their colour to the cellular tissue, the walls of which are always transparent. M. Turpin, who, in an excellent paper printed in the *Memoires du Museum*, vol. xii., has again directed attention to these corpuscules, gives them the name of *globuline*. Each grain of globuline is a minute vesicle, in which are subsequently formed other minute granules, which, successively increasing in size, ultimately burst the vesicle which contained them. Each of them, in its turn, then becomes a small vesicle, in which are developed new granules, which present the same phenomena. In this manner the cellular tissue, which forms the mass of vegetables, increases and is developed in all directions. M. de Candolle, considering that it is this granular substance which colours all the parts of vegetables, has recently proposed to give it the name of *chromule.*

These cellules, when they meet with no other resistance than that of the cellules in their vicinity, not unfrequently present a nearly hexagonal form, so as to bear a considerable resemblance to the cells of a honeycomb. But they may be more or less elongated, rounded or compressed, according to the obstacles which oppose their free development. In fact, the regular and hexagonal form of which we have just spoken is of rare occurrence. Their walls are thin and transparent, and they all communicate together, either by their cavities opening into each other, or by means of pores, or even slits, in their walls. These pores, which are with difficulty perceptible with the aid of the most powerful optical instrument, were observed by Leuwenhoek and Hill; and more recently MM. Mirbel and Amici have again admitted their existence. According to several physiologists, and in particular Rudolphi and Sprengel, the different cellules communicate together by a point at which these walls are interrupted. But Bernhardi first demonstrated that the communication between the cellules is exclusively effected by the invisible pores of their walls. This opinion is now generally adopted. It thus appears very probable that the fluids pass from one cell to another by exudation.

In the woody parts, the cellules of the areolar tissue are greatly elongated, and form a kind of small tubes, parallel to each other. Their walls are opaque and thick; and they even sometimes become at length entirely obliterated. To this modification M. Link has given the name of *elongated tissue.*

This elongated tissue exists abundantly in vegetables, and is in them much more common than the cellular tissue. It is composed of small tubes, which are contracted at intervals. Sometimes the tubes are fusiform, or, in other words, gradually diminish at their two extremities. To this particular modification of the cellules of the elongated tissue, M. Amici has given the name of *clostres*. They are generally parallel to each other, more or less opaque, and very abundant in the woody tissue. It sometimes happens that the cellules of the elongated tissue can only touch each other by the most prominent points, whence intervals or vacuities are formed between them. These empty spaces have been named by Hedwig, *vasa revehentia;* by Treviranus, *meatus intercellulares;* and by Link, *ductus intercellulares*. In the opinion of Professor Amici, these spaces never contain liquid, but only air; for the large pores of the epidermis, which, as we shall presently see, when we come to speak of that membrane, are organs that afford passage to air only, are always placed over one of these spaces. When the tissue is too compact, and the small tubes too close to allow the formation of these spaces, there are no cortical pores.

There is another modification of the elongated tissue which deserves to be mentioned here, and which consists of the cellules formed by the insertions or medullary rays of the stem of dicotyledonous vegetables. They are very small, elongated, and placed horizontally, instead of being vertical.

The cellular tissue, in its state of native purity, has little consistence, and is easily torn. Accordingly, in certain vegetables there often occur spaces resulting from the rupture of the walls of several cellules, and filled only with air. These cellules, to which the name of *lacunæ* is given, are met with more especially in vegetables which live in water, and in which they seem to resist the maceration which these plants would infallibly undergo in consequence of their prolonged sojourn in that liquid. M. Amici has a very different opinion respecting the lacunæ. According to him, they are not, as M. Mirbel thinks, the result of the laceration of the cellules, but more or less regular spaces, always containing air. Sometimes they present hairs of a peculiar nature, in the form of tufts of pencils, on their inner walls. These hairs have been seen by MM. Mirbel and Amici. Two kinds of lacunæ may be distinguished, some having the cortical pores for their orifice, and communicating with the external air, while others have no external communication. The latter are especially met with in plants which are destitute of porous tubes.

In here concluding what relates to the organization of the vesicular tissue, we would remark that it possesses two essential properties, its faculty of absorbing fluids, and its organic contractility. By means of these two fundamental properties, several of the phenomena of vegetable life may be explained.

Of the Vascular Tissue.

The *Vascular* or *Tubular Tissue* is the second modification of the elementary tissue. The vessels are laminæ of elementary tissue rolled upon themselves, so as to form canals or more or less elongated cells, placed end to end, and having their partitions often obliterated. The walls of the vessels are sometimes pretty thick, possessed of little transparency, and perforated by a great number of apertures, by means of which they allow to escape into the surrounding parts a portion of the gaseous fluids or liquids which they convey. These vessels are not continuous from the base to the summit of the plant, but anastomose frequently with each other, and are ultimately converted into areolar tissue.

Seven principal kinds of vessels are known: 1. Beaded or moniliform vessels; 2. Porous vessels; 3. Slit vessels or False Tracheæ; 4. Tracheæ; 5. Mixed vessels; 6. Proper vessels; 7. Tubes or simple vessels.

1. *Beaded* or *Moniliform Vessels* (Fig. 3.)—These are porous or dotted tubes, contracted at intervals, and crossed by diaphragms or partitions, which are perforated with holes, like a riddle, although, in the opinion of most anatomists, these diaphragms do not exist. The beaded vessels occur principally at the junction of the root and stem, of the stem and branches, &c. These vessels, we think, might rather be considered as simple cellules of areolar tissue, regularly disposed in longitudinal series or lines.

Fig. 3.

2. *Dotted Vessels* (Fig. 4. 5.)—These represent continuous tubes, exhibiting numerous opaque points, which others have considered as pores, arranged in transverse lines. M. Mirbel names them *porous vessels.* They are met with in the woody layers of the stem, roots and branches.

4. 5. 6.

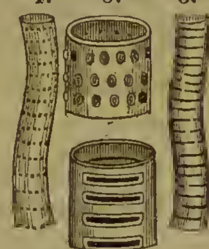

Fig. 7.

3. *False Tracheæ* (Fig. 6. 7.)—These are tubes having transverse slits, according to the opinion most generally adopted. These vessels, and the tracheæ, are the principal conductors of the sap. M. de Candolle designates them by the name of *slit* or *streaked vessels.* They are very abundant in the woody layers of dicotyledonous vegetables, and in the woody bundles of the monocotyledonous.

4. The *Tracheæ*, or *Spiral Vessels* (Fig. 8.), which Malpighi and Hedwig compared to the respiratory organs of insects, are vessels formed by a silvery and transparent lamina, rolled upon itself in a spiral form, and having its edges, which are a little thicker, in mutual contact, so as to leave no space between them, but without contracting adhesions. Sometimes, however, the spiral turns of these vessels cannot be unrolled; and to this kind of tube M. Link has given the name of *united spiral vessel.* According to MM. Link and

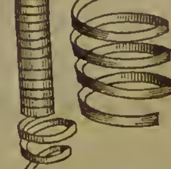

Fig. 8.

Schrader, the spiral lamina of which the tracheæ consist, has a groove running along its inner side. In the dicotyledones, spiral vessels are observed around the pith; and in the monocotyledones generally in the centre of the woody filaments. The bark and the annual layers of the wood never contain any. They are sometimes found in the roots, and it is very easy to unrol them in the nerves of the leaves, in the petals, the filaments of the stamina, &c.

At their extremities, the tracheæ terminate in cellular tissue, according to M. Mirbel, while, in M. Du Trochet's opinion, they end in a kind of cone, which is more or less acute.

Hedwig considered the spiral vessels or tracheæ, which Grew named *air-vessels*, as composed of two parts, a straight and central tube, filled with air, and which he named for this reason *pneumatophorous vessel*, and a tube spirally rolled over the former, and filled with aqueous fluid, to which he gave the names of *aductor vessel*, *chyliferous vessel*, &c. M. Bernhardi also has expressed another opinion respecting the structure of the tracheæ. He considers them as formed of a very thin external tube, within which a small silvery lamina is rolled in a spiral form, so as to keep the walls separated. Lastly, some authors admit the spiral turns of the tracheæ to be united together by a very thin membrane, which is easily torn asunder when the spiral thread is unrolled. There would result from this organization that, in their natural state, the tracheæ form a continuous tube.

The tracheæ are not always simple, but are sometimes found with two, three, and even a very great number of parallel spirals, as is observed in many monocotyledonous plants.

5. The *Mixed vessels* (Fig. 9.), which were discovered by M. Mirbel, participate at once of the nature of all the others; that is to say, are alternately porous, slit, or spirally rolled in different parts of their length. M. Amici, however, who has made a great number of microscopic examinations in vegetable anatomy, is of opinion that the false tracheæ never become


Fig. 9.

spiral vessels. Besides, as he remarks, these two kinds of vessels occupy entirely different positions.

6. The *Proper Vessels*, which are also designated by the name of *reservoirs* of *the proper juices*, are short tubes, destitute of pores, and containing a proper juice, peculiar to each vegetable. Thus in the Coniferæ they contain resin, in the Euphorbiæ a white and milky juice, &c. They are met with in the bark, the pith, the leaves, and the flowers. They are sometimes solitary, sometimes collected into bundles.

7. The *Simple Tubes* are vessels of variable size, often branched and anastomosing with each other, and serving to circulate the sap. Their walls are thin, or more or less opaque, and have no visible pores.

These different species of vessels, to which might be added many other modifications, are often collected into elongated fasciculi, united to each other by cellular tissue. They then form the *fibres* properly so called. These fibres, or bundles of tubes, constitute the frame-work, and, as it were, the skeleton of most of the foliaceous organs of vegetables.

The *parenchyma*, on the other hand, is the generally soft part, essentially composed of cellular tissue, which is observed in fruits, leaves, &c. This term is employed in opposition to the word *fibre*. Every part which is not fibrous is composed of parenchyma.

The parenchymatous and fibrous tissues, by uniting and combining in various ways, constitute the different organs of vegetables. In all, in fact, we find by analysis, only these two essential modifications of the fundamental tissue.

The seven principal modifications of the vascular tissue differ from each other, not only in their organization and relative position, but also in respect to the nature of the fluids which they contain. In the latter point of view, they may be distinguished into three series:—1. The sap-vessels or lymphatics, in which the sap circulates; 2. The vessels of the proper juices; 3. The air-vessels, in which there is never found any thing else than air or other elastic fluids.

But the different writers on vegetable anatomy and physiology are far from being agreed as to the class to which the different kinds of vessels which we have described ought to be referred. Thus, Malpighi, Hedwig, and several others of the older botanists, considered the tracheæ as vessels destined to contain only air. M. Link has maintained the same opinion, which he has extended to the porous vessels and false tracheæ. But, after the observations of Professor Mirbel, the existence of air-vessels was doubted, and even absolutely denied. He thus considered all the tubes of vegetables as solely destined for the circulation of the sap. This opinion, which is now generally adopted, has lately been opposed by Professor Amici, who positively asserts that he has been assured by observation, that the tracheæ, the false tracheæ, the porous vessels, and, in general, all the tubular or cellular organs of vegetables which present visible holes or slits, never contain any thing but air. When the diameter of these tubes is considerable, this observation may easily be verified by cutting them across, in which case they are always found empty. When they are cut under water, each of them presents a small bubble of air at its orifice.

The apertures or pores with which the porous vessels are perforated, are very frequently organized like the pores of the epidermis; in other words, they present a kind of rim or thickened margin at their circumference. This observation, which was first made by M. Mirbel, has been confirmed by M. Amici. From this resemblance, the latter derives an additional inference in favour of his opinion respecting the nature of the fluid contained in these vessels. In fact, as we shall afterwards see, the large pores of the epidermis never afford a passage to any other than aëriform fluids.

The air contained in the porous vessels does not communicate with the external air. M. Amici thinks that it is produced in the interior of the vegetable tissue itself, but its nature is not yet perfectly known.

In the ligneous vegetables, where the air-vessels at length disappear, the medullary rays take their place, and perform the same functions. They are, in fact, composed of small tubes placed horizontally, or of porous cellules transversely elongated, which, according to the Professor of Modena, serve to establish a communication between the internal parts of the vegetable and the exterior. These tubes or cells never contain any thing but air.

From what has been said above, it is seen that there are two principal means of communication between the different parts of the vegetable tissue. In the air-cells or air-tubes, the communication is effected by means of intermolecular pores or slits of extremely small size, but whose existence can be established, and whose organization can be discovered by the aid of the microscope. These pores are absolutely wanting in the cellular tissue properly so called, and in the vessels which we have designated by the name of simple tubes, or sap-vessels. In this part of the tissue of vegetables, the communication is effected, either by a kind of imbibition, or by the intermolecular spaces which the globules that compose the laminæ of the tissue leave between them.

Although the pores which are observed on the walls of the elongated cellules, the moniliform vessels, and the porous vessels, have been seen and described with minute accuracy by many modern authors, and especially by MM. Mirbel and Amici; yet M. Du Trochet, in his memoir on the anatomy of the sensitive plant, has very recently denied their existence. On this circumstance he has founded a theory, which we shall here briefly expose. He asserts that the organs described by M. Mirbel as pores surrounded with a prominent rim, are nothing else than small globular cellules placed in the substance of the walls of the areolæ of the cellular tissue or vessels, and filled with a green transparent matter. These cellules, he says, in their quality of transparent spherical bodies, collecting the luminous rays in a central focus, must appear opaque in their circumference, and transparent at their centre, which would lead to the supposition of their being perforated. There are no pores therefore. But it seems to us evident that M. Du Trochet is entirely mistaken. The corpuscules which he has examined, and which he supposes to be the pores described by M. Mirbel, are organs altogether different from these latter. There is no wonder, then, that he did not see them perforated. They are nothing else than the grains of amylaceous matter, or the greenish glandular bodies, abundantly disseminated through all parts of the vegetable tissue, and to which M. Turpin has recently given the name of *globuline*. M. Du Trochet's denial, therefore, falls to the ground of itself, as his observations refer to an entirely different organ.

Believing that the pores of the cellular tissue are cellules filled with a greenish substance, the able experimenter whom we here oppose, would naturally make application of this observation to the vessels upon which holes or slits have been described. Accordingly, he has asserted that the porous vessels are merely tubes which present some of these globular and greenish cellules more or less symmetrically disposed, and that the false tracheæ, or slit vessels, present these cellules arranged in transverse lines.

The author has then examined the nature and uses of this greenish matter. Having tested it by chemical reagents, he found that it was rendered concrete by nitric acid, and that the alkalies again reduced it to its original state. Now, the cerebral substance of animals is affected in precisely the same manner by the same reagents. It therefore follows, that this greenish matter is a true nervous system, or rather the scattered elements of a diffuse nervous system, which is not collected into a mass, but presents itself under the appearance of small dispersed or united points, which he names *nervous corpuscules.* This consideration, says he, supported by the similarity of the chemical nature of the globular corpuscules, is further strengthened by the observation of the intimate nature of the nervous system of certain animals. Thus, in the gasteropodous mollusca, the medullary substance of the brain is composed of agglomerated globular cellules, on the walls of which there exists a great quantity of globular or ovoidal corpuscules, which are nothing else than very small cellules filled with nervous medullary substance. The resemblance of this organization to that of which we have just been speaking in vegetables is perfect, according to M. Du Trochet, and forces us to admit that plants are furnished with a nervous system.

We are contented with here stating the opinions recently advanced by this celebrated physiologist. We shall examine them more in detail when we come to speak of the motility of vegetables, after examining the functions of the leaves.

To conclude what relates to the examination of the anatomy of the different constituent and elementary parts of vegetable organization, we must turn our attention to the glands and hairs, considered with reference to their anatomical structure.

The GLANDS are peculiar organs which are observed in nearly all parts of plants, and which are destined to separate a fluid of some kind from the general mass of the humours. In their uses and structure, they bear the greatest resemblance to those of animals. They appear to be formed of a very delicate cellular tissue, in which numerous vessels ramify. But the name of glands has been extended to vesicular bodies, often transparent, placed in the substance of organs, and filled with a volatile oil, which has probably been secreted in their interior. Their form and particular structure are very diversified, and they have been distinguished into several species. Thus, there are:

1. *Miliary Glands.*—They are very small and superficial,

and appear in the form of round grains, disposed in regular series, or dispersed without order, over all the parts of plants that are exposed to the air.

2. *Vesicular Glands.*—These are small reservoirs filled with essential oil, and lodged in the herbaceous envelope of vegetables. They are very apparent in the leaves of the myrtle and orange-tree, and exhibit the appearance of small transparent dots, when these leaves are placed between the eye and the light.

3. *Globular Glands.*—Their form is spherical, and they adhere to the epidermis only by a point. They are especially observed on the Labiatæ.

4. *Utricular* or Ampulliform Glands.—They are filled with a colourless fluid, as in the Ice-plant.

5. *Papillar Glands.*—These have the form of nipples or papillæ, and have been compared to those of the tongue. They are found on several of the Labiatæ, for example on *Satureja hortensis.*

Lastly, there are lenticular glands, sessile glands, and others which are supported upon hairs. The tribe of the Drupaceæ in the family of the Rosaceæ, the family of the Passifloræ, and many of the Leguminosæ and Malvaceæ, have, on the petiole or limb of their leaves, glands of a very diversified form, and which frequently furnish good characters for distinguishing the species.

The Hairs are filamentous organs, more or less attenuated, and subservient to absorption and exhalation. Few plants are destitute of them. They are principally observed on those which grow in dry situations. In this case, they have been considered by some botanists as serving to multiply and enlarge the extent of the absorbent surface of vegetables. Accordingly, they are not seen on plants abounding in liquids, such as the succulent plants, or those which habitually live in water.

In many cases, the hairs appear to be the excretory ducts of vegetable glands. In fact, they are frequently inserted upon a papillar gland. It is well known that the hairs of *Urtica urens* and *Urtica dioica* produce blisters on the skin, only because in penetrating it, they at the same time pour into it an irritating fluid, which is secreted by the glands upon which they are inserted; for when this fluid is evaporated by desiccation, the hairs of nettles do not produce the same effect.

Hairs are distinguished into *glanduliferous*, *excretory*, and *lymphatic*. The first are either applied immediately upon a gland, or surmounted by a small glandular body, as in *Dictamnus albus*. The excretory hairs are placed upon glands, of which they appear to be the excretory ducts, destined to pour out the secreted fluids. Lastly, the lymphatic hairs are merely prolongations of a cortical pore.

The form of hairs presents numerous varieties. Thus there are *simple*, *branched*, *subulate*, and *capitate* hairs. Others are *hollow*, and intersected at intervals by horizontal partitions. In the Malpighiaceæ they have the form and horizontal position of a shuttle.

They are sometimes *solitary*, at other times collected into fasciculi, star-like tufts, &c.

As to their disposition upon a part (which is designated by the name of *pubescence*), we shall speak of it when we come to treat of the modifications of the stem in reference to this circumstance.

We have now considered the anatomical structure of vegetables, penetrated into the interior of their tissue, and separated and analyzed the rudiments, or elementary parts, of their organization. Let us next examine the vegetable considered as a whole: let us see what are the organs or parts which compose it in its perfect state of development.

A vegetable, in its highest degree of development and perfection, presents the following organs for consideration.

1. The *Root*, or that part which, terminating the plant below, commonly sinks into the ground, to which it fixes

the vegetable, or floats in the water, when the plant swims at the surface of that fluid.

2. The *Stem*, which, growing in a direction the reverse of that of the root, always shoots upwards the moment it begins to be developed, becomes covered with leaves, flowers, and fruit, and divides into branches and twigs.

3. The *Leaves*, or those membranous appendages, inserted upon the stem and its divisions, or proceeding directly from the neck of the root.

4. The *Flowers*: very complex parts, enclosing the organs of reproduction in two particular envelopes, which are destined to contain and protect them. These organs of reproduction are the *pistil* and *stamina*. The floral envelopes are the *corolla* and *calyx*.

5. The *Pistil*, or female sexual organ, which may be single or multiple, and almost always occupies the centre of the flower, is composed of a hollow inferior part, named *ovary*, destined to contain the rudiments of the seeds, or the *ovules;* a glandular part, generally situated at the summit of the ovary, destined to receive the influence of the male organ, and which is named *stigma;* and sometimes a *style*, being a kind of filiform prolongation of the summit of the ovary, which then supports the stigma.

6. The *Stamina*, or male sexual organs, essentially composed of an *anther*, which is a kind of small membranous bag, generally having two cells, and containing in its interior the *pollen*, or substance by which fecundation is effected. The anther is usually supported upon a *filament* varying in length. In this case the stamen is formed of an *anther* or essential part, and a *filament* or accessory part.

7. The *Corolla*, or innermost envelope of the flower, often decorated with the richest colours, sometimes formed of a single piece, and then named a *monopetalous corolla;* at other times *polypetalous*, that is, composed of a greater or less number of distinct pieces, each of which bears the name of *petal.*

8. The *Calyx*, or outermost envelope of the flower, of a leafy nature, and commonly green. It may consist of a single piece, in which case it is said to be *monosepalous;* or it may be formed of several distinct pieces, which are named *sepals*, when it is said to be *polysepalous*.

9. The *Fruit*, that is, the *ovary* now developed, and containing the fecundated seeds, is formed by the *pericarp* and *seeds*.

10. The *Pericarp*, which varies greatly in form and consistence, is the developed and enlarged ovary, in which were contained the ovules, which are now become seeds. It consists of three parts: the *epicarp*, or outer membrane, which defines the form of the fruit; the *endocarp*, or membrane which invests its internal simple or multiple cavity; and lastly, a parenchymatous part, situated and contained between these two membranes, and which is named *sarcocarp*. The sarcocarp exists in the highest state of development in fleshy fruits.

11. The *Seeds* contained in a *pericarp*, are there attached by means of a particular support, formed of vessels which convey nourishment to them. This support is the *trophosperm*, or *placenta*. That point of the seed's surface at which the trophosperm is attached, is named the *hilum* or *umbilicus*. Sometimes the trophosperm, instead of ceasing at the circumference of the hilum, is more or less prolonged over the seed, and even so as to cover it entirely. To this peculiar prolongation the name of *arilla* is given.

The seed is essentially composed of two distinct parts, the *episperm* and *kernel*.

12. The *Episperm* is the proper membrane or integument of the seed.

13. The *Kernel* is essentially composed of the *embryo*, or of that part which, being placed in favourable circumstances, tends to be developed and to produce a vegetable perfectly similar to that which gave rise to it. Besides the embryo, the kernel also sometimes contains a peculiar body,

varying in its nature and consistence, upon which the embryo is applied, or in the interior of which it is entirely concealed. This body has received the names of *endosperm*, *perisperm*, and *albumen*.

The embryo is the essential part of the vegetable, and it is for the purpose of contributing to its formation and perfect development, that all the other organs of plants seem to have been created. It is formed of three parts: an inferior, the *radicular* body, which, in germination, gives rise to the root; a superior, the *gemmule*, which, on being developed, produces the stem, the leaves and the other parts which are to vegetate at the surface; and lastly, an intermediate and lateral part, the *cotyledonary* body, which may be single, or divided into two parts, named *cotyledons*. Upon these circumstances depends the division of vegetables furnished with an embryo into two great classes: the *Monocotyledones*, or those whose embryo has only a single cotyledon; and the *Dicotyledones*, or those whose embryo presents two cotyledons.

Such is the most common and the most perfect organization of vegetables. But it must not be expected to find always collected upon the same plant the different parts which we have just briefly enumerated, several of them being very frequently wanting on the same vegetable. Thus, for example, the stem has sometimes received so little development, that it seems not to exist, as in the Plantain and Primrose; the leaves are entirely wanting in the Dodder; there is no corolla in any of the Monocotyledones, there being in them only a single envelope around the sexual organs; the single envelope sometimes disappears, as in the Willow; the flower often contains only one of the two sexual organs, as in the Hazel, in which the stamina and pistils are placed on separate flowers; or, lastly, the two sexual organs sometimes disappear entirely, and the flower is then called *neutral*, as in *Viburnum opulus*, *Hortensia*, &c.

In the different cases which we have just stated, however, this absence of certain organs is only accidental, and has no decided influence upon the rest of the organization; so that the vegetables in which these organs are wanting, are not materially different, either in their external characters, or in their mode of vegetation and reproduction, from those which possess them all.

But there is a certain number of other vegetables which, in the constant absence of sexual organs, in their external forms, and in their mode of vegetation and reproduction, differ so much from other known plants, that they have at all times been separated to form a class by themselves. It was to these vegetables that Linnæus gave the name of *Cryptogamic* plants, that is to say, plants with concealed or invisible sexual organs, to distinguish them from other known vegetables, the sexual organs of which are apparent, and which have, for this reason, received the name of *Phanerogamic* plants.

The *Cryptogamic* plants, which are also named *Agamic*, as they are destitute of sexual organs, are very numerous, constituting about the seventh or eighth part of the fifty thousand vegetables already known. As they are destitute of seeds, and consequently of embryo and cotyledons, they are also named *Inembryonate* or *Acotyledonous.* We are thus led to institute in vegetables two fundamental divisions, derived from the embryo, namely,

1. The *Inembryonate* or *Acotyledonous*, that is to say, plants in which there are observed neither flowers properly so called, nor consequently an embryo and cotyledons. Of this kind are *Ferns* *, *Mosses*, *Hepaticæ*, *Lichens*, *Fungi*, &c.

2. The *Embryonate* or *Phanerogamic* plants, which are provided with very evident flowers, with seeds and an embryo. They are distinguished into—

* Some authors have placed the Ferns among the plants which have a monocotyledonous embryo; but in our opinion very erroneously. In fact, it is perfectly clear that these vegetables do not reproduce by means of true seeds, but merely by peculiar bodies, a kind of bulbils, which are observed upon other vegetables, and to which the name of *sporules* is given.

Monocotyledonous, or those in which the cotyledonary body of the embryo is of a single piece, and developes a single leaf when it germinates; of which kind are the Gramineæ, Palms, Liliaceæ, &c.;

And *Dicotyledonous*, or those whose embryo, having two cotyledons, developes two seminal leaves in germinating; for example, the Oak, the Ash, the Labiatæ, Cruciferæ, &c. The number of dicotyledonous vegetables is greater than that of the acotyledonous and monocotyledonous together.

Such are the great fundamental divisions that have been established in the vegetable kingdom. We have judged it expedient to mention them here concisely, and to give a succinct and general idea of them, because, in the course of this work, we shall be obliged to employ the terms *acotyledones*, *monocotyledones*, and *dicotyledones*, which, were they not previously defined, would necessarily disturb the natural order of ideas. And here we are forced to acknowledge that the progress of the natural sciences is not so strictly precise as that of the physical and mathematical sciences. In exposing the fundamental facts and ideas which belong to natural history, one cannot always proceed rigorously from the known to the unknown. It is often impossible to avoid passing over certain intermediate ideas, not yet defined, and supposing in those for whom we write a degree of knowledge which happily they almost always possess.

We have, as much as possible, tried to remedy this inconvenience in the exposition of the elementary notions of Botany which has been just given. We have been obliged to present the facts here in their greatest simplicity, that even persons as yet having no knowledge of the science may be able to follow with ease the successive details on which we now enter with respect to the different organs of plants.

These organs are divided into two classes:

1. According as they are subservient to nutrition, in

other words, extract from the earth or the atmosphere the nutritious substances necessary for their development; in which case they are named *Organs of nutrition* or *of vegetation.* Of this kind are the root, the stem, the buds, the leaves, &c.

2. According as they are subservient to the reproduction of the species; in which case they are named *Organs of reproduction* or *of fructification.* Such are the flower, its different parts, and the fruit which succeeds them.

We shall begin with examining the Organs of Nutrition, after which we shall examine those of Fructification. The most natural order of ideas would no doubt have been to begin with examining the organs of the plant in the seed, which already contains them in the rudimentary state, and then to follow their progress up to their most perfect state of development; but the organization of the seed being unquestionably the most difficult point in Botany, and that on which there still remain the greatest doubt and obscurity, we have thought it necessary to accustom our readers, in some degree, to more simple ideas and facts, in order that they may thus gradually arrive at the most complicated parts of vegetable organization.

FIRST CLASS.

ORGANS OF NUTRITION OR OF VEGETATION.

In the foregoing introduction, we have divided the organs of vegetables into two classes, according to their uses. To the First Class belong the Organs of Nutrition or of Vegetation; to the Second, those of Reproduction or of Fructification.

The organs of nutrition or of vegetation are all those to which is confided the care of the individual preservation of vegetables. They are the roots, the stems, the buds, the leaves, the stipules, and some of these organs degenerated, such as spines, prickles, and tendrils.

These organs have one common object, the support of life in the vegetable. In fact, the root, immersed in the ground, absorbs part of the fluids destined for nourishing the plant and repairing its losses; the stem transmits these fluids to all parts of the plant; while the leaves, which are spread out in the atmosphere, perform the same functions there as the roots do in the ground, and serve at once as absorbing and exhaling organs. From this brief account of their functions, it is seen that these different organs all tend to one and the same object; that they nourish the vegetable, and are subservient to its vegetation, that is, to the development of all its parts.

CHAPTER I.

OF THE ROOT.

The name of *Root* * is given to that part of a vegetable which, occupying its lower extremity, and most commonly concealed in the earth, always grows in a direction the reverse of that of the stem; in other words, penetrates perpendicularly into the ground, while the latter ascends toward the sky. A not less remarkable character of the root is, that it never becomes green (at least in its tissue), when it is exposed to the action of air and light, while all the other parts of vegetables, when thus exposed, assume that colour.

With the exception of some *Tremellæ*, and certain species of *Conferva*, which, being immersed in water or vegetating at its surface, absorb the substances intended for their nutrition by every part of their extent, all vegetables are furnished with roots, which serve to fix them in the ground, and to extract from it a portion of the principles by which they are nourished.

Roots, as has been said, are in most cases implanted in the ground. But there are plants which, living at the surface of the water, have their roots floating in that fluid, as is observed in certain species of *Lemna*. Most aquatic plants, as the Buck-bean, Water-lily, and *Utriculariæ*†, have roots which, penetrating into the mud, attach them to the soil, and others, which, commonly proceeding from the base of the leaves, are free and floating in the water.

* In Latin *Radix;* in Greek ῥιζα.

† The filamentous parts, which most botanists have taken for leaves in the Utriculariæ, are floating roots.

Other plants vegetating on rocks, as the lichens; on walls, as the Common Wall-flower, Snap-dragon, and Red Valerian; on the trunks or roots of trees, as the Ivy, certain tropical Orchideæ, most of the mosses, the Orobanche, and Hypocystus, immerse their roots in them, and, like true parasites, extract the materials of nutrition from them, and live at their expense *.

The *Clusia rosea*, a sarmentaceous shrub of South America, the *Sempervivum arboreum*, the Maize, the Mangrove, and some exotic Fig-trees, besides the roots by which they are terminated below, produce others from various parts of their stem, which descend, often from a considerable height, and penetrate into the ground. These supernumerary roots have been named *adventitious*. A very remarkable fact relating to them is, that they begin to enlarge in diameter only when their extremity has reached the soil, and extracts from it the materials of its growth.

We must not confound with roots, as has very frequently been done, certain *subterranean stems*, which creep horizontally under ground, as in the *Iris germanica*, Solomon's-seal, &c. Their direction alone would almost always suffice to distinguish them, were there not other characters also tending to throw light on their real nature. (See in the following chapter what refers to the stock or subterranean stem.)

Different parts of vegetables are capable of producing

* The principle adopted in translating being simply to render the French text into English, it has not been thought expedient to alter this manifestly erroneous sentence. Lichens vegetate on rocks, but do not seem to extract any nourishment from them. The plants which grow on walls are similar, in respect to their roots, to those which grow in ordinary soil, and imbibe moisture from the earth in their crevices, although in many cases, very little nutrition seems to be furnished in this way. Parasitic plants are commonly supposed to live at the expense of their patrons; but the mode in which they do so has not received due investigation. There is no reason to suppose that the lichens and mosses which grow on trees, extract nourishment from them.—Transl.

roots. If a branch of a willow or a poplar be cut off, and immersed in the ground, its lower extremity will some time after be covered with radicles. The same phenomenon takes place when the two extremities of the branch are immersed in the ground, both of them fixing themselves in it by means of roots which shoot out from them. In the Gramineæ, and particularly the Maize or Indian corn, the lower knots of the stem sometimes give out roots which descend to immerse themselves in the ground. It is on this property, which the stems and even the leaves of many vegetables possess, of giving rise to new roots, that the theory and practice of propagating by slips and layers, a means of multiplication much employed in the art of horticulture, are founded.

There is a great similarity of structure in the roots which a tree gives out in the earth, and the twigs which it spreads out in the air. The principal differences which are observed in these two organs depend chiefly upon the difference of the mediums in which they are developed *. The roots of certain trees give off at intervals a kind of cones or excrescences of soft and loose wood, entirely naked, and rising above ground, which have been designated by the name of *exostoses*. The Deciduous Cypress of North America (*Taxodium distichum* of Richard) affords the most remarkable example of these excrescences.

* It has been said that when a young tree is reversed so that its branches are immersed in the ground, and its roots spread out in the air, the leaves change into roots, and the roots into leaves; but this fact is not true, or at least the explanation which is given of it is not correct. In fact, the leaves no more change into roots, than the roots into leaves; but when the former are immersed in the soil, the buds situated in their axillæ, in place of developing young twigs or leafy scions, elongate, become blanched, and are converted into radical fibres; while the *latent* buds which exist in the roots, and which are destined to renew the fibrils each year, being now placed in a different medium, become developed into leaves. We have a striking example of this tendency of the *latent* buds of the root to change into leafy twigs, when exposed to the contact of the air, in the shoots which rise around trees that have creeping roots, as the acacia, the poplar, &c.

The roots, considered as a whole, may be divided into three parts: 1*st*, The *body* or middle part, varying in form and consistence, sometimes more or less bulging, as in the turnip and carrot; 2*d*, The *neck* or *life-knot*, the point or line of demarcation which separates the root from the stem, and from which, in perennial roots, proceeds the bud of the annual stem; 3*d*, The *radicles*, which are more or less attenuated fibres, commonly terminating the root at its lower part.

A. With reference to their *duration*, roots have been distinguished into *annual*, *biennial*, *perennial*, and *woody*.

Annual roots are those plants which, in the space of a single year, are developed, produce fruit, and die. Of this kind are Wheat, Lark's-spur *(Delphinium consolida)*, the Common Red Poppy *(Papaver Rhœas)*, &c.

Biennial roots are those of plants which require two years for their perfect development. Biennial plants commonly produce only leaves the first year, and die the second year, after producing flowers and fruit; as the Carrot, &c.

Perennial roots are those which belong to woody plants, and to plants which, enduring an indeterminate number of years, give out herbaceous stems, which are developed and die each year, while their root continues to live for many years; such are the roots of Asparagus, Asphodel, Lucern, &c.

This division of plants into *annual*, *biennial*, and *perennial*, according to the duration of their roots, is liable to vary under the influence of different circumstances. Climate, temperature, the situation of a country, and even cultivation, produce singular modifications in the duration of plants. It is not uncommon to see annual plants vegetate two or even more years, if they be placed in a soil which is favourable to them, and protected from cold. Thus the Mignonette, which with us is an annual plant, becomes perennial in the deserts of Egypt. On the other hand, perennial and even woody plants of Africa and America, when transplanted into the northern regions, become annual. *Nyctago hortensis* and *Cobœa* are perennial in Peru, and annual in our gardens. The Castor-oil plant, which, in Africa, forms a tree, lasts only a single year in our climate, but resumes its woody character when it happens to be placed in a favourable situation. While collecting plants in the neighbourhood of Villefranche, on the shores of the Mediterranean, in September 1818, I discovered a small wood formed of castor-oil plants in the state of trees, upon the mountain which shelters the arsenal of that city, to the west. Their trunk is woody and hard. The largest are about twenty-five feet high, and have much of the aspect of our plane-trees. It is true that the situation of Villefranche, which is exposed to the south, and protected from the westerly winds by a chain of pretty high hills, approximates it in a singular degree to the climate of certain parts of Africa.

In general, all the perennial exotic plants, whose seeds are capable of forming individuals, which flower the first year in our climates, become *annual* there. This has been the case with the Castor-oil plant, the *Cobœa*, *Nyctago hortensis*, &c.

Woody roots differ from perennial roots only in being more solid, and in supporting a stem which is also perennial. Of this kind are the roots of trees and shrubs.

B. With reference to their *form* and *structure*, roots may be divided into *vertical*, *fibrous*, *tuberiferous*, and *bulbiferous*.

1. The *Vertical Root (Radix perpendicularis)*, is that which passes perpendicularly into the ground. It may be *simple* (Fig. 10.), without divisions of any size, as in the Radish and Carrot; or *branched* (Fig. 11.), as in the Ash, the Lombardy poplar, &c. Roots of this kind belong exclusively to dicotyledonous vegetables.

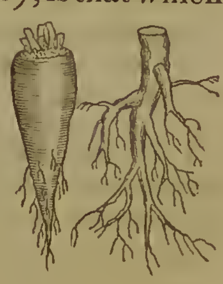

Fig. 10. 11.

2. The *Fibrous Root* (Fig. 12.), consists of a great number of fibres, which are sometimes slender and simple, at other times thick and branched. The roots of most palms are of this kind. Fibrous roots are observed in monocotyledonous plants only.

Fig. 12.

3. I give the name of *Tuberiferous Roots* (Fig. 13.), to those which, at various points of their extent, sometimes at their upper part, sometimes at the middle or at the extremities of their ramifications, present more or less numerous tubercles. These tubercles or fleshy bodies, which long were erroneously considered as roots, are merely masses of amylaceous fecula, which nature has, as it were, placed in reserve, for the purpose of contributing to the nutrition of the plant *. Accordingly, real tubercles are never observed in annual plants, but belong exclusively to perennial ones. Of this kind are those of the Potato, the Jerusalem Artichoke, the Orchideæ, and the *Convolvulus Batatas* †.

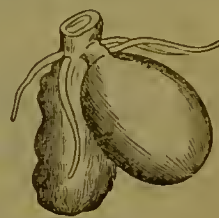

Fig. 13.

* The view which I here take of the tubercles is different from that usually taken. They are by no means roots, as many authors have said, and we agree with M. Sprengel *(Linnæi Philos. Bot.)* in considering them as nothing but a kind of subterranean buds of perennial plants, to which nature has confided the care and preservation of the rudiments of the stem. The only difference which the tubercles thus considered present, is, that the young stem, in place of being protected by numerous and close scales, is enveloped by a dense and fleshy body, which not only serves to protect it during winter, but supplies it in spring with the first materials of its development and nutrition. They might equally be considered as short and fleshy subterranean stems, and the eyes which spring from them might be viewed as buds.

† The potato is, in one sense, an annual plant, as indeed are the Orchideæ, inasmuch as the tubers annually produced, are perfectly independent, and give rise to a new individual each year.—Tr.

4. The *Bulbiferous root* (Fig. 14.), is formed of a kind of thin and flat tubercle, called a *disk*, which, at its lower part, produces a fibrous root, and by its upper supports a bulb, which is nothing else than a bud of a particular kind, formed of a great number of scales or coats applied over each other; as in the Lily, the Hyacinth, the Garlic, and bulbous plants in general.


Fig. 14.

Such are the principal modifications which the root presents with reference to its particular structure. We confess, however, that these differences are not always so decided as we have represented them. Here, as in her other works, Nature does not lend herself servilely to our systematic divisions. She sometimes obliterates, by insensible gradations, those differences which we at first thought so constant and decided. All the roots which cannot be referred to any of the four principal modifications above described, retain the generic name of roots.

The *radicles* or fibrils of roots, are comparatively larger and more abundant, the looser the soil in which the vegetable lives. When the extremity of a root happens to meet a stripe of water, it elongates, divides into capillary and branched fibrils, and constitutes what gardeners designate by the name of *fox's tail*. This phenomenon, which may be produced at will, shews why aquatic plants generally have much larger roots.

After presenting these general considerations on the structure of the root, we have now to describe the principal modifications which that organ may undergo, with respect to its consistence, its form, and its other external characters.

C. With respect to *consistence*, the root is *fleshy*, when, besides being manifestly thicker than the base of the stem, it is at the same time more succulent; as in the Carrot, the Turnip, &c. It is *woody*, on the contrary, when its parenchyma is more solid, and approaches in some degree to the hardness of wood. This is the case in most woody vegetables.

D. The root may be *simple (simplex)*, that is, formed of a tapering body, entirely without divisions, as in the Beet, the Parsnip, the Radish, &c. (Fig. 10, 15.); or *branched (ramosa)*, when divided into more or less numerous and attenuated ramifications, always of the same nature as itself, which is the case in most of our forest trees, the Oak, the Elm, &c. (Fig. 11).

E. Considered as to its *direction*, the root may be vertical, as in the Carrot and Radish; *oblique*, as in the genus *Iris;* or situated *horizontally* under ground, as in *Rhus radicans*, the Elm, &c. Not unfrequently these three positions are found united in the different ramifications of the same root.

F. The most remarkable varieties of form are the following:

1. The *Fusiform*, or *spindle-shaped root (R. fusiformis)* (Fig. 15.), when it is elongated, smaller at its two extremities, and thicker in the middle, as in the Radish.

2. *Napiform*, or *top-shaped (R. napiformis)* (Fig. 16.), when it is simple, rounded, and swelled out at its upper part, narrowed and rapidly terminating in a point below; as in the Turnip, the Spanish Radish, &c.

3. *Conical (R. conica)* (Fig. 17.), when it presents the form of a reversed cone; as in the Beet, the Parsnip, and Carrot.

4. *Rounded* or *roundish (R. subrotunda)*, as in the Earthnut *(Bunium Bulbocastanum)*, &c.


Fig. 15.


Fig. 16.


Fig. 17.

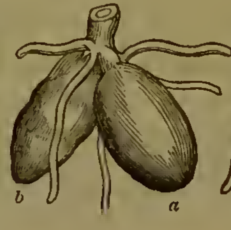

Fig. 18.


Fig. 19.

5. *Didymous* or *testiculate* (R. didyma, testiculata)* (Fig. 18.), when it possesses one or two rounded or egg-shaped tubercles, as in *Orchis militaris, mascula,* &c.

This kind of root is named *palmate (R. palmata)* (Fig. 19.), when the two tubercles are divided to about the middle into divergent lobes, like fingers; as in *Orchis maculata.*

Digitate (R. digitata), when the tubercles are divided nearly to their base; as in *Satyrium albidum.* According to these modifications of the didymous root, Linnæus has divided the genus Orchis into three sections.

6. *Knotty (R. nodosa)* (Fig. 20.), when the ramifications of the root present at intervals a kind of enlargement or knots, which give it some resemblance to a necklace; as in *Avena præcatoria* †.

Fig. 20.

Fig. 21.

7. *Granulated (R. granulata)* (Fig. 21.). M. de Candolle gives this name to the kind of root which presents a mass of small tubercles containing eyes, by which the plant is reproduced, without being enveloped with cellular tissue filled with amylaceous fecula; as in *Saxifraga granulata.*

* In the testiculate root, one of the tubercles (Fig. 18. *a*), is firm and solid, and a little larger than the other. It contains the rudiment of the stem which is to be developed the following year. The other (Fig. 18. *b*), is soft, wrinkled, and smaller, and contains the germ of the stem newly developed, and upon the growth of which it has expended the greater part of the amylaceous fecula which it contained.

† These knots must not be confounded with the true tubercles, which always contain the rudiments of new stems.

8. *Fasciculate (R. fasciculata)* (Fig. 22.), when it is formed of numerous thick, simple or little branched radicles; as in the Asphodels and Ranunculi.

Fig. 22.

9. *Articulate* or Jointed *(R. articulata)*, when it presents joints or articulations at regular distances; as in Gratiola.

10. *Contorted (R. contorta)*, when it is curved in different directions; as in Bistort.

11. *Capillar (R. capillaris)* (Fig. 23.), when formed of very slender capillar fibres; as in most of the Gramineæ, Wheat, Barley, &c.

Fig. 23.

12. *Comose (R. comosa)*, when the capillary filaments are branched and very close; as in the Heaths.

The consideration of the anatomical structure of the root will come best after that of the stem, as, in this respect, these two organs bear a great resemblance to each other.

Uses of the Roots.

The uses of the roots have reference to the plant itself, or to its applications to domestic economy, the arts, and medicine.

With reference to the plant itself, the roots serve, 1*st*, To attach it to the soil, or to the body on which it is to live; 2*dly*, To derive from thence part of the materials necessary for its growth.

The roots of many plants appear to perform only the first of these two offices. This is observed chiefly to be the case in thick and succulent plants, which absorb the substances necessary for their nutrition by every part of their surface.

In them, the roots serve no other purpose than that of fixing them in the ground. The magnificent *Cactus peruvianus* which grows in the hothouses of the Museum of Natural History at Paris, is an object which has attracted general notice. This vegetable, which is of an extraordinary height, sends out enormous branches with extreme vigour, and often with surprising rapidity; and yet its roots are contained in a box, which scarcely holds three or four cubic feet of earth, which is never renewed or watered.

The roots of plants are not always proportional to the strength and size of the trunks which they support. The Palms and Coniferæ, whose trunks sometimes acquire a height of more than a hundred feet, have short roots, which do not extend deeply into the ground, and attach them but feebly to it. On the contrary, herbaceous plants, whose weak and slender stem dies yearly, have sometimes roots of great length and size, compared with the stem; as is observed in the Liquorice, Lucern, and *Ononis arvensis*, which, on account of the great length and toughness of its roots, is named *Rest-harrow*.

Roots also extract from the earth the substances which are intended to serve for the growth of the plant. But all parts of the root do not perform this office, it being only by the extremity of their smallest fibres that this absorption takes place. Some say that they are terminated by little ampullæ, or spongy bodies, which are more or less tumid; and others, by a kind of absorbing mouths. Whatever be their structure, it is certain that the office of absorption is performed by these extremities alone.

No experiment is more easily made than that by means of which the truth of this fact is undeniably established. If we take a radish or a turnip, and immerse in water the extremity of the radicle by which it is terminated, it will vegetate and shoot forth leaves. On the contrary, if it be so placed in the water that its lower extremity is not immersed, it gives no sign of development.

The roots of certain plants appear to excrete a peculiar matter, which differs in the different species. Duhamel relates, that, having caused some old elms to be rooted up, he found the earth about their roots of a darker colour, and more unctuous. This unctuous matter was the product of a kind of excretion performed by the roots. To this matter, which, as we have said, is different in the different species of plants, the sympathies and antipathies which certain vegetables have towards each other, have been attributed. It is well known, in fact, that certain plants have, as it were, a kind of liking to each other, and constantly live together. These are named *social plants.* Others, on the contrary, seem incapable of growing in the same place.

It has been remarked, that roots have a decided tendency to direct themselves towards veins of good earth, and that they are often greatly elongated for the purpose of reaching places where the soil is less compact, and contains more substance. They then develope themselves with more power and rapidity. Duhamel relates that, wishing to protect a field of good earth from the roots of a row of elms, which extended into it, and exhausted part of it, he caused a deep trench to be dug along the row of trees, which cut across all the roots that stretched into the field. But soon after, the new roots, on arriving at one of the sides of the ditch, curved downwards, following the slope, until they arrived at its lower part, when they proceeded horizontally under the ditch, rose again on the other side, following the opposite slope, and extended anew into the field.

The roots of all trees have not the same power of penetrating the hard subsoil. Duhamel observed, that a vine root had penetrated a very hard subsoil to a great depth, while an elm-root had been stopped by it, and had, in a manner, retraced its steps.

The root, as we have already said, has a natural and invincible tendency to direct itself toward the centre of the earth. This tendency is especially remarked in that organ, at the moment when it begins to be developed, at the period of germination of the embryo. It is afterwards less manifest, although it always exists, especially in the roots which are simple, or in the tap-root of those which are branched, for it frequently does not exist in the lateral ramifications of the root.

Whatever obstacles may be opposed to this natural tendency of the radicle, it possesses the power of surmounting them. Thus if a germinating bean or pea be placed in such a manner that the cotyledons are situated in the earth and the radicle in the air, the radicle is soon seen to bend towards the earth, to immerse itself in it. This phenomenon has received various explanations. Some say that the root tends to descend, because the fluids which it contains are less elaborated, and consequently heavier than those of the stem. But this explanation is contradicted by facts. In certain exotic vegetables, such as *Clusia rosea*, &c. we see roots forming upon the stem at a great height, and descending perpendicularly to penetrate into the ground. Now, in this case, the fluids contained in these aërial roots are of the same nature as those which circulate in the stem; and yet these roots, in place of rising like it, descend towards the earth. It is not, therefore, the difference of the weight of the fluids that gives them this tendency towards the centre of the earth.

Others have imagined the cause of this phenomenon to exist in the avidity which the roots have for moisture, which is more abundant in the earth than in the atmosphere. Duhamel, with the view of ascertaining the truth of this explanation, made seeds germinate between two moist sponges, suspended in the air. The roots, in place of directing themselves towards either of the two sponges, which were well soaked with water, crept between them, and hung out below, thus tending towards the earth. It is not moisture, then, that attracts roots towards the earth's centre.

May it be the earth itself, by its nature, or its mass? This explanation also is contradicted by experiments. M. Du Trochet filled with earth a box, in the bottom of which several holes were bored. In these holes he placed French beans, in a state of germination, and suspended the box in the open air, at a height of six metres. In this manner, the seeds, being placed in the holes formed at the lower surface of the box, received from beneath the influence of the atmosphere and light, and the moist earth was placed above them. Were the cause of the direction of this part to be found in its predilection for moist earth, the radicle would be seen to ascend into the earth placed above it; and the stem, on the other hand, would descend towards the atmosphere placed under it; but this was not the case. The radicles of the seeds descended into the atmosphere, where they soon withered, and the plumules ascended into the earth.

Mr Knight, a celebrated English naturalist, was desirous of ascertaining, by experiment, whether this tendency might not be destroyed by a rapid circulatory motion impressed upon seeds in a state of germination. He fixed some French beans in the trough of a wheel, constantly moved by a stream of water, in a vertical plane, the wheel performing 150 revolutions in a minute. The seeds, which were placed in moss, continually moistened, soon germinated, when all the radicles directed themselves towards the circumference of the wheel, and all the gemmules towards its centre. By each of these directions, the radicles and gemmules obeyed their natural and opposite tendencies. The same naturalist made a similar experiment with a wheel moving horizontally, and performing 250 revolutions per minute. The results were similar; that is to say, all the radicles directed themselves towards the circumference, and the gemmules towards the centre; but the former with an inclination of ten degrees towards the earth, and the latter towards the sky. These experiments were repeated by M. Du Trochet, and yielded the same results, only that, in the second, the inclination was much greater, and the radicles and gemmules had become almost horizontal.

From the different experiments above stated, there evidently results that the roots direct themselves towards the earth's centre, not because they contain a less elaborated fluid, nor because they are attracted towards it by the humidity or the nature of the earth itself, but by a spontaneous motion, a kind of submission to the general laws of gravitation.

But, although this law of the tendency of roots towards the earth's centre may be said to be general, some vegetables seem to be exempt from it. Of this kind are the parasitic plants in general, and the misseltoe in particular. This singular plant, in fact, shoots out its radicle in whatever position chance places it. Thus when the seed, which is enveloped with a thick and clammy gluten, happens to fix itself to the upper part of a branch, its radicle, which is a kind of tubercle hollowed out like a horn, is then perpendicular to the horizon; but, when the seed is placed on the under part of the branch, the radicle directs itself upwards. If it be situated on the lateral part of the branch, the radicle takes a lateral direction. In short, in whatever position the seed may be fixed to the branch, the radicle always directs itself perpendicularly to the axis of the branch.

M. Du Trochet has made numerous experiments on the germination of this seed, with the view of determining the direction of the radicle. The more interesting of these experiments we shall here state. This seed, which finds the first materials of its growth in the glue that envelopes it, germinates and grows not only on living and dead wood, but also on stones, glass, and even iron. M. Du Trochet made it germinate on a cannon-ball. In all these cases, the radicle is constantly directed towards the centre of these bodies, which proves, as that ingenious experimenter remarks, that it is not towards a medium suited to afford it nourishment that the embryo of the misseltoe directs its radicle, but that this radicle obeys the attraction of the bodies on which the seed is fixed, of whatever nature they may be.

But this attraction is only a remote cause of the tendency of the root of the misseltoe towards bodies. The true cause is in an internal and spontaneous motion performed by the embryo, under the influence of the attraction exercised upon its radicle. M. Du Trochet fastened a misseltoe-seed that had germinated to one of the extremities of a copper needle, similar to that of a compass, and placed like it on a pivot. A little ball of wax, placed at the other extremity, balanced the needle. Things being thus arranged, M. Du Trochet approached laterally towards the radicle, a small board, to about the distance of half a line. The apparatus was then covered by a glass receiver, to protect it from the influence of external agents. At the end of five days, the stem of the embryo was bent, and had directed the radicle towards the small piece of wood, without any change having taken place in the position of the needle, notwithstanding its extreme mobility on the pivot. Two days after, the radicle was directed perpendicularly towards the board, with which it had come into contact, without the needle, which supported the seed, having experienced the least derangement.

The radicle of the misseltoe presents another unvarying tendency, which is that of avoiding light. If misseltoe-seeds are made to germinate on the inner surface of the panes of a window, all the radicles will be seen directing themselves towards the interior of the room in quest of darkness. If one of these seeds be taken and applied to the outside of the window, its radicle will apply itself to the glass, as if it were tending toward the interior of the room to avoid the light.

In domestic economy, many roots are usefully employed as food. Thus carrots, turnips, parsnips, salsifies, and many other roots, are so generally known that it is unnecessary for us to enter into any details on this subject. Salep is prepared from the tubercles of many species of Orchis. From the root of the beet, there is extracted, by a process which chemistry has brought to a singular degree of perfection, a kind of sugar, which forms an advantageous substitute for that procured at great expense from the colonies.

Certain plants, which possess the faculty of sending out roots, which ramify and extend to great distances, have been employed for fixing and consolidating loose ground. Thus in Holland, and in the vicinity of Bordeaux, *Carex arenaria* is planted on the sands, and the edges of the canals, for the purpose of consolidating them. In several other countries, *Hippophaë rhamnoides*, Spanish Broom, and other species, are planted with the same view.

Several roots are advantageously used in dyeing. Of this kind are those of Madder, Alkanet, Turmeric, &c.

It is well known that the healing art derives valuable medicines from roots. With reference to the principles which predominate in them, officinal roots have been divided as follows:

1. *Insipid* roots, containing a mucous or amylaceous principle: Marsh-mallow, *Althæa officinalis*, Lin.; Common Comfrey, *Symphytum officinale*, Lin.; Couch-grass, *Triticum repens*, Lin.; &c.

2. *Sweet* roots, containing saccharine matter: Liquorice, *Glycyrrhiza glabra*, Lin.; Common Polypody, *Polypodium commune*, Lin.; &c.

3. Roots having little taste, or *slightly bitter:* Sarsaparilla, *Smilax Salsaparilla*, Lin.; Squine, *Smilax China*, Lin.; Burdock, *Arctium Lappa*, Lin.; Patience, *Rumex Patientia*, Lin.

4. *Aromatic* roots: Valerian, *Valeriana officinalis;* Virginian Snake-root, *Aristolochia serpentaria*, Lin.; Angelica, *Angelica Archangelica*, Lin.; Elecampane, *Inula Helenium*,

Lin.; Common Avens, *Geum urbanum*, Lin.; Horse-radish, *Cochlearia Armoracia*, Lin.; Ginseng, *Panax quinquefolium*, Lam.

5. *Bitter* roots: Gentian, *Gentiana lutea*, Lin.; Rhubarb, *Rheum palmatum* and *Rh. undulatum*, Lin.; Columbo, *Cocculus palmatus*, Dec.; Bitter Milkwort, *Polygala amara*, Lin.

5. *Astringent* roots: Bistort, *Polygonum Bistorta*, Lin.; Tormentil, *Tormentilla officinalis*.

7. *Acrid* and *nauseating* roots: Ipecacuan, *Cephaelis Ipecacuanha*, Rich, and *Psychotria emetica*, Lin. *; Asarabacca, *Asarum europæum*; Black Hellebore, *Helleborus niger*, Lin.; White Hellebore, *Veratrum album*, Lin.; Jalap, *Convolvulus Jalapa*, Lin.; &c.

* See my memoir on the two species of Ipecacuan, derived from the family of *Rubiaceæ*, inserted in the *Bulletins de la Societé de la Faculté* for the year 1818, and my Natural and Medical History of the different species of Ipecacuan used in commerce, Paris, 1820, one volume, 4to, with figures.

CHAPTER II.

OF THE STEM.

We have seen that the root generally tends towards the earth's centre. The *Stem*, on the contrary, is that part of the plant, which, growing in a direction the reverse of that of the root, seeks the air and light, and serves to support the leaves, the flowers, and the fruit, when the plant is possessed of these organs.

All Phanerogamous vegetables have a stem properly so called. But this stem is sometimes so short, and has received so little development, that it seems as if wanting. Plants presenting this disposition are said to be *stemless (acaules)*. Of this kind are the Primrose, Hyacinth, and many others.

We must not confound with the true stem the *Scape* and *Radical Peduncle*. The *Scape (Scapus)* is a floral peduncle, which is naked, or, in other words, destitute of leaves, proceeds from the neck of the root, and is terminated by one or more flowers, as in the Hyacinth. The *Radical peduncle (Pedunculus radicalis)* differs from the scape only in the circumstance, that, instead of springing from the centre of a tuft of radical leaves, it comes from the axilla of one of these leaves; as in the Plantains, *Plantago media*, *P. lanceolata*, &c.

There are distinguished five principal kinds of stems, founded upon their organization, and their peculiar mode of development. These are: 1. The *Trunk*; 2. The *Stipe*; 3. The *Culm* or *Straw*; 4. The *Stock*; 5. The *Stem* properly so called.

1. The *Trunk (Truncus)* is the stem of our forest trees, the Oak, the Fir, the Ash, &c. It possesses the characters of being conical and elongated; in other words, has its greatest diameter at its base. It is naked below, and is terminated at its summit by divisions which are successively smaller, and which are named branches, twigs, and ramuli. These commonly bear the leaves and organs of reproduction. The trunk is peculiar to the dicotyledonous trees. It is composed internally of concentric layers, superimposed upon each other, and increases in length and diameter by the addition of new layers to its circumference.

2. The *Stipe (Stipes)* is a kind of stem which is observed only in Monocotyledonous trees, such as Palms, *Dracænæ*, *Yuccæ;* and certain Dicotyledones, namely, *Cycas* and *Zamia.* It consists of a kind of cylindrical column *, as thick at the top as at the base (which is not the case in the trunk), frequently even larger at the middle than at the two extremities, seldom branched, and crowned at its summit by a tuft of leaves intermingled with flowers. Its bark, when it has any, generally differs little from the rest of the stem. Its growth in height is effected by the development of the bud by which it is terminated above. It increases in thickness by the multiplication of the filaments of its circumference.

We shall presently shew, when we come to treat of the anatomical structure of stems, that the stipe differs from the trunk as much by its internal organization as by the physical characters just stated.

3. The *Culm* or *Straw (culmus)* is peculiar to the *Gramineæ*, that is, to such plants as wheat, barley, oats, &c., the *Cyperaceæ*, the *Junci*, and other allied genera. It is a simple stem, seldom branched, generally fistulous † (hollow

* It is often designated by the name of columnar trunk or stem.

† Sometimes, however, it is full internally, as in the sugar-cane and maize.

within), and marked at intervals by *knots* or partitions, from which proceed alternate, sheathing leaves.

4. The *Stock* or *Rhizoma** (Fig. 24.) This name has been given to the subterranean and horizontal stems of perennial plants, entirely or in part concealed under ground, and sending out new stems from their anterior extremity, in proportion as their posterior extremity disappears. It is to this subterranean stem that the names of *progressive root* and *abrupt* or *premorse root*, are generally, but improperly, given. Examples of it are seen in the roots of the Iris, *Scabiosa succisa*, and Solomon's-seal †. Besides its nearly horizontal direction under ground, one of the principal characters of the stock, and by which it is distinguished from the root, is, that it always, in some parts of its extent, presents traces of the leaves of preceding years, or scales which take place of them, and that it increases by its base or the part nearest the leaves, which is the reverse of what takes place in the true root.

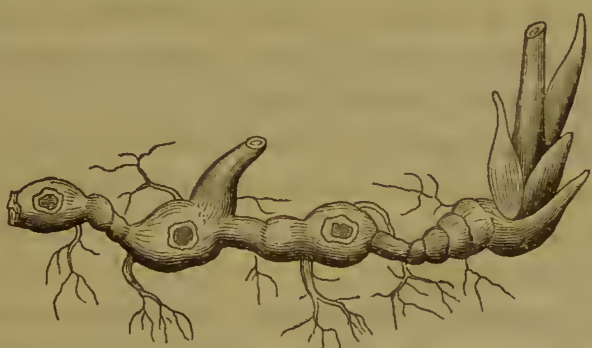

Fig. 24.

5. The common and general name of *Stems* is given to

* Rhizoma, from ῥιζα, root; and σωμα, body.

† The number of plants that are provided with a stock or subterranean stem is much greater than is commonly imagined. Many of the plants considered as stemless (*acaules*), and many perennial herbaceous plants, have a stock, which is more or less developed. This is the case, for example, in *Anemone nemorosa*, *Adoxa Moschatellina*, *Paris quadrifolia*, &c. The part of these plants that has been described as a tuberous root, is a true stock.

all those which, differing from the four preceding kinds, cannot be referred to any of them. The number of vegetables that have a stem properly so called, is much greater than that of vegetables which have a stipe, a culm, or a trunk.

We now proceed to examine the stem in general, with reference to the modifications which it presents.

A. With respect to consistence, the stem may be :

1. *Herbaceous (Caulis herbaceus)*, when it is tender and green, and continues for a single year only. Of this kind are the stems of annual, biennial, and perennial herbaceous plants, Chickweed, Borage, Comfrey, &c. All these plants take the general name of herbs *(herbæ)*.

2. *Semiligneous* or *Subligneous (C. suffruticosus)*, when the base is hard and continues above ground a great number of years, while the twigs and the extremities of the branches perish and are renewed each year. Of this kind are the Common Rue *(Ruta graveolens)*, the Garden Thyme *(Thymus vulgaris)*, and Sage *(Salvia officinalis)*. Vegetables which present a stem of this kind bear the name of *Suffrutices* *. They have no scaly buds.

3. *Woody (C. lignosus)*, when the stem is persistent, and its hardness such as to resemble that which is known to belong to wood in general. Vegetables possessed of a woody stem are divided into—

Shrubs (Frutices), when they send out branches from their base, and are destitute of buds: for example, the genus *Erica*.

Small trees, *Arbuscles (Arbusculæ)* †, when they are

* The name of *undershrubs* is absurdly given to plants of this kind, from an erroneous translation of the term *suffrutices*, which signifies, not *under* shrubs, but *somewhat* shrubby plants.—Tr.

† It is more usual to divide these plants into *trees* and *shrubs*, from a difference in height merely ; and the various gradations are often amusingly named : for example, large trees, trees of ordinary size, small trees ; large shrubs, small shrubs, diminutive shrubs, &c.—Tr.

branched at their base, and carry buds: for example, the Hasel and Lilac.

Lastly, they retain the name of *Trees (Arbores)* properly so called, when they have a trunk, which is simple and naked in its lower part, and branched only towards its upper part: for example, the Oak, the Elm, the Fir, &c.

This division is entirely arbitrary, and has no existence in nature. In fact, a tree of the same species may present these three modifications of size according to the difference of its exposure, or from the art of the cultivator. Thus the Dwarf Elm and the Box, which are made to answer as borders in our gardens, by being frequently clipped, are absolutely of the same species as the Common Elm and Box, whose stems, and especially that of the first, usually attain a great height when left to themselves.

4. *Solid* or *full (C. solidus, plenus)*, when it has no internal cavity: for example, the Sugar-cane, and the trunk of most trees. This term is always employed in opposition to the following.

5. *Fistulous* or *hollow (C. fistulosus)*, when it presents an internal cavity, which may be continuous, or separated by horizontal partitions; as in *Arundo Donax*, *Angelica*, *Œnanthe fistulosa*, the Bamboo, and *Cecropia peltata*, a large South American tree, whose trunk is always hollow, and for this reason is named *Cannon-wood* by the natives.

6. *Pithy* or *Medullar (C. medullosus)*, filled with pith; as in the Elder, the Rasp, and the Fig.

7. *Spongy (C. spongiosus)*, formed internally of a compressible, elastic, spongy tissue, retaining moisture like a sponge; as in *Typha latifolia*, *Scirpus lacustris*, &c.

8. *Soft (C. mollis, flaccidus)*, when it is unable to support itself, and falls down upon the ground: for example, *Anagallis arvensis* *.

* The term corresponding to this definition is not *mollis*, but *debilis*, weak.—Tr.

9. *Firm* or *stiff* (*C. rigidus*), when it rises directly, and supports itself erect: for example, *Polygonum Bistorta.*

10. *Flexible* (*C. flexibilis*), when it may be easily bent without being broken; as in the Osier.

11. *Brittle* (*C. fragilis*), stiff and easily broken; as in *Geranium Robertianum*, the different species of Chara, &c.

12. *Fleshy* or *succulent* (*C. carnosus, succulentus*), when it contains a great quantity of juice or aqueous substance: for example, Borage and Purslane. Fleshy stems may be *milky*, that is, may contain a white or yellowish milky fluid; as in the *Euphorbiæ*, *Chelidonium majus*, the Poppy, &c.

B. Considered with respect to *form*, the stem presents numerous modifications. Thus it is named:

1. *Cylindrical* (*C. cylindricus*) *, when its general form comes near to that of a cylinder, that is, when its transverse section is more or less circular. This form occurs in the trunk of most of our forest trees, and in certain herbaceous plants; as Stramonium, Flax, &c.

2. *Wandlike* (*C. virgatus*), when it is slender, long, and straight, and diminishes from the base towards the summit; as in *Althæa officinalis*, *Reseda luteola*, and *Lythrum Salicaria.*

3. *Compressed* (*C. compressus*), when it is slightly flattened on two opposite sides; as in *Poa compressa.*

4. *Two-edged* (*C. anceps*), when so much compressed as to present two edges like those of a sword †.

5. *Angled* or *angulate* (*C. angulatus*), when marked with angles or longitudinal prominent lines, the number of which

* It is to be remarked here, that, in the organic kingdom, geometrical forms are never so regular, or so strictly determinate, as in minerals. Thus when we say of a stem that it is *cylindrical*, we merely mean that its form approaches most to that of a cylinder.

† A stem, however, may be two-edged, without being much compressed; that is, it may be in itself nearly cylindrical, and yet have two acute edges. —Tr.

is determinate. According as these angles are acute or obtuse, the stem may be *acutely angular* or *obtusely* so.

According to the number of angles, and consequently of distinct faces which it presents, it is named—

Triangular, *trigonal* or *triquetrous (C. triangularis, trigonus, triqueter)*, when it has three angles; as in many species of *Carex*, in *Scirpus sylvaticus*, &c.

Quadrangular or *tetragonal (C. quadrangularis, tetragonus)*, when it has four angles and four faces. If the angles are equal, and the faces so too, it is *square;* as in most of the *Labiatæ:* for example, Sage, Mint, Horehound, &c.

Pentagonal (C. pentagonus), when it has five faces.

Hexagonal (C. hexagonus), when it has six faces.

6. The stem is said to be *Angular (C. angulosus)*, when the number of angles is considerable, or when they cannot be accurately determined.

7. *Knotty (C. nodosus)*, presenting knots or enlargements at intervals; as in the *Gramineæ*, and in *Geranium Robertianum.*

8. *Jointed* or *Articulate (C. articulatus)*, formed of joints placed above each other, and connected by their extremities; as in the Misseltoe, many *Caryophylleæ*, &c.

9. *Geniculate* or *Kneed (C. geniculatus)*, when the articulations are angularly bent; as in *Alsine media* and *Geranium sanguineum.*

10. *Sarmentaceous (C. sarmentosus);* a shrubby stem too weak to support itself, and ascending upon the bodies in its vicinity, either by means of peculiar appendages, named *tendrils*, or by being twisted round these bodies: for example, the Vine and Woodbine.

11. *Climbing (C. scandens, radicans)*, when it raises itself upon the neighbouring bodies, and attaches itself to them by means of roots; as the Ivy and *Bignonia radicans.*

12. *Twining* or *Voluble (C. volubilis)*, when it twists in a spiral form around bodies in its vicinity. It is a remark-

able circumstance that the same plants do not commence their spiral turnings indiscriminately to the right or left, but in the same species, always turn to the same side. Thus, when the turns are from right to left, the stem is said to be *sinistrorsum volubilis, twining to the left,* as in the French Bean, the *Dolichos* and Bindweed; while it is *dextrorsum volubilis,* or *twining to the right,* when it commences its spiral from left to right; as in the Hop and Honeysuckle.

13. *Slender (C. gracilis),* when its length is very great compared with its thickness: for example, *Stellaria holostea, Orchis conopsea,* &c.

14. *Filiform* or *thread-like (C. filiformis),* when very slender and lying on the ground; as in the Cranberry *(Vaccinium Oxycoccos).*

C. With respect to its *composition,* the stem is,

1. *Simple (C. simplex),* when it has no decided ramifications; as in the White Mullein *(Verbascum Thapsus),* and the Foxglove *(Digitalis purpurea).*

2. *Branched (ramosus),* divided into branches and twigs. The stem may be branched from its base *(basi ramosus),* like the Common Furze *(Ulex europæus),* or only towards its summit *(apice ramosus).*

3. *Dichotomous (C. dichotomus),* when it divides by successive bifurcations; as in Lamb's-lettuce *(Valerianella locusta),* and Stramonium *(Datura Stramonium).*

4. *Trichotomous (C. trichotomus),* dividing by successive trifurcations; as in *Nyctago hortensis.*

The disposition of the branches, with respect to the stem, being precisely similar in its different modifications to those which we observe in the leaves, we have thought it unnecessary to speak of it here, what we shall presently say respecting the position of the leaves upon the stem being equally applicable to that of the branches and twigs.

D. Viewed with respect to its *direction,* the stem is said to be,—

1. *Vertical* or *erect (C. verticalis, erectus)* *, when it is in a vertical direction with respect to the horizon: for example, in *Campanula Rapunculus* and *Antirrhinum Linaria.*

2. *Prostrate* or *procumbent (C. prostratus, procumbens* †, *humifusus* ‡*)*, when it does not rise, but lies upon the ground, without taking root; as in *Malva rotundifolia*, and *Thymus Serpyllum.*

3. *Creeping (C. repens)*, when it lies upon the ground and takes root in its whole extent; as in *Lysimachia Nummularia.*

4. *Stoloniferous (C. reptans, stoloniferus)*, sending off from the principal plant small and slender lateral stems, named *stolons* or *runners*, which take root and produce new plants: for example, the *Strawberry (Fragaria vesca).*

5. *Oblique (C. obliquus)*, rising obliquely to the horizon.

6. *Ascending (C. ascendens)*, forming at its base a curve, the convexity of which looks to the ground, and at its upper part erect: for example, the common Red Clover *(Trifolium pratense)*, and the Spiked Speedwell *(Veronica spicata).*

7. *Reclining (C. reclinatus)*, erect, but suddenly bent back at its summit; as in some species of Gooseberry.

8. *Tortuous (C. tortuosus)*, forming several curves in different directions; as in the Sea Rocket *(Bunias Cakile).*

9. *Spiral (C. spiralis)*, forming curves in a spiral form: for example, most of the species of *Costus.*

E. Viewed with reference to its *clothing* and *appendages*, the stem is,

1. *Leaf-bearing (C. foliatus)*, carrying leaves; as is the

* The *straight* stem *(rectus)* must not be confounded with the *erect* or *upright (erectus).* The first rises directly, without forming any curve or lateral deviation; as in the White Mullein. The term *erect*, on the contrary, is used in opposition to *prostrate.* An erect stem may not be straight, and a straight stem is not necessarily erect.

† *Prostratus*, lying on the ground, but in one direction only.

‡ *Humifusus*, spreading along the ground in all directions.

case with most stems. It is said of the stem, in another sense, that it is *leafy (foliosus)*, when it is copiously furnished with leaves.

2. *Leafless (C. aphyllus)*, destitute of leaves; as in Dodder *(Cuscuta)*.

3. *Scaly (C. squamosus)*, bearing leaves in the form of scales; as in the genus *Orobanche*.

4. *Winged (C. alatus)*, having longitudinal membranous or leafy appendages, proceeding most commonly from the leaves; as in the Common Comfrey *(Symphytum officinale)*, and White Mullein *(Verbascum Thapsus)*.

F. Considered with respect to its *surface*, the stem is,

1. *Even (C. lævis)*, when it has no asperities or eminences; as in *Tamus communis*.

2. *Smooth* or *glabrous (C. glaber)*, destitute of hairs; as in the Greater Periwinkle *(Vinca major)*.

3. *Smooth and even (C. lævigatus)*.

4. *Powdery* or *pulverulent (C. pulverulentus)*, covered with a kind of powder produced by the plant; as in *Primula farinosa*.

5. *Glaucous (C. glaucus)* *, when this powder forms an excessively thin layer, which is easily removed, and is of a sea-green colour; as in *Cucubalus Behen*, *Chlora perfoliata*, &c.

6. *Dotted (C. punctatus)*, covered with more or less prominent and numerous dots; as in the Common Rue *(Ruta graveolens)*. These dots are commonly small vesicular glands, filled with essential oil.

7. *Spotted (C. maculatus)*, marked with spots of varied colour: for example, Wake-robin *(Arum maculatum)*, the Common Hemlock *(Conium maculatum)*, the Spotted Orchis *(Orchis maculata)*.

8. *Rough* or *scabrous (C. scaber, asper)*, when the surface presents to the touch a roughness which is not easily dis-

* It is this powder which, in certain fruits, as the Plum and Grape, is commonly called the *bloom*.

tinguishable by sight, and which appears owing to very small hairs, which are stiff and extremely short; as in *Lithospermum arvense.*

9. *Verrucose* or *warty (C. verrucosus)*, presenting small callous excrescences; as in *Euonymus verrucosus.*

10. *Corky (C. suberosus)*, when the bark is of the nature of cork; as in the Cork-tree *(Quercus Suber).*

11. *Chinky* or *rifted (C. rimosus)*, presenting deep and unequal fissures; as in the Elm, the Oak, and many other trees.

12. *Streaked* or *striated (C. striatus)*, presenting small prominent longitudinal lines, named striæ; as in the Common Sorrel *(Rumex Acetosa).*

13. *Grooved* or *furrowed (C. sulcatus)*, presenting longitudinal grooves, more or less deep; as in Cicuta and Parsnip.

G. Viewed with respect to its *pubescence*, or the hairs upon its surface, the stem is named as follows:

1. *Downy (C. pubens)* *, furnished with very delicate, soft, and close, but distinct hairs; as in the Purple Foxglove *(Digitalis purpurea)* and White Saxifrage *(Saxifraga granulata).*

2. *Hairy (C. pilosus)*, covered with long, soft, and widely set hairs; as in Common Agrimony *(Agrimonia Eupatorium)*, and Crowfoot *(Ranunculus acris).*

3. *Villous (C. villosus)*, when the hairs are soft, long, and very close.

4. *Woolly (C. lanatus)*, covered with long, somewhat frizzled and coarse hair, resembling wool; as in *Ballota lanata.*

* The word *pubescens*, although commonly employed to denote a part covered with hairs, is erroneously so. The Romans, whom we ought strictly to copy, when we employ their language, used the verb *pubescere*, in speaking of vegetables, only to express their growth. Thus Pliny says, *Jam pubescit arbor*, the tree already begins to grow; while, in another place, he says, *Folia quercus pubentia*, to express the pubescence of the leaves of the oak. It seems to me, from this circumstance, that we can do nothing better in this case than copy the Latin writers; for they must certainly have known the meaning of the words of their own language better than we can do.

5. *Cottony*, when the hairs are white, long, and soft, like cotton; as in *Stachys germanica* and *Hieracium eriophorum*.

6. *Silky (C. sericeus)*, when the hairs are long, soft, shining, and not entangled, as *in Protea argentea*.

7. *Tomentose (C. tomentosus)*, when the hairs are short, entangled, and seem interwoven like cloth; as in *Verbascum Thapsus*.

8. *Fringed* or *ciliate (C. ciliatus)*, when the hairs are disposed in rows or lines, which are more or less regular; as in *Veronica Chamædrys*, which has two opposite rows on its stem, and the Common Chickweed, which has a single row.

9. *Hispid (C. hispidus)*, furnished with long, stiff hairs, which have a tubercle at their base; as in *Galeopsis Tetrahit* and *Sinapis arvensis*.

H. The stem is sometimes furnished with acute appendages, when it is said to be *armed*. In this case it is named,

1. *Spinous* or *thorny (C. spinosus)*, when armed with spines; as in *Genista anglica*, *Gleditschia ferox*, &c.

2. *Prickly* or *aculeate (C. aculeatus)*, when armed with prickles; as in the genus *Rosa* *.

When the stem is destitute of thorns or prickles, it is said to be *unarmed (inermis)*, this term being applied in opposition to the two last.

Anatomical Structure of the Stem.

In speaking on a former occasion of the distinction between the *trunk* and the *stipe*, we mentioned that these two kinds of stems, of which the former belongs to the great class of *Dicotyledones*, and the latter to the *Monocotyledones*, differ as much in their internal structure, and the relative disposition of the elementary parts of which they are com-

* See, in a subsequent part, the description of the *Spines* and *Prickles*.

posed, as in their external characters. It is to M. Desfontaines that science is indebted for this important discovery, as we shall presently show. That learned botanist was the first who made known, with accuracy and precision, the internal organization, or anatomical structure of the stem of vegetables, and especially of the Monocotyledones. The facts which we are about to state on this subject are, in a great measure, derived from that celebrated naturalist. But it will be better to examine the organization of the stem of the Dicotyledones separately, and afterwards that of the Monocotyledones.

Sect. I.—Organization of the stem of dicotyledonous plants.

The trunk of dicotyledonous trees is formed of concentric layers superimposed upon each other, so that it in some measure resembles a series of tubes placed within each other, and increasing in size from the centre to the circumference. A transverse section of it (Fig. 25.) presents the following objects: 1*st*, At the centre, the *Medullary canal*, *a*, formed of the *Medullary tube*, which forms the walls of this canal, and of the *pith*, which fills up its cavity. 2*dly*, At the circumference of the section, we see the *Bark*, *b*, which is composed of the *Epidermis*, or the external pellicle which covers all parts of the vegetable, the *Herbaceous Envelope*, the *Cortical Layers*, and the *Liber*. 3*dly*, Between the medullary tube and the bark are found the *Woody Layers*, *c*, formed externally by the *Alburnum* or *false wood*, and internally by the *Wood*

Fig. 25.

properly so called. We shall now examine these parts in succession, beginning at the outermost, and proceeding inwards.

1. *Of the Epidermis.*

The *Epidermis (Epidermis, Cuticula)* is a thin and nearly transparent lamina, formed of a uniform tissue, which appears composed of cellules varying extremely in form, and which presents numerous small openings or pores, which some authors consider as a kind of inhaling mouths. It envelopes all parts of the vegetable; but it is more especially apparent on young stems, from which it may easily be separated with a little caution. As it possesses only a certain degree of extensibility, beyond which it cannot be further stretched, it tears and splits when the trunk has acquired a certain size, as is observed in the Oak and Elm. At other times it is detached in flakes or plates, as in the Birch and Plane. When removed from a young stem, it is reproduced without difficulty. It is the part of the vegetable that resists decomposition longest, and putrefaction has no perceptible action upon it. The colour which it presents is not inherent in its nature, but is derived from the peculiar colouring of the tissue on which it is applied.

The nature and origin of the epidermis form two rather obscure subjects in vegetable anatomy. Some authors say, with Malpighi, that the epidermis is not a membrane distinct from the rest of the vegetable tissue. They consider it as formed by the outer wall of the subjacent cellules, belonging to the herbaceous tissue, it having been hardened by the continued action of the air and light. Others again, of whom Grew may perhaps be considered as the author of this opinion, consider it as a perfectly distinct membrane, simply applied upon the subjacent cellular tissue. We are indebted to Professor Amici for microscopic observations of the highest importance, which throw much light on this question, and seem to confirm the second of these opinions. According to that naturalist, the epidermis is a membrane entirely distinct from the cellular tissue upon which it is applied. When examined with the microscope, it is seen to be composed of a single layer of cellules, whose form varies exceedingly in different plants. It is this cellular structure that has led into error the authors who have thought the epidermis to be formed of the outer wall of the cellular tissue. But, were this the case, the cellules which constitute the epidermis would always have the same form as the subjacent tissue, which, however, they are found not to have. Thus, in the Pink, the cellules of the epidermis have a quadrilateral form, while the immediately subjacent layer consists of a multitude of tubes perpendicular to the epidermis. The case is the same in many other vegetables; from which it may be concluded that the epidermis is a cellular membrane, entirely distinct from the subjacent tissue, upon which it is merely applied.

The epidermis, as we have said above, presents numerous small openings, named *cortical pores*, *cortical glands*, *epidermic glands*, and lastly *stomata*. Several authors have denied their existence; but the microscopic observations of Professor Amici leave no doubt on this subject. He has seen them in a great number of vegetables, and has described and figured them with the greatest accuracy. They are a kind of small bags, situated in the substance of the epidermis, and opening externally by a slit or elongated oval aperture, bordered with a kind of rim formed by particular cellules of the epidermis. This rim, or thickened margin, which is very seldom wanting, performs the office of a kind of sphincter which contracts or dilates the aperture according to various circumstances. Thus, humidity or water closes the pores, while drought and the action of the solar rays keep them open, and separate their margins. The motions of dilatation and contraction are not confined to the living plant alone, but also take place in fragments of epidermis that have been detached from a vegetable. These pores or little bags always correspond by their base to spaces filled with air only, and resulting from the arrangement of the cellules or tubes with respect to each other. These intercellular spaces almost always communicate with each other, and thus afford a means of communication to the aëriform fluids which exist in the interior of vegetables. Some parts, however, appear to be destitute of stomata; of which kind are the roots, the petioles which are not leafy, the petals in general, the epidermis of old stems, and that of fleshy fruits and seeds. Certain leaves have them only on one of their surfaces, while others have them on both.

What is the use of these curious pores? Are they, says M. Amici, destined for the absorption of moisture? No: we have already seen that they correspond to internal spaces which are destitute of juices, that they are closed by water, and that light and drought cause them to open. Moreover, they are wanting in all roots, as well as in plants that live constantly under water. They do not therefore serve for the absorption of water. Nor are they intended for evaporation; for if we allow a plant which has been detached from its roots to die, although the pores close after some time, evaporation still continues, so long as any fluid remains in its interior. It has been observed, moreover, that the corollas and fruits, which are destitute of cortical pores, yet produce an abundant evaporation. M. Link supposed them to be exerctory organs, but this cannot be the case, as they always correspond to empty spaces. The real office of the cortical pores is to give passage to air. But it is not easy to determine with certainty whether they serve for inspiration more than expiration, or for both these functions alike. If we consider that at night, when the large pores of the epidermis are closed, leaves absorb carbonic acid gas dissolved in the dew, which undoubtedly penetrates into the cellules by passing through their membrane; and if we refleet moreover that these leaves decompose carbonic acid gas, when the pores are open, that is during the day, we may suppose them to be solely destined for the exhalation of oxygen. This use becomes still more probable, when we add that the corollas which, according to M. de Candolle's observations, are destitute of pores, are equally destitute of the faculty of disengaging oxygen.

The surface of the epidermis sometimes presents certain organs which appear under the form of small spots elongated in the longitudinal direction in young branches, and in the transverse direction in older branches, which Guettard first designated by the name of *lenticular glands*, and which M. de Candolle has since named *lenticelles*. No traces of them have yet been discovered in the monocotyledonous or acotyledonous plants. They are also wanting in the herbaceous plants of the dicotyledonous class. They are very distinct on the epidermis of the birch, and especially on that of *Euonymus verrucosus*, where they are very prominent and close. It is from these lenticelles that the roots spring which certain trees develope upon their stem, some species of Ficus, for example, or those which form when a branch is immersed in the ground, as in the operation of propagating by layers. They may therefore be in some measure considered as root-buds.

From the surface of the cuticle also spring the hairs of various kinds which are observed on many plants.

2. *Of the Herbaceous Envelope.*

Under the epidermis is observed a layer of cellular tissue, which connects it with the cortical layers, and to which M. Mirbel gives the name of *Herbaceous Envelope*. Its colour is generally green in young stems. It covers the trunk, the branches and their divisions, and fills up the spaces which exist between the ramifications of the nerves of the leaves. M. Du Trochet names it the *Outer Medulla*, in opposition to the name of *Inner Medulla,* which he gives to the pith. Its colour is not derived from the cellular tissue of which it is composed, but is owing to the small grains of globuline, situated in the walls of the cellules, and which M. Du Trochet considers as nervous corpuscules.

The herbaceous envelope, or outer medulla, frequently contains the proper juices of vegetables, which are enclosed in particular canals or reservoirs. It is readily repaired on the stem of woody vegetables; but this phenomenon does not take place in annual plants. It appears to have an organization and uses similar to those of the pith contained in the medullary tube. It is this herbaceous envelope which, having acquired great thickness, and peculiar physical qualities, constitutes the part known by the name of cork in *Quercus Suber,* and some other plants. The herbaceous envelope is the seat of one of the most remarkable chemical phenomena which vegetable life presents, it being in its interior that, by a cause which it is difficult to understand, the decomposition of the carbonic acid absorbed in the air by the plant, is effected. The carbon remains in the interior of the vegetable, while the oxygen that has been disengaged is thrown out. It is to be remarked, however, that this decomposition takes place only when the plant is exposed to the rays of the sun, whereas the carbonic acid is thrown out undecomposed, when the vegetable is withdrawn from the influence of that luminary. This organ is partly renewed each year. It also performs a very important part in the phenomena of vegetation. At the return of summer, it solicits the sap to ascend towards the buds, and thus becomes one of the most powerful agents in producing their elongation in the atmosphere.

The herbaceous envelope is very easily discovered on the young branches of a tree, it being the part exposed when the epidermis is removed.

3. *Of the Cortical Layers.*

The *Cortical Layers*, or *Outer Bark*, do not always exist, or at least are sometimes so slightly developed, and so little distinct from the liber, that it becomes very difficult to recognise them. They are placed beneath the herbaceous envelope, and are applied upon the outermost layers of the liber, from which they can hardly be distinguished. In no vegetable are they more apparent, or more remarkable for the singular disposition of the tissue of which they are composed, than in the Lace-tree, in which they form several layers above each other, which, on being stretched out, bear a perfect resemblance to some kinds of linen, or represent lacework of pretty regular texture. In most plants, however, it is difficult to distinguish this part from the liber.

3. *Of the Liber.*

The *Liber*, or *Inner Bark*, occurs between the cortical layers, which are external of it, and the woody body, which is internal. It is composed of a vascular network, the elongated areolæ of which are filled with cellular tissue. It is seldom that it can be easily separated into distinct laminæ, which have been compared to the leaves of a book; but this effect may almost always be obtained by maceration.

The different laminæ of which the liber is composed, and which have been successively formed, are separated from each other by thin layers of cellular tissue. When the liber is macerated, this cellular tissue is destroyed, and allows the laminæ to be separated.

Like all other parts of the bark, the liber is capable of being replaced when it has been removed. Before it can be reproduced, however, the part from which it has been detached must be guarded from the contact of air. This important fact we owe to Duhamel. That excellent naturalist, to whom vegetable physiology is indebted for so many happy discoveries, removed a portion of bark from a vigorous tree in full vegetation. He secured the wound against the contact of air, and presently saw exuding from the surface of the woody body, and the edges of the bark, a viscid substance, which, spreading over the wound, acquired consistence, became green and cellular, and reproduced the portion of liber that had been removed.

To this viscid substance which exudes from the denuded parts, to reproduce the liber, Grew, and after him Duhamel, gave the name of *Cambium.* Several authors are, not without reason, of opinion that the cambium is nothing else than the descending and elaborated sap. I am the more inclined to adopt this opinion, when I reflect that this viscid fluid performs exactly the same functions in the animal economy as those generally attributed to the descending sap, which is conveyed by the same parts.

Whatever be the origin of the cambium, it performs a very important part in the growth of the stem. In fact, in all the theories that have been advanced with the view of explaining that phenomenon, its presence is indispensable, as we shall presently shew, when we come to treat of the growth of dicotyledonous stems.

Numerous experiments prove that the liber is absolutely necessary for vegetation. A graft does not succeed unless its liber be in contact with that of the tree on which it is inserted; and a slip, whose lower part is destitute of liber, does not take root. If a circular band of liber be removed from the trunk of a tree, in such a manner as to leave the woody body exposed, not only will all the parts of the tree above this band cease to be developed the following year, but the entire tree will ultimately perish.

The liber is hardened each year, and new layers are formed at its inner surface, by means of the cambium.

5. *Of the Alburnum or False Wood.*

The outermost woody layers, or those which are in contact with the liber, constitute the *alburnum*. This part is not a distinct organ from the wood properly so called, of which the layers are situated beneath it. It is wood, but wood in a young state, and not yet possessed of all the hardness and tenacity which it is ultimately to present. Accordingly, the alburnum exhibits precisely the same structure as the wood, although its tissue is formed of fibres that are weaker, more distant from each other, and generally of a paler tint.

The difference of colour between the wood and alburnum is very remarkable in trees whose wood is very hard and compact, and especially in those in which it is of a more or less deep colour. Thus in Ebony and Logwood, the wood properly so called is black or deep red, while the layers of alburnum are of very light greyish tint. But in trees which have white and coarse-grained wood, the difference between the woody layers and alburnum is very slight.

When we come to speak of the manner in which the stems increase in diameter, we shall state the very discordant opinions of authors respecting the origin of the alburnum.

6. *Of the Wood properly so called.*

The *Wood* derives its origin from the innermost layers of the alburnum, which become successively harder, and are ultimately converted into true wood. The latter is therefore composed of all the circular layers situated between the alburnum and the medullary tube. At a certain period of the life of the vegetable, there are formed each year a layer of wood and a layer of alburnum ; in other words, the innermost layer of the alburnum is converted into wood in proportion as a new layer of alburnum is produced at the outside, so that every year a new concentric band is added to those previously existing.

The wood is generally the hardest part of the trunk; but its hardness is not the same in all the layers of which it is composed. In dicotyledonous trees, the innermost layers, which are also the oldest, are more solid and more compact than the outer, which generally approach the alburnum in these respects. The transition from wood to alburnum is, in most cases, hardly perceptible, their colour being commonly the same; but sometimes the difference is very decided, as we have already remarked with reference to Ebony and Logwood.

A not less remarkable difference between wood and alburnum exists in the circumstance that the latter is entirely destitute of vessels, while they are distinctly perceived in the wood. The vessels of the wood are false tracheæ and porous vessels, but never true tracheæ or true spiral vessels. By means of these tubes, which are sometimes dispersed without order in the substance of the wood, and sometimes collected into bundles, the sap is conveyed into the substance of the trunk. But a period arrives when, through the progress of age, the walls of these vessels become thickened, their cavity diminishes, and at length even disappears, and the course of the fluids is for ever arrested in the woody substance.

Duhamel very clearly demonstrated the transformation of the alburnum into wood. He passed a silver wire into the layers of alburnum, brought its two extremities out, and tied them. Some years after, having cut the branch, and examined the wires which he had passed into the alburnum, he found them engaged in the wood, which proved that the alburnum had been converted into wood.

7. *Of the Medullary Tube.*

The *Medullary Tube*, as we have already said, occupies the centre of the stem, lining the innermost layer of the wood, and containing the pith. Its walls are formed of very long parallel vessels, longitudinally disposed. These vessels are tracheæ, false tracheæ, and porous vessels. It is in the medullary tube alone that the tracheæ have as yet been observed. The form of this part is not the same in all vegetables, it being pretty frequently roundish in its transverse section, sometimes elliptical, compressed, with three, four, five, or more angles Its form, as has been shewn by Palisot de Beauvois, appears to be determined by the position of the leaves upon the branches. Thus, when the leaves are opposite, the transverse section of the medullary canal is elliptical, as in the Ash; if they are verticillate in threes, it is triangular, as is observed in the Rose-bay, and so forth. This law is far from being general, however, but presents numerous exceptions. Thus the *Hortensia*, which has opposite leaves, has a regularly hexagonal medullary tube.

The medullary tube, once formed, no longer changes its figure and dimensions, but remains the same during the whole life of the vegetable. It is therefore erroneous to say that it gradually contracts upon itself, and at length disappears, as the plant grows old. It was M. Du Petit Thouars who first proved that the medullary canal undergoes no change.

8. *Of the Pith.*

The *Pith* or *Inner Medulla*, is the loose, transparent, light, and spongy substance, formed almost entirely of cellular tissue, in its most simple state, which fills the medullary tube. A few vessels seem to run through it in the longitudinal direction. Its cellules are generally very regular. Like those of the cellular tissue in other parts, they all communicate with each other. Sometimes, and especially in young branches and herbaceous plants, the cellular tissue of the pith is abundantly supplied with fluids, and filled with granulations of a green colour, as may be seen on breaking a branch of Elder, one year old, in which the pith presents the appearance of a green and very moist fleshy body. But, in the progress of vegetation, all these substances, which are in a manner foreign to the proper nature of the pith, disappear, and there remains in the medullary tube nothing but a transparent tissue.

In some vegetables, as the stem grows, the medullary canal becomes in part, and sometimes altogether empty, the whole pith finally disappears, and the stem becomes hollow or fistulous. This is observed, for example, in many plants of the family of Umbelliferæ.

The pith communicates with the cellular and herbaceous layer of the bark by means of peculiar prolongations, which it sends through the woody body. To these prolongations, which are disposed, in a transverse section of the trunk, like rays diverging from the centre to the circumference, the names of *insertions*, *medullary prolongations*, or *medullary rays*, have been given. They establish a direct communication between the pith and the external cellular tissue of the stem.

The medullary rays are also to be found in the greater part of the thickness of the bark, since they serve to establish a communication between the internal medulla and the external medulla; but those of the bark have not a direct communication with those of the woody layers.

Professor Amici has found them to be formed of small porous tubes, transversely placed, which never contain any thing but air, and establish a communication between the internal and external parts of the plant.

If we now inquire into the uses of the pith, we shall find that there have been very different opinions on the subject. Thus, according to the celebrated Hales, it is the essential organ of vegetation. Being elastic and dilatable, it acts, in the manner of a spring, upon the other parts, which it thus urges onwards in their development. Others, again, consider it as a totally inert body. Of late M. Du Trochet has revived the opinion of Hales, and made it perform a very important part in the phenomena of the growth of vegetables. We shall soon revert to this opinion.

Such are the various organs which we find on analyzing the stem of dicotyledonous vegetables. All these parts, however, are far from being, in every case, united and visible in the same plant. Sometimes they are so confounded with each other, that it is impossible to distinguish and separate them. But, when the most complicated structure of a part is known, it becomes easy to imagine the organs which, in certain cases, may happen to be wanting.

We have now to institute a comparative examination of the structure of the stem of the monocotyledones, in order subsequently to explain the mode of development and growth peculiar to each of these two great divisions of the vegetable kingdom.

Sect. II.—Organization of the Stem of the Monocotyledones.

M. Desfontaines was the first who confirmed the great division of phanerogamic vegetables into Monocotyledones and Dicotyledones, by the anatomical structure of their stem, which is so different in these two classes. It was he, in fact, who first made known, in an excellent paper inserted in the first volume of the Memoirs of the Institute of France, the true organization of the monocotyledonous stem, and the differences by which it is distinguished from that of the dicotyledones.

In general, the stem of the monocotyledones is more lengthened and more simple than that of the dicotyledonous trees. It is very seldom that it divides into branches, like that which we have just examined.

The stipe of a monocotyledonous tree, of a Palm, for example, when cut across, does not, like the trunk of an Oak, an Elm, or any other of our forest trees, present a regular and symmetrical aspect; circular zones of wood, alburnum, liber, and bark, always disposed in the same order, and a medullary canal, always occupying the central part of the stem. Here all these parts seem united, or rather confounded together. The pith fills up the whole diameter of the stem; the wood, disposed in longitudinal fasciculi, is in a manner lost, and dispersed, without order, in the midst of the medullary substance. The bark does not always exist; and, when present, is so little distinct from the other parts of the stem, that they might as well be considered as not covered by it. In the dicotyledonous trees, the hardest part is that which is nearest the centre of the stem, because it is formed of the oldest woody layers. The reverse is the case in the monocotyledonous trees, the part nearest the circumference being found in them to possess the greatest solidity. In the dicotyledonous trees, in fact, the oldest layers are at the centre; while, in the monocotyledonous trees, they occupy the circumference This will be easily understood, when we shall have explained the peculiar manner in which the stem of the monocotyledonous trees grows. The woody fasciculi of the stem, which frequently unite together by their lateral parts, so as to form a more or less regular network, are, as in the dicotyledones, accompanied by porous vessels, tracheæ, and false tracheæ, destined to convey the sap, and other nutritious fluids, to all parts of the stem.

Thus, then, the monocotyledonous trees are distinguished from the dicotyledonous trees, not only by the structure of their embryo, but also by that of their stem. In fact, their stipe, which is generally simple and cylindrical, does not, like the trunk of the Oaks and Elms, present layers of wood enclosing each other, and disposed regularly around a central canal containing the pith; but the pith in a manner forms the whole thickness of their trunk; and the woody fibres, instead of being collected and brought close to each other, are separated, and have their fasciculi scattered in the midst of the spongy substance of the pith. When we come to treat, in the third section, of the growth and development of the stems, we hope to prove that the organ which, in the monocotyledones, is named woody, and especially in the Palms, Dracænæ, Yuccæ, &c. is not a true stem, but an entirely different organ.

Fig. 26.

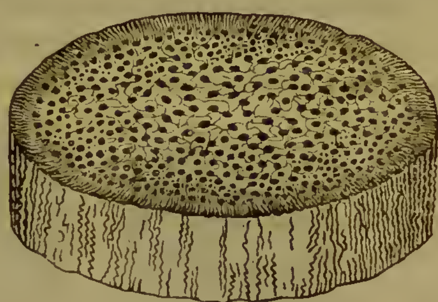

Fig. 27.

Fig. 27. represents a section of a monocotyledonous stem, in which the vascular apertures are seen in the midst of a cellular or parenchymatous substance, which occupies the whole diameter. There is no appearance of woody layers, as in Fig. 26, which represents a dicotyledonous stem. The cellular tissue becomes more condensed, and the apertures smaller, towards the circumference of the stem.

[It has been judged expedient to add a few words respecting the organization of the monocotyledonous and dicotyledonous stems. Without reference to the general character of the plants belonging to these classes, and comparing the stems of different woody vegetables, we might arrange them under three principal divisions.

I. The stems of the true Dicotyledones, such as the Oak, the Ash, the Elm (Fig. 28.), in a transverse section present a central circular mass of cellular tissue, the pith, around which are arranged a series of layers, of greater or less breadth, according to the species, and in variable number, according to the age of the individual. From the central cellular tissue proceed a number of lines running to the circumference, and named *insertions* or *medullary rays.* Between these lines the woody texture appears in the form of series of more or less hexagonal cells, interspersed in which are larger roundish or oval apertures.

II. The stem of the Coniferæ, such as the Pines, Firs, Larches, Junipers, the Yew, &c. (Fig. 29.), in a transverse section present a central pith like the former, around which are disposed similar layers. There are medullary rays also; but the hexagonal apertures fill up their intervals in

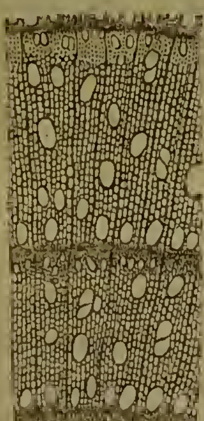

Fig. 28.

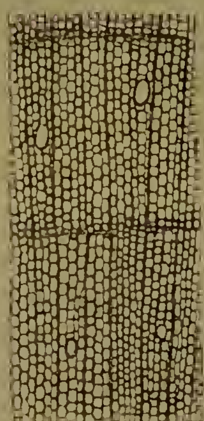

Fig. 29.

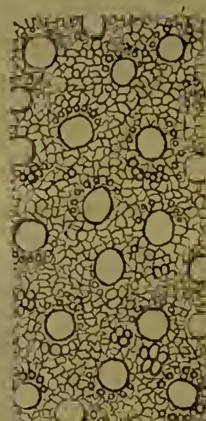

Fig. 30.

regular series, there being none of the larger apertures seen in the true dicotyledonous stems. Sometimes, however, there are a few scattered vacuities of an irregular form.

III. The stems of the monocotyledonous plants, such as the Sugar Cane, Palms, &c. (Fig. 30.), present in a transverse section a cellular mass, without central pith, layers, or medullary rays, in which are interspersed large roundish apertures, generally accompanied with smaller ones, either margining the larger or irregularly scattered in the cellular tissue.

In fistulous woody stems of the monocotyledonous plants, such as Reeds and Canes, the structure is similar to that last mentioned; but the central part is absent.

For a fuller exhibition of these varieties of woody stems, see Mr Witham's Observations on Fossil Vegetables.—Tr.]

Sect. III.—Of the organization of the root.

Now that the internal structure of the different kinds of stem is known, it will be more easy for us to examine that which the roots present. The roots are generally organized like the stems. Thus in dicotyledonous trees, a transverse section of the roots presents concentric zones of wood disposed in a circular form, and enclosed one within the other. It has been said that the best distinction between the stem and the root, is found in the circumstance that the latter is destitute of a medullary canal; while, on the contrary, we know that it always exists in dicotyledonous trees. From this it necessarily follows, that the medullary insertions are also wanting in the roots.

This difference, however, appears to us of little importance, and even entirely at variance with facts. Indeed we have found, in a great number of vegetables, that the medullary canal of the stem is prolonged, without any interruption, into the body of the root. If, for example, the stem and root of a Horse-chestnut, of two years old, be split in the longitudinal direction, the medullary canal of the stem will be seen extending to the lowest part of the root. We find the same appearances if we examine a young plant of Sycamore or Maple. But very frequently, the medullary canal, which was very distinct in the plant soon after germination, ultimately diminishes, and even gradually disappears as vegetation goes on; so that, in the adult plant, it is no longer to be seen. There results from this, that we cannot assume as a distinctive anatomical character between the stem and the root, the want of a medullary canal in the latter, since it almost always exists in the radicle of the germinating seed, and often in the root of many vegetables, long after the first period of their life. The tapering roots, however, never present it in their ramifications, even in those which are the largest.

Until lately, the want of tracheæ in the root had been considered as affording a distinctive character between the anatomical structure of the root and that of the stem; but two of the German naturalists who have made the most important observations in vegetable anatomy, MM. Link and Treviranus, have found these vessels in the root of certain plants. Still more recently, M. Amici has unrolled tracheæ in the roots of several plants, and among others of *Agapanthus umbellatus* and *Crinum erubescens*.

The difference which we have seen to exist in the organization of the trunk of the dicotyledones and of the stipe of the monocotyledones, is equally observed in their roots. In fact, in the monocotyledones a vertical root is never found forming a continuation of the stem. This disposition is a consequence of the mode of development of the seed at the epoch of germination, since, as we shall see more particularly when we speak of that function, the central and principal radicle is always destroyed soon after germination.

There is another very remarkable difference between roots and stems. The latter, in general, grow in height by every portion of their extent, while the roots are elongated at their extremity only. This was demonstrated by Duhamel's experiments. If little marks, at some distance from each other, an inch, for example, are made in a young stem, at the moment of its development, it will be seen, when the growth is terminated, that the spaces between these marks have been greatly enlarged. If the experiment be repeated on the roots, it will be found that the spaces remain unaltered, while the root itself has been elongated, which proves that the increase in length has taken place by its extremity only.

Sect. IV.—General considerations respecting the growth of vegetables, and particularly respecting the development of the stem.

All bodies in nature have a tendency to grow. This law applies to inorganic bodies as well as to organized beings. But growth presents many striking differences in these two primary groups of natural objects. In minerals it has no determinate limits. These bodies grow continually, until some fortuitous cause puts an end to their development. Animals and vegetables having, in general, an existence whose duration is determinate, their growth is always proportional to the duration of their existence. In minerals, new particles are added externally to those which already existed, and which formed the original nucleus; so that the surface of these bodies is renewed each moment, and in proportion as their volume augments. On this account, the peculiar mode of growth in bodies that are not possessed of life, is named *juxta-position.* On the contrary, if growth be examined in bodies possessed of organization, it will be seen that it takes place from the interior towards the exterior—that there is an elongation of previously existing parts, or that new organs are formed in the interior of the first, and are developed in all directions, to augment the mass and the volume of the body. This mode of growth, which is peculiar to animals and vegetables, is named *intus-susception.*

Growth presents differences not less striking, when we compare vegetables and animals together. In the former, the growth is not confined within limits so rigorously determined as in the latter. Neither the volume of the body, nor the number of its constituent parts, are fixed. Art and cultivation may exercise the greatest influence upon the development of vegetables. To be convinced of this, it is only necessary to compare together two trees of the same species, one of which lives neglected in a dry and rocky soil, while the other is cultivated in a rich and deep soil. The first is small, with short branches and narrow leaves; the other, on the contrary, majestically rears its trunk, crowned with long and vigorous branches, and adorned with thick foliage. In animals, the volume and general form of the body, and the number of the parts which are to enter into its constitution, are more fixed and less subject to variation; while, in vegetables, it is almost impossible to find two individuals of the same species that present an equal number of parts.

If we now wish to examine the phenomena of growth in vegetables, we find that they are developed in two directions; in other words, in proportion as their height increases, their diameter is also extended. When speaking of the organization of the stem, we saw that dicotyledonous trees and monocotyledonous trees are far from having the same internal structure, and that very decided differences exist between them. These differences evidently depend upon the peculiar mode in which the vegetables of these two great classes are developed. We shall therefore treat of the growth of monocotyledonous trees, and of that of dicotyledonous trees separately.

This is undeniably one of the most interesting parts of vegetable physiology, but it is one of those that are as yet involved in the greatest obscurity and uncertainty. In fact authors, especially for a certain number of years back, are far from being agreed as to the manner of explaining the phenomena of the growth of the stem, especially in dicotyledonous trees. On this subject there are even opinions so opposed to each other, that we find it necessary to state them separately.

1. *GROWTH OF THE STEM OF DICOTYLEDONOUS TREES.*

A. *Growth in Diameter.*

All vegetables grow in diameter. It is sufficient to cast our eyes on the trees which vegetate around us, to be convinced of this truth; nor has any person ever denied it. But by what mechanism is this growth effected? On this point there is the greatest disagreement. Of the different opinions which have been advanced by physiologists, we shall select the three most important, which are these:— 1. Growth is effected by the annual transformation of liber into alburnum; 2. By the development of buds; 3. By the cambium, which every year forms a distinct layer of liber and alburnum. These opinions we now proceed to expose at some length.

1. *The growth in diameter is effected, in dicotyledonous trees, by the annual transformation of the liber into alburnum, of the alburnum into wood, and by the successive renewal of the liber.*

Such is the foundation of Duhamel's theory, which that celebrated author has given at length in his *Physique des Arbres.* We shall present it in detail, because it is the most generally adopted, and almost the only one that, for a long time, has been publicly taught, at least in France.

We shall take the stem at the period of its first development, that is when, in consequence of germination, it emerges from the seed which contained it, and begins to appear externally.

All parts of the vegetable that are contained in the seed, previous to germination, are formed exclusively of a dense and regular cellular tissue. The stem, like the other organs, is found to be entirely destitute of vessels. Properly speaking, there are perceived no traces of bark, pith, liber,

&c. But scarcely has germination commenced—scarcely has the stem begun to shoot up, when we see tracheæ, false tracheæ, and porous vessels forming, and by their union constituting, the walls of the medullary tube. This internal part of the stem is the first that is apparent and becomes organized. The pith is contained within it; but it is as yet green, and filled with watery fluids. The outer surface of the medullary tube is soon observed to become covered with a fluid cellular tissue. This is the first layer of cambium, which, on the one hand, at length forms the first liber, and, on the other, constitutes the cortical layers. This liber is presently to be converted into alburnum, in proportion as a new layer becomes organized to replace the first. The following year, the new liber forms a second zone of alburnum, and thus successively, each year, a layer of alburnum is converted into true wood, while the liber itself acquires the properties and nature of alburnum. This regular development of the stem explains the formation of the concentric layers or zones which are observed on a transverse section of the stem of a dicotyledonous tree. But these layers are not all of the same thickness, and frequently the thickness is not equal in the whole circumference of the same layer. An attentive observation easily explains this singular disposition. It has been remarked, in fact, that the greatest thickness of the woody layers always corresponds to the side on which the largest roots are found, and which have consequently extracted a more abundant nutriment from the earth. Thus, for example, trees that are situated on the edge of a wood always have thicker woody layers on their outer side, because the roots, meeting no obstacles in that direction, extend themselves farther than in any other, and acquire a larger size.

In this theory of Duhamel's, we see that the liber performs the most important part in the formation of the woody layers, it being each successive year converted into a new layer of alburnum, which is added to those previously existing.

The liber being the essential organ of vegetation, and changing its form and consistence each year, it was necessary that nature should also have provided means for reproducing it annually. This, in fact, is the case. If we examine attentively the successive development of the different organs which compose the stem of the dicotyledones, we see that, in the first year, a gelatinous fluid, to which Grew and Duhamel have given the name of *cambium*, occurs between the cortical layers and the medullary tube. This peculiar fluid contains the first rudiments of organization. In proportion as the young stem is developed, the innermost layer of this fluid acquires consistence, is organized, becomes hardened, and changes into liber, which, at the end of the first year, is found to be converted into a yet soft and ill-formed woody substance. Autumn arrives, and vegetation is arrested in this state. The outer layer of the cambium, which has not yet entirely changed its nature, remains stationary, and as it were torpid. But, at the return of spring, when the gentle heat of the sun awakens vegetables from their winter's sleep, the cambium resumes its vegetative power. It developes the buds and the new roots, and, when it has produced all the parts that are to serve for supporting the life of the vegetable, it gradually hardens, becomes compact, and, in a word, undergoes the same changes as that which preceded it. But, in proportion as these changes are effected, as the liber hardens and changes its nature, as the layer which it has replaced acquires greater solidity, a new liber is developed. From all parts of the outer surface of that which is ready to be converted into wood, there exudes a viscid humour, under the form of small drops, which spread and unite. This is a new cambium, a new liber, which is about to be organized, and to pass through the different epochs of growth that have been gone through by those which have preceded it, and from which it has derived its origin.

Such are the means which nature employs for renewing each year successively the vegetating part of the stem. It is here that the greatest difference between woody stems and herbaceous stems presents itself. In woody stems, it is to the successive development of a new layer of liber that the tree owes its duration and the continuance of its vegetation. In herbaceous stems, on the contrary, all the cambium is consumed in producing the different organs of the plant, and at the end of the year it is found to be entirely converted into a kind of ligniform, dry and arid substance. There does not, therefore, remain, as in the woody stem, a certain quantity of gelatinous matter, to which is confided the charge of preserving, from year to year, the germs of a new vegetation, and the plant necessarily dies, for want of a substance qualified to renew its development.

Having thus given a pretty full account of the theory of the formation of woody layers by means of the annual transformation of the liber into alburnum, we shall next make known the theory which has been proposed by M. Du Petit-Thouars, and which, to many physiologists, has formed a subject of so much dispute.

2. *The successive formation of the woody layers, in other words, the growth in diameter, is produced by the development of the buds.*

In Duhamel's theory, the liber performs the principal part in the phenomena of the growth in diameter; but here the buds are the most important instruments in that operation. M. Du Petit-Thouars having remarked that the buds are seated upon the external parenchyma, and that their fibres communicate with those of the scions or young branches which support them, has drawn from these circumstances the following conclusions, which form the basis of his theory of vegetable organization.

1*st*, Buds are the first perceptible phenomena of vegetation. In fact, all the parts which in vegetables are to be developed at the exterior, are at first contained in buds. There is one in the axilla of every leaf; but this bud is apparent in dicotyledonous plants only, and, among the monocotyledones, in the single family of the Gramineæ. In the other monocotyledones, the bud is latent, and consists merely of a vital point, which, in certain circumstances, is susceptible of being developed in the manner of the buds of dicotyledonous plants.

2*dly*, By their development, buds give rise to scions or young branches, which are furnished with leaves, and most commonly with flowers. Each bud has an existence in some measure independent of that of the other buds. M. Du Petit-Thouars considers them as analogous in their structure and development to the embryos contained in the interior of seeds, which, through the act of germination, develope a young stem, that may, with justice, be compared to the scion produced by the evolution of a bud. Accordingly, he has given the name of *fixed* or adherent embryos to the latter, in opposition to that of *free* embryos, which he applies to those contained in the interior of the seed.

3*dly*, If we examine the interior of these buds on a scion or young branch of the year, we shall find that they communicate directly with the internal parenchyma or pith. Now, this pith, as we have already said, is at first green, and its cellules are filled with an abundance of aqueous fluids. It is from these aqueous fluids that the buds derive the first materials for their development. They are thus nourished at the expense of the internal parenchyma, and, by absorbing the fluids which it contains, dry it up, and convert it into pith properly so called, which is more or less opaque or transparent.

4thly, As soon as these buds make their appearance, they obey two general motions, the one ascending or aërial, the other descending or terrostrial. It is here that M. Du Petit-Thouars finds a similarity in tho structure and uses of buds to those of tho seed-embryos. He considers buds in some measure as germinating embryos. The layer of cambium situated between the bark and the wood is, with respect to the bud, analogous to the soil in which the seed begins to germinate. Its aërial evolution gives rise to a scion, or young branch; while from its base, that is, from the point by which it adheres to the parent plant, proceed fibres, which the author compares to the radicle of the embryo, and which, gliding along in the moist layer of cambium, between the liber and alburnum, descend to the lower part of the vegetable. Now, in their course downwards, theso fibres meet those which descend from other buds, unite with them, anastomose together, and thus form a more or less thick layer, which acquires consistence and solidity, and forms each succeeding year a new woody layer. The liber, when once formed, does not change its nature, and undergoes no transformation.

This theory is extremely ingenious, and M. Du Petit-Thouars adduces several facts in proof of its accuracy. Thus, he says, whon a strong circular ligature is applied to the trunk of a dicotyledonous treo, a swelling or rim is formed above the obstacle, and no growth in diameter takes place below the ligature. This swelling is formed by the woody fibres which descend from the base of the buds, running in the cambium situated between the liber and alburnum. These woody fibres meet an obstacle which they are unable to surmount, are stopped and accumulate there. Henceforth no new woody layers can be formed beneath the ligature, as the fibres of which they are formed cease to arrive there. Such is the explanation given by M. Du Petit-Thouars of the phenomena presented after the application of a ligature, which most authors account for in quite a different manner.

M. Du Petit-Thouars farther adduces, in support of his theory, the phenomena exhibited in consequence of the act of grafting. In grafting by *inoculation*, it is usual to take a bud which is yet stationary, and apply its base to the layer of cambium which has been laid bare. After this the radicles or fibres which proceed from the base of the bud, glide between the bark and alburnum, and the new stock is thus identified with that on which it has been grafted.

I have seen with M. Du Petit-Thouars a very valuable preparation, which seems to furnish a very strong argument in favour of his theory, and of which he has given an excellent figure in a collection of memoirs that has been printed, but, I believe, not yet published. It is a branch of *Robinia pseudacacia*, on which has been grafted a young scion of *Robinia hispida*. The stock died, but the graft having continued to vegetate, there is seen proceeding from its base a mass formed of very distinct fibres, which embrace the extremity of the branch to a considerable extent, and form a kind of sheath for it. In this example, it is perfectly clear that the fibres descend from the base of the graft to spread over the stock.

Notwithstanding all the arguments brought forward by the author in defence of his theory, it has not as yet been entirely adopted by any physiologist. On the contrary, almost all authors who treat of vegetable physics have in some degree opposed it. The principal arguments that have been brought against it are the following: 1*st*, It has been said that there is no incontrovertible proof that the fibres which establish a communication between the buds and the stems which support them, descend in the manner alleged from these buds to the roots. To this, however, M. Du Petit-Thouars replies, that the buds are indeed the source, the first origin, of the woody fibres, but that they do not furnish all the materials of the elongation of these fibres; for when the latter have once emerged from the base of the buds, they are found to be immersed in the cambium, where they absorb all that is necessary for their growth. 2*dly*, It has been objected that the phenomena of the circular swelling which forms after a ligature has been applied to the trunk, may be accounted for by the interception and stagnation of the descending sap. But, says M. Du Petit-Thouars, the experiment of Hales, which was confirmed by Duhamel, affords a refutation of this objection: Two cylinders of bark having been completely insulated by the removal of three rings, one of the cylinders being furnished with a bud, while the other had none, the result was that a circular swelling formed on the first cylinder only, thus affording an evident proof that the buds give rise to the woody fibres. 3*dly*, It is impossible to conceive how fibres so slender as those which unite the buds to the stems could, in a space of time so short as that during which the stem grows in diameter, descend, by their proper weight, from the summit of a tree sixty or eighty feet high to its base. As the opinion of the learned academician is not that the fibres issue and descend ready formed from the base of the buds, but, on the contrary, that they form as they pass through the layers of cambium, this objection requires no refutation. 4*thly*, That, since the woody layers are formed of the fibres which descend from the base of the buds, if, in grafting by inoculation, a bud taken from a tree having coloured wood, is grafted upon an individual having white wood, the fibres which proceed from this bud ought to retain their colour, and the new woody layers which they form ought to be similarly coloured; but this is not the case. This objection, which has been considered as one of the strongest that have been adduced, our author finds little difficulty in refuting, it having originated in a misconception of the author's opinion. In fact, as M. Du Petit-Thouars has constantly stated, the fibres coming from the base of the bud are nourished by the cambium of the branch at whose surface they are formed. Now, in the case of grafting with two trees, the wood of which is differently coloured, so long as the new fibres are immersed in the cambium of the piece that has coloured wood, they retain their natural tint; but, when they are formed at the expense of the cambium of the piece that has white wood, they assume the same colour. *5thly*, If it be the development of the buds that gives rise to the formation of the wood, how can the first woody layer itself form on a young shoot of the first year, when as yet none of the buds which it supports have been developed? According to the celebrated academician whose theory we are here explaining, at the moment when a bud is developed to form a scion, the leaves which compose it separate from each other, leaving between them spaces which have been named *merithalli*. If at this period we examine the internal structure of the young shoot, we see that from the base of each leaf there proceeds a bundle of fibres, which, by joining those from the other leaves, forms the medullary tube; but as these leaves become developed, there appears in the axilla of each of them a bud, which subsequently tends to establish its radical communication, by shooting forth woody fibres, which gradually cover the medullary tube, and form a continuous layer around it.

The two theories which we have just stated cannot then be adopted in all their parts, as affording a satisfactory explanation of all the phenomena of the growth of vegetables in diameter. In fact, that of Duhamel is essentially founded upon the annual transformation of the liber into alburnum, and its reproduction by means of the layer of cambium. The experiment by which that celebrated naturalist having passed a silver wire into the liber, found it the following year in the alburnum, is altogether incorrect. In fact, none of those who have repeated the experiment after Duhamel have obtained the same result; and when the silver wire had actually been passed through the liber, it was always found again in that organ, and not in the alburnum. This theory must therefore of necessity fall, if we sap the foundation on which its author raised it. The following is the explanation which appears to us to agree best with facts.

3. *The annual formation of woody layers is owing to the cambium, which every successive year forms at once a new layer of alburnum and a new layer of liber.*

This is the opinion which M. Mirbel has latterly professed, and which appears to us to have the greatest number of probabilities in its favour.

The liber which has hitherto been considered as the most essential organ of vegetation, that which contributes each year to the increase in diameter of the trunk of dicotyledonous trees, being, on the contrary, neutral and passive in this operation, another explanation of the phenomena of growth in diameter must be sought for. The following, then, is that which appears to us the most probable, and the most conformable to the strict observation of facts. If we examine a young branch at the period of vegetation, that is, when the sap circulates abundantly in all parts of the vegetable, we find the following appearances:—Between the liber and alburnum is seen a layer of a fluid, which, at first colourless and limpid, gradually thickens, and acquires consistence. This fluid, the *cambium*, is formed by the descending sap, mixed with part of the proper juices of the vegetable. As the cambium thickens, filaments are seen to form in its interior, and it is presently organized, and assumes the appearance of a vegetable tissue. This transformation is gradual, and continues during the whole period of the development of the buds, so that the formation of the annual layer takes place in a slow and progressive manner.

It is for this reason that the new layers of alburnum very frequently present several concentric zones, which show that their whole thickness has not been formed at once.

Thus, then, the alburnum is not formed by the liber, which thickens and acquires more consistence, but by the cambium, which is organized, and thus becomes the agent of growth in diameter, giving rise each successive year to the formation of a layer of alburnum and a layer of liber, both distinct from each other, although deriving their origin from the same organ. When Duhamel found in the alburnum the silver wire which he thought he had inserted in the liber, it was because he had passed the wire through the organic layer of the cambium.

It also follows from this, that the liber increases every year in thickness, by its inner surface. In fact, the layer of cambium, which bathes its inner surface, becomes organized, and is added to the liber, so that the latter gradually becomes thicker. It is on this account that the liber is found to be formed of several laminæ or folia, which are connected with each other by an excessively thin layer of cellular tissue.

In this manner, then, a new woody layer is formed each year in the trunk of dicotyledonous trees. This new layer is produced by a part of the cambium, which is organized and becomes solid. The alburnum formed the preceding year acquires more density, and changes into wood. But the liber undergoes no transformation; only it is renewed and increased at its inner surface by means of a part of the cambium, which successively forms new laminæ. It is by this mechanism, in our opinion, that the growth in thickness of the stems of dicotyledonous trees is effected. We shall now explain their development in height.

B. *Growth in height.*

At the period of germination, the radicle sinks into the ground, while the ascending caudex shoots upwards. The first layer of cambium becomes organized, and obeys this impulse. Towards autumn, when it is organized into alburnum and liber, its growth stops. When, at the return of spring, vegetation recommences, the vegetable tissue is gorged with nutritious fluids, which vivify the buds. From the upper part of the stem proceeds a new centre of vegetation, from which rises a new shoot, which in its development exhibits the same phenomena as the first. To this second shoot succeeds a third, which the following year is surmounted by a fourth, and so on.

The trunk is therefore found to be formed by a series of very elongated cones, superimposed upon each other, and having their apex directed upwards. But the apex of the innermost cone stops at the base of the second shoot, that of the next cone at the base of the third shoot, and so on successively, it being only at the base of the trunk that the number of woody layers corresponds to the number of years of the plant. Thus, for example, a stem of ten years has ten woody layers at its base, but presents only nine at the height of the second shoot, eight at the third, and finally only one at the top. It is for this reason that the trunk of dicotyledonous trees is more or less conical, the number of its woody layers becoming gradually less, as they ascend from the base to the summit.

There are trees in which this growth in height is very manifest; in Pines and Firs, for example. At the end of the first year, there is seen at the top of the stem a conical bud, from which proceeds a whorl of young branches, at the centre of which is one that rises vertically. It is this branch which is destined to continue the stem. At the end of the second year, there proceeds from its summit a similar bud, which, in its development, presents the same phenomena. Thus the age of these trees may be known by the number of whorls of branches which they have on their stem.

2. GROWTH OF THE STEM OF MONOCOTYLEDONOUS TREES.

If we examine the growth of the stipe of a Palm, we find that it takes place in the following manner:—After germination, the leaves, which are generally folded upon themselves, become expanded, and form a circular bundle, which arises from the neck of the root. From the centre of this bundle there issues, the second year, another tuft of leaves, which push outwards those previously existing. Then the oldest fade, dry, and fall off; but their bases, being intimately adherent to the summit of the root, remain without withering; and, by uniting, form a solid ring which becomes the base of the stipe. A new central bud being developed every year, the outermost leaves of that which preceded it, fall of, and their persistent base forms a new ring, which is added above those that already existed.

Such is the development of the stem of monocotyledonous plants. Their stipe, in place of being formed of concentric layers, like the trunk of the dicotyledones, is composed of rings placed one above another. From this it will be seen, that the trunk of the monocotyledones can grow but very little in thickness. In fact, its lateral development can take place only inasmuch as the persistent base of the leaves is not yet sufficiently solidified and hardened to resist the excentric pressure which the bud tends to exercise upon it. Accordingly, we see that the Palms, which sometimes shoot up to a height of 120 or 140 feet, have a stem which is often scarcely a foot in diameter.

In dicotyledonous trees, the cambium is the essential agent by which the enlargement of the stem is effected, as it every year becomes organized, and forms a new woody layer. Here, on the contrary, it is the terminal bud which crowns the stipe that performs this office; and, were this centre of vegetation removed, the tree would inevitably perish.

If we compare, in a general way, the growth in diameter of the stem of dicotyledonous trees and that of the monocotyledones, we shall find that it differs not less than their anatomical structure. In fact, in the dicotyledones there are two distinct systems, the *central system*, formed of the medullary tube and the woody layers, and the *cortical system*, which is composed of the bark. These two systems enlarge separately, so that there are two surfaces of growth in this class of vegetables. The central system increases by the new layers which are added to its outer surface, and the cortical system increases by its inner surface.

In monocotyledonous vegetables, on the contrary, there is but a single surface of growth, and consequently but a single system. M. Them. Lestiboudois, a professor of Lille, remarking, and justly, that, in this single system, which forms the stem of the monocotyledones, the growth takes place by the inner surface, draws from this circumstance the inference that the system which exists in these plants, is the cortical, and that the central system is wanting: whence it follows that the stipe of the Palms is organized like the bark of the dicotyledones.

From these different considerations, it may be seen, that the stipe of Palms, and other woody monocotyledonous vegetables, differs essentially, both in its organization and in its mode of development, from the trunk of dicotyledonous vegetables. If we extend this observation farther, it will be seen that the stipe differs so much from the trunk, in its origin and mode of development, that it is not surprising that its internal organization, which is merely the result of this mode of development, should differ so much from that of the woody stem of dicotyledonous plants. For, let it be recollected, how the stem of an Oak, or any other dicotyledonous vegetable is formed and grows:—the seed germinates; the radicle descends into the ground; the little stem, or the organ which represents it, in other words, which serves as a support to the gemmule, and raises it above the base of the radicle, ascends. In short, at this early period of the life of the plant, the organ which is to constitute the stem already exists under the form of a more or less elongated cylinder, composed internally of a cellular tissue, which represents the medulla, and externally of tubes or fibres, which constitute the first rudiments of the wood, the bark, and in general all the filamentous parts of the stem. Let us now examine a Palm-seed at the period of germination. Its radicular extremity elongates more or less, bursts at its summit, to permit the escape of the radicle, which was previously imprisoned in a kind of closed bag, named the *coleorhiza*, which it tears in order to penetrate into the ground, and become the root. The opposite extremity to the radicle, in other words, the cotyledon, assumes a slight development, but is presently seen to split on one of its sides, beneath its summit; and through this slit or rupture, issues a variable number of leaves, at first embracing each other. But in this embryo of the Palm, we see no rudiment of the stem, as in the embryo of the Oak, Lime, Pine, and other dicotyledones. The organ to which that name is ultimately given, has to be gradually formed at the expense of another organ. In fact, as we have already explained, the bases of the leaves which are successively developed, becoming closer to each other, in consequence of the pressure exerted upon the outermost, in proportion as new ones are developed within, adhere together, and ultimately form a kind of fleshy platform, composed of cellular tissue, and traversed by scattered fibres. What is called the stipe or trunk in the Palm, is therefore an organ composed of a great number of scales, which are only the bases of leaves more or less united together, and presenting at their interior a central and terminal bud, which is its essentially vegetating organ. Thus, then, the stipe of a Palm is not really a stem, whether we consider it as to its origin and development, or its organization. Let us see whether something of the same nature may not occur in the series of other vegetables. And, in the first place, what is the alleged subterranean stem, commonly named the root in most of the species of the genus Iris? It is a fleshy body, having some longitudinal fibres in its interior, and presenting, at its outer surface, the cicatrices of the scales which compose it. Now, if we follow its development, we find that it owes its formation to the bases of the leaves, which having remained unwithered, while their upper part has been destroyed, have united together and formed the fleshy body, which, in the genus Iris, is commonly designated by the names of Root, Rhizoma, Stock-root, or Subterranean stem. Consequently, this organ, like the stipe of the Palms, is in reality neither a root nor a stem, but a collection of bases of leaves all united into a single mass. A species of Garlic, *Allium senescens*, presents an organ precisely similar, in other words, a more or less fleshy and branched stock. Now, from this stock of *Allium senescens* and the genus *Iris*, there appears to me to be a gradual transition to the solid or scaly bulbs of the *Liliaceæ*. A bulb, in fact, is merely an organ composed of scales, varying in their form and disposition, but always seated on a fleshy platform, and covering a central and terminal bud; while the scales themselves are nothing but leaves, whose base alone is developed, or whose base alone has remained unwithered, while the upper part has been destroyed. If, as we think we have proved to be the case, the subterranean stock of the Irides has the same origin, the same mode of development, and the same organization as the stipe of the Palms; and if, on the other hand, we have demonstrated that, in these respects, there is no perceptible difference between the alleged stock of the Irides and the bulb of most of the Liliaceæ, it appears to us impossible not to draw the conclusion, that the stipe of the Palms, in place of being a stem, is in fact merely a bulb. This opinion might seem paradoxical to a person who should not overlook the general form, the size and duration of the stipe of the Palms, compared with the bulb of other monocotyledonous plants. But if we reflect attentively that these different properties are not essential to the nature of that organ; that they are often wanting in a great number of species; that thus in some the stipe, in place of being long and cylindrical, is short, scarcely perceptible, and sometimes consists merely of a kind of bulbiform enlargement; that, in other species, this stipe, so far from being hard and woody, is soft and fleshy, and is easily penetrated by cutting instruments, these differences, which at first seem so striking, instantly disappear. If, on the other hand, we examine the origin, the mode of formation, and the manner of growth of the stipe compared with those of the bulb, we must conclude that the two organs are essentially the same.

In this manner of viewing the stipe, we can easily account for the circumstance of its being so rarely branched. In fact, it is well known that a branch is never any thing else than the result of the elongation of a bud, generally placed in the axilla of a leaf. Now, in the monocotyledones, these axillar buds are almost always abortive, or remain in the rudimentary state, as in most of the Gramineæ for example. This is also the case in the Palms: their axillar buds generally remain in the rudimentary state, and then the stipe is perfectly simple; but, in certain circumstances, some of these buds receiving more nourishment than the rest, are developed, in other words, the leaves which, being united together at their base, compose them, ultimately form a new stipe proceeding from the first. This is what takes place, for example, in certain species of *Yucca*, in the Doom Palm of Upper Egypt, &c.

To conclude here what relates to the growth of the stem in vegetables, there remains for us to make known the result of the observations recently published by M. Du Trochet, in the *Memoires du Museum*, vols. vii. and viii. Hitherto the growth in diameter was generally admitted as the exclusive result of the new layers which are added every year between the alburnum and bark. M. Du Trochet has proved that vegetables increase in diameter in two directions; 1*st*, In *thickness*, by the formation of new layers between the bark and alburnum; 2*dly*, In *breadth*, by the lateral development of the new layer and the formation of new bundles of fibres. This growth, in the direction of the thickness and breadth, takes place equally in the roots and stems. But we must remark, that Professor Link was the first who, in his Anatomy of Plants, and subsequently in his *Philosophia Botanica*, established the fact that the stem grows not only in the direction of its centre and circumference, but also laterally by the multiplication of the vascular fasciculi. (See Link's *Grundl. d. Anat. f. d. Pfl.* p. 146. f. 58–60).

It was on the stem of *Clematis Vitalba* that M. Du Trochet made his first observations. When the extremity of a young branch of that plant is cut across, it is found to be composed of six fasciculi of longitudinal fibres, separated from each other by medullary rays or spaces of considerable breadth. By degrees, and in the progress of vegetation, there forms at the centre of each medullary space a new fasciculus of longitudinal fibres, which presently acquires the same size as the six original fasciculi, so that, by the end of the first year, the stem is found to be composed of twelve fasciculi of fibres, separated by an equal number of medullary rays.

In the course of the second year, each of the six original bundles is divided into three by the median production of a new fasciculus of longitudinal fibres, separated from the other two, between which it has been developed, by two imperfect medullary rays, which do not reach the central medulla. On the other hand, the six other secondary fasciculi of the first year divide each into two, by the formation in their middle of a new imperfect medullary ray. From this there results, that, at the end of the second year, there are thirty fasciculi of fibres, separated from each other by an equal number of medullary rays or spaces, of which twelve only, viz. those which existed at the end of the first year, are complete, and establish a direct communication between the external and the internal medulla.

If we attend to the manner in which the fasciculi of longitudinal fibres have been multiplied, we shall see that the growth has taken place in a lateral direction. In fact, the median production of new fasciculi of fibres at the centre of the medullary rays, or that of new medullary rays at the centre of the fasciculi of fibres, would necessarily produce a lateral dilatation, and consequently increase the width of the circular layer in which this development had been effected. This lateral dilatation was first perceived by the able experimenter, whose observations we here relate.

The growth in breadth stops in the parts the moment they become solid. Thus it no longer takes place in the woody layers; but it continues in the bark, and it is thus that it allows the woody layers to increase in thickness.

The growth *in breadth* takes place in the roots also, as we have already said; but, in that organ, it always commences by the median production of new medullary rays at the centre of the fasciculi of fibres. Subsequently, these new medullary spaces themselves give rise to other aggregations of fibres.

From what has been said above, it will be seen that the organic elements of vegetables have a natural tendency to the *median production.* Thus the fasciculi of fibres tend to produce new medullary rays in their middle part, and, on the other hand, the medullary rays tend to produce new fasciculi of longitudinal fibres.

Having thus stated M. Du Trochet's opinion respecting the growth in breadth, we now proceed to give an account of his ideas on the development *in thickness.* The woody layers of new formation which are developed each year, are separated from the old layers by a thin layer of central medulla. These layers of medulla, which separate the woody layers from each other, are not always easily perceived; but they are very distinct in some trees, for example in *Rhus typhina*, where their darker colour distinguishes them at first sight from the layers of wood, which are lighter. In spring, the growth in thickness always commences by the formation of this thin layer of cellular or medullary tissue. Soon after, in consequence of the faculty which it possesses of giving rise to longitudinal fibres, this layer of pith produces vessels which surround it, and thus forms a kind of medullary canal, which is destined at a later period to become the new woody layer.

In this theory we see the important function which the author attributes to the pith. It, in fact, becomes the essential agent of the growth in diameter, as it gives rise to the vessels which are subsequently to form the new layer of wood.

The same phenomena take place in the liber. Each of its laminæ is separated by a thin layer of cellular tissue, which belongs to the cortical medulla, and by means of which its annual growth is effected.

Theory of certain processes employed for the Artificial Multiplication of Vegetables, explained by the laws of Vegetable Physiology.

The most natural and most easy means of multiplication in vegetables is undoubtedly by seeds, and it is that by which the vegetables dispersed over the surface of the globe are naturally renewed; but there are others which art frequently employs to perpetuate and multiply certain races or varieties of trees which cannot be propagated by seed. The processes here alluded to, are the propagation by layers, by slips, and by grafts. We shall now state the theory of these three operations, considered in a general manner, and with reference to vegetable physics.

1*st*, Propagating by *layers* is an operation by which the base of a young branch is surrounded with earth, and made to shoot forth roots, before it is separated from the parent stock. Sometimes this operation is performed upon the lower branches of a young shrub, which are bent downwards and covered with earth; and sometimes it is made upon the upper branches, which are made to pass through a vessel filled with peat-earth. To facilitate this process, an incision is generally made at the base of the young branch, or a tight ligature is applied to it, in order to favour the formation of roots. These roots are buds which, on being immersed in earth, become elongated into slender radicular fibres; whereas, if left in the air, they would be developed into young scions. This mode of propagation is employed for many plants, such as Pinks, Hortensiæ, Heaths, Gooseberries, &c.

2*dly*, Propagating by *slips* differs from the preceding method in this respect, that the young branch is separated from the stock previously to its being fixed in the ground. There are trees of which slips take root very readily. In general, those of which the wood is white and light succeed best. Thus a slip of Willow, Poplar, or Lime, on being stuck in the ground, takes root there in a short time, and soon shoots up vigorously. A slip succeeds with more certainty when two or three young buds are left under ground; that is, upon the lower part of it. These buds become elongated into roots, which singularly aid the suction by which the development of the young scions is to be effected. Not unfrequently incisions are made at the base of the slips, or ligatures applied, to facilitate the growth of the roots. Sometimes they are even split longitudinally at their base, and a piece of sponge, soaked in water, is inserted. Some woody species are very difficult to be propagated by slips, such as the genera *Pinus*, *Quercus*, and *Erica*, and in general trees with very dense or resinous wood.

3*dly*, *Grafting* is an operation by which a bud or young scion is inserted upon an individual, and is there developed so as to become identified with the stock on which it has been placed. Grafting can only succeed when it is performed between vegetating parts. Thus, wood cannot be grafted, nor even alburnum. In the operation and phenomena of grafting, the great similarity which exists between buds and seeds, especially with respect to their development, may be remarked. These two organs, in fact, are destined to give rise to new individuals, some of which live at the expense of the stock on which they are developed; while the rest subsist by themselves, and without requiring foreign assistance.

It is to be remarked, that grafting or union of parts can take place only between vegetables of the same species, species of the same genera, or, lastly, genera of the same family; but never between individuals belonging to different natural orders. For example, the Peach may be grafted upon the Almond, the Apricot on the Plum, the Pavia on the Horse-chestnut; but the operation would not succeed between the latter tree, for example, and the Almond, it being necessary that there should be a kind of agreement or similarity between the sap of the two individuals before the union of a graft can be effected.

It is the cambium or proper juice of vegetables that serves as a means of union between the individual and the graft, in the same manner that in animals coagulable lymph is interposed between the two lips of a recent wound, which it brings together and unites. When the wound of a graft is examined about a fortnight after the operation, a thin layer of small greenish granulations dispersed in a viscid fluid is seen between the two parts that have been brought together. These granulations, which are rudiments of vegetable organization, are produced by the cambium, which becomes solidified and organized; and this phenomenon takes place whenever a superficial wound is made upon a tree, provided the contact of air be prevented.

Several advantages are derived from this method of multiplying vegetables. Thus, it is used for perpetuating remarkable varieties or monstrosities, which could not be reproduced by means of seed; for procuring quickly many interesting trees, which are with difficulty multiplied by any other means; for hastening the fructification of certain vegetables by several years; for improving and propagating the varieties of fruit-trees, &c.

The late Professor Thouin published an excellent monograph on grafting, in which he refers all the known methods to the four following kinds: 1. Grafting by approach; 2. Grafting by scions; 3. Grafting by buds; 4. Grafting of herbaceous vegetables. These different kinds of grafting we shall now briefly explain.

1. *Grafting by approach.* This process is performed between two plants growing by the roots, and which it is intended to unite by one or more points. For this purpose, wounds exactly corresponding to each other are made upon the parts which are to be grafted. Plates of bark of equal size are removed, and the wounds thus produced are kept together, and protected from the contact of air, when union takes place between them. By this method, stems, branches, and roots, may be united, and fruits, or even flowers, may be grafted upon leaves.

2. *Grafting by scions.* Grafting by scions is performed with young twigs, or even with roots, which are separated from the parent plant to be placed upon another, in order to live upon it and be developed at its expense. The twigs which are to be grafted are generally separated some days, and in some cases even several months, before the operation is performed, that they may have less sap than the stocks on which they are to be placed. In this case, they are kept alive by immersing their lower extremity in water or in earth.

Before this kind of grafting is performed, the head of the stock on which it is to be practised is commonly cut off. Sometimes the stock is cut close to the ground, especially in trees in which the graft requires to be placed in the earth, as in the Vine, &c. Before this species of grafting can succeed, it is necessary that the liber of the graft should correspond in the greater part of its extent with that of the stock on which it is inserted.

Grafting by scions is managed in several ways. Sometimes the head of the stock is split into two, and the twig to be grafted is inserted in the slit. This kind is known by the name of *cleft-grafting*. Sometimes the bark is separated from the subjacent woody layers, and there are insinuated between them several small twigs, which are disposed in a circular manner. This method is named *crown-grafting*. At other times the trunk of the tree is perforated, and there is fitted to it a young branch, which is kept fixed to it. This method, which is now little employed, bears the name of *wimble-grafting* or *peg-grafting*. Sometimes grafting by scions is practised upon young twigs covered with leaves, flowers, and even young fruits. In this case, it is effected during the full flow of the first sap. By this process, it is not uncommon, M. Thouin says, to obtain fruit from a tree fifteen or twenty years sooner than it would otherwise have produced it. It has even happened, that, in sowing a seed at a particular period, ripe fruit has been obtained from it before the end of the year.

Grafting by scions is also practised without cutting off the head of the stock, a notch being made on one of its sides, to which the graft is applied. This is named *side grafting*, and is principally used for the purpose of repairing the head of a tree which has lost some of its branches.

Lastly, to this section may be referred the grafting which is performed with a scion upon a root left in its place, or with a root upon the root of another stock.

3. *Grafting by buds.* This consists in transferring to another individual a plate of bark to which one or more buds adhere. Of this kind also is scutcheon-grafting, flute-grafting, and other varieties. Bud-grafting is the most generally practised, especially for multiplying fruit-trees,

it being, in fact, more easily and expeditiously performed than any other kind. It is performed in spring, at the time when the sap ascends, or in August. The form to be given to the graft, and that of the incision, vary greatly according to the peculiar mode employed.

4. *Grafting of herbaceous parts of vegetables.* The discovery of this kind of grafting dates from a recent period, there being only a few years since it was for the first time performed by Baron de Tschoudy, after whom the process is commonly named. It may be performed with the young herbaceous shoots of trees, during the full flow of the sap, or with annual plants. In order that this graft may succeed, it must be inserted into the axilla, or into the vicinity of a living leaf of the stock. This leaf serves to draw the sap into the graft, and to facilitate its union and development. The methods employed are much the same as for the other kinds of grafting.

Such are the different kinds of grafting employed for the multiplication of vegetables. It does not properly belong to our subject to describe the numerous and diversified processes used in their practice; and, on this subject, we refer to the treatises on agriculture, and in particular to the Monograph published in 1822 by Professor Thouin.

Of the Height of Trees.

Trees are, in general, larger and taller, the more the climate and the situation in which they grow are adapted to their nature, and the more favourable they are to their development. A certain degree of humidity, joined to a pretty high temperature, appears to be the circumstance most favourable to the growth of trees; and it is in regions which possess these conditions of the atmosphere that they attain the greatest height. The forests of South America are, in general, composed of trees which greatly exceed ours in their port, their height, and the beauty of their foliage and flowers.

There are certain trees which take a long series of years in acquiring any considerable height or diameter; as, for example, the Oak, the Elm, and the Cedar. Others, on the contrary, grow much more rapidly. They are chiefly trees which have light and soft wood, as Poplars, Pines, Acacias, &c. Lastly, there are plants which grow with such rapidity, that the eye can, in a manner, follow the progress of their development. Of this kind is the *Agave Americana.* This plant, which I have seen covering the rocks along the shores of the Mediterranean, in the Gulf of Genoa, when it flowers, shoots out a stalk which sometimes acquires a height of thirty feet, in the space of thirty or forty days, or even less. As it thus grows about a foot in the day, it may be conceived to be in a manner possible that its successive development should be perceptible to the observer.

In general, the greatest height which the trees of our forests attain, is from 120 to 130 feet. In America, Palms and many other trees often exceed 150 feet.

Of the Thickness of Trees.

Trees vary as to their diameter, not less than in height. Some of them occasionally acquire monstrous dimensions. We shall not here speak of the celebrated Chestnut-tree of Mount Etna, which, by the accounts of travellers, was 160 feet in circumference, because it is generally considered as having been composed of several trunks united together; but we may adduce as well authenticated examples of enormous size, the Baobaos observed by Adanson in the Cape Verd Islands, and of which some were 90 feet in circumference. In our own climates, Oaks, Elms, Limes, Pear-trees and Apple-trees, are seen to attain a girth of 25 or 30 feet.

Of the Duration of Trees.

Trees, when placed in suitable soil, and in a situation adapted to their nature, are capable of living for centuries. Thus the Olive-tree may continue for 300 years, and the Oak about 600. The Cedars of Lebanon seem in a manner incapable of decay. According to very ingenious calculations, Adanson supposed that the Baobaos of which we made mention above might be about 6000 years old.

In dicotyledonous trees, the age may be known by the number of woody layers which a transverse section of the trunk presents. In fact, as a new layer of wood is formed every year, it will easily be seen that a tree twenty years old, for example, must present, but only at its base, twenty concentric rings of wood, and so on successively.

Uses of Stems.

Wood is applied to so many uses in domestic economy and the arts, and is so indispensable in the construction of ships and buildings of all kinds, as well as for machines and instruments, that no part of vegetables can dispute the superiority with it in this respect.

Many herbaceous stems are employed as food for man and animals.

The stem of *Saccharum officinarum* supplies most of the sugar of commerce.

Many woods are used for dyeing: for example, Sandal-wood, Logwood, Brazil-wood, &c.

Leather is tanned with Oak-bark, and, in general, with those kinds of bark which contain a great quantity of tannin.

With respect to medical properties, the stems, the wood, and the bark, occupy one of the highest ranks in therapeutics. Who, in fact, is ignorant that to this class of organs belong the Cinchonas, Cinnamon, Winter's-bark, Sassafras, Guyacum, and so many other medicines which possess so well-merited a reputation. According to their most remarkable chemical properties, the principal kinds of bark and wood may be arranged as follows :—

1. *Bitter.*
   Simarouba (*Simarouba guyanansis*).
   Quassia (*Quassia amara*).
2. *Bitter, astringent and slightly aromatic.*
   Angustura (*Cusparia febrifuga*).
   Grey Cinchona, or Peruvian-bark (*Cinchona condaminea.* Humb. et Bonpl.)
   Red Cinchona (*Cinchona oblongifolia.* Mutis).
   Yellow Cinchona (*Cinchona cordifolia.* Mutis).
   Orange Cinchona (*Cinchona lancifolia.* Mutis).
   White Cinchona (*Chincona ovalifolia.* Mutis).
   Cascarilla (*Croton Cascarilla*).
3. *Astringent.*
   Oak-bark (*Quercus Robur*).
   (*Rhus coriaria*).
   Horse-chestnut (*Æsculus Hippocastanum*).
4. *Aromatic.*
   Cinnamon (*Laurus Cinnamomum* and *L. Cassia*).
   Winter's-bark (*Drymis Winteri*).
   Canella (*Canella alba*).
   Sassafras (*Laurus Sassafras*).
5. *Acrid.*
   Mezereon (*Daphne Mezereum*).
   Guyacum-wood and bark (*Guaiacum officinale*).

CHAPTER III.

OF BUDS.

Under the general name *Buds* are comprehended, 1*st*, *Buds* properly so called; 2*dly*, The *Turio;* 3*dly*, The *Bulb;* 4*thly*, The *Tubercle;* 5*thly*, The *Bulbils*. These we shall now describe.

1. *Of Buds properly so called.*

Buds (gemmæ) are bodies of varied form, nature and aspect, generally formed of scales closely imbricated upon each other, and containing in their interior the rudiments of stems, branches, leaves, and organs of fructification. They are always developed upon the branches, in the axilla of the leaves, or at the extremity of the twigs. They are oval, conical or rounded, composed of scales which are superimposed upon each other, and imbricated, covered externally, in the trees of our climates, with a viscous and resinous coating, and furnished internally with a downy tissue, destined to defend the organs which they enclose from the rigours of winter. Accordingly, no envelopes of this kind are observed on the trees of the torrid zone, nor upon those which are reared in the shelter of our hot-houses; but those vegetables which are destitute of them are unable to resist the cold of our winters, and would unavoidably perish were they left exposed to it.

Buds begin to appear in summer, that is, at the period when vegetation is in its greatest vigour and activity. They are then called *eyes*. They enlarge a little in autumn, and remain stationary during winter: but, at the return of spring, they follow the general impulse communicated to the other parts of the plant; they dilate and swell, their scales separate and allow the organs which they protected to emerge. It is then only that they are properly called buds.

The scales which constitute the outermost part of the buds, are not all of the same nature or origin. The only circumstance in which they all agree, is, that they are always abortive and imperfect organs. Thus, they are sometimes leaves, petioles, or stipules, which have not acquired their full development, and which yet, in certain circumstances, grow, are unfolded, and thus disclose their true nature.

Buds are divided into *naked* and *scaly*. The first are those which have no scales at their exterior, and of which all the parts shoot out and become developed. Of this kind are the buds of most herbaceous plants. Scaly buds, on the other hand, are those whose outer part is formed of more or less numerous scales, as may be observed in the trees of our climates. According to the organs of which their scales are formed, the scaly buds are distinguished into—

1. *Foliaceous* or *leafy (Gemmæ foliaceæ)*, those whose scales are merely abortive leaves, which are often capable of being developed, as in Mezereon *(Daphne Mezereum)*.

2. *Petiolar (G. petiolaceæ)*, when their scales are formed by the persistent base of the petioles; as in the Walnut *(Juglans regia)*.

3. *Stipular (G. stipulaceæ)*, when the stipules come together and envelope the young shoot; as is observed in the Hornbeam *(Carpinus sylvestris)*, the Tulip-tree *(Liriodendron tulipifera)*, and especially in certain kinds of Fig-tree, as in *Ficus elastica.*

4. *Fulcraceous (G. fulcraceæ)*, when they are formed by petioles furnished with stipules; as in the Plum-tree.

Buds are, in general, visible externally long before they expand. There are trees, on the contrary, in which they are, as it were, immersed in the very substance of the wood, and only make their appearance just when they are about to be developed; as in the Acacias *(Robinia pseud-acacia)*, and many other Leguminosæ.

Buds may be *simple*, that is, may give rise to a single shoot only; as in the Lilac and Oak: or *compound*, that is, containing several stems or twigs; as in the genus *Pinus*.

According to the parts which they contain, buds are further distinguished into *Flower-buds*, *Leaf-buds*, and *Mixed Buds*.

1. The *Flower-bud* or *Fruit-bud (Gemma florifera seu fructifera)* is that which contains one or more flowers without leaves. It is generally pretty large, of an oval or rounded form; as in Pear-trees and Apple-trees.

2. The *Leaf-bud (G. foliifera)* contains only leaves. Of this kind is the bud which terminates the stem of *Daphne Mezereum*.

3. Lastly, the *Mixed Bud (G. folii-florifera)* is that which contains flowers and leaves together; as in the Lilac.

Cultivators are never mistaken respecting the nature of a bud, which they easily distinguish in fruit-trees by its form. Thus, the bud which bears flowers is conical and enlarged, while that which bears leaves only, is slender, elongated, and pointed.

2. *Of the Turio.*

The name of *Turio* is given to the subterranean bud of perennial herbaceous plants, which, on being developed annually, produces the new stem. Thus, the part of the Asparagus which we eat is the *turio* of that plant. The difference between the bud properly so called and the turio, is, that the latter always arises from a vivacious root, or a rhizoma; in other words, is of subterranean origin, while the bud always arises upon a part exposed to air and light.

3. *Of the Bulb.*

The *Bulb (Bulbus)* is a kind of bud belonging to certain perennial herbaceous plants, and particularly to the Monocotyledones. We have already seen, when speaking of the bulbiferous roots, that it is supported by a kind of solid and horizontal plate, which lies between it and the true root. It is to this flattened *tubercle* that the fleshy scales of which the bulb is externally formed are fixed by their base. The interior contains the rudiments of the flower-stalk and leaves. These scales become thicker, and more fleshy and succulent, the more internally they are situated in the bulb. The outermost, on the contrary, are thin and dry like paper.

Sometimes these scales are of one piece, and are enclosed within each other; in other words, a single scale embraces the whole circumference of the bulb; as in the Common Onion *(Allium Cepa)*, the Hyacinth *(Hyacinthus orientalis)*. They are then named *Coated* or *Tunicated Bulbs (Bulbi tunicati)*. Fig. 31. represents this kind of bulb.

Fig. 31.

Fig. 32.

Fig. 33.

At other times, these scales are smaller, free at their sides, and cover each other only in the manner of tiles on a roof; as in the White Lily *(Lilium candidum)*. In this case, they are called *Scaly Bulbs (B. squamosi, imbricati)*. Fig. 32.

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Lastly, the coats are sometimes so close as to be confounded together, when the bulb seems as if formed of a solid and homogeneous substance. Bulbs of this kind are named *solid (B. solidi).* Examples of them are seen in the Common Saffron *(Crocus sativus)*, in *Colchicum autumnale*, and *Gladiolus communis.* Fig. 33.

We may here remark the gradual transition of the bulb properly so called, into the true tubercle; while, at the same time, we find a proof and confirmation of the principle formerly stated, namely, that the tubercles, which were so long considered as roots, are nothing but true buds. In fact, no one denies that the coated and scaly bulbs, and even the solid bulbs of Colchicum, Crocus, &c., ought to be regarded as buds. Now, we ask, what difference is there between these solid buds and the two *tubercles* of the Orchideæ, or those of the Potato? If, in the one case, a name has been applied to one of these organs, why should another name be given to a part precisely similar in its structure and uses? *

Bulbs are generally of an oval or globular form. Sometimes, however, they are more or less elongated and even cylindrical; as is observed in some species of Allium. In the Bananas the bulb is very elongated, cylindrical, and stem-like. We have already proved that the stipe of the Palms, *Dracænæ*, *Yuccæ*, &c., is a true bulb.

The bulb is sometimes *simple*, that is, formed of a single body; as in the Tulip and Squill:

Or it is *multiple*, when several small bulbs are found collected under the same envelope; as in *Allium sativum.*

Bulbs, being the buds of certain perennial herbaceous plants, are necessarily reproduced every year. But their regeneration does not take place in the same manner in all

* In the solid bulbs, the platform is no longer distinct. Might we not say, in this case, that it is the substance of the platform which is considered as a real tubercle, that has assumed an extraordinary development, and has covered the whole bud?

the species. Sometimes the new bulbs arise in the very centre of the old ones, as in the Common Onion *(Allium Cepa)*; at other times, from the lateral part of their substance, as in *Colchicum autumnale*, *Ornithogalum luteum*, &c.; or the new bulbs are developed by the side of the old ones, as in the Tulip and Hyacinth; or above them, as in *Gladiolus*; or beneath them, as in many species of *Ixia*. In common language, the young bulbs are named *Offsets*.

In proportion as a bulb shoots up the stem which it contains, the outer scales diminish in thickness, fade, and at length become perfectly dry. They therefore appear to supply the young stem with a portion of the materials necessary for its development.

4. *Of the Tubercles.*

Tubercles (Tubercula) are true subterranean bulbs, belonging to certain perennial plants. We shall not here revert to what we have already said respecting the nature of the tubercles, or repeat the facts and reasons which have induced us to consider these fleshy excrescences as true buds.

They are sometimes *simple*, and develope only a single stem; as in the genus *Orchis*:

Sometimes *multiple*, that is, several together, each sending out a particular stem; as in *Saxifraga granulata*:

Sometimes *compound*, which is the case when several stems issue from a single tubercle; as in the Potato.

5. *Of the Bulbils.*

The name of *Bulbils (Bulbilli)* is applied to a kind of small solid or scaly buds, growing on different parts of a plant, and which are susceptible of vegetating by themselves; in other words, when detached from the parent plant, they become developed and produce a vegetable perfectly similar to that from which they derived their origin. Plants bearing buds of this kind are named *viviparous* (*Plantæ viviparæ*).

They may occur in the axilla of the leaves, as in *Lilium bulbiferum;* in which case they are called *axillar*.

At other times they are developed in the place of the flowers; as in *Ornithogalum viviparum*, *Allium carinatum*, &c.

It has also been said that the bulbils are sometimes developed in the interior of the pericarp, and occupy the place of the seeds. But we have shown, in the *Annales des Sciences Naturelles* for 1824, that these alleged bulbils are nothing but true seeds, which have acquired an extraordinary development, often at the expense of the pericarp itself. But their internal organization remains absolutely the same.

The nature of the *bulbils* is similar to that of the *bulbs* properly so called. Sometimes they are *scaly;* as in *Lilium bulbiferum*, sometimes *solid* and compact.

The small bodies which are developed in different parts of *agamic* plants, such as Ferns, Lycopodiaceæ, Mosses, Lichens, &c., and which have been improperly named *seeds*, must be considered as true bulbils. Although these bodies, to which we give the name of *sporules*, are capable of producing a plant similar to that from which they are detached, they cannot be confounded with true seeds. In fact, the essential character of the seed is that it contains an embryo, that is, a body complex in its nature, composed of a radicle or rudiment of a root, a gemmule or germ of the stem, and a cotyledonary body. By the act of germination, the embryo properly so called merely developes the parts which already existed in it perfectly formed. Germination does not give rise to them; it merely places them in circumstances favourable to their growth. In the bulbils, on the contrary, and especially in the sporules of the agamic plants, there is no embryo. In them there is no trace of radicle, cotyledons or gemmule. Germination creates these parts in them. They are not, therefore, true seeds.

Uses of Buds, Bulbs, &c.

Several kinds of buds are employed in domestic economy as food; such, for example, as the turios of Asparagus, and of several other plants of the same family. Every one knows the daily use that is made of different species of the genus *Allium;* such as the Common Onion *(Allium Cepa)*, the Garlic *(Allium sativum)*, the Leek *(Allium porrum)*, and the Shallot *(Allium escalonicum)*.

The bulbs or buds of some vegetables are also used in medicine. Thus it is of the buds of the *Pinus picea* infused in beer that *spruce beer* is made. The scales of the bulb of the Common Squill *(Scilla maritima)* furnish a powerful diuretic. They are also employed as a stimulant to the pulmonary organs. Garlic is well known to be an excellent anthelmintic, &c.

CHAPTER IV.

OF THE LEAVES.

Previous to their entire development, the *Leaves (Folia)* are always enclosed in buds. They are there differently arranged with respect to each other, but always in the same manner in all plants of the same species, often in those of the same genus, and sometimes even in those of a whole natural family.

This disposition of the leaves in the bud has been named *præfoliation* or *vernation.* Good characters may often be derived from it for the arrangement of genera into natural families.

The principal modifications which the leaves present in this state are the following.

1. They may be *folded lengthwise*, the one half being applied against the other, in such a manner that their margins perfectly correspond on each side; as in *Philadelphus coronarius.*

2. They may be *folded from above downwards*, several times upon themselves; as in *Aconitum Napellus.*

3. They may be *plaited* in the longitudinal direction, so as to resemble the folds of a fan; as in those of the Vine, Currants, &c.

4. Leaves may be *rolled* upon themselves in a spiral form; as in certain Fig-trees, the Apricot, &c.

5. Their margins may be *rolled outwards* or *downwards;* as in those of Rosemary.

6. At other times they are *rolled inwards* or *upwards*; as in the Poplar, Pear-tree, &c.

7. Lastly, They may be rolled like a crosier, or like the

volute in architecture; as is the case, for example, in all the plants of the family of Ferns.

Let us now examine the leaves after they have been developed.

Leaves are usually membranous, flat, greenish, and horizontal organs, arising from the stem and branches, or proceeding immediately from the neck of the root. By the numerous pores which they present at their surface, leaves serve for absorbing the gases which are adapted for the nutrition of the plant, or for exhaling those which have become useless for that purpose.

The leaves seem to be formed by the expansion of a bundle of fibres proceeding from the stem. These fibres, which are vessels, ramify in various directions, and thus form a kind of network, which in some measure represents the skeleton of the leaf, and of which the meshes are filled by a cellular tissue, varying in quantity, which derives its origin from the herbaceous envelope of the stem.

When the bundle of fibres coming from the stem, which, by its expansion, is to constitute the leaf, divides and ramifies the moment it leaves the stem, the leaf is then attached to it without the aid of any intervening support, and is said to be *sessile* (*Folium sessile*); as in the Poppy, and *Convallaria multiflora.* Fig. 34.

When, on the contrary, the bundle of fibres is prolonged before it spreads out into a membrane, it then forms a kind of footstalk, to which the name of *petiole (petiolus)* is given. In this case, the leaf is said to be *petiolate (F. petiolatum)*; as in the Lime, the Tulip-tree, the Horse-chestnut, &c. Fig. 35.


Fig. 34. Fig. 35.

This being the most general arrangement, the leaf may be considered as formed of two parts, the *petiole*, and the *disk* or *limb*; the latter being the generally flat and greenish part which constitutes the leaf properly so called.

As the petiole is wanting in many leaves, so also the limb itself is sometimes absent, through abortion, and the leaf then consists of the petiole only, which frequently dilates and assumes the form and characters of a sessile leaf. This is the case, for example, in all the simple-leaved Acacias of New Holland. It is even probable that, in the genus *Bupleurum*, the leaves are merely petioles. They have received the name of *Phyllodia*.

In the leaf there are distinguished an *upper surface*, which is commonly smoother, more green, covered with a more closely adhering epidermis, and presenting fewer cortical pores; and a *lower surface*, of a less deep colour, often covered with hair or down, with an epidermis more loosely attached to the herbaceous layer, and presenting a great number of small holes, which are the orifices of the internal vessels of the plant. It is accordingly by their lower surface that the leaves absorb the fluids which are exhaled by the earth, or which are diffused and mingled in the atmosphere.

There are also distinguished in the leaf, its *base*, or the part by which it is attached to the stem; its *tip* or *summit*, the opposite point to the base; its *circumference*, or the line by which its surface is limited externally.

The *lower surface* of the leaf is also remarkable for numerous projecting prolongations running in different directions, which are merely divisions of the *petiole*, and which are named *nerves*.

One of these nerves is nearly constant in its disposition. It forms the continuation of the petiole, has generally a longitudinal direction, and divides the leaf into two lateral parts which are pretty frequently equal. It is named the *mid-rib* or *middle nerve*. From its base and sides the other nerves proceed, running in different directions, and anastomosing frequently with each other.

According to their thickness, and the degree in which they project at the lower surface of the leaf, the nerves assume different names. They retain that of *nerves* properly so called, when they are prominent and very distinct; when they are less so, they are named *veins (venæ)*; and the last ramifications of the veins, which anastomose frequently, and, properly speaking, form the skeleton of the leaf, are called *venules* (*venulæ*).

The *nerves* of plants, although they bear the same name, have no resemblance in structure or functions to the nerves of animals. They are bundles of *porous vessels*, *spiral vessels*, and *false tracheæ*, enveloped in a certain quantity of cellular tissue.

Sometimes the nerves are prolonged beyond the circumference of the *disk* of the leaf, and then form, when they possess a certain rigidity, spines, or thorns, which are more or less acute, as is seen, for example, in the Holly *(Ilex Aquifolium)*.

The disposition of the nerves upon the leaves merits the greatest attention. In fact, they are capable of serving to characterize certain divisions of vegetables. Thus, for example, in most of the *Monocotyledones*, the nerves are almost always simple, very little branched, and often parallel to each other *. In the *Dicotyledones*, they may present this disposition; but they are more frequently much ramified, and anastomose with each other.

The more remarkable varieties in the disposition of the nerves may be referred to the following:

1. The nerves may all proceed from the base of the leaf, and direct themselves towards its summit, without dividing in any remarkable degree; as is the case in a great number of monocotyledonous plants. Those leaves which present an arrangement of this kind, are named *basinerved*, or *digitinerved (F. basinervia, digitinervia)*.

* The Aroideæ and certain Asparagineæ form exceptions to this nearly general rule.

2. On the other hand, when the nerves arise from the sides of the middle nerve, and direct themselves either horizontally, as in the Banana *(Musa paridisiaca)*, or obliquely towards its summit, as in *Amomum Zerumbet*, the leaves take the name of *laterinerved*, or *penninerved*, *(F. laterinervia, penninervia)*.

3. If the nerves come off at the same time from the base, and from the lateral parts of the middle nerve, the leaves are then said to be *mixtinerved (F. mixtinervia)*, as is observed in many of the Buckthorns.

All the other dispositions which the nerves of leaves may present, are capable of being referred to some one of the three principal types which we have just described, or are only slight modifications of them.

A leaf, whether sessile or petiolate, may be attached, in various ways, to the stem or branches which support it. Sometimes it is simply *articulated* to it; that is, does not directly unite with it by the whole of its base, but is simply fixed to it by a kind of contraction or articulation, as in the Maple and Horse-chestnut. These leaves are then *caducous*, or fall very early.

At other times the leaf is so united to the stem, that it cannot be separated from it without being torn. Such leaves remain on the tree as long as the branch that supports them, as in the Ivy, &c.

The manner in which *sessile* leaves are attached to the stem also deserves examination.

Thus the middle nerve sometimes enlarges and embraces the stem in about the half of its circumference. The leaves are then named *semiamplexicaul* (*F. semiamplexicaulia*). Fig. 36.

Fig. 36.

Fig. 37.

The leaf is said to be *amplexicaul (F. amplexicaule)*, on the other hand, when it embraces the stem in its whole circumference; for example, in the Common Goatsbeard *(Trago-*

pogon pratense), the White Poppy *(Papaver somniferum)*, &c. Fig. 37.

Frequently also the base of the leaf is prolonged so as to form a sheath, which entirely surrounds the stem, and envelopes it for a certain length. In this case, the leaves are named *sheathing (F. vaginantia)*, as in the *Gramineæ*, *Cyperaceæ*, &c. This sheath may be considered as a very broad petiole, of which the two edges are sometimes united to form a kind of tube. The place at which the limb of the leaf and the sheath meet, is named the *neck*. Sometimes it is naked, sometimes furnished with hairs, as in *Poa pilosa*, or with a small membranous upper appendage, named *ligule*, as is observed chiefly in the *Gramineæ*. The form of the ligule is greatly diversified in the different species, and it very frequently affords a good specific character.

The sheath is commonly *entire ;* at other times it is longitudinally *slit.* This character, with very few exceptions, distinguishes the family of *Gramineæ* from that of *Cyperaceæ ;* the former having in general the sheath slit, while in the latter it is entire.

Sometimes the *limb* of the leaf, instead of terminating at the point where it comes off from the stem, is prolonged to a greater or less extent upon that organ, where it forms a kind of membranous appendage or wing. In this case, the leaves are said to be *decurrent (F. decurrentia)*, and the stem is *winged (Caulis alatus) ;* as in *Verbascum Thapsus* and *Symphytum officinale.*

A *perfoliate* leaf *(F. perfoliatum)* (Fig. 38.), is that of which the disk is as it were perforated by the stem ; as in *Bupleurum rotundifolium*, &c.

Connate leaves *(F. connata)* (Fig. 39.), are opposite leaves

Fig. 39. Fig. 38.

which are joined at their base in such a manner that the stem passes through their united limb. Of this kind are the upper leaves of *Lonicera caprifolium*, *Dipsacus fullonum*, and *Saponaria officinalis*.

A *simple* leaf *(F. simplex)* (Fig. 40.), is one whose petiole has no perceptible division, and whose limb is formed of a single piece; for example, in the Lilac, the Lime, the Elm, &c.

Fig. 40. Fig. 41.

A *compound* leaf *(F. compositum)* (Fig. 41.), on the contrary, is the result of the collocation of a greater or less number of small leaves, distinct from each other, which are named *folioles* or *leaflets*, and which are all attached to the sides or summit of a *common petiole*, which, in the former case, bears the name of *rachis*. Each *foliole* may be *sessile* on the rachis; in other words, attached by the base of its middle nerve only; or it may be supported upon a small petiole of its own, which takes the name of *petiolule* or *partial leaf-stalk*. Of this kind are the leaves of the False Acacia, Horse-chestnut, &c.

Compound leaves are distinguished into *articulate* and *inarticulate*. The first are those of which the leaflets are attached to the common petiole by means of a kind of articulation or joint, which is capable of motion, as is observed in the False Acacia, the Cassias, and in general in most plants of the family of Leguminosæ. It is in these plants only that the phenomenon which Linnæus calls the *sleep of plants* takes place; the others, which have no articulations to their leaflets, not exhibiting it.

Between the simple leaf and the compound leaf, there exists a series of modifications which form as it were a gradual transition from the one to the other. Thus we have, in the first place, *toothed* leaves Others are divided half way down into distinct lobes; and, in others, the incisions nearly reach the middle nerve, and thus give them the appearance of a compound leaf. But it is always easy to distinguish simple leaves of this kind from the truly compound leaf, by observing that, in the latter, each of the pieces of which it is formed may be detached without damaging any of the rest; whereas, in the simple leaf, however deeply it may be divided, the leafy part or limb of each division, is continuous at its base with the next divisions; so that it cannot be separated without tearing the other two between which it is placed *.

All the leaves of a plant are not always precisely of the same form. In some plants, there is in this respect a very great difference. Thus every one must have observed that the Ivy has some of its leaves entire, and others deeply lobed. In general, plants which have leaves proceeding directly from the root, and others springing from different parts of the stem, seldom have them alike. *Valeriana Phu* has the *radical* leaves laterally divided, while the leaves of its stem are entire.

Leaves also vary according to the medium in which they vegetate. Aquatic plants generally have two kinds of leaves; one set swimming at the surface of the water, or raised a little above its level, the other always immersed in that fluid. Thus, for example, the Water Crowfoot *(Ranunculus aquatilis)* has lobed leaves which float at the surface, and leaves divided into exceedingly narrow and very numerous segments, which are immersed in the water. There are many other plants of the same nature.

We shall now consider the numerous modifications of *form*, *direction*, *nature*, &c. which simple and compound leaves present.

* A compound leaf may also be known by the circumstance, that each of its leaflets has a contracted base, and is attached to the rachis only by its middle nerve, or the petiole which continues it; whereas a simple leaf, however deeply divided, is always attached by a more or less broad portion of its leafy part.

1. *Of the Simple Leaf.*

A. Considered with respect to the *part of the plant* from which they arise, leaves are:

1. *Seminal (F. seminalia)*, when they are formed by the development of the cotyledonary body. There may thus be one or two, and in some rare cases, a greater number. Fig. 42, *a a*.

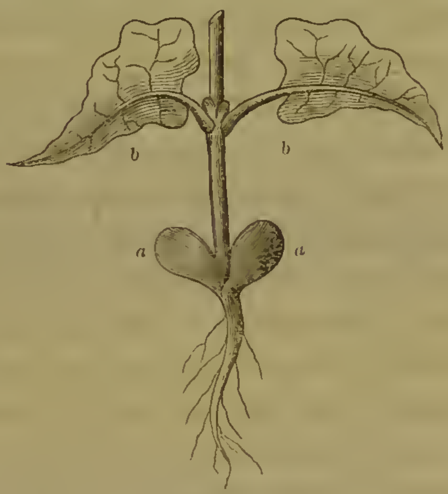

Fig. 42.

2. *Primordial* (*F. primordialia*), the first leaves that are developed after the seminal leaves. They are formed by the two outer folioles of the gemmule. Fig. 42, *b b*.

3. *Radical* or *Root leaves (F. radicalia)*, those which come off directly from the neck of the root, as in the Plantain *(Plantago major)* and Dandelion *(Leontodon Taraxacum)*.

4. *Cauline* or *Stem leaves (F. caulinaria)*, those which are attached to the stem.

5. *Branch leaves (F. ramealia)*, when they grow upon the branches.

6. *Floral (F. floralia)*, those which accompany the flowers, and are placed at their base, but which have not changed their form or nature, as in *Lonicera Caprifolium*. When the form of the floral leaves differs greatly from that of the other leaves, they are then named *Bracteæ*. We shall presently speak of the bracteas, when we come to treat of the floral organs.

B. Viewed with respect to their *disposition* on the stem or branches, they are:

1. *Opposite (F. opposita)* (Fig. 43.), arranged one by one at the same height on two diametrically opposite points of the stem; as in *Salvia officinalis*, and all the *Labiatæ*, in Germander Speedwell *(Veronica Chamædrys)*, &c.

Fig. 43.

Fig. 44.

Leaves are said to be *cross-wise opposite* or *decussate (cruciatim opposita, s. decussata)*, when the pairs of superimposed leaves grow in such a manner as to form right angles; as in the Spurge *(Euphorbia Lathyris)*.

2. *Alternate (F. alterna)*, coming off one by one, at nearly equal distances, from different points of the stem; as in the Lime *(Tilia europæa)*, &c. Fig. 44.

3. *Sparse* or *scattered (F. sparsa)*, when they affect no regular disposition, and are as it were dispersed without order upon the stem; as in *Linaria vulgaris*, &c.

4. *Verticillate* or *whorled (F. verticillata)*, when they come off more than two together at the same height, around the stem, or on the branches; as in the Rose-laurel *(Nerium Oleander)*, Madder *(Rubia tinctorum)*, &c.

According to the number of leaves of which each whorl or verticil consists, they are said to be,

Ternate (F. terna), when the whorl is formed of three leaves; as in *Verbena triphylla*, *Nerium Oleander*, &c.

Quaternate (F. quaterna), when the whorl is composed of four leaves; as in *Valancia cruciata.*

Quinate (F. quinata), when there are five leaves in the whorl; as in several species of *Galium*, and in *Myriophyllum verticillatum.*

Senate (F. sena), when there is a whorl of six leaves; as in *Galium uliginosum.*

Octonate (F. octona), when the whorl consists of eight leaves, as in the Woodruff *(Asperula odorata)*.

5. *Geminate* or *Twin*-leaves *(F. gemina)*, growing in pairs, one leaf beside the other, and attached to the same

point of the stem ; for example, the upper leaves of *Atropa Belladonna*, and *Physalis Alkekengi*.

6. *Distichous* or *Two-ranked (F. disticha)*, disposed in two rows opposite to each other; as in the Common Elm *(Ulmus campestris)*, and the Cherry-laurel *(Cerasus Lauro-cerasus)*.

7. *Unilateral (F. unilateralia)*, when they are all directed to one and the same side; as in *Convallaria multiflora*.

8. *Distant (F. remota)*, when they are widely separated from each other.

9. *Close*, *Approximated*, or *Crowded (F. approximata, conferta)*, growing at very short distances from each other. The terms *distant* and *close* are never employed in an absolute sense, but are always used to express a comparison with other known species.

10. *Imbricated (F. imbricata)*, when they are partly laid over each other, like the tiles on a roof; as in certain species of *Aloe*, the genus *Thuya*, &c. Imbricated leaves are said to be:

Biserial (F. biseriata), when arranged in two longitudinal lines.

Triserial (F. triseriata), when disposed in three longitudinal rows.

Quadriserial (F. quadriseriata), when forming four longitudinal series; as in *Thuya*.

Lastly, They are said to be *Imbricated all round (F. undique imbricata)*, when they present no regular arrangement.

11. *Fasciculate* or *Tufted (F. fasciculata)*, coming off more than two together from the same point of the stem; as in the Cherry-tree *(Cerasus communis)*, the Common Larch *(Larix vulgaris)*, the Barberry *(Berberis vulgaris)*.

12. *Crowning* or *Terminating (F. coronantia, terminantia)*, growing in a bundle or tuft at the summit of the stem; as in Palms and the Papaw-tree *(Carica papaya)*.

13. *Rosulate* or *Rose-like (F. rosulata)*, alternate and close together, somewhat like the petals of a Rose; as in the House-leek *(Sempervivum tectorum)*, the Dandelion, &c.

C. Viewed with respect to their *direction* relative to the stem, leaves are:

1. *Erect (F. erecta)*, when they form a very acute angle with the part of the stem above their origin; as in *Typha latifolia.*

2. *Close-pressed* or *Adpressed (F. adpressa)*, when the limb of the leaf lies in contact with the stem.

3. *Spreading (F. patentia)*, when they form nearly a right angle with the stem; as in the Ground-ivy *(Glechoma hederacea)*, and in Tutsan *(Hypericum Androsæmum).*

4. *Inflected (F. inflexa)*, when bent inwards; as in several Malvaceæ.

5. *Involute (F. involuta)*, when they are curled inwards; as in Ferns.

6. *Reflected (F. reflexa)*, when suddenly bent outwards and downwards; as in *Inula pulicaria* and *Dracæna reflexa.*

7. *Revolute (F. revoluta)*, curled outwards.

8. *Pendent* or *Hanging (F. pendentia)*, when they are directed almost perpendicularly downwards; as in the Greater Bindweed *(Convolvulus sepium)*, and the Spurge Laurel *(Daphne Laureola).*

9. *Inverted (F. inversa)*, when the petiole is twisted so that the lower surface is turned upwards; as in the Pharus.

10. *Humifuse (F. humifusa)*, when they are radical, soft and spread out on the ground, as in the Daisy *(Bellis perennis).*

11. *Floating (F. natantia)*, resting upon the surface of the water; as in the White Water-lily *(Nymphæa alba).*

12. *Submersed (F. submersa, demersa)*, covered by the water; as in *Hottonia palustris.*

13. *Emersed (F. emersa)*, when their point of attachment is under the water, and their petiole rises above the fluid; as in the Water Plantain *(Alisma Plantago)* and the Arrowhead *(Sagittaria sagittæfolia).*

D. Considered with respect to *outline* or *figure*, leaves are:

1. *Orbicular (F. orbiculata)* (Fig. 45.), when their circumference approaches the circular form; as in *Hydrocotyle vulgaris.*

2. *Oval* * *(F. ovalia)* (Fig. 46.), when elongated and rounded at both extremities, the lower extremity being broader; for example, Elecampane *(Inula Helenium)*, Common Chickweed *(Alsine media)*, and the Greater Periwinkle *(Vinca major)*.

3. *Oboval* † *(F. obovalia)* (Fig. 47.), having the same form, with the broad end upwards; as in the Bear-berry *(Arbutus Uva-ursi)*, *Samolus Valerandi*, &c.

4. *Elliptical* ‡ *(F. elliptica)* (Fig. 48.), elongated, both ends rounded and equal; as in the Lily-of-the-Valley *(Convallaria majalis)*, &c.


Fig. 45.


Fig. 46.


Fig. 47.


Fig. 48.


Fig. 49.


Fig. 50.


Fig. 51.

5. *Oblong (F. oblonga)* (Fig. 49.), elliptical, much elongated and narrow.

6. *Lanceolate (F. lanceolata)* (Fig. 50.), oblong and tapering to a point at the summit; as in Ribwort Plantain *(Plantago lanceolata)*, Rose-laurel *(Nerium Oleander)*, and the Peach *(Amygdalus persica)*.

7. *Linear (F. linearia)* (Fig. 51.), lanceolate, but narrow; as in most of the Gramineæ.

8. *Ribbon-like (F. fasciaria, graminea)*, somewhat broader than the last, but much more elongated; as in *Valisneria spiralis* and *Typha latifolia.*

* The oval figure is that presented by the oblique section of a cone.

† *Obovalia*, contracted from *obversè ovalia.*

‡ The elliptical figure is that presented by the oblique section of a cylinder.

9. *Subulate* or *Awl-shaped (F. subulata)*, very narrow at the base, and gradually tapering to a sharp point; as in *Juniperus communis.*

10. *Aciculate* or *Setaceous (F. acicularia, setacea)*, elongated, stiff and acute, having some resemblance to a needle or bristle; as in *Asparagus acutifolius.*

11. *Capillar* or *Hair-like (F. capillaria)*, slender and flexible like a hair; as in *Asparagus officinalis.*

12. *Filiform (F. filiformia)*, thin, slender, and very much elongated, like a thread; for example, those of *Ranunculus aquatilis.*

13. *Spatulate (F. spatulata)* (Fig. 52.), thin, narrow at the base, broad and rounded at the summit; as in *Bellis perennis*, &c.

14. *Cuneate* or *Wedge-shaped (F. cuneata)* (Fig. 53.), very narrow at the base, and broad at the end, which is truncated, with the angles rounded; as in *Saxifraga tridentata*, &c.

Fig. 52. Fig. 53.

15. *Parabolic (F. parabolica)*, oblong, rounded above and truncated below.

16. *Falcate (F. falcata)*, in the shape of a scythe; as in *Bupleurum falcatum.*

17. *Inequilateral (F. inæquilateralia)*, when the middle nerve divides the leaf into two unequal portions; as in the Lime, *Begonia obliqua*, &c.

E. The leaves may be variously *cut out at their base*, and in consequence, assume several varieties of form. Thus, they are said to be,

1. *Cordate* or *Heart-shaped (F. cordata, cordiformia)* (Fig. 54.), when they are cut out at the base so as to represent two rounded lobes, and taper upwards; as in *Tamus communis*, *Nymphæa alba*, &c.

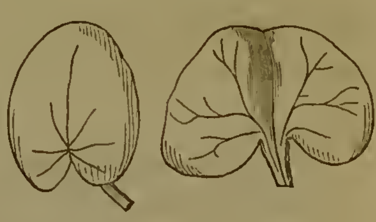

Fig. 54. Fig. 55.

2. *Reniform* or *Kidney-shaped (F. reniformia)* (Fig. 55.), when their breadth is much greater than their height, their summit rounded, and their base marked with a broad notch; as in Asarabaeca *(Asarum europæum)*, and Ground-ivy *(Glechoma hederacea)*.

3. *Lunulate* or *Crescent-shaped (F. lunata)*, rounded and divided at their base into two narrow lobes.

4. *Sagittate* or *Arrow-shaped (F. sagittata)* (Fig. 56.), when they are acute, and have their base prolonged into two pointed lobes, which do not diverge much; as in *Sagittaria sagittæfolia*.

5. *Hastate (F. hastata)* (Fig. 57.), having the base prolonged into two acute lobes, widely separated, and spreading outwards; as in *Arum maculatum*, &c.


Fig. 56.


Fig. 57.

F. Leaves may be *terminated* at their summit in various ways; whence they are named,

1. *Acute (F. acuta)* (Fig. 58.), when they gradually taper to a point; as in the Rose-laurel, &c.

2. *Pungent (F. pungentia)*, when terminated by a stiff point; as in Gorse *(Ulex europæus)*, and Butcher's-broom *(Ruscus aculeatus)*.

3. *Acuminate (F. acuminata)* (Fig. 59.), when the tip is acute and greatly prolonged; as in the Hasel *(Corylus Avellana)* and the Cornel *(Cornus mascula)*.


Fig. 58.


Fig. 59.

4. *Mucronate (F. mucronata)*, surmounted by a small, slender and isolated point, which seems not to form a continuation of the leaf; as in the House-leek *(Sempervivum tectorum)*.

5. *Uncinate (F. uncinata)*, terminated by a point which is curved like a hook.

6. *Obtuse (F. obtusa)* (Fig. 60.), rounded at the summit;

as in *Nymphæa alba*, &c. The term is employed generally in opposition to *acute*.

7. *Emarginate* or *Notched (F. emarginata)* (Fig. 61.), having at their summit an obtuse sinus in the form of a notch; as in *Buxus sempervirens* and *Asarum europæum*.

8. *Retuse (F. retusa)* (Fig. 62.), having a shallow notch at the summit; as in the Bilberry *(Vaccinium Vitis-idæa)*.

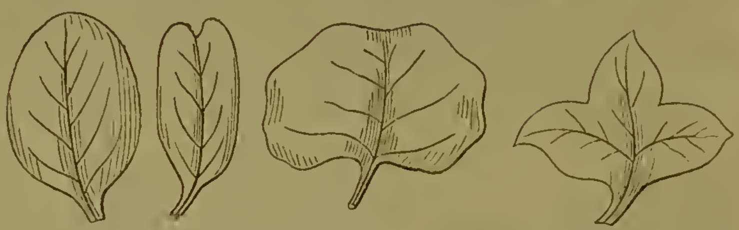

Fig. 60. Fig. 61. Fig. 62. Fig. 63.

9. *Obcordate (F. obcordata)* *, inversely heart-shaped; as in the Wood Sorrel *(Oxalis Acetosella)*.

10. *Bifid (F. apice bifida)*, divided at the summit into two acute segments, not deeply separated.

11. *Bilobate* or *Two-lobed (F. apice biloba)*, when the two divisions are separated by an obtuse sinus.

12. *Bipartite (F. apice bipartita)*, when the two divisions are very deep and acute.

G. The leaves may have their *circumference* marked with angles, varying in number and the degree of prominence, in consequence of which they may assume various forms. Thus they may be,

1. *Rhomboidal (F. rhomboidea)*, when they have four angles, of which two opposite ones are more acute; as in *Campanula rhomboidalis*.

2. *Deltoid (F. deltoidea)*, rhomboidal, with the lower angle very short, so that they appear as if triangular, or approaching the form of the Greek *delta* (Δ); as in *Mesembryanthemum deltoides*.

* *Obcordata*, abbreviated for *obversè cordata*.

3. *Trapezoidal (F. trapezoidea)*, resembling a trapezium, or four-sided figure, of which the four sides are unequal; as in various Ferns.

4. *Triangular (F. triangulata)*, having three projecting angles.

5. *Quadrangular (F. quadrangulata)*, having four angles.

H. *Simple* leaves, as we have already said, may present incisions of greater or less depth, without their being, for this reason, considered as *compound*. Thus they may be,

1. *Trifid (F. trifida)*;
2. *Quadrifid (F. quadrifida)*;
3. *Quinquefid (F. quinquefida)*;
4. *Sexfid (F. sexfida)*;
5. *Multifid (F. multifida)*; when they have three, four, five, six, or more narrow divisions of no great depth.
6. *Trilobate (F. trilobata)* (Fig. 63.);
7. *Quadrilobate (F. quadrilobata)*;
8. *Quinquelobate (F. quinquelobata)*;
9. *Multilobate (F. multilobata)*; when the divisions are broader and separated by obtuse sinuses.
10. *Tripartite (F. tripartita)* (Fig. 64.);
11. *Quadripartite (F. quadripartita)*;
12. *Quinquepartite (F. quinquepartita)* (Fig. 65.);


Fig. 64.


Fig. 65.

13. *Multipartite (F. multipartita)*; when the incisions are so deep as to reach within a third of the base of the leaf.

14. *Laciniate (F. laciniata)* (Fig. 66.); when the divisions are deep and remarkably unequal; as in many species of *Synanthereæ* or Syngenesian Plants.

15. *Palmate (F. palmata)* (Fig. 67.), when all the nerves, proceeding in a radiating manner from the top of the petiole, direct themselves towards the middle of the divisions; as in *Ricinus communis*.

16. *Auriculate (F. auriculata)*, having at their base two appendages, which are named auricles; as in Sage *(Salvia officinalis)*, Water Figwort *(Scrophularia aquatica)*, &c.

17. *Panduriform* (*F. pandurata, panduriformia*), (Fig. 68.) approaching the figure of a violin; in other words, elongated, rounded at both extremities, and presenting two re-entering lateral sinuses; as in *Convolvulus panduratus*, *Rumex pulcher*, &c.

18. *Sinuate (F. sinuata)*, when they present one or more rounded notches or sinuses in determinate number.

Fig. 66. Fig. 67. Fig. 68. Fig. 69. Fig. 70.

19. *Sinuous (F. sinuosa)* (Fig. 69.), presenting rounded sinuses and projections, in indeterminate number; as in the Oak *(Quercus Robur)*.

20. *Pinnatifid (F. pinnatifida)* (Fig. 70.), divided laterally into lobes, which may be more or less deep; as in *Polypodium vulgare* and *Coronopus Ruellii*.

21. *Interruptedly Pinnatifid (F. interruptè pinnatifida)*, when the upper divisions are confluent at their base, while the lower are entirely free, so that these leaves, at their upper part, represent a pinnatifid leaf, and at their lower a pinnate leaf. But they must not be confounded with truly compound leaves.

22. *Pectinate* or *Comb-like (F. pectinata)*, pinnatifid leaves, the divisions of which are narrow, close, and nearly parallel; as in *Achillæa pectinata*.

23. *Lyrate (F. lyrata)* (Fig. 71.), pinnatifid leaves, terminated by a rounded

Fig. 71. Fig. 72.

lobe, which is much larger than the rest; as in *Geum urbanum*, *Raphanus Raphanistrum*, &c.

24. *Runcinate (F. runcinata)* (Fig. 72.), pinnatifid leaves, of which the lateral lobes are acute and directed downwards; as in Dandelion *(Leontodon Taraxacum)*, *Prenanthes muralis*, &c.

I. With respect to their *outline*, or the modifications which their *margin* presents, leaves are,

1. *Entire (F. integra)* (Fig. 73.), when the margin is continuous, and does not present teeth, incisions, or sinuses: for example, *Vinca minor*, *Syringa vulgaris*, &c.

2. *Eroded* or *Gnawed (F. erosa)*, presenting small unequal teeth, as if the margin had been gnawed by an insect; as in *Sinapis alba*.

3. *Crenate (F. crenata)* (Fig. 74.), when the margin presents crenatures or small rounded projecting parts, separated by re-entering angles; as in the Ground-ivy *(Glechoma hederacea)*, White Horehound *(Marrubium vulgare)*, and Betony *(Betonica officinalis)*.

4. *Doubly Crenate (F. duplicato-crenata)* (Fig. 75.), when each principal crenature is divided into several others; as in *Chrysosplenium alternifolium* and *Hydrocotyle vulgaris*.

5. *Dentate* or *Toothed (F. dentata)*, when the margin is marked with small acute teeth, which do not incline either towards the summit or towards the base of the leaf; as in *Erysimum Alliaria* and *Senecio vulgaris*.


Fig. 73.


Fig. 74.


Fig. 75.


Fig. 76.


Fig. 77.

6. *Serrate (F. serrata)* (Fig. 76.), when the teeth are inclined towards the summit of the leaf; as in *Viola odorata*, *Viburnum Lantana*, &c.

7. *Doubly serrate (F. duplicato-serrata)* (Fig. 77.), when each tooth is itself serrate; as in *Corylus Avellana* and *Ulmus campestris.*

8. *Spinous (F. margine-spinosa)*, margined with acute rigid teeth; as in the Holly *(Ilex Aquifolium)*, and many species of Thistle.

9. *Ciliated* or *Fringed (F. ciliata)*, having the margin furnished with hairs disposed in a regular series, like the eye-lashes; as in *Erica Tetralix*, *Luzula vernalis*, &c.

K. Viewed with respect to *expansion*, leaves may be,

1. *Flat* (*F. plana*), when their surface is neither concave nor convex; as in most plants.

2. *Convex* (*F. convexa*), when they are swelled out on their upper surface, and concave on the lower.

3. *Concave* (*F. concava*), when swelled out on their lower surface, and hollow above.

4. *Ensiform* (*F. ensiformia*), greatly compressed on the sides, so that their faces have become lateral, and their edges posterior and anterior; as in *Iris germanica*, &c.

5. *Striated* (*F. striata*), presenting striæ running in various directions.

6. *Undulated* (*F. undulosa*), having irregular prominences and depressions, which have been compared to the undulations of water in a state of agitation; as in *Rheum undulatum.*

L. Viewed with respect to their *surface*, they may be,

1. *Shining* (*F. lucida*), when their surface is even and reflects the light strongly; as in the Cherry-laurel and Ivy.

2. *Even* (*F. lævia*), destitute of prominences or asperities; as in the genus *Nymphæa.*

3. *Glabrous* or *Smooth* (*F. glabra*), destitute of all kinds of hairs; as in the Centaury (*Erythræa Centaurium*), and the Rose-laurel.

4. *Pertuse* (*F. pertusa*), marked with very perceptible holes; as in *Dracontium pertusum.*

5. *Cancellated* (*F. cancellata*), when there is no paren-

chyma, and the leaves are merely formed by the ramifications of the frequently anastomosed nerves, which represent a kind of trellis-work; as in *Hydrogeton fenestralis.*

6. *Glandular* (*F. glandulosa*), covered with small glands.

7. *Scabrous* (*F. scabra*), rough to the touch; as in the Elm (*Ulmus campestris*), Gromwell (*Lithospermum officinale*), &c.

8. *Glutinous* (*F. glutinosa*), presenting, when touched, a degree of viscosity; as in *Inula viscosa.*

M. With respect to *pubescence*, see what has already been said on the subject of the stem.

N. With respect to *consistence* and *texture*, leaves are,

1. *Membranous* (*F. membranacea*), when they have little perceptible thickness, and are soft and pliant; as in *Aristolochia Sypho.*

2. *Scarious* (*F. scariosa*), thin, dry, and semitransparent.

3. *Coriaceous* or *Leathery* (*F. coriacea*), when thick and having a certain consistence; as in the Misseltoe, Cherry-laurel, &c.

4. *Soft* (*F. mollia*), soft to the touch, and having little solidity; as in *Spinacia oleracea* and *Althæa officinalis.*

5. *Rigid* or *Stiff* (*F. rigida*), leathery and resisting flexion; as in *Ruscus aculeatus.*

6. *Fleshy* (*F. carnosa*), thick and juicy, but possessing considerable consistence; as in the House-leek (*Sempervivum tectorum*), and generally in all the plants named *Succulent.*

7. *Fistulous* (*F. fistulosa*), elongated and hollow; as in the Onion (*Allium Cepa*).

O. Considered with respect to *form* *, leaves are,

* The *form* and *figure* of a body ought not to be confounded, as they frequently are. *Form* applies only to solid bodies, or those which have length, breadth, and thickness. The department of geometry to which the consideration of it belongs, is named *Stereometry.* The term *figure* is applicable to flat bodies only, or to surfaces which have only two dimensions, breadth and length. The part of geometry which treats of the figure of flat bodies

1. *Ovate* or *Egg-shaped* (*F. ovata*), when they have the form of an egg, or represent that body not merely in outline, with parallel surfaces and thin substance, but in all their diameters.

2. *Obovate* (*F. obovata*), having the form of a reversed egg, that is, with the narrower end next the stem.

3. *Conoidal* or *Conical* (*F. conoidea*), having the form of a cone.

4. *Cylindrical* (*F. cylindrica, teretia*), having the form of an elongated cylinder; as in *Sedum album* and *Allium Cepa*.

5. *Linguiform* (*F. linguiformia*), resembling the tongue in form; as in the House-leek (*Sempervivum tectorum*).

6. *Triquetrous* (*F. triquetra*), elongated in the form of a three-sided prism; as in the Flowering Rush (*Butomus umbellatus*).

7. *Tetragonal* (*F. tetragona*), elongated in the form of a four-sided prism; as in *Gladiolus tristis*.

8. *Compressed* (*F. compressa*), thick, fleshy, laterally flattened, having more thickness than breadth.

P. Viewed as to *colouring*, leaves are,

1. *Green* (*F. viridia*), as is generally the case.

2. *Coloured* (*F. colorata*), of any other colour than green.

3. *Glaucous* (*F. glauca*), of a sea-green colour; as in *Magnolia glauca*, and the Cabbage (*Brassica oleracea*). This colouring is owing to a slight layer of resinous matter, similar to that which covers certain fruits, and, in particular, plums and grapes. It is a remarkable fact, that when glaucous leaves have been immersed in water, and again taken out of it, they do not remain wet, which of itself sufficiently shows the nature of the covering which imparts the glaucous colour to them.

4. *Differently coloured* (*F. discolora*) *, when the two faces

is named *Planimetry*. Thus, an egg has an *ovate form*; whereas a flat leaf, representing the longitudinal section of an egg, has an *oval figure*. The necessity of distinguishing *form* from *figure* is therefore apparent.

* The word *discoloured* is not equivalent to *discolor*, as in ordinary lan-

are not of the same colour. Thus, in *Antirrhinum Cymbalaria* and *Cyclamen europæum*, the upper surface is green, while the other is purple.

5. *Spotted* (*F. maculata*), presenting spots of greater or less size, and of a colour different from that of the leaf; as in *Arum maculatum.*

6. *Hoary* (*F. incana*), pure white; as in *Achillæa incana.*

Q. With respect to their connection with the *petiole*, or the absence of that part, leaves are:

1. *Sessile* (*F. sessilia*) (Fig. 78), attached to the stem or branch, without the intervention of a petiole; as in *Buxus sempervirens.*

2. *Petiolate* (*F. petiolata*) (Fig. 79), furnished with a petiole; as in the Sycamore, the Pear-tree, the Apricot, &c.

Fig. 79.

Fig. 78.

3. *Peltate* (*F. peltata*), (Fig. 80), when the petiole is inserted in the centre of the lower surface of the leaf, and the nerves issue from this point, radiating towards the circumference; as in *Tropæolum majus* and *Hydrocotyle vulgaris.*

Fig. 80.

When the leaves are furnished with a petiole, the characters which may be derived from its different modifications must not be neglected. Thus it may be *cylindrical*, *compressed*, *triquetrous*, *filiform*, *short*, *long*, &c. It is not necessary to explain these terms, as they have already, for the most part, been defined in another place.

The *petiole* may be *twisted* upon itself, as in several *Cucurbitaceæ*, &c.

guage it means a natural or artificial alteration of the original colour of a part.—Tr.

Claviform (*Petiolus claviformis*), when it is distinctly enlarged at its upper part; as in *Trapa natans.*

Canaliculate or *Channelled* (*P. canaliculatus*), when convex at its outer surface or back, and concave along the middle, on the side next the stem; as in many *Umbelliferæ.*

Winged (*P. alatus*), when the limb of the leaf is prolonged upon itself, so as to form a membranous appendage on each side; as in the Orange-tree (*Citrus Aurantium*).

In compound leaves, the common petiole is sometimes formed of as many articulated and membranous pieces as there are pairs of leaflets; as is observed in *Quassia amara,* for example, and many species of *Inga.*

Foliiform or *leaf-like* (*P. foliiformis*), when it is broad and thin, and has the appearance of a leaf. In this case, it very often takes the place of the true leaves, which exist only in young individuals, and fall off at a certain period. Thus the alleged simple leaves of the *Mimosæ* of New Holland, are nothing but expanded *leaf-like* petioles. They have been named *Phyllodia.*

The petiole is sometimes accompanied by a membranous sheath, to which the name of *Ochrea* has been given, and which embraces the stem in its whole circumference. The presence of this *Ochrea* is one of the best characters for distinguishing the plants which belong to the family of *Polygoneæ,* all of which are furnished with it.

R. According to the period during which the leaves remain on the stem, they are distinguished into,

1. *Caducous* (*F. caduca*), when they fall soon after their first appearance; as in many species of *Cactus.*

2. *Deciduous* (*F. decidua*), when they fall before the next set spring up; as in the Chestnut, the Lime, &c.

3. *Marcescent* (*F. marcescentia*), when they wither upon the plant before falling; as in the Oak.

4. *Persistent* (*F. persistentia*), when they remain on the plant more than one year; as in the genera *Pinus* and *Buxus.* Trees in which this happens, are called Evergreen.

2. *Of Compound Leaves.*

The true *compound leaf*, as we have said, is that which, on a common petiole, bears several leaflets which may be separated from each other, without being individually injured. These leaflets are either articulated on the rachis or common stalk, that is, attached by a very contracted point of the base of their little petiole, or continuous with it by the whole base of their petiole.

There are various degrees of composition in leaves. Thus the common petiole may be *simple*, or it may be *ramified.*

When the common petiole does not ramify, the leaf is said to be simply *compound ;* but when it ramifies, the leaf is *decompound* or *doubly compound.* We shall now examine the modifications which it presents in these two cases.

Leaves which are simply compound, present two principal modifications, according to the position affected by the leaflets of which they are composed. Thus all the leaflets sometimes issue from the very summit of the common petiole, as in the Horse-chestnut, the Trefoil, &c. Sometimes, on the contrary, they come off from the lateral parts of the common petiole or rachis, as in the Ash, the Bladder-senna, the Locust-Tree or False Acacia, &c. The first of these two modifications produces what are called *digitate* leaves, the other *pinnate* leaves.

Digitate leaves (*F. digitata*), are those of which all the leaflets come off in a diverging manner from the top of the common petiole, like the fingers of the hand when they are spread out *.

The number of leaflets of which a digitate leaf is composed, varies greatly, as may be seen on comparing the leaves of the Common Clover, which has three, with those of the *Paviæ*, which have five ; of the Horse-chestnut,

* Or, rather, like the toes of a fissipede or lobipede bird.—Tr.

which has seven; and of the Lupines, which present a greater number. According to the number of their leaflets, digitate leaves are divided into,

1. *Unifoliolate* (*F. unifoliolata*) (Fig. 81), when they have only a single leaflet, which, however, is articulated to the summit of the petiole. In this case, analogical reasons, and the existence of a joint, cause this leaf, although apparently simple, to be ranked among the compound leaves. Of this kind are the leaves of the Orange-tree (*Citrus Aurantium*), of *Rosa simplicifolia*, &c.

2. *Trifoliolate* (*F. trifoliolata*) (Fig. 82.), when they have three leaflets; as in the Buck-bean (*Menyanthes trifoliata*) and Wood Sorrel (*Oxalis Acetosella*).

3. *Quadrifoliolate* (*F. quadrifoliolata*), composed of four leaflets; as in *Marsilea quadrifolia.*

4. *Quinquefoliolate* (*F. quinquefoliolata*), having five leaflets; as in *Cissus quinquefolia*, *Potentilla reptans*, &c.

5. *Septemfoliolate* (*F. septemfoliolata*) (Fig. 83.), with seven leaflets; as in the Horse-chestnut, &c.

Fig. 81. Fig. 82. Fig. 83.

6. *Multifoliolate* (*F. multifoliolata*), composed of numerous leaflets; as in *Lupinus varius.*

Pinnate leaves (*F. pinnata*) (Fig. 84.), as we have said, are those which, on a common petiole, bear a greater or less number of leaflets, arranged on its lateral parts, like the barbs of a feather on the shaft. Of this kind are the leaves of the Locust-tree (*Robinia Pseudacacia*) and the Ash (*Fraxinus excelsior*).

Fig. 84.

The leaflets of a pinnate leaf may be *op-*

posite to each other, and arranged in pairs, in which case the leaf is said to be *oppositely pinnate ;* or its leaflets may be *alternate*, when it is said to be *alternately pinnate.*

Oppositely pinnate leaves (*F. opposite-pinnata*) are also named *conjugate.* They are said to be,

1. *Unijugate* (*F. unijugata*) (Fig. 85.), when the common petiole bears only a single pair of leaflets; as in *Lathyrus latifolius* and *L. sylvestris.*

Fig. 85. Fig. 86.

2. *Bijugate* (*F. bijugata*) (Fig. 86.), when they are composed of two pairs of leaflets; as in certain *Mimosæ.*

3. *Trijugate* (*F. trijugata*), having three pairs of leaflets; as in *Orobus tuberosus.*

4. *Quadrijugate* (*F. quadrijugata*), having four pairs.

5. *Quinquejugate* (*F. quinquejugata*), having five pairs; as in *Cassia Fistula.*

6. *Multijugate* (*F. multijugata*), when the pairs of leaflets are in indeterminate number; as in *Astragalus glycyphyllos, Vicia Cracca*, &c.

Oppositely pinnate leaves are said to be

Pari-pinnate, abruptly pinnate, or pinnate without an odd leaflet (*F. pari-pinnata*) (Fig. 87.), when the leaflets are attached in pairs, and the top of the common petiole does not present either a solitary leaflet, or a tendril occupying its place; as in *Ceratonia Siliqua, Orobus tuberosus*, &c. On the contrary, they are said to be—

Fig. 87. Fig. 88. Fig. 89.

Impari-pinnate, or pinnate with an odd leaflet (*F. impari-pinnata*) (Fig. 88.), when the common petiole is terminated by a solitary leaflet; as in *Robinia Pseudacacia* and *Fraxinus excelsior.*

Impari-pinnate leaves are named *trifoliolate* (*F. impari-*

pinnata trifoliolata), when above the single pair of leaflets, of which they are formed, there is a solitary petiolate leaflet; as in the genera *Dolichos*, *Glycina*, *Phaseolus*, &c.

Interruptedly pinnate leaves (*F. interrupte-pinnata*) (Fig. 89.), are those whose leaflets are alternately large and small; as in Common Agrimony (*Agrimonia Eupatoria*).

Decursively-pinnate leaves, or those of which the common petiole is winged by the prolongation of the base of the leaflets, we do not consider as compound leaves, as none of the leaflets can be pulled off without tearing the others. They are merely pinnatifid leaves.

Decompound leaves (*F. decomposita*) (Fig. 90.) are those

Fig. 90. Fig. 91.

in which the common petiole is divided into secondary petioles, which bear leaflets. They are named,

1. *Digitate-pinnate* (*F. digitato-pinnata*), when the secondary petioles represent pinnate leaves all issuing from the top of the common petiole; as in certain *Mimosæ*.

2. *Bigeminate* (*F. bigeminata*), when each of the secondary petioles bears a single pair of leaflets; as in *Mimosa Unguis-cati*.

3. *Bipinnate* (*F. bipinnata*, *duplicato-pinnata*), when the secondary petioles are so many pinnate leaves, proceeding from a common petiole; as in *Mimosa Julibrizin*, &c.

Supradecompound leaves (*F. supradecomposita*) (Fig. 91.) are those in which the secondary petioles are divided into tertiary petioles, bearing leaflets. Thus a *triternate* supradecompound leaf is one whose common petiole divides into three secondary petioles, each of which is again divided into three tertiary petioles, which themselves bear each three leaflets; as in *Actæa spicata*.

We have now, in some degree, described the numerous varieties of form, figure, consistence, simplicity, and decomposition, which leaves present. It was judged necessary to be somewhat particular in this respect, as many other organs, which we shall examine in succession, such as the stipules, sepals, petals, &c., exhibit similar modifications in their figure, form, structure, and other qualities, which being once described and defined, need only be mentioned to be perfectly understood.

Structure, Uses, and Functions of Leaves.

Leaves, as we have already said, are formed of three principal organs, namely, a bundle of vessels coming from the stem; parenchymatous substance, which is a prolongation of the herbaceous envelope of the bark; and, lastly, a portion of epidermis, by which they are covered in their whole extent.

The bundle of vessels constitutes the petiole, when the latter is present. These vessels are tracheæ, false tracheæ and porous vessels. In the petiole, they are externally enveloped by a layer of the herbaceous substance, which is prolonged over them when they come off from the stem. By their expansion and successive ramifications, they form the network of the leaf. The meshes or empty spaces which they leave between them are filled with parenchymatous tissue coming from the bark. This parenchyma is sometimes wanting, as in the *Hydrogeton*, when the leaf, consisting of its vascular network alone, presents the appearance of a kind of lattice-work or lace.

The epidermis which covers the surfaces of the leaf is generally thin and very porous, especially at the under surface. The two laminæ of this organ, seen upon the upper and under surfaces of the leaf, cover the part which is formed by the vascular fibres and parenchyma, and to which Professor De Candolle has proposed giving the name of *Mesophyllum*. This organ is sometimes very thin, as is observed in flat and membranous leaves; but in such as are thick and fleshy, in those of succulent plants for example, it is greatly developed, and gives the leaf its form.

The *Stomata* or pores which are observed on leaves, are, according to some authors, nothing but the upper orifices of the sap-vessels; from whence it results that they are the more abundant the more fibrous the leaf is.

The leaves and roots are the principal organs of absorption and nutrition in vegetables. The former absorb from the atmosphere the nutritious substances which are subservient to growth. Accordingly, some authors have designated them by the name of *aërial roots*. They are also subservient to other purposes of great importance in the economy of plants. They transpire and exhale the fluids which have become useless to vegetation, and it is by their agency that the sap is freed of the aqueous juices which it contains, and acquires all its nutritive qualities.

It is chiefly by the pores situated on the lower surface of the leaves of woody plants that the aqueous vapours and gases diffused in the atmosphere are absorbed. The lower surface, in fact, is softer, less smooth, and is almost always covered by a light down which is favourable to this absorption; while the upper surface, on the contrary, is smoother, generally glabrous, and performs the excretion of the fluids which are useless for the nutrition of the plant. This excretion is named *transpiration* in vegetables.

The leaves of herbaceous plants, being nearer the ground, and immersed in a constantly humid atmosphere, absorb equally by both surfaces. The knowledge of this fact we owe to the celebrated Bonnet. That naturalist laid some leaves of a tree upon water, placing their lower surface undermost, in which state they remained fresh and green for several months; while others, which he placed on the water with their upper surface in contact with it, became withered in a few days. Leaves of herbaceous plants remained green for a very long time in both positions.

The decomposition of the carbonic acid absorbed from the air is effected in the parenchyma of the leaves, as well as in all the other green and herbaceous parts of the vegetable. When exposed to the action of the sun, they decompose that gas, retain its carbon and disengage the oxygen. The reverse takes place when they are withdrawn from the influence of light, in which case they extract from the air a portion of its oxygen, which they replace by disengaging an equal quantity of carbonic acid gas. It is well known that vegetables, when removed from the influence of the sun, become blanched, in other words, lose their green colour, are rendered soft and watery, and contain a larger proportion of saccharine principle. But we shall speak more particularly of the phenomena of absorption and transpiration, when we come to treat of nutrition in plants.

The leaves are susceptible of certain motions which evidently depend upon the irritability of which they are possessed. This property in plants is clearly established by numerous and authentic facts.

If a branch still attached to its stem be so placed that the lower surface of the leaves is turned upwards, the leaves will be seen gradually to turn round and resume their natural position. This fact may be daily observed in pruning and palisading espaliers; such as the Peach, the Vine, &c.

Compound and articulated leaves, in other words, those whose leaflets are attached by a joint to the common petiole, are those which present the most remarkable motions. Thus the leaflets of many Leguminosæ, whose leaves are all articulated, have a different position at night from that which they occupy in the day. Linnæus called this singular phenomenon the *sleep of plants*. The leaflets of the Acacia, for example, are extended nearly in a horizontal direction at sunrise; but as the day advances, they gradually rise, and at length become almost vertical, falling again as the day declines.

Other plants present similar phenomena, which appear to us to depend upon the influence of light, as, in fact, may be inferred from the ingenious experiments of M. De Candolle. That excellent botanist having placed some plants with compound leaves in a dark cellar, changed their hours of sleeping and waking, by depriving them of light during the day, and exposing them to a strong light at night.

But the leaves of certain plants also perform motions depending upon irritability, and which cannot be attributed to the influence of light alone. The Sensitive Plant *(Mimosa pudica)* is of this kind. The slightest shock, the least agitation of the air, the shadow of a cloud or of any other body, the action of the electric fluid, heat, cold, irritating vapours, such as chlorin or nitrous gas, are sufficient to cause its leaflets to perform the most singular motions. If one of them be touched, it raises itself against the one which is opposite to it, and presently all the other leaflets of the same leaf perform a similar motion, until at length they cover each other like tiles on the roof a house. The leaf itself soon after bends towards the ground. But, in a short time, if the exciting cause has ceased to operate, all these parts, which seemed withered, resume their natural aspect and position.

Hedysarum gyrans, a singular plant, which is a native of Bengal, presents very remarkable motions. Its leaves are unifoliate, and have two smaller lateral stipules. The two stipules perform a twofold motion of bending and twisting upon themselves, which in the one appears to be independent of that of the other. In fact, one of them sometimes moves with rapidity, while the other continues at rest. This motion takes place without the intervention of any external stimulus, and is not suspended at night. The motion of the leaflet, on the contrary, appears to depend upon the action of light, and ceases when the plant is withdrawn from it.

The leaflets of the *Porliera* approach each other and stick together, whenever the sky is cloudy.

Dionæa Muscipula, a native of North America, has two lobes connected by an intermediate hinge, at the extremity of its leaves. When an insect or any other body touches and irritates one of the small glandular bodies which are observed on their upper surface, the two lobes quickly rise, approach each other, and seize the insect by which they were irritated. From this circumstance, the plant has received the vulgar name of *Fly-trap.* But it is to be remarked, that the only irritable parts in this leaf are the two or three small glandular points which are observed on its upper surface.

M. Du Trochet, of whom we have already made honourable mention in the course of this work, has particularly attended to the motions of the leaves of vegetables, more especially in the Sensitive Plant. The opinions which he has formed on this subject, we shall here briefly state.

At the base of the petiole of *articulated* leaves, which are the only ones that exhibit the motions dependent upon irritability, there is observed a swelling which is afterwards terminated by a very perceptible contraction. It had been supposed that the motions took place in this contracted part, which was looked upon as similar to the joints of the limbs of animals; but M. Du Trochet's experiments tend to prove that all the motions are performed in the enlarged part itself, and that they consist solely of flexion and rising. In the first of these cases, it forms a curve, the convexity of which is turned upwards. In the other case, it is nearly straight. The enlargement at the base of the leaf is essentially composed of fine and delicate cellular tissue, furnished with a very large quantity of small grains of a green colour, which, in M. Du Trochet's opinion, are so many nervous corpuscules. At the centre is found a bundle of nutritious vessels. The cellular tissue of the enlarged part is the seat of the motions which the petiole performs, and these motions may be destroyed by removing it. Thus when the cellular tissue is taken away from the lower side of the enlargement, the leaf remains bent, and is incapable of rising; and, when it is removed from the upper part, the leaf retains the faculty of rising, but is no longer able to bend. From this experiment it clearly follows, that the bending of the leaf is produced by the action of the upper part of the enlargement, while its rising is effected by means of the lower part. These parts may be compared to two opposing springs, one of which becomes alternately stronger than the other.

In more attentively examining the internal organization of the enlargement, M. Du Trochet made another discovery. If a very thin slice of the cellular tissue of this part be cut off from the upper side, it immediately bends in a circular form, with its concavity always directed towards the axis of the enlargement. If the same operation be performed on the lower side, the concavity of the circle is also directed towards the centre. From this it would appear that the enlargement is composed of two antagonist springs, which have a tendency to curve in opposite directions, the lower spring raising the petiole, while the upper depresses it. M. Du Trochet gives the name of *incurvation* to this property, which the laminæ of the enlargement of the petiole possess.

The immediate cause of these motions of incurvation resides, according to our author, in the nervous action excited by external agents. It was natural enough for M. Du Trochet, after attributing to plants a nervous system similar to that of animals ,to give it, in the phenomena of vegetation, the important influence which that system exercises upon the actions of animal life. In this way, then, the action of the nervous system is the cause of the visible motions of vegetables, as it is of those of animals. But, were this really the case, the nervous system would be, as in animals, the organ by which these motions are transmitted; or, in other words, the part which transmits the stimulus which excites the action of that system. Now, by M. Du Trochet's own avowal, this is not the fact; for, by extremely delicate experiments, he has found that the nervous action which produces the motions of the leaves, is transmitted solely by the vessels which form the medullary tube, although these vessels are entirely destitute of nervous tubercles. In this manner, then, the nervous system of vegetables would be the agent of the nervous power, without being the organ by which that power is transmitted.

From this brief statement, it would appear to us that the important question of the cause of the motions of the leaves has not yet received a full solution, and that new experiments are still necessary to enable us to come to any satisfactory conclusion with respect to it.

Of Defoliation, or the Fall of the Leaves.

A PERIOD arrives every year, when most vegetables are stripped of their leaves. It is commonly at the end of autumn, or the beginning of winter, that trees lose their foliage. But the phenomenon does not take place at the same period in all plants. It is observed, in general, that the trees whose leaves are earliest expanded, are also those which lose them first, as is seen to be the case with the Lime, the Horse-chestnut, &c. The Elder forms an exception to this rule; for its leaves appear at an early season, and are very late in falling. The Common Ash presents another peculiarity: its leaves are very late in coming out, and fall at the end of summer.

Petiolate leaves, and especially those which are articulated upon the stem, detach themselves sooner than those which are sessile, and still more so than those which are amplexicaul. In general, in herbaceous plants, whether annual or perennial, the leaves die along with the stem, without previously separating.

There are trees and shrubs which remain always adorned with their foliage. These are, in general, the resinous species, such as Pines and Firs, or certain vegetables whose leaves are stiff and leathery, as the Myrtles, Alaterni, Rose-laurels *(Neria)*, &c. These are named *Evergreen* trees.

Although the fall of the leaves generally takes place at the approach of winter, cold is not to be considered as the principal cause of this phenomenon. It is much more natural to attribute it to the cessation of vegetation, and the want of nourishment which the leaves experience at that season, when the course of the sap is interrupted. The vessels of the leaf contract, dry up, and, soon after, that organ is detached from the twig on which it had been developed.

Economical and Medicinal Uses of the Leaves.

Many vegetables are cultivated in our gardens on account of their leaves, which afford excellent food. Thus we frequently employ different varieties of Cabbage, Spinage, Sorrel, Celery, Artichoke, and many other species. It may here be remarked, that cultivators often take advantage of the property which vegetables possess, when removed from the action of light, of becoming more tender and saccharine, to render them better adapted for being used as food by man.

Leaves possess many useful medicinal properties; and, in reference to this subject, may be arranged as follows:

1. *Emollient* leaves: Marsh-mallow, *Althæa officinalis;* Round-leaved Mallow, *Malva rotundifolia;* Beet, *Beta vulgaris.*

2. *Bitter* or *Tonic* leaves: Marsh Trefoil, *Menyanthes*

trifoliata; Common Speedwell, *Veronica officinalis;* Water Speedwell or Brooklime, *Veronica Beccabunga;* Common Centaury, *Erythræa Centaurium.*

3. *Exciting* or *Stimulant* leaves: the Orange, *Citrus Aurantium;* Pepper-mint, *Mentha piperita;* Curled Mint, *Mentha crispa;* Sage, *Salvia officinalis;* Water Cress, *Sisymbrium Nasturtium;* Scurvy-grass, *Cochlearia officinalis;* Garden Cress, *Lepidium sativum.*

4. *Narcotic* leaves: Hemlock, *Conium maculatum;* Stramonium, *Datura Stramonium;* Tobacco, *Nicotiana Tabacum;* Belladonna, *Atropa Belladonna;* Purple Foxglove, *Digitalis purpurea,* &c.

5. *Purgative* leaves: Italian Senna, *Cassia Senna;* Alexandrian Senna, *Cassia lanceolata;* Gratiola, *Gratiola officinalis;* Bladder Senna, *Colutea arborescens.*

CHAPTER V.

OF THE STIPULES.

The *Stipules* (*Stipulæ*) (Fig. 92. *a*, *a*, *a*), are organs connected with the leaves. They do not exist in monocotyledonous plants, but only in those which are dicotyledonous, of which, however, some have none. They are small scale-like or leafy appendages, which are observed at the point where the leaves come off from the stem. They are commonly in pairs, there being one on each side of the petiole, as in the Hornbeam and Lime. They are more frequently free, not being attached to the petiole; but, at other times, they are united to the base of that organ, as in the genus *Rosa*.

Fig. 92.

The stipules afford excellent characters for the arrangement of plants. When a vegetable of a natural family has these organs, it is very seldom the case that all the others are not equally provided with them. Thus they exist in all the plants of the families of *Leguminosæ*, *Rosaceæ*, *Tiliaceæ*, &c.

As they fall off very easily when they are free, their absence might sometimes induce one to suppose a plant destitute of them; but this error may easily be avoided by observing that they always leave on the stem, at the place where they were attached, a small cicatrix, which attests the fact of their having existed.

In the exotic Rubiaceæ, with opposite leaves, such as the genera *Coffæa*, *Psychotria*, and *Cinchona*, the stipules are situated between the leaves, and appear to be nothing but abortive leaves. In fact, in the Rubiaceæ of our climates, such as the genera *Galium*, *Rubia*, and *Asperula*, they are substituted by true leaves, which then form a whorl around the stem.

Some plants, as the Barberry (*Berberis vulgaris*), have single stipules.

When there are two, they are always distinct from each other; but sometimes they unite and are *connate* (*Stipulæ connatæ*), as in the Hop (*Humulus Lupulus*). The stipules may be united within the axil of the leaf, between the stem and the petiole, in which case they are said to be *axillar* (*S. axillares*); as in *Melianthus major*. It is very probable that the membranous sheath of the Polygoneæ, to which the name of *Ochrea* has been given, is formed by the union of two stipules.

The stipules vary greatly in their nature and consistence. Thus they may be *foliaceous* (*S. foliaceæ*); in other words, similar to leaves, as in the Common Agrimony (*Agrimonia Eupatoria*); *membranous* (*S. membranaceæ*), as in the genera *Ficus* and *Magnolia*; *spinescent* or thorny (*S. spinescentes*), as in the Jujube (*Zizyphus vulgaris*), and the Gooseberry (*Ribes Grossularia*).

Their *figure* is not less diversified than that of the leaves. Thus they may be orbicular, oval, sagittate, reniform, &c. They may also be entire, toothed, or laciniate.

With respect to *duration*, some are *fugacious* (*S. fugaces*), or fall off before the leaves; as in the Common Fig (*Ficus carica*), and the Lime (*Tilia europæa*). Others are merely *caducous*, or fall at the same time as the leaves; as is the case in most plants. Lastly, There are others which continue for a longer or shorter time after the leaves have fallen; as in the Jujube, the Gooseberry, &c.

The use of the stipules appears to be to protect the leaves before their expansion, as is evidently shown by their relative disposition in the buds of the *Amentaceæ*, *Rosaceæ*, and other families.

CHAPTER VI.

OF THE TENDRILS OR CIRRHI.

By these names are designated appendages which are generally filamentous, situated on different parts of the plant, simple or branched, twist themselves, in a spiral form, around neighbouring bodies, and thus serve to support the stem of weak and climbing plants.

Tendrils (*Cirrhi*) are in all cases abortive organs. Sometimes, in fact, they are floral peduncles, which have been greatly elongated, as in the Vine, and are occasionally seen to bear flowers and fruits. Sometimes they are formed of petioles; as in many species of *Lathyrus*, *Vicia*, and other genera. At other times, they are altered stipules, or even abortive twigs. Not unfrequently, the leaves themselves are rolled up at the extremity, and thus constitute a kind of tendrils, as in the Pink.

The relative position of the tendrils deserves to be carefully attended to, as it indicates the organ for which they are substituted. Thus in the Vine they are, like the clusters of flowers, *opposite* to the leaves, which shows them to be abortive clusters. They are *axillar* in the Passion-flowers; *petiolar* in *Lathyrus latifolius* and *Fumaria vesicaria; peduncular* in the Vine; *stipular* in certain species of Smilax. Lastly, they may be *simple*, as in *Bryonia alba*, or *branched*, as in *Cobæa scandens.*

The name of *Claspers* is given to the kind of roots which sarmentaceous and climbing plants sink into the bodies on which they raise themselves, as in the Ivy and *Bignonia radicans;* while that of *suckers* is given to the very slender filaments which are met with on the surface of claspers, and which appear to be destined to absorb the nutritious parts contained in the body into which they are inserted.

CHAPTER VII.

OF THE SPINES AND PRICKLES.

Spines or *Thorns* (*Spinæ*) (Fig. 93), are sharp-pointed organs, formed by the prolongation of the internal tissue of the vegetable; while *Prickles* (*Aculei*) originate only from the most external part of plants, that is, from the epidermis, from which they may be detached with the greatest ease.

Fig. 93.

The origin and nature of the spines are not less variable than their seat. They are substituted for the leaves in certain African species of Asparagus, and for the stipules in the Jujube and the Gooseberry. Very frequently they are merely abortive twigs; as in the Sloe, which, on being transplanted into a good soil, changes its spines into twigs. The trunk of some trees is so covered with spines as to render them inaccessible; of which kind are the different species of *Gleditschia*. The persistent petioles of *Astragalus Tragacanthos* are converted into spines.

According to their situation and origin, they are *cauline* (*Spinæ caulinæ*), when they spring from the stem; as in the genera *Cactus* and *Gleditschia*.

Terminal (*Sp. terminales*), when they are developed at the extremity of the branches and twigs; as in the Sloe (*Prunus spinosa*).

Axillar (*Sp. axillares*), when they are situated in the axilla of the leaves; as in the Citron (*Citrus medica*).

Infra-axillar (*Sp. infra-axillares*), when they spring from beneath leaves or twigs; as in the Gooseberry.

Lastly, they may be *simple*, *branched*, *solitary*, or *fasciculate*. These terms it is unnecessary to define, as their meaning is obvious.

Prickles (*Aculei*) (Fig. 94.), have been considered by some physiologists as indurated hairs. They adhere but slightly to the parts on which they are observed, and may easily be detached from them, as is seen in the genus *Rosa*.


Fig. 94.

The modifications which they present with respect to situation, form, &c. are the same as in the spines.

CHAPTER VIII.

OF NUTRITION IN VEGETABLES.

Having now examined all the organs of vegetation, in other words, those which are subservient to the development and formation of the vegetable, let us next see in what manner nutrition is effected, what are the functions of these different organs individually with respect to it, and what are the circumstances necessary for its being performed.

Nutrition is a function by which vegetables assimilate a portion of the solid, liquid, or gaseous substances distributed in the earth or in the atmosphere, and which they absorb in these media, either by the delicate extremities of their radicles, or by means of the green parts which they spread out in the atmosphere.

The absorption of these substances, and their introduction into the vegetable tissue, are effected by virtue of a peculiar power of suction with which these different parts are endowed. We shall first explain the suction or absorption performed by the roots within the soil, and by the leaves and other green parts in the atmosphere; after which we shall describe the progress of the nutritious juices, or the sap, from the roots towards the leaves. We shall then examine the phenomena of transpiration, expiration, and excretion, and afterwards follow the sap in its retrograde course from the leaves towards the roots.

1. *Of Absorption or Suction.*

We have already said that the roots absorb the fluids and gases which occur diffused in the soil, by the minute extremities of their fibrils. But all the green parts of vegetables, such as the leaves, the young branches, &c. are in like manner possessed of a very remarkable power of suction, and contribute to the performance of this important function.

Immersed in the earth, the capillary radicles extract from it the moisture with which it is impregnated, by means of a kind of spongioles or aspirant mouths situated at their extremity. Water is the necessary vehicle of the nutritive substances of plants. It does not form the basis of the alimentation of the vegetable, as the older naturalists imagined; but it forms a solvent or menstruum to the bodies which are to be assimilated. In fact, if a plant be made to vegetate in distilled water, and withdrawn from all foreign influence, it will soon perish. Besides, do not vegetables contain carbon, gases, earthy substances, salts, and even metals in the state of oxides, or in combination with acids? Now, could water give rise to these different substances? Let us see, then, by what means they have been introduced into the interior of the plant, of which they have become constituent parts.

How has *carbon* been introduced into vegetables? It cannot have been in its pure and isolated state, as in that state it is very rare in nature, and is insoluble in water. But every body knows the great affinity which carbon has for oxygen. It is well known that carbonic acid, which is formed by their union, is very abundantly distributed in nature; that it occurs in the soil, and in the manures which are mixed with it; and that, being very soluble in water, that fluid always contains a certain quantity of it. It is, therefore, in the state of an acid that carbon is carried into the vegetable tissue. Now, we have already said that plants, when exposed to the action of the sun's rays, decompose carbonic acid, retain and assimilate the carbon, and reject the greater part of the oxygen. Water, then, can only serve as a vehicle to this alimentary substance of vegetation.

Oxygen also forms part of the substance of vegetables; and it were easy for us to account for the presence of that fluid in it. In fact, as is proved by the experiments of Theodore de Saussure, plants do not eject all the oxygen which acidified the carbon, but retain a certain quantity of it. The atmospheric air which circulates in vegetables also yields them a portion of the oxygen which it contains; but it is water chiefly that, in consequence of the decomposition which it undergoes in the vegetable tissue, and of which the ordinary laws of chemistry can no more afford a satisfactory explanation than of the decomposition of carbonic acid, furnishes it with the greater part of its oxygen, and at the same time yields it the hydrogen, which it also contains in so large a proportion.

Azote or *nitrogen*, which also occurs in vegetable substances, evidently derives its origin from the decomposition of atmospheric air in the interior of the plant.

Such are the different inorganic substances which enter essentially into the composition of the vegetable tissue, and of which its basis is formed. But there are others also, which, although not constituting a necessary part of its organization, are always found in it in greater or less quantity. Of this kind are lime, silica, carbonate, phosphate and malate of lime, carbonates of soda and potash, nitrate of potash, iron, &c. Now, it has been proved by the experiments of M. Theodore de Saussure, that these substances arrive ready formed in the interior of the vegetable. They are deposited in the soil or in the atmosphere, where they are dissolved, or carried along by the water which transports them into the interior of the vegetable tissue.

These substances are not formed by the act of vegetation, as some botanists and natural philosophers have alleged; but the soil or the medium in which vegetables grow yields them the alkalies, earths, and metallic substances, which chemical analysis discovers in them. This fact, which had already been proved by the numerous experiments of M. Theodore de Saussure, has been fully established by others recently made by M. Lassaigne. This young and able chemist has repeated M. Theodore de Saussure's experiments in the following manner:

"On the 2d of April last," says he, "I placed two grammes of Buckwheat seed *(Polygonum Fagopyrum)* in a platina capsule containing washed flowers of sulphur, which I had moistened with recently prepared distilled water. I placed it on a porcelain vessel which contained half a centimetre of distilled water, and covered the whole with a glass bell, at the upper part of which was a stop-cock, which, by means of a glass tube bent into a syphon and terminated by a funnel, allowed me to pour water from time to time upon the sulphur. At the end of two or three days, the seeds had for the most part germinated. They were daily watered, and by the end of a fortnight had thrown out stems six centimetres in height, which were surmounted by several leaves. They were carefully collected, together with several seeds which had not germinated, and reduced to ashes in a platina crucible. The ashes which were obtained weighed 0·220 grammes, and on being submitted to analysis, yielded 190 of phosphate of lime, 25 of carbonate of lime, and 5 of silica. Ten grammes of the same seeds, when incinerated, furnished the same quantity of ashes, which were found to consist of precisely the same principles."

By this experiment, which on being repeated afforded the same result, it is clearly shewn, that after they had been developed in distilled water, the young buckwheat plants did not contain a larger quantity of alkaline salts than the seeds from which they sprung: whence we may conclude, with M. Theodore de Saussure, *that the alkalies and earths which are found in plants have been absorbed and extracted from the soil.*

But by what power is the suction of the roots produced? The laws of physics and mechanics are insufficient for explaining such a phenomenon. The extraordinary force with which this absorption is operated cannot be conceived in a satisfactory manner without admitting a power—a vital energy—inherent in the vegetable tissue itself, and by its influence, the nature of which is unknown, producing the perceptible phenomena of vegetation.

We are indebted to the celebrated natural philosopher Hales for the most accurate and ingenious experiments, by means of which the prodigious power of suction, of which the roots and branches are possessed, is demonstrated. He exposed one of the roots of a Pear-tree, cut off its extremity, fitted to it one of the ends of a tube filled with water, and having the other end immersed in a mercurial trough, and in six minutes the mercury rose eight inches in the tube.

To measure the force with which the Vine absorbs humidity in the ground, Hales made an experiment, the results of which might appear inaccurate and exaggerated, had they not been verified of late years by M. Mirbel, who repeated the experiment. The English philosopher, on the 6th April, cut across a Vine shoot without twigs, of about seven or eight lines in diameter, at a height of thirty-three inches above the ground. He then fitted to it a doubly bent tube, which he filled with mercury up to the curve which surmounted the transverse section of the stem. The sap which issued had sufficient force to raise the column of mercury thirty-two inches and a half above its level, in a few hours. Now, the weight of a column of air of the height of the atmosphere is equal to that of a column of mercury twenty-eight inches high, or of a column of water of the height of about thirty-three feet. In this case the force with which the sap rose from the roots into the stem, was much greater than the pressure of the atmosphere.

Many facts and experiments demonstrate the office which the leaves perform in the phenomenon of suction and absorption. Thus, a branch detached from the tree of which it formed part, still absorbs with great power the fluid in which its extremity is immersed. The same action takes place when it is turned upside down, and its summit is immersed in the water, its absorbent power suffering no diminution.

In summer, we see that the heat of the sun causes the plants which ornament our gardens to shrivel and fade; but when we examine them at night or in the morning, we find that the dew which the leaves have absorbed has restored their vigour and freshness to them.

If a plant be entirely stripped of its leaves, it will soon perish, because the absorption which takes place by the roots is insufficient to supply all the materials necessary for its nourishment.

In many vegetables, and particularly in the genus *Cactus*, and other succulent plants, whose roots are very small, and which commonly vegetate on rocks, or in the shifting sands of deserts, it is evident that the absorption of the nutritious fluid is almost exclusively performed by the leaves and the other parts immersed in the atmosphere; for the smallness of the roots, and the extreme dryness of the soil in which they grow, would otherwise prevent them from vegetating.

From what we have just said, it will be seen that the absorbent surface of vegetables, compared with their general volume, is incomparably greater than in animals.

2. *Of the Course of the Sap.*

The *sap* is the colourless and essentially watery fluid which the roots absorb in the earth, and the leaves in the atmosphere, for the purpose of supplying nourishment to the plant. It contains in solution the true nutritious principles, and deposits them in the interior of the plant, as it passes through its tissue.

The older physiologists were long in doubt respecting the part of the stem through which the ascent of the sap takes place,—some believing it to be the pith, while others considered the bark as the seat of this singular phenomenon. But when recourse was had to direct experiments, it was shown that both these opinions were alike erroneous. In fact, the course of the sap is performed through the woody layers. The lymphatic vessels distributed in the wood and alburnum, serve as canals for the transport of this nutritive fluid. It is the part nearest the medullary tube that appears to be the principal seat of this ascent. If a branch or a young plant be immersed in a coloured liquid, the traces of the absorbed fluid may be followed, especially in the vessels near the medullary tube, whereas none of it will be seen either in the pith or in the bark. Coulon accidentally discovered this fact. He had a row of large poplars cut down, when in one of them which had been circularly sawn, and had fallen, but which still held to the stump by its centre, he saw bubbles of liquid and air rising from the inner fibres, and emitting a very distinct sound. He then tried some experiments on the trees which still remained to be cut down. Thus, on having them bored with a large auger, he found that the fragments which were taken from the outer layers of the wood were nearly dry, that they became moister as the auger went deeper, and that when it had arrived at the centre of the stem, the sap began to flow out at the surface. These experiments were laid before the Academy of Sciences, and MM. Desfontaines and Thouin, who repeated them, confirmed their accuracy. This fact, then, evidently proves that the ascent of the sap takes place in the woody layers, and especially in those which are nearest the medullary canal. It has also been shown by experiment, that the progress of the sap is not arrested in trees deprived of their bark, and in which the pith is more or less obstructed; while in trees from which all the woody layers are removed, it no longer takes place, although, in such as have only a small cylinder of woody layers remaining, the sap may still continue to ascend, as is the case in hollow trees, and especially willows, the trunk of which is very frequently carious in the interior.

In thus passing through the layers of the wood, in its progress upwards, the sap communicates with the lateral parts and branches of the stem, either directly by anastomosis of their vessels, or by gradually diffusing itself through the intermolecular pores with which the canals that transport it are perforated. The water, which forms its essential basis, and is impregnated with the principles destined for the nutrition of the plant, and the reparation of its expended fluids, gives them off in its progress, and deposits them in the vegetable tissue.

When speaking of the suction of the roots, we mentioned the experiments of Hales, which prove the force with which the progress of the sap takes place in a stem even of small diameter, as it acts with more power upon the mercury than a column of air equal to the height of the atmosphere. Bonnet has also made experiments for the purpose of determining the rapidity with which the sap may rise. Thus on immersing two stalks of the kidney bean in coloured fluids, he found that the latter rose sometimes half an inch in half an hour, sometimes three inches in one hour, and sometimes four inches in three hours.

There results from the observations and experiments of Professor Amici of Modena *, that the fluids contained in

* *Atti della Societ. Italiana,* vol. xviii. & xix; and *Ann. des Sc. Nat.* t. ii.

the vessels, or in the areolæ of the cellular tissue of plants, move and circulate in each of these vessels or cells, quite independently of the manner in which they move in the others. Each cavity, he says, constitutes a distinct organ, and in its interior the fluid moves in a circulating manner, independently of the particular circulation which takes place in each of the adjacent cavities. It was chiefly on *Chara vulgaris*, *Ch. flexilis*, and *Caulinia fragilis*, aquatic plants whose organization is more easily perceived on account of the transparency of their elementary parts, that Professor Amici made his observations. During his residence in Paris, in the summer of 1827, he showed me, by means of his admirable microscope, a great number of facts which have formed the basis of his observations. The motion of the fluid in each cavity of the cellular tissue, or in each vessel, may be distinctly perceived, on account of the solid particles which float in the fluid. These particles, which are globules of extreme minuteness, and sometimes of a very decided green tint, are seen ascending along one of the walls of the cavity, and, on arriving at the horizontal partition which separates the cell from the one above it, changing their direction, and following a horizontal course until they reach the opposite wall, when they descend along it to its lower part, where their course again becomes horizontal; after which they recommence the same route. In the same vessel there are thus always four different currents, an ascending, a descending, and two horizontal ones, in opposite directions.

It is very remarkable that the direction of the motion in each vessel does not seem to have any connexion with that which takes place in the neighbouring tubes. Thus sometimes two vessels in mutual contact present the same motion, while, in those which surround them, a directly opposite motion is observed in the fluids.

The same observer has also remarked, that no globule is seen passing from one cavity into another. "However," says he, "I do not pretend to maintain that the fluid contained in a vessel, does not, when circumstances require it, penetrate into the neighbouring vessels. I am even persuaded that this transfusion is necessary for the development of the plant; but it is only the most fluid and most subtile part of the juice that can penetrate through the membrane invisibly, by passing through holes which the eye, assisted by the microscope, is unable to perceive."

What is the cause of this independent motion of the fluid in each organic part of the vegetable? Some have attributed it to the irritability possessed by the membrane of which the tubes are formed. Professor Amici is not of this opinion. He thinks he recognises the moving power of the fluid in the small green or transparent grains lining the walls of the tubes where they are disposed in rows, and which, by an action similar to that of voltaic piles, produce the motion of the fluid. These green grains are evidently the same as those which M. Du Trochet considers as the nervous system of vegetables, and which, as we have already said, are nothing but globules filled with green matter.

But what is the cause of this ascent of the sap? How can that fluid rise from the roots to the upper part of the the stems? It may well be supposed that each of the older physiologists must have had an opinion of his own to account for this surprising phenomenon.

Grew attributed it to the action of the utricles. That author, who considered the vegetable tissue as formed of small utricles, placed in juxta-position, one above another, and all communicating together, thought that when the sap had once entered into the lower utricles, they contracted upon themselves, and pushed it into those immediately above; and that, by this mechanism, the sap at length reached the summit of the plant.

Malpighi, on the other hand, attributed the ascent of the sap to its alternate rarefaction and condensation by heat.

De La Hire, who supposed the sap-vessels to be furnished with valves, like the veins of animals, thought that it depended upon this arrangement.

Perault imagined it to be produced by a kind of fermentation.

Lastly, many persons have compared the progress of the sap in the vegetable tissue, to the ascent of fluids in capillary tubes. But it will readily be seen that such hypotheses are insufficient to account for the phenomena in question. In fact, if they were owing to the capillarity of the sap-vessels, their action would necessarily be independent of external circumstances, and even of the life of the plant; but this is not the case. Every person knows that the sap no longer circulates in a plant deprived of life. Life has therefore a direct and powerful action upon the exercise of this function. As in the suction performed by the roots in the soil, we have admitted a peculiar vital power, on which depend all the phenomena of vegetation, and which forms the distinctive character of living beings, and withdraws them from the influence of physical and chemical agents; so also are we here obliged to have recourse to it for explaining the progress of the sap. In fact, if all the phenomena of vegetation were only produced by the action of mechanical or chemical agents, by what characters could we distinguish vegetables from inorganic objects? We must therefore admit, in vegetables, as in animals, a vital power which presides over all their functions.

But although this vital power be the agent by which the ascent of the sap is produced, certain internal and external causes may facilitate the exercise of this phenomenon.

Among the external causes are to be ranked temperature, and the influence of light and electricity. It is generally known that a high temperature is singularly favourable to the progress of the sap. In fact, during winter, the tree is full of sap, but the latter is thick and stagnant. In spring, the return of heat causes the ascent of the juices in the vessels of the stem, which seemed to be obstructed by them.

Light and the electric fluid have also a decided influence upon the phenomena of the progress of the sap. It is well known that when the atmosphere is long charged with electricity, vegetables acquire a great development, which necessarily implies that the sap moves with more rapidity and power.

Certain internal causes, inherent in the vegetable itself, appear also to act upon the ascent of the sap. Of this kind are the greater or less quantity of cortical pores which the vegetable presents, and the greater extent of its surface. These two circumstances are evidently favourable to the rapidity and force of the progress of the sap.

We have just seen by what force and by what organs the sap is raised from the roots to the extremities of all the branches of the plant. Here other phenomena are produced, and a new circulation commences.

When the sap has arrived at the extremities of the branches, it spreads out into their leaves, where it loses part of the principles which it contained, and acquires new ones. The leaves and green parts are the seat of vegetable transpiration, expiration, and excretion. The sap is deprived, in them, of the atmospheric air which it still contains, of its superabundant quantity of aqueous principles, and of the substances which have become foreign or useless to its nutrition. But while it thus loses part of the principles of which it was previously constituted, it undergoes a particular elaboration, acquires new qualities, and, following a course the reverse of that which it has already performed, descends from the leaves towards the roots, through the liber or vegetating part of the cortical layers.

Let us now institute a particular examination of all the phenomena which are produced in the leaves in consequence of the ascent of the sap.

3. *Of Transpiration.*

The transpiration or aqueous emanation of vegetables, is that function by which the sap, on arriving in the leaves, loses and gives out the superabundant quantity of water which it contained.

It is generally in the form of vapour that this water is exhaled into the atmosphere. When the transpiration is not great, the vapour is absorbed by the air as it forms; but if the quantity increases, and the temperature of the atmosphere is low, the liquid is seen transpiring in the form of extremely small drops, which often unite together, and then acquire a considerable size. Thus at sunrise, limpid drops are often observed hanging at the point of the leaves of many Gramineæ. Cabbage-leaves also present them of large size. It was long thought that they were produced by dew; but Muschenbroëk first proved, by conclusive experiments, that they result from vegetable transpiration, condensed by the coldness of the night. He intercepted all communication between a poppy and the ambient air, by covering it with a bell, and between it and the earth, by covering the vessel in which it grew with a leaden plate. Next morning the drops appeared upon it as before.

Hales, in like manner, made experiments to determine the proportion existing between the quantity of fluids absorbed by the roots, and that exhaled by the leaves. He placed a plant of *Helianthus annuus* in a varnished vessel, which he covered with a plate of lead, having two holes in it, one for the passage of the stem, the other for the supply of water. He weighed this apparatus accurately for fifteen successive days, and found that the mean quantity of water expired during the twelve hours of day, was about twenty ounces. Dry and warm weather greatly increased the transpiration, which, in these circumstances, amounted to thirty ounces. On the contrary, an atmosphere loaded with moisture, sensibly diminished the quantity. Accordingly, the transpiration never exceeded three ounces during the night, and even sometimes became imperceptible when the night was cold and moist.

These experiments have since been repeated by MM. Desfontaines and Mirbel, who have again found occasion to admire the accuracy and sagacity of the English philosopher.

Senebier demonstrated, by numerous experiments, that the quantity of water expired was to that absorbed by the vegetable as two to three. This circumstance is an additional proof that a part of this liquid is fixed or decomposed in the interior of the plant.

These facts incontestably prove:

1. That vegetables transpire by their leaves; in other words, throw out a certain quantity of aqueous fluids.

2. That this transpiration is greater in proportion to the heat and dryness of the atmosphere; whereas in moist weather, and especially at night, there is scarcely any.

3. That this function is performed with greater activity, the younger and more vigorous the plant is.

4. That nutrition takes place more effectually the more the transpiration is proportionate to the absorption; for, when one of these functions is performed with more vigour than the other, the plant languishes. This is observed, for example, in plants which, on being exposed to the heat of the sun, fade and lose their vigour, because their transpiration is no longer proportionate to the absorption performed by the roots.

4. *Of Expiration.*

We have already shown that vegetables *absorb* or *inspire* a certain quantity of air or of other aëriform fluids, whether directly or mixed with the sap; that is, by means of their roots and leaves, which operate simultaneously in producing this effect. The portion of these absorbed fluids, which has not been decomposed for the purpose of supplying alimentary matter, is ejected by *expiration*. Plants, like animals, are therefore provided with a kind of respiration, which in the former, as in the latter, consists of two phenomena, inspiration and expiration, but with this remarkable difference that, in plants, there is no development of caloric. This function is very perceptible when we immerse a branch of a tree, or a young plant, in a glass bell filled with water, and expose it to the action of light. There is then seen rising from its surface a great number of small bubbles, which are formed of a very pure air, almost entirely composed of oxygen gas. On the other hand, let the experiment be made in a dark place, and the leaves will expire carbonic acid and nitrogen gas, but no oxygen. It must here be carefully remarked, that all the other parts of the vegetable which are not of a green colour, such as the roots, the bark, the flowers, and the fruits, when subjected to the same experiments, always exhale carbonic acid gas, but never oxygen. Consequently, the expiration of oxygen gas does not depend solely upon the direct influence of the rays of light, but also upon the green colouring of the parts.

We know that vegetables, when exposed to the action of the sun, absorb a great quantity of carbonic acid, which they decompose in the interior of their substance, and eject the greater part of the oxygen which was combined with the carbon. Now, this phenomenon is also a true expiration.

When a plant is dead or languishing, either expiration ceases entirely, or the expired fluid is always nitrogen gas. Some vegetables, even when exposed to the influence of the sun's rays, expire only azote. Of this kind are the Sensitive Plant, the Holly, the Rose-laurel, and some others. It seems difficult to point out the true cause of this anomaly.

Of Excretion.

The ejected matters of vegetables are fluids of various degrees of thickness, sometimes capable of condensing and becoming solid. They are of very diversified nature, being sometimes resins, wax, or volatile oils; sometimes saccharine substances, manna, fixed oils, &c. All these substances are thrown out at the surface by the power of vegetation. Thus the *Fraxinus Ornus*, and some other species of Ash, exude, in Calabria, a thick saccharine fluid, which, under the action of the air, becomes concrete, and forms *manna*. Pines, Firs, and, in general, all trees of the family of Coniferæ, furnish large quantities of resinous matter. Many plants, such as the *Ceroxylon andicola*, a superb species of Palm, described by MM. de Humboldt and Bonpland, and the *Myrica cerifera* of North America, yield a large quantity of wax, which is usefully employed in the countries to which these plants are indigenous.

Roots also excrete, by their slender extremities, certain fluids, which are injurious or useful to the plants that grow in their vicinity; and, in this manner, the likings and antipathies of certain plants may be accounted for. Thus, it is well known that the Creeping Thistle is hurtful to Oats, *Erigeron acre* to Wheat, *Scabiosa arvensis* to Flax, &c.

Such are the different phenomena which depend upon the presence of the sap, when it has arrived at the upper parts of plants. Let us now follow it in its retrograde course from the leaves to the roots.

Of the Descending Sap.

This has been a subject of much discussion among physiologists. In fact, several of them long denied the existence of a descending sap; but the perceptible phenomena of vegetation, and the most accurate experiments, have demonstrated that there really is a second sap, which follows a course the reverse of that which we have just examined. If a strong ligature be applied to the trunk of a dicotyledonous tree, there forms above it a circular swelling, which gradually becomes more prominent. Now, might this swelling be formed by the sap which ascends from the roots toward the leaves? Were this the case, it ought to present itself beneath the ligature, and not above it; but this is not what happens. The swelling, therefore, can only depend upon the obstacle which the juices encounter as they descend from the upper parts of the plant to the lower, in their passage through the cortical layers. There is, therefore, a descending sap.

The descending sap, divested of the greater part of its watery principles, more highly elaborated, and containing more nutritious principles than the ascending sap, contributes essentially to the nourishment of the plant. As it circulates in the vegetating part of the stem, the only part susceptible of growth, its uses cannot be equivocal.

Let us examine more strictly the phenomena which result from the application of a circular ligature to the trunk of a dicotyledonous tree, and we shall see that not only does a swelling form above the ligature, but also that the part of the trunk situated beneath it ceases to grow, no new circular layer being henceforth added to those which previously existed. Now, do we not here see, in the clearest manner, the use of the descending sap? It continually maintains and renews the cambium, and contributes essentially to the growth and development of dicotyledonous trees.

But this second sap is not of the same nature in all vegetables. There are some in which it forms a white and milky juice, as in the *Euphorbiæ*. In others (the *Papaveraceæ)* it is a yellowish or brownish fluid; and in the *Coniferæ* it is resinous. But it is necessary to remark, that, in the opinion of many physiologists, the proper juices of plants are not the descending sap itself, but fluids which are separated from it by the act of vegetation. The diversity of nature which these juices present, their occurring in some vegetables only, and their being contained in vessels appropriated to themselves and existing in small number, appear to us so many proofs in favour of this opinion.

We have now given a successive account of the various phenomena which are connected with the nutrition of plants, or contribute to effect it. We have seen the juices which have been absorbed by the roots in the earth conveyed by an inherent power, depending upon the life of the plant, to the highest parts of the ultimate ramifications of the stem. There, we have seen them mingling with the absorbed fluids, losing such of their aqueous and aëriform principles as are useless for nutrition, and thus acquiring new properties; after which, pursuing a retrograde course, they become the true aliment of the plant.

We thus see, that, although nutrition in plants has a great analogy to the same function in animals, it yet differs essentially from the latter. Thus animals introduce by their mouth the different substances by which they are nourished; while plants absorb, in the interior of the earth, by the imbibing orifices which terminate their roots, water impregnated with substances which are either necessary or useful for their nutrition.

In animals, the substances that have been introduced pass along a single canal, from the mouth to the place where the substance which is alone directly subservient to nutrition (the *chyle*), is to be separated from the useless and excrementitious parts. In vegetables the same phenomena take place; the absorbed fluids pass through a certain course before they arrive at the leaves, in which the parts essential to nutrition are separated from those which are useless.

Animals and vegetables eject the substances which are unfit for their nutrition.

One of the most striking differences between vegetables and animals consists in the circumstance, that the former are essentially nourished by inorganic substances, such as water, carbon, hydrogen, oxygen, &c., whereas the substances which alone are subservient to the nutrition of animals are organic, and derived from the animal and vegetable kingdoms.

The chyle, or the part by which the nutrition of animals is effected, mingles with the blood, which it continually renews and keeps up in due quantity, circulates through all parts of the body, and serves for the development and nutrition of the organs. The sap of plants, after being exposed in the leaves to the influence of the air, and changing its nature and properties, descends into all parts of the vegetable, carrying into them the materials necessary for their growth, and thus effecting the development of all their parts.

SECOND CLASS.

ORGANS OF REPRODUCTION.

The Organs of Reproduction, which are also called Organs of Fructification, are those by which the preservation of species and the propagation of races are effected. Their office is not less important than that of the organs whose structure and uses we have already examined; for, if the latter are necessary for the existence of the individual, and the development of all its parts, the organs of reproduction are again necessary to enable the individual to procreate others similar to itself, by which its species may be renewed and perpetuated.

In plants, the flower, the fruit, and the various parts of which they are composed, constitute the organs of reproduction. We shall, accordingly, divide this part of our subject into two sections, the one containing the organs of florescence, the other the organs of fructification.

Sect. I.—Of the Organs of Florescence.

General Considerations respecting the Flower.

We are already acquainted with the parts by which the plant is fixed in the soil, and the aqueous and aëriform fluids necessary for its nutrition and development are absorbed in the earth, or in the atmosphere. We have examined the series of organs which concur towards the maintenance of individual life. Let us now turn our attention to those not less essential organs, whose action tends to renew and perpetuate the species.

Here we find a great resemblance between animals and vegetables. Both, in fact, are provided with particular organs, which, by their mutual influence, concur in producing the most important function of their life. Generation is the ultimate object for which nature has created the various organs of vegetables and animals. They exhibit the most perfect similarity in respect to this great function. From the action which the male organ exercises upon the female organ, results *fecundation*, the phenomenon by which the embryo, yet in the rudimentary state, receives and preserves the vivifying principle of life. Here, however, we remark the modifications which nature has impressed upon these two great classes of organized beings. Most animals are furnished at birth with the organs which are, at a future period, to effect their reproduction. These organs remain in a state of torpidity until the period when nature, imparting to them a new energy, renders them capable of performing the offices for which they were destined. Vegetables, on the contrary, are, at their first appearance, destitute of sexual organs, these not being developed by nature until the moment when they are to be employed for the purpose of fecundation. Another great dissimilarity between animals and vegetables is, that, in the former, the sexual organs are capable of performing the same function several times, and exist during the whole life of the individual which bears them; while in vegetables, which have a soft and delicate texture, these organs have only a temporary existence, make their appearance for the purpose of accomplishing the views of nature, and fade and disappear whenever they have performed their office.

We admire the wisdom by which Nature has regulated the distribution of sexes in organized beings. Vegetables, which are invariably fixed to the place in which they have sprung to life, and are destitute of the locomotive faculty, usually bear on the same individual the two organs by the reciprocal action of which fecundation is to be effected. Animals, on the other hand, which, being possessed of will and the faculty of moving, can pass in any direction from one place to another, generally have the sexes separated upon distinct individuals. For this reason, the union of the sexes in one individual is as common in vegetables as it is rare among animals.

The flower is essentially constituted by the presence of one of the two sexual organs, or of the two placed together upon a common support, with or without external envelopes intended for their protection.

In its greatest degree of simplicity, the flower may, therefore, consist of only a single sexual organ, male or female, that is, of a *stamen* or a *pistil*.

Thus, in the Willows, whose flowers are *unisexual*, the *male* flowers merely consist of one, two, or three stamina, attached to a small scale. The *female* flowers are formed of a pistil, which is also accompanied with a scale, but without any other organs. In this case, as in many others, the flower is as *simple* as possible. It then takes the name of *male flower* or *female flower*, according to the organs of which it is composed.

The *hermaphrodite flower*, on the other hand, is that in which the two sexual organs, the male organ and the female organ, exist together.

But the different flowers which we have just examined are not *complete*. In fact, although the essence of the flower consists in the sexual organs, yet, before it can be called perfect, it must present other organs, which are not indeed essential to it, but which, nevertheless, belong to it, and assist it in performing its functions. These organs are the floral envelopes, or *perianth*, that is, the *calyx* and the *corolla*. A *complete* flower, then, is one which presents the two sexual organs surrounded by a corolla and a calyx.

With reference to its primary organization, it may be said that the complete flower consists of four verticils of variously modified leaves, placed very close to each other. We shall afterwards explain this idea at length, when we shall have described the different constituent parts of the flower and their relative position.

It is of importance here to examine the order in which the different organs that constitute a complete flower are symmetrically disposed.

Proceeding from the centre towards the circumference, we first find the *pistil*, or female sexual organ, which always occupies the central part of the flower. It consists of the *ovarium*, the *style*, and the *stigma*. Externally of this, we observe the male sexual organs, or *stamina*, which are generally more numerous than the pistils, and are composed of a *filament* and an *anther*.

On the outside of the stamina is found the innermost of the two floral envelopes, or the *corolla*, which is called *monopetalous*, when it is formed of a single piece, and *polypetalous*, when it is formed of several pieces or petals. Lastly, the outermost of the two floral envelopes is the *calyx*, which is *monosepalous* or *polysepalous*, according as it is composed of one or of several pieces, which are named *sepals*. Whatever occurs externally of the calyx, does not properly belong to the flower. Of this kind are the *floral leaves* or the *bracteas*, which very frequently accompany them, and which are to be considered as accessory parts.

Let us take from nature an example of a flower, in which we shall examine and name the various parts above enumerated; and let that example be the Garden Wallflower (*Cheiranthus Cheiri*).

We see the centre of the flower occupied by a small elongated body, a little compressed, and, when longitudinally split in its two lower thirds, presenting two cavities, in which are contained the ovules. This body is the *pistil.* It is composed of an *ovary* or lower part, a *style*, which is a thread-like prolongation of the summit of the ovary, and which is terminated by a small clammy, glandular, and two-lobed body, the *stigma.* Externally of the pistil, we find six organs all of the same form and structure, arranged in a circular manner around the female organ, each composed of an inferior filamentary part, which is surmounted by a kind of small ovoidal bag, having two cells, filled with a yellowish powder. By their position and structure we know that these parts are the *stamina*, or male sexual organs. Their lower slender part is the *filament;* their upper ovoidal part the *anther*, and the powder which they contain is the *pollen.* In examining what remains on the outside of the sexual organs, we perceive eight membranous appendages, arranged in two rows, four more internal, and four occupying the outer part of the flower. The four inner, larger, yellow parts, perfectly similar to each other, constitute a single organ, the *corolla*, which in this case is composed of four distinct pieces or *petals.* It is now very easy for us to name the four greenish pieces, of smaller size, which are situated externally of the corolla, as we already know that the outermost of the two floral envelopes is the *calyx*, which here is formed of four pieces or sepals.

Such are the structure and relative position of the different organs which constitute a complete flower. Let us now examine some flowers in which some of the organs which we have just enumerated are not met with. In the Tulip, for example, we find in the centre of the flower the *pistil*, which is composed of a prismatic, three-sided ovary, having its summit crowned by a glandular body, which is the *stigma.* There is no *style.* Externally of this, we see six stamina, in the structure of which there is nothing remarkable. These, then, are the two sexual organs; but beyond them we find six membranous pieces or segments, perfectly similar to each other, and evidently forming a single organ. In this flower, there is therefore wanting one of the two floral envelopes. But which of them is it that is wanting? This is a question which has received much discussion from botanists, and has not yet been settled to the satisfaction of all parties. In fact, some of them, following Linnæus, call a single floral envelope placed externally of the sexual organs, when it has lively colours, a *corolla*, and when it is green, a *calyx*. This distinction, however, is not founded on very solid characters. Others, with M. Jussieu, following the laws of analogy, consider it as a calyx whatever may be its colour and consistence. We are of this opinion, and shall give the name of *calyx* to the single floral envelope which presents itself around the sexual parts. Other authors, wishing to reconcile these differences of opinion, and in some measure to conciliate both parties, give the name of *perigonium* to the single floral envelope which surrounds the sexual organs. The Tulip, which we are examining, has then a *calyx* formed of six *sepals*, or a *perigonium* composed of six distinct pieces.

Lastly, as we have already seen, there are flowers in which the two floral envelopes are both wanting. These are named *naked* flowers, to distinguish them from those which are furnished with floral envelopes.

CHAPTER I.

OF THE PEDUNCLES AND BRACTEAS.

The flower may be fixed in various ways to the branches or twigs which support it. Thus, it is sometimes directly attached by its base, without the aid of any accessory or intermediate part. In this case, it is said to be *sessile (Flos sessilis)*. On the other hand, it is named *pedunculate (Flos pedunculatus)* (Fig. 95.), when it is attached by means of a peculiar prolongation, commonly named the *stalk* of the flower, and botanically designated by the name of *Peduncle* (Fig. 95. *a*). The peduncle of the flower, like the petiole of the leaf, may be simple or branched. When it is branched, each of its divisions, bearing a single flower, takes the name of *Pedicel*, and the flowers are said to be *pedicellate (Flores pedicellati)*. Thus the flower of the Pink is pedunculate, and each of the flowers which compose the cluster of the Lilac or Vine is pedicellate.

Fig. 95.

The *Peduncle (Pedunculus)*, or support of the flowers, assumes various modifications, which it is necessary to make known.

Thus, according to its *situation*, it is *radical*, when it proceeds from the axil of a radical leaf; as in the Dandelion *(Leontodon Taraxacum)*, and the Cowslip *(Primula veris)*.

It obtains the particular name of *Scape (Scapus)*, when it proceeds immediately from an assemblage of radical leaves; as in the Hyacinth, the genus *Narcissus*, &c.

It is *cauline* or *rameal*, according as it springs from the stem or branches; which it generally does.

It is *petiolar (P. petiolaris)*, when it is united to the petiole, in part of its length.

Epiphyllous (P. epiphyllus), when, in place of growing upon the stem or branches, it springs from the surface of the leaves themselves; as in *Ruscus aculeatus*.

Axillar (P. axillaris), when it arises from the stem or branches in the axil of the leaves.

Extra-axillar or *lateral (P. extra-axillaris, lateralis)*, when it arises from the lateral parts of the point of insertion of the leaf; as in the *Solaneæ*.

Terminal (P. terminalis), when it terminates the summit of the stem, of which it appears to be the continuation.

The peduncle is *uniflorous*, *biflorous*, *triflorous*, or *multiflorous*, according to the number of flowers which it supports.

It is sometimes twisted in a spiral form, or like a screw; as in *Vallisneria spiralis*. *Cyclamen europæum* also presents this singular disposition, when its fruit approaches maturity.

It frequently happens that around a flower, or several flowers placed near each other, there is observed a certain number of small leaves differing entirely from the rest in their colour, form, consistence, or other qualities. These are named *Bracteas (Bracteæ)* (Fig 96. *a*). The bracteas must not be confounded with the *floral leaves* properly so called, which do not differ materially from the other leaves of the same plant, but are only smaller and nearer the flowers. Thus in *Salvia horminum* and *S. sclaræa*, the bracteas are very apparent, and very distinct from the leaves, being of a blue colour.

Fig. 96.

When the bracteas or the floral leaves are symmetrically disposed around one or more flowers, so as to form a kind of accessory envelope, they are collectively named an *involucre*. Thus, in the genus *Anemone*, we find beneath the flower three floral leaves symmetrically disposed, and constituting a *triphyllous* or *three-leaved involucre.* The involucre is said to be *tetraphyllous*, *pentaphyllous*, *hexaphyllous* or *polyphyllous*, according as it is formed of four, five, six or more bracteas. When the *peduncle* is divided, and there occurs at the base of each pedicel a small involucre, the latter is named *involucel.* Thus, in the Carrot, there is observed at the base of the peduncles a *polyphyllous involucre*, and at the base of the pedicels an *involucel*, which is also polyphyllous.

The *bracteas* are generally *free*, without any adhesions; but sometimes they adhere to the peduncle of the flower, as in the Lime *(Tilia europæa).*

They have commonly a *foliaceous* structure and consistence. Sometimes, however, they are small scales, varying in number, and arranged close together around the flower. In this case, if they are persistent, and surround the base of the fruit, or entirely envelope it, at the period of its maturity, they form what by botanists is named a *Cup (Cupula)*; as in the genus *Quercus*, &c. (Fig. 97.)

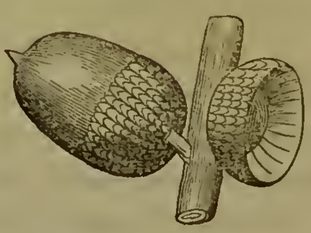
Fig. 97.

The *Cupula* may be *squamaceous*, or formed of small scales placed very close together; as in the Oak *(Quercus Robur).*

It may be *foliaceous*, or formed by small leaflets, more or less free and distinct; as in the Hasel *(Corylus Avellana).*

Lastly, it is sometimes *pericarpoid*, that is, formed of a single piece, covering and entirely concealing the fruit, sometimes opening regularly, to allow them to escape at the period of their maturity; as in the Chestnut, the Beech, &c.

When the *involucre* surrounds a single flower, is very close to it, and resembles a calyx, it is named the *caliculus* or outer calyx; as in the genera *Malva* and *Althæa.* Flowers which are thus furnished with a caliculus are named *caliculate (Flores caliculati)*.

The *Spatha* is a membranous involucre, enclosing one or more flowers, which it entirely covers previous to their expansion, and which are not exposed to view until it has burst. Thus, in the Palms, the genus *Narcissus*, the different species of *Allium*, such as the Onion, &c. the flowers are enveloped in a spatha.

It is *monophyllous*, or consists of a single piece, as in *Arum maculatum; diphyllous*, or of two pieces, as in the Garlic, Onion, &c.

Cuculliform or *cowl-shaped (Spatha cucullata)*, bent in the form of a horn; as in *Arum*.

Ruptile (S. ruptilis), irregularly bursting to allow the flowers to issue; as in the genus *Narcissus*.

Uniflorous, *biflorous*, or *multiflorous*, according as it contains one, two, or a greater number of flowers.

Membranous (S. membranosa), when it is thin and semitransparent; as in the genera *Narcissus* and *Allium*.

Woody (S. lignosa), when it has the consistence and texture of wood; as in several Palms, for example, the Date *(Phœnix dactylifera)*.

Petaloid (S. petaloidea), when it is soft and coloured like the corolla; as in *Richardia æthiopica*, &c.

Sometimes the flowers contained in a spatha are enveloped each in a small spatha of its own, which is named *spathella;* as in most of the Irideæ.

The Gramineæ and Cyperaceæ, which differ so much from the other families of plants in their general appearance and the structure of their organs, have neither calyx nor corolla properly so called. The parts to which these names have been given in them differ essentially from the same organs in other phanerogamic vegetables, and are nothing else than true involucres, which, however, affect a peculiar arrangement, not observed in other plants. They have, accordingly, received particular names.

Thus the name of *glume (gluma)* is given, in the *Gramineæ*, to the two scales, varying greatly in form, which are placed nearest to the sexual organs (Fig. 98. *a a*). Sometimes these two scales are united into one, which is then bifid; as in *Alopecurus* and *Cornucopiæ*. All the other scales which are placed externally of the *glume* constitute the *lepicene (lepicena)*. They vary much in number: thus, there is one in *Agrostis canina* of Linnæus, two in most of the other species of *Agrostis*, in *Cynodon*, &c. (Fig. 98. *b b*). In many cases, there are observed externally of the sexual organs one or two small bodies of very variable form, which are individually named *paleoles (paleolæ)*, and generally or collectively the *glumella* (Fig. 99. *a a*).

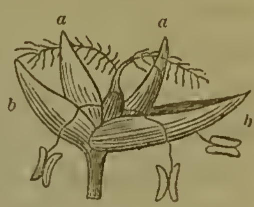

Fig. 98.

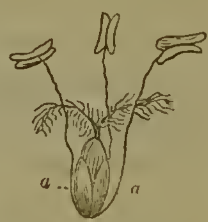

Fig. 99.

When, in the Gramineæ, two or more flowers are placed together, so as to form a kind of small *spikelet (spicula)* or *lodicule*, their common envelope also receives the name of *lepicene*. It may be *unipaleaceous*, or of one scale, as in the genus *Lolium; bipaleaceous*, of two scales, as in the genus *Poa;* or *multipaleaceous*, of several scales, as in some species of *Uniola*. There results from this circumstance that each little flower or *floret* is destitute of a *lepicene* of its own, and is only surrounded by a *glume*, which in this case is always *bipaleaceous*. It is then said that the *spikelet* or the *lepicene* are *biflorous*, *triflorous*, two-flowered, three-flowered, &c. according to the number of flowers which they contain.

CHAPTER II.

OF THE INFLORESCENCE *.

The term *Inflorescence (inflorescentia)* is applied to designate the general disposition or arrangement which the flowers affect upon the stem, or the other organs which support them.

The flowers are said to be *solitary (Flores solitarii)*, when the plant produces only one, or when they come off one by one from different points of the stem, at some distance from each other; as in the Tulip and the Common Garden Rose.

They are *terminal (F. terminales)*, when they are situated at the top of the stem; as in the Tulip.

Lateral (F. laterales), when they spring from the sides of the stems or branches.

Axillar (F. axillares), when they spring from the axilla of the leaves; as in the Greater Periwinkle *(Vinca major)*, the Ivy-leaved Speedwell *(Veronica hederæfolia)*, &c.

Flowers are named *geminate (F. gemini)*, when they come off in pairs from the same point of the stem; as in *Viola biflora*.

Ternate (F. ternati), when they come off three together; as in *Teucrium flavum*.

Fasciculate (F. fasciculati), when they come off more than three together from the same point of the stem or branches; as in the Cherry *(Cerasus communis)*.

Let us now examine the kinds of inflorescence which have received particular names.

* M. Ræper, Professor of Botany at Bâle, has lately published a very interesting memoir on the inflorescence.

1. When the flowers are arranged upon a common stalk or axis, which is simple or not branched, whether they be sessile or pedunculate, and whether the peduncle be straight or inclined, they form a *Spike (spica)*, and are accordingly described as *spiked (Flores spicati);* as in Wheat, Barley, Rye, the Ribwort Plantain, the Black Currant, the Barberry, and the genus *Orchis.*

The base of each flower is often accompanied by a scale or bractea, in which case the spike is said to be *squamiferous* or *bracteolate ;* as in *Orchis militaris.*

Sometimes the flowers are arranged in a spiral manner around the common stalk; as in *Ophrys æstivalis* and *O. autumnalis (Spiranthes,* Rich.).

At other times the flowers are very close, and the spike short and *globular (Spica globosa);* as in *Orchis globosa,* several species of *Scilla,* &c.

2. If the common peduncle branches several times, and in an irregular manner, this arrangement takes the name of *Raceme (racemus),* and the flowers are described as being *racemose (flores racemosi) ;* as in the Vine.

The characters which most authors have given as distinguishing the spike from the raceme are so uncertain, that it is almost impossible to discriminate between these two modes of inflorescence. Thus, some say that the flowers are sessile in the spike, and pedunculate in the raceme; and others, that the raceme is always pendulous, and the spike erect. We think it useless to insist on the insufficiency of these characters. The distinction which we adopt appears to us more determinate, and has the advantage of being more easily applied in practice: it is, that the axis of a spike is always simple, whereas that of a raceme is always branched.

3. When the common axis is erect, and the peduncles are irregularly divided into pedicels bearing the flowers, if the whole assumes a nearly pyramidal form, it obtains the name of *Thyrsus (thyrsus),* and the flowers are said to be

thyrsoid (Flores thyrsoidei); as in the Lilac *(Syringa vulgaris)*, the Privet *(Ligustrum vulgare)*, and the Horse-chestnut *(Æsculus Hippocastanum)*. This species of inflorescence is closely allied to the *raceme*.

4. The flowers are said to be disposed in a *Panicle (panicula)*, or to be *paniculate (Flores paniculati)*, when the common axis is branched, and its secondary divisions are greatly elongated and widely separated. This species of inflorescence belongs almost exclusively to the Gramineæ: such, for example, are the male flowers of the Maize *(Zea Mays)*, *Agrostis Spica-venti*, *Arundo Donax*, &c.

5. The flowers are *corymbose (Flores corymbosi)*, or are disposed in a *Corymb (corymbus)*, when the peduncles and pedicels spring from different points of the upper part of the stem, but all attain nearly the same height; as in Common Milfoil *(Achillæa Millefolium)*.

6. The *Cyme (cymus)* is produced, and the flowers are said to be *cymose (Flores cymosi)*, when the peduncles proceed from the same point, the pedicels being unequal, and coming off from different points, but raising all the flowers to the same height; as in the Elder *(Sambucus nigra)* and the Cornel *(Cornus sanguinea)*.

7. The flowers are said to be *umbellate (Flores umbellati)*, when all the peduncles are equal, spring from the same point of the stem, diverge, and branch into pedicels, which again come off from the same point, so that the general mass of the flowers represents a convex surface, like an expanded umbrella. This disposition is observed in the whole natural family of the Umbelliferæ; for example, in the Carrot *(Daucus Carota)*, Hemlock *(Conium maculatum)*, Opoponax *(Pastinaca Opoponax)*, &c.

The peduncles form collectively an *umbel (umbella)*; and each group of pedicels constitutes an *umbellule (umbellula)*.

At the base of the umbel, there is very frequently observed an involucre; and at the base of each umbellule an involucel; as in the Carrot. At other times, the involucre is wanting, while the involucels are present; at in Chervil *(Chærophyllum sativum)*. Lastly, both involucre and involucels may be absent; as in *Pimpinella Saxifraga*, *P. magna*, &c.

8. The flowers are *sertulate (Flores sertulati)*, when the peduncles are simple, spring all from the same point, and attain nearly the same height; as in the Flowering Rush *(Butomus umbellatus)*, most of the species of *Allium*, the genus *Primula*, &c.

This kind of inflorescence has been referred to the umbel; but it differs so much from that species as to deserve a name of its own.

9. The flowers are disposed in a *Whorl* or *Verticil (verticilla)*, or are *whorled* or *verticillate (Flores verticillati)*, when they come off around the stem at the same height; as in the genus *Myriophyllum*, in *Hippuris vulgaris*, &c.

It is generally said that the Labiatæ have their flowers verticillate, but in this case one is deceived by appearances; for, in all the plants of that family, the flowers are placed in the axilla of two opposite leaves, and are borne upon divided peduncles. They thus spring from two opposite points, and not from the circumference of the stem.

10. The *Spadix* is a species of inflorescence, in which the common peduncle is covered with unisexual flowers, which are naked, in other words, destitute of a proper calyx, and generally distinct and separated from each other; as in *Arum maculatum*, *Calla palustris*, &c. Sometimes, however, there are observed scales, which separate the flowers; but these cannot be considered as calyces, as they spring from the substance of the peduncle itself, of which they appear to be appendages, and are always situated beneath the point at which the flowers are attached; as in certain species of Pepper.

The spadix is peculiar to the monocotyledonous plants, and to the different species of *Piper*. Sometimes it is naked, in other words, destitute of a general envelope; as in the genus just mentioned. At other times, it is enveloped in a spatha; as in the Aroideæ, and certain species of Palms.

11. The *Catkin (Amentum)* is a kind of inflorescence in which unisexual flowers are inserted upon scales which, in some measure, perform the office of a peduncle. Flowers so arranged are named *amentaceous (Flores amentacei)*. Of this kind are the male flowers of the Chestnut *(Juglans regia)*, and Hasel *(Corylus Avellana)*, the male and female flowers of Willows, &c. This species of inflorescence is that observed in a whole family of plants, composed of trees of various sizes, and which are named *Amentaceous* *. Of this kind are Willows, Poplars, Alders, the Birch, the Hornbeam, the Oak, the Beech, &c.

12. The names of *Capitulum*, *Calathidium* or *Anthodium*, are given to the mode of inflorescence which the older writers improperly designated as forming *compound flowers*. It is that which we observe in Thistles, the Artichoke, Scorzonera, and in general in all the plants of the family of *Synanthereæ*. The *capitulum* is formed by a greater or less number of small flowers, placed together upon a common receptacle, which is much wider and more bulging than the summit of the peduncle, of which, however, it is the termination, and which is named *phoranthium;* the flowers being surrounded by a peculiar involucre, which was formerly considered as a compound calyx. Thus, in the Artichoke *(Cinara Scolymus)*, the green leaves, of which the base is eaten, belong to the involucre, and the lower, broad and fleshy part is the *phoranthium* or *clinanthium*. The flowers are placed within the leaflets of the involucre. They are very small, and intermingled with stiff, erect bristles.

* Jussieu's family of Amentaceæ has been divided, agreeably to the recent observations of some botanists, into several groups or families, which are very distinct from each other in respect to the different parts of their flowers and fruits. Such are the *Cupuliferæ*, *Betulineæ*, *Salicineæ*, *Ulmaceæ*, &c.

The *phoranthium* has not always the same arrangement. Sometimes it is slightly concave, as in the Artichoke; at other times, very convex, prominent, and approaching to the cylindrical form, as in some species of *Anthemis*, in *Rudbeckia*, &c.

It is more commonly smooth, but it often presents alveolæ or small depressions, in which is contained the base of the flowers; as in *Onopordium*. Sometimes it is naked, in other words, bears flowers only; at other times, the flowers are accompanied by scales or hairs, which are more or less stiff and sharp-edged.

The *involucre* also varies greatly, it being sometimes formed of a single row of leaflets; as in the genus *Tragopogon;* sometimes of very numerous, imbricated scales, arranged in several rows; as in the genera *Centaurium*, *Cnicus*, &c.

CHAPTER III.

OF PRÆFLORATION OR ÆSTIVATION.

By the terms *Præfloration* or *Æstivation (præfloratio, æstivatio)*, is understood the mode in which the different parts of a flower are disposed previous to its expansion. From this definition it will be seen that we here include the diversified positions which the various parts of a flower affect in the bud.

This circumstance has long been neglected, although it is deserving of the greatest attention; for the præfloration is generally the same in all the plants that belong to the same natural family. The præfloration of the corolla has alone hitherto been studied; but that of the calyx and sexual organs is not less important.

1. The petals or the divisions of the corolla may be *imbricated (Petala imbricata, Præfloratio imbricativa)*, when they cover each other laterally by a small portion of their breadth; as in the genera *Rosa, Pyrus, Cerasus, Linum*, &c.

2. The monopetalous corolla may be folded upon itself, or *plaited, (Corolla plicata, Præfloratio plicativa);* as in the *Convolvulaceæ*, and several *Solaneæ*.

3. The petals, or the divisions of the monopetalous corolla, are sometimes placed close together, and *spirally twisted (Petala spiraliter contorta, Præfloratio torsiva);* as in the genus *Oxalis*, the *Apocineæ*, &c.

4. The petals are often *puckered (Petala corrugata, Præfloratio corrugativa)*, that is, folded in all directions; as in the genera *Papaver* and *Cistus*.

5. The petals may be in contact by their edges, like the

valves of a capsule *(Præfloratio valvaris)*; as in the *Araliaceæ.*

6. When the petals are five in number, two external, two internal, and one covering the two inner by one of its sides, and itself covered on the other side by the outer petals, M. De Candolle gives this disposition the name of *quincuncial (Præfloratio quincuncialis)*; as in the Pink.

There are several other modes of præfloration, which it is of less importance to know, as they are much less frequently met with.

The various modifications above described refer equally to the calyx.

In the Umbelliferæ and Urticeæ, the stamina are *inflected* towards the centre of the flower; and, when the latter expands, rise up, and sometimes even bend outwards.

CHAPTER IV.

OF THE FLORAL ENVELOPES IN GENERAL.

We have already seen that the Floral Envelopes are not essential organs of the flower, as many plants are entirely destitute of them. We shall not, therefore, be surprised when we see flowers in which the calyx and corolla are wanting, and which, nevertheless, produce perfect fruits.

Linnæus gave the general name of *Perianth (Perianthium)*, to the whole of the floral envelopes which surround the sexual organs.

The *perianth* is *single* or *double*.

When it is single it is named the *calyx*, whatever may be its colour, consistence, or form; as in the Tulip, the Lily, the Thymeleæ, &c.

All the monocotyledonous plants are destitute of a *corolla*. Their perianth is always single, and they have only a *calyx*.

When the *perianth* is double, the innermost envelope, or that which is nearest to the sexual organs, takes the name of *corolla;* while the outermost envelope is named the *calyx*. It has also been said, that the calyx forms a continuation of the bark of the peduncle, and that the corolla is the continuation of the woody body, or the part situated between the pith and the bark, in annual plants; but this assertion is incorrect.

Such is the opinion generally admitted by authors who treat of the natural relations of plants; and, in fact, it appears conformed to nature in most cases. But we would here remark, with reference to the monocotyledones, that, in many circumstances, especially when the *perianth* is composed of separated segments, we might believe in the existence of two envelopes around the sexual organs. Thus the six pieces which form the single *perianth* of a great number of monocotyledones, are most commonly disposed as if in two rows, so that three of them appear more internal, and three more external. If we add to this, that the three inner are often coloured and *petaloid*, while the three outer are green, and similar to the *calyx*, we might readily conceive that a double perianth, in other words, a calyx and a corolla, might be admitted in these plants. This disposition is especially observable in *Tradescantia virginica*, of which the single perianth has six divisions, three inner, which are larger, thinner, delicate, and of a beautiful blue colour; and three outer, which are smaller, green, and entirely different from the rest. This is also the case with *Alisma Plantago*, *Sagittaria sagittæfolia*, &c., which have always the three inner divisions of their perianth coloured and petaloid, while the three outer are green and calyciform.

But these exceptions are more apparent than real, and disappear before a more close inspection: For, although the six segments of the perianth of a great number of monocotyledones are disposed in two rows, they yet form, on the top of the peduncle which supports them, only a single circle; that is, they have only one common point of attachment, and are manifestly all six continuous with the outermost part of the peduncle. They, therefore, constitute one and the same organ, that is, a calyx. In fact, did they constitute two distinct envelopes, a calyx and a corolla, the point of insertion of the corolla would be more internal than that of the calyx, since it is continuous with the woody substance of the stem, or the part which represents it; whereas the calyx is a continuation of the epidermis, or the most external part of the peduncle. From all this, we may conclude, that, in the monocotyledones, there are never corollas, but only a calyx, whatever may be the disposition of the parts which compose it.

The vast and interesting family of the *Orchideæ*, which differs as much from the other monocotyledonous plants in the form and external appearance of its flowers, as in their internal organization, also presents a single perianth, with six divisions, but modified in a manner which it is of importance here to notice. Of these divisions, three are more internal, and three more external. The three outer are very frequently united to two of the inner, at the upper part of the flower, and, being closely applied upon each other, form a kind of vault or helmet, which covers and protects the sexual organs; for which reason the calyx is said to be *galeated* or *helmet-like (calyx galeatus)*. Of the three inner divisions, one is median and inferior, and generally differs in form and colour from the other two. It has received the name of *lip (labellum)*. It is this third part which, in many species, presents such diversified and extraordinary forms. Sometimes, in fact, one might imagine that he saw a humble bee resting upon the plant *(Ophrys apifera)*; sometimes a spider *(Ophrys aranifera)*; at other times, a monkey, of which the lower parts are separated *(Orchis zoophora, Ophrys anthropophora)*. In several genera of this family, the *labellum* has at its lower part a hollow prolongation, in the form of a horn, to which the name of *spur (calcar)* is given. In this case it is said to be *spurred (labellum calcaratum)*. The presence, absence, or relative length of the spur, often afford distinctive characters in certain genera of Orchideæ.

The floral envelopes, notwithstanding the delicacy of their texture and the varied colours with which they are very frequently decorated, are in general nothing but leaves slightly modified. In the calyx, in particular, this similarity, or even identity of structure, is very striking. In fact, there are flowers in which the sepals or leaflets of the calyx have so great a resemblance to the leaves, that it is difficult not to consider them as the same organ. However, to facilitate the establishment of generic characters in plants, botanists have agreed to consider these organs, although of precisely the same structure, as entirely distinct.

We now proceed to examine separately the two floral envelopes which compose the double perianth; in other words, the calyx and the corolla.

CHAPTER V.

OF THE CALYX.

The *Calyx* is the outermost envelope of the double *perianth*, or the perianth itself, when it is single.

It consists of a variable number of leaves forming the outermost verticil of the flower, sometimes perfectly distinct from each other, sometimes more or less united together.

It is easy to prove, by analogy, that the single perianth is a calyx, and not a corolla, as Linnæus often named it.

In fact, a general principle, sanctioned by all botanists, is, that the ovary is said to be *inferior (Ovarium inferum)*, whenever it is united with the tube of the calyx in all parts of its circumference. Now, the ovary is inferior in a great number of monocotyledonous plants, which have only a single perianth; as in the *Irideæ*, the genus *Narcissus*, the *Orchideæ*, &c. It must therefore be inferred, from this circumstance, that the single envelope in question, being entirely united, by its base, with the ovary, is a true calyx.

Fig. 100.

Fig. 101.

The calyx is *Monosepalous (Calyx monosepalus)* (Fig. 100.), whenever it consists of a single piece, or, to speak more correctly, whenever the calycine leaves are all united, as in Stramonium, and all the other *Solaneæ;* in the Sage, and all the other *Labiatæ*.

M. De Candolle proposes substituting the name of *gamosepalous calyx* for that of *monosepalous;* the first of these terms signifying that the calyx, in this case, is composed of several united sepals, and not of a single sepal, as the term monosepalous would imply. (Fig. 101.)

It is *Polysepalous (C. polysepalus)*, when it is formed of a greater or less number of distinct pieces, which may be separated from each other, without producing any tearing of their substance, and to which the name of *Sepals (sepala)* is given; as in the Wallflower, the Water-cress, &c.

Whenever the calyx is united to the ovary, or, which is the same thing, whenever the ovary is *inferior*, the calyx is naturally *monosepalous*.

The monosepalous calyx is almost always persistent, that is, remains after fecundation, and very frequently continues until the fruit is ripe. It even sometimes increases in size, in proportion as the fruit advances towards maturity; as is observed in the Winter-cherry *(Physalis Alkekengi)*, &c.

The polysepalous calyx is generally caducous, commonly falling off at the period of fecundation, sometimes immediately after the expansion of the flower; as in Poppies.

In the *monosepalous* calyx, there are distinguished, 1. The *tube*, or lower part, which is commonly elongated and narrow; 2. The *limb*, or upper part, which is more or less open and spreading; 3. The *throat (faux)*, or the line which separates the tube from the limb.

The *Limb (limbus)* of the monosepalous calyx, may be more or less deeply divided. Thus it is: *Toothed (C. dentatus)*, when it has sharp-pointed teeth. It may be *three-toothed (C. tridentatus)*, as in *Cneorum tricoccum; four-toothed (C. quadridentatus)*, as in the Privet and Lilac; *five-toothed, (C. quinquedentatus)*, as in many Labiatæ and Caryophylleæ. The teeth themselves may present various modifications. Thus they may be equal or unequal, erect, spreading, or deflected. These expressions require no explanation.

The monosepalous calyx may be *Cleft (C. fissus)*, when the incisions reach nearly to the middle of the whole length of the calyx. In this case it may be: *Bifid (C. bifidus)*, with two clefts, as in Marsh Lousewort *(Pedicularis palustris); trifid (C. trifidus); quadrifid (C. quadrifidus)*, as in *Rhinanthus Crista-galli ; quinquefid (C. quinquefidus)*, as in *Hyoscyamus niger*, *Nicotiana Tabacum*, &c.; *multifid (C. multifidus)*, with numerous clefts.

When the divisions are so deep as almost to reach to the base, the calyx is *Partite (C. partitus)*. In this case, it may be: *Bipartite (C. bipartitus)*, as in the genus *Orobanche ; tripartite (C. tripartitus)*, as in *Anona triloba* ; *quadripartite (C. quadripartitus)*, as in *Veronica officinalis ; quinquepartite (C. quinquepartitus)*, as in Common Borage *(Borago officinalis)*, Foxglove *(Digitalis purpurea)*, &c. *multipartite (C. multipartitus)*, with numerous deep segments.

In opposition to all these terms, the calyx is said to be *Entire (C. integer)*, when its limb has neither teeth nor incisions; as in many genera of the Umbelliferæ.

The monosepalous calyx may be *regular* or *irregular*.

It is *Regular (C. regularis)*, when all its incisions are perfectly equal to each other, of whatever figure or form they may be; as in Borage, the Pink, &c.

It is *Irregular (C. irregularis)*, when the segments differ in size and figure; as in *Tropæolum majus*.

With respect to form, the calyx is *Tubular (C. tubulosus)*, when it is narrow, elongated, and has not its limb spreading; as in the Cowslip *(Primula veris)*, the Pink, &c.

Turbinate (C. turbinatus), having the form of a pear or top; as in the Berry-bearing Alder.

Urceolate (C. urceolatus, ventricosus), swelled out at the base, contracted at the throat, and having the limb dilated; as in the genus *Rosa*, and the Henbane.

Inflated or *Bladdery (C. inflatus, vesiculosus)*, when it is thin, membranous, and dilated like a bladder, and much wider than the base of the corolla, which it surrounds; as in *Cucubalus Behen*, *Rhinanthus Crista-galli*, &c.

Campanulate or *Bell-shaped (C. campanulatus)*, dilated from the base towards the orifice, which is very wide; as in *Melittis melissophyllum*.

Cup-shaped or *Cupulate (C. cupuliformis)*, flattened or slightly concave; as in *Citrus medica.*

Cylindrical (C. cylindricus), when it forms a tube, of which the diameters are nearly equal in its whole length; as in the Pink.

Claviform or *Club-shaped (C. clavatus, claviformis)*, when the tube is slightly inflated at its summit; as in *Silene Armeria.*

Compressed (C. compressus), broad, and laterally flattened; as in the Marsh Lousewort *(Pedicularis palustris).*

Prismatic (C. prismaticus), with distinct angles and sides; as in the Common Lungwort *(Pulmonaria officinalis).*

Angular (C. angulosus), having numerous prominent and longitudinal angles.

Grooved or *Furrowed (C. sulcatus)*, marked with longitudinal impressed lines.

Bilabiate or *Two-lipped (C. bilabiatus)*, having its divisions so disposed as to present an upper lip and a lower lip, separated from each other; as in Sage *(Salvia officinalis)*, and many other Labiatæ.

Spurred (C. calcaratus), having a hollow prolongation at its base; as in *Tropæolum majus.*

Dipterous (C. dipterus), having two lateral membranous appendages, in the form of wings.

Tripterous (C. tripterus), having three lateral, membranous, wing-like appendages.

The calyx is often pretty highly coloured, especially when there is no corolla. In this case, it is said to be *petaloid* or *corolliform (C. petaloideus, corolliformis)*; as in Mezereon, the genus *Narcissus*, the *Orchideæ*, &c.

It is of importance to notice the relative proportions of the calyx and corolla. Thus, the calyx is generally *shorter* than the corolla. Sometimes it is *longer*, as in the Corn Cockle *(Agrostemma Githago)*. Lastly, it may be *equal* to the corolla.

The calyx may be *free* or without adhesion *(C. liber)*;

or it may be united, wholly or in part, with the ovary, in which case it is *adherent (C. ovario adhærens)*, and the ovary is necessarily inferior.

The *polysepalous* calyx may be composed of a greater or less number of *sepals* or distinct pieces. Thus it is—

Disepalous (C. disepalus), when formed of two sepals; as in the Poppy *(Papaver somniferum)* and the Fumitory *(Fumaria officinalis)*.

Trisepalous (C. trisepalus), formed of three sepals; as in Pilewort *(Ficaria ranunculoides)*.

Tetrasepalous (C. tetrasepalus), having four sepals; as in Cabbage, the Radish, the Cress, and other Cruciferæ.

Pentasepalous (C. pentasepalus), when it is composed of five sepals; as in the Common Flax *(Linum usitatissimum)*.

The figure and form of the *Sepals* themselves must be examined and defined in the same manner as those of the leaves, or the divisions of the *monosepalous* calyx. Thus, they may be *lanceolate*, *acute*, *obtuse*, *cordiform*, &c.

A *polysepalous* calyx may also present various forms, in consequence of the arrangement of the sepals with respect to each other. Thus, it is *tubular (C. tubularis)*, when the sepals are long, erect, and placed close together, so as to form a tube. The calyx of many Cruciferæ is of this kind.

It may be *Campanular (C. campanularis)*, in the form of a bell; or

Stellar (C. stellaris), when it is formed of five spreading and equal sepals; as in several Caryophylleæ.

CHAPTER VI.

OF THE COROLLA.

The *Corolla* never exists unless when there is a double perianth, of which it forms the innermost part. It immediately surrounds the organs of reproduction, and, although continuous with the woody part of the stem, is of soft and delicate texture. It is often painted with the richest colours, and is thus the principal part that attracts the notice of common observers, who see flowers only where there are large and brilliant *corollas*, or coloured perianths. The botanist, on the contrary, considers this organ only as accessory to the essential parts of the flower; while a pistil or a stamen, sometimes to be seen only with difficulty, he considers as a true flower.

The corolla may be *Monopetalous* or *Gamopetalous (Corolla monopetala, gamopetala)*, that is, may have the different parts of which it is composed united, so as to form a single piece: as in Foxglove *(Digitalis purpurea)*, the Common Bindweed *(Convolvulus arvensis)*, and the Deadly Nightshade *(Atropa Belladonna)*. (Fig. 102.)


Fig. 102.


Fig. 103.

It may be composed of a greater or less number of separated segments, which are named *Petals (petala)*. In this case, it is said to be *Polypetalous (C. polypetala)*; as in the Rose, the Pink, the Cabbage, and the Wallflower. (Fig. 103.)

Each petal is composed of two parts: 1*st*, The *claw (unguis)*, or the lower, contracted, and more or less elongated part, by which it is attached; 2*dly*, The *lamina* or broad part, of varied form, which surmounts the claw.

The figure of the petals varies in a singular degree, but may, in general, be referred to the different modifications which we have described when speaking of the leaves. Thus there are petals which are *round;* others *elongated*, *acute*, *obtuse*, *toothed*, *entire*, &c.

Like the calyx, the corolla may be *regular* or *irregular.*

It is *Regular* whenever its incisions and divisions are equal to each other, or when its parts appear to be regularly disposed around a common axis; as in *Campanula Rapunculus*, the Wall-flower *(Cheiranthus Cheiri)*, and the Primrose. (Fig. 104.)

Fig. 104.

Fig. 105.

It is *Irregular*, on the contrary, when its incisions are unequal, or when the different parts of which it is composed do not appear symmetrically disposed around a common imaginary axis; as in the Snap-dragon *(Antirrhinum majus)*, the Hooded Milfoil *(Utricularia vulgaris)*, and the Garden Nasturtium *(Tropæolum majus)*. (Fig. 105.)

The *monopetalous* corolla falls off entire when it fades. Sometimes its base is persistent, as in the Marvel of Peru *(Nyctago hortensis)*.

In the *polypetalous* corolla, on the contrary, each of the petals falls separately. It may however happen, that in a polypetalous corolla, the segments or petals are detached all together, and united by their base; as in the Round-leaved Mallow *(Malva rotundifolia)*, the Marsh-mallow *(Althæa officinalis)*, &c. In this case, the corolla is, notwithstanding, polypetalous; but the petals are accidentally united at their base by a prolongation of the substance of the filaments of the stamina. Other examples of a like nature might be mentioned.

A monopetalous corolla is said to be *Spurred* *(C. calcarata)*, when it has at its base a hollow prolongation, in the form of a horn; as in the Toadflax and Butterwort. (Fig. 106.)

Fig. 106.

In the monopetalous corolla, three parts are to be considered: 1*st*, A lower part, commonly cylindrical, tubiform, and more or less elongated, which is named the *tube* (*tubus*); 2*d*, A part placed above the tube, and more or less dilated, sometimes spreading or even reflected, which is called the *limb* (*limbus*); 3*d*, The circular line which separates the tube from the limb, and which takes the name of *throat* (*faux*, *palatum*). These three parts require to be carefully studied, as their diversified forms, and relative proportions, furnish the botanist with characters by which certain genera of plants may be distinguished.

In general, the monopetalous corolla has the stamina attached to it.

We now proceed to give an account of the various modifications which the monopetalous and polypetalous corolla present, when they are regular or irregular.

1. *Regular Monopetalous Corolla.*

The regular monopetalous corolla presents a great variety of forms. Thus, it may be *Tubulate* (*C. tubulata*) (Fig. 107.), when its tube is very long; as in *Nyctago hortensis* and *Syringa vulgaris*.


Fig. 107.


Fig. 108.


Fig. 109

The tube is sometimes *capillar* or *filiform*; as in certain *Synanthereæ*.

The corolla is *Bell-shaped* or *Campanulate* (*C. campanulata*) (Fig. 108.), when it has no evident tube, but widens from the base towards the upper part; as in *Campanula rapunculoides*, *Convolvulus Sepium*, *Convolvulus Jalapa*, &c.

It is *Infundibuliform* or *Funnel-shaped* (*C. infundibuliformis*), when the tube is at first narrow at its lower part, and then gradually dilates, so that the limb is campanulate; as in the Tobacco (*Nicotiana Tabacum*).

It is said to be *Salver-shaped* or *Hypocrateriform* (*C. hypocrateriformis*) (Fig. 107, 109.), when its tube is long, narrow, and not dilated at its upper part, while the limb is spread out flat, so as to represent an ancient cup, or a salver; as in the Lilac (*Syringa vulgaris*), the Jasmine (*Jasminum officinale*), the Primrose (*Primula vulgaris*), &c.

The corolla is *Rotate* or *Wheel-shaped* (*C. rotata*), when the tube is very short, and the limb spreading and nearly flat; as in Borage (*Borago officinalis*), and most of the species of *Solanum*.

It is said to be *Stellate* or *Star-like* (*C. stellata*), when it is very small, its tube very short, and the divisions of its limb acute and elongated; as in the genera *Galium* and *Asperula*.

It is *Urceolate* or *Pitcher-shaped* (*C. urceolata*) (Fig. 110.), when it is swelled at its base, like a pitcher, and contracted towards the orifice; as in many species of *Erica* and *Vaccinium*.

Fig. 110.

It is called *Scutellate* or *Saucer-shaped* (*C. scutellata, scutelliformis*), when it has the form of a saucer, or is spreading and slightly concave.

2. *Irregular Monopetalous Corolla.*

The irregular monopetalous corolla is said to be *Two-lipped* or *Bilabiate* (*C. bilabiata*), when the tube is more or less elongated, the throat open and dilated, the limb transversely separated into two divisions, an upper and a lower, which are compared to two parted lips. This form of corolla particularly characterizes an

Fig. 111.

entire family of plants, one of the most natural in the vegetable kingdom, the *Labiatæ*, of which Thyme, Balm, Sage, and Rosemary, are examples. (Fig. 111.)

The two *Lips* present numerous modifications, from which are derived characters for distinguishing the numerous genera of this family. Thus the upper lip is sometimes *flat*, sometimes *erect*, *vaulted* or *falciform*. It may be *entire*, *notched*, *bidentate*, *two-lobed*, *bifid*, &c.

The lower lip is commonly *reflected*. Sometimes it is *concave* and *plicate* on the edges; as in the genus *Nepeta*. It may also be *trifid*, *three lobed*, or *tripartite*.

Sometimes the upper lip seems to be wanting, or at least is so small that it can scarcely be distinguished; as in the genera *Teucrium* and *Ajuga*.

The corolla is said to be *Personate* or *Masked (C. personata)* (Fig. 112.), when the tube is more or less elongated, the throat very wide, and closed above by the approximation of the limb, which is divided into two unequal lips, so as in some degree to represent the mouth of an animal, or certain antique masks; as in *Antirrhinum majus*, *Linaria vulgaris*, &c. *

Fig. 112.

Lastly, under the name of *Anomalous* irregular monopetalous corollas are included all those which, by their extraordinary form, and the impossibility of comparing them to any other object, separate themselves from the different types which we have above defined, and cannot be referred to any of them. Thus the corolla of the Foxglove *(Digitalis purpurea)*, which in some degree resembles in form

* The labiate and personate corollas approach each other by insensible gradations, which renders it very difficult to define them strictly, and induces the necessity of employing an auxiliary character derived from the form and structure of the ovary. In the Labiatæ, in fact, the ovary is deeply four-lobed, whereas it is simple in all the true Personatæ.

the finger of a glove, and the corollas of *Utricularia* and *Pinguicula*, are irregular and anomalous corollas.

In the different forms of *regular* and *irregular* monopetalous corollas which we have just examined, the three parts which compose these corollas, namely, the tube, the limb and the throat, present modifications which it is useful to know. Thus,

The *Tube (tubus)* may be—

Cylindrical (Tubus cylindricus), as in the Lilac *(Syringa vulgaris)*, the Marvel of Peru *(Nyctago hortensis)*, &c.

It may be *long* or *short*, as compared with the calyx or the limb.

Bellying or *Inflated (T. ventricosus, inflatus)*, whether in its lower part, or towards its summit. In the latter case, it is said to be *Claviform* or *Club-shaped (T. claviformis)*; as in *Spigelia marilandica*.

Lastly, it may be *smooth*, *striated*, *angular*, *prismatic*, &c. We have already repeatedly defined these terms.

The *Throat (faux)* may be—

Closed (clausa), when completely shut; as in *Antirrhinum majus* (Fig. 112.)

Open or *dilated (aperta, patens)*, as in *Digitalis purpurea*, certain *Labiatæ*, &c.

It may be furnished with hairs, as in the Thyme, the Marjoram, &c.

Ciliate (ciliata), furnished with strong hairs, as in *Gentiana Amarella*, &c.

Crowned by projecting appendages of various forms; as in Borage *(Borago officinalis)*, the Comfrey *(Symphytum Consolida)*, the Bugloss *(Anchusa italica)*, and many other *Boragineæ*.

In opposition to the above expressions, it is said to be *Naked*, when it is destitute of hairs, protuberances, or appendages.

The *Limb (limbus)*, or the part of the corolla situated above the throat, may be—

Erect (erectus); as in Hound's-tongue *(Cynoglossum officinale)*.

Open or *spreading (patens)*, when it forms a right angle with the tube; as in *Nerium oleander*.

Reflected or bent outwards *(reflexus)*; as in the Bitter-sweet *(Solanum Dulcamara)*, the Cranberry *(Vaccinium Oxycoccus)*, &c.

The limb may be also more or less deeply divided. Thus it is sometimes merely *dentate* or toothed on the margin; or it may be *trifid*, *quadrifid*, *quinquefid*, *quadripartite*, *quinquepartite*, &c., according to the depth of its incisions.

The form of the different divisions of an incised limb presents numerous varieties, which may be referred to those of the petals and leaves.

We may observe here, in concluding our account of the *monopetalous corolla*, that its form is not an essential character in the arrangement of the genera into natural families. In fact, several forms are often seen to exist in groups which are essentially natural. Thus, in the *Solaneæ*, we find rotate corollas, as in the genera *Verbascum* and *Solanum*; funnel-shaped corollas, as in *Tabacum*; hypocrateriform corollas, as in certain *Cestra*; and campanulate corollas, as in *Hyoscyamus* and *Atropa*. We might mention similar combinations as existing in many other families equally natural.

Polypetalous Corolla.

The number of petals varies exceedingly in the different polypetalous corollas. Thus there are corollas formed of two petals, as in the Enchanter's Nightshade *(Circæa lutetiana)*. In this case, the corolla is termed *Dipetalous (C. dipetala)*.

It is *Tripetalous (C. tripetala)*, when composed of three petals; as in *Cneorum tricoccum*, &c.

Tetrapetalous (C. tetrapetala), composed of four petals; as in all the Cruciferæ, such as the Water-cress (*Sisymbrium Nasturtium*), the Horse-radish (*Cochlearia Armoracia*), the Broad-leaved Pepperwort (*Lepidium latifolium*), &c.

Pentapetalous (*C. pentapetala*), formed of five petals, as in all the Umbelliferæ and Rosaceæ; for example, the Parsnip (*Pastinaca sativa*), Parsley (*Apium Petroselinum*), the Hemlock (*Conium maculatum*), the Strawberry (*Fragaria vesca*), &c.

Hexapetalous (*C. hexapetala*), having six petals; as in the Barberry (*Berberis vulgaris*), &c.

The petals or segments of a polypetalous corolla may often be *unguiculate*, that is, furnished with a very distinct claw; as in the Pink and Wallflower (Fig. 113.) Or they may be *sessile*, that is, destitute of a claw or inunguiculate; as in the Vine (*Vitis vinifera*), *Gypsophila muralis*, &c.

Fig. 113.

The length and proportion of the claw, as compared with the calyx, also deserves notice. In fact, the claw is often *shorter* than the calyx (*unguis calyce brevior*); while, at other times, it is *longer*, and extends beyond it (*unguis calyce longior*).

The petals are often *Erect* (*petala erecta*), that is, have a direction parallel to the axis of the flower; as in *Geum rivale.*

They are sometimes *Inflected* (*petala inflexa*), or curved towards the centre of the flower; as in many Umbelliferæ.

Spreading (*P. patentia*); as in the Strawberry (*Fragaria vesca*), the Common Avens (*Geum urbanum*), &c.

Reflected (*P. reflexa*), curved outwards.

The figure of the petals is extremely variable. Its principal modifications may be referred to those already described as belonging to the leaves and sepals. They present some singular forms, however, which we shall now mention.

The petals are *Concave* (*P. concava*) in the Lime (*Tilia europæa*), the Rue (*Ruta graveolens*), &c.

Galeiform or *Helmet-shaped* (*P. galeiformia*), when they are vaulted, hollow, and resemble a helmet; as in Monk's-hood (*Aconitum Napellus*), &c.

Cuculliform or *Cowl-shaped* (*P. cuculliformia*), having the form of a *cowl* or *hood;* as in Columbine (*Aquilegia vulgaris*), Lark's-spur, &c.

The polypetalous corolla may be *regular* or *irregular*, according as the parts of which it is composed are symmetrically or otherwise arranged around the axis of the flower. In either case, the petals, by their form, number, and disposition with respect to each other, give the corolla a peculiar aspect and form, which occasions its being divided into various groups.

1. *Regular Polypetalous Corolla.*

The *Regular Polypetalous Corolla* presents three principal modifications. It may be—

1. *Cruciform* (*C. cruciformis*) (Fig. 114.), composed of four unguiculate petals, placed crosswise, or in pairs opposite to each other. The plants whose corolla presents this arrangement form one of the most natural groups in the vegetable kingdom, and have received the name of *Cruciferæ*. Of this kind are the Cabbage, the Wall-flower, the Water-cress, &c.

Fig. 114.

The four petals of a cruciform corolla are not always equal and similar to each other, some of them being often smaller or larger than the rest. Thus, in the genus *Iberis*, two of the petals are always larger.

Fig. 115.

2. *Rosaceous* (*C. rosacea*) (Fig. 115.), when it is composed of from three to

five petals, seldom of a greater number, with very short claws, and spreading in the manner of a rose. Of this kind are all the Rosaceæ, such as the Single Rose, the Almond, the Apricot, the Plum, &c., the Celandine, and plants of other families.

Fig. 116.

3. *Caryophyllaceous* or *Pink-like* (*C. caryophyllata*) (Fig. 116.), formed of five petals, whose claws are very long and covered by the calyx, which is also very long and erect; as in the genera *Dianthus*, *Silene*, *Cucubalus*, &c.

2. *Irregular Polypetalous Corolla.*

1. *Papilionaceous* (*C. papilionacea*) (Fig. 117.) This kind of corolla is composed of five very irregular petals, each having a peculiar form, which has obtained for it an appropriate name. Of the five petals, one is superior, two lateral, and two inferior. The upper petal is named the *standard* (*vexillum*): it is commonly erect (Fig. 117. *a*), varies greatly in figure, and covers the other petals previous to the expansion of the flower. The two lower petals (Fig. 117. *b*) are generally united together by their lower edge, and form the *keel* (*carina*). The two lateral petals (Fig. 117. *c c*) form the *wings* (*alæ*).

Fig. 117.

It is on account of the resemblance which this corolla is imagined to bear to a butterfly with expanded wings, that it has obtained the name of *papilionaceous*.

The true *papilionaceous* corolla belongs exclusively to the immense family of *Leguminosæ*, which contains the Pea (*Pisum sativum*), the Kidney-bean (*Phaseolus*), the

False Acacia (*Robinia Pseudacacia*), the genus *Astragalus*, &c.

The *Anomalous* corolla (*C. anomala*), is one which, although resembling the papilionaceous, cannot be referred to it on account of the irregularity of its petals. Of this kind are the petals of the Monk's-hood, Lark-spurs, Violets, Balsam, Tropæolum, &c.

The position of the petals, or the divisions of the monopetalous corolla, with relation to the sepals, or the divisions of the monosepalous calyx, presents the following modifications:

The petals may be *opposite* to the divisions of the calyx, that is, they may be so placed that their under surfaces may correspond to the upper surfaces of the calycine segments; as in the Barberry (*Berberis vulgaris*), *Epimedium alpinum*, &c.

They may be *alternate* with the divisions of the calyx, or correspond to the incisions of the calyx, but not to its segments. This arrangement is of much more frequent occurrence than the last, which is very rare. The petals are alternate with the sepals in the Cruciferæ, &c.

The relative size of the corolla and calyx is equally deserving of attentive consideration, as excellent distinctive characters may often be derived from it.

With respect to its duration, the corolla is *Fugacious* or *Caducous* (*C. caduca*, *fugax*), when it falls off as soon as it expands; as in *Papaver Argemone*, several species of *Cistus*, &c.

Deciduous (*C. decidua*), falling after fecundation. This is the case with most corollas.

Marcescent (*C. marcescens*), continuing after fecundation, and withering in the flower before it becomes detached; as in the Heaths and certain Cucurbitaceæ.

The corolla is generally the most brilliant part of the flower. The delicacy of its texture, the brightness and freshness of its colours, and the delicious perfume which it often exhales, render it one of the most agreeable productions of nature. Its uses, as well as those of the calyx, appear to be those of protecting the sexual organs previously to their complete development, and of favouring, at the period of fecundation, the mutual action which these two organs exercise upon each other.

CHAPTER VII.

OF THE SEXUAL ORGANS.

The discovery of sexual organs in plants does not date at a very remote period. Until the sixteenth century, the flowers with which vegetables are covered were merely considered as an ornament with which it had pleased Nature to clothe them. Camerarius and Grew, at that period, demonstrated by experiment the utility of the different parts of the flower in perfecting the seed, and conducing to the preservation and succession of the species. They shewed that the *pistil*, which occupies the centre of the flower, resembles in its structure, and especially in its uses, the organs of generation of the female in animals. In fact, we find in it, as in the latter, the imperfect rudiments of the embryo (the *ovules*) ; a cavity destined to contain them and to protect them during their development (the *ovary*) ; an organ adapted for receiving the fecundating influence of the male (the *stigma*) ; and another organ by which this influence is transmitted to the embryos (the *style*). In like manner, they proved that the *stamen* resembles the organs appended to the male in animals; for it contains in a particular cavity (the *anther*), a peculiar substance (the *pollen*), the use of which is to fecundate the ovules.

It was now proved that plants, like animals, are furnished with sexual organs, destined for reproduction ; the male sexual organ being the *stamen*, and the female organ the *pistil*.

In vegetables the two organs of reproduction are almost always placed together in the same flower, a circumstance which constitutes hermaphrodism, and the flower is said to be *hermaphrodite.* In other cases, however, only one of the sexual organs is met with, and the flower is then named *unisexual.*

The *unisexual* flower may be *male* or *female*, according as it contains stamina or a pistil.

Male flowers and *female* flowers are sometimes placed together on the same plant; in which case, the latter is said to be *monœcious* or *monoicous.* Of this kind are the Chestnut (*Castanea vulgaris*), and the Hasel (*Corylus Avellana*).

At other times, the male flowers and the female flowers are separated from each other, and placed on different individuals of the same species. In this case, the plants are said to be *diœcious* or *dioicous.* Such are the Common Mercury (*Mercurialis perennis*), the Paper Mulberry (*Broussonetia papyrifera*), and the Date Palm (*Phœnix dactylifera*).

Lastly, there sometimes occur together on the same individual plant, or on different individuals of the same species, male flowers, female flowers, and hermaphrodite flowers. Vegetables which present this irregular mixture of the three kinds of flowers, are named *polygamous.* Of this kind are the *Pellitory* (*Parietaria officinalis*), the Crosswort (*Valantia cruciata*), &c.

These three divisions, founded upon the separation, the union, and the mixture of the sexes, form the basis of the last three classes of phanerogamous plants in the system of Linnæus; viz. *Monœcia*, *Diœcia*, and *Polygamia.*

CHAPTER VIII.

OF THE STAMEN OR MALE SEXUAL ORGAN.

The *Stamen* answers the same purposes in plants as the male organs in animals; in other words, it contains the substance by which the fecundation of the germs is effected.

The *stamen* is generally composed of three parts: 1. The *anther* (*anthera*), a kind of membranous bag, having a double internal cavity, in other words, formed of two cells in contact with each other; 2. The *pollen* (*pollen*), a substance commonly formed of small vesicular grains, which contain the parts necessary for fecundation; 3. The *filament* (*filamentum*), a thread-like appendage by which the anther is frequently supported.

Such are the three parts of which the stamen is usually composed. But of these parts two only are essential to it, the anther and the pollen. The filament is merely an accessory part of the stamen, and is accordingly often wanting, the anther being then directly attached to the body on which it is inserted, without the intervention of a filament. In this case the stamen is said to be *sessile* (*stamen sessile*), as in many Thymeleæ.

The essence and perfection of the stamen, therefore, reside in the presence of the anther. But in order that this organ be placed in a condition fitting it for performing the functions which nature has allotted to it, it must not only contain *pollen*, but must also open, that the pollen may come into contact with the stigma; for, unless this were to happen, fecundation could not take place.

The number of the stamina varies greatly in different plants. It was, in fact, upon the number of the male sexual organs contained in each flower that Linnæus founded the first classes of his system.

Thus, there are flowers which contain only a single stamen, and which are therefore named *Monandrous* (*Flores monandri*). Of this kind are *Hippuris vulgaris*, *Centranthus ruber*, *Blitum virgatum*, &c.

They are called *Diandrous* (*Flores diandri*), when they contain two stamina. Such are the flowers of the Lilac (*Syringa vulgaris*), the Privet (*Ligustrum vulgare*), the Common Speedwell (*Veronica officinalis*), the Sage (*Salvia officinalis*), &c.

Triandrous flowers (*Flores triandri*), such as have three anthers; as most of the Gramineæ, Cyperaceæ, Irideæ, &c.

Tetrandrous flowers (*Flores tetrandri*); the Yellow Bed-straw (*Galium verum*), Madder (*Rubia tinctorum*), most of the Labiatæ, Antirrhineæ, Dipsaceæ, &c.

Pentandrous flowers (*Flores pentandri*); the Great Mullein (*Verbascum Thapsus*), and most of the Solaneæ; the Hound's-tongue (*Cynoglossum officinale*), and most of the Boragineæ; the Carrot (*Daucus Carota*), and all the Umbelliferæ, &c.

Hexandrous flowers (*Flores hexandri*); the White Lily (*Lilium candidum*), the Tulip (*Tulipa gessneriana*), and most of the Liliaceæ and Asphodels; the Rice (*Oryza sativa*).

Heptandrous flowers (*Flores heptandri*); the Horse-Chestnut (*Æsculus Hippocastanum*).

Octandrous flowers (*Flores octandri*); those of the genera *Erica*, *Vaccinium*, *Daphne*, *Polygonum*, &c.

Enneandrous flowers (*Flores enneandri*); as those of the Flowering-rush (*Butomus umbellatus*).

Decandrous flowers (*Flores decandri*); as in the Pink, *Saponaria officinalis*, and most of the Caryophylleæ; the Rue (*Ruta graveolens*), the Pyrolas, Saxifrages, &c.

When the number of stamina exceeds ten, it is no longer determinate. Thus flowers are said to be—

Dodecandrous (*Flores dodecandri*), when they contain from twelve to twenty stamina; as in the Dyer's-weed (*Reseda Luteola*), and Agrimony (*Agrimonia Eupatoria*).

Polyandrous (*Flores polyandri*), when they contain more than twenty stamina; as in the White Poppy (*Papaver somniferum*), the genus *Ranunculus*, &c.

The stamina may be all *equal* to each other; as in the Lily, the Tulip, &c.

They may be *unequal*, that is, some large, others smaller, on the same flower.

Sometimes this disproportion is symmetrical, while at other times it exists without any kind of order. In *Geranium* and *Oxalis*, there are ten stamina, five large and five smaller, alternately disposed in such a manner that a large one occurs between two smaller, and *vice versa*.

When a flower contains four stamina, two of which are always shorter, these stamina take the name of *Didynamous* (*Stamina didynama*). Of this kind are the flowers of most of the Labiatæ, the Horehound, Thyme, &c.; most of the Antirrhineæ, as the Toad-flax (*Linaria vulgaris*), and the Greater Snapdragon (*Antirrhinum majus*).

When there are six stamina in a flower, and four of them are larger than the other two, they are said to be *Tetradynamous* (*Stamina tetradynama*). This arrangement is observed in the whole family of Cruciferæ, as in Scurvy-grass (*Cochlearia officinalis*), the Turnip and Cabbage (*Brassica Napus* and *oleracea*).

The situation of the stamina with relation to the divisions of the corolla and calyx is also deserving of attention. In general, the stamina correspond to the incisions of the corolla; in other words, the stamina are *alternate* with the divisions of the corolla or with the petals, when they are of the same number with these divisions; as in Common Borage and the other plants of that family.

Sometimes, however, each stamen, in place of corresponding to the incisions, is situated opposite each lobe or petal. In this case, the stamina are said to be *opposite* to the petals; as is observed in the Primrose, the Vine, &c.

When the number of stamina is double that of the divisions of the corolla, half of the stamina are alternate, the other half opposite to the divisions of the corolla.

In most cases, the stamina are opposite to the sepals or divisions of the calyx, although in some rare instances, when they are opposite to the petals, they are alternate with the sepals.

In the Lily and Tulip, the six stamina are opposite to the six segments of the simple perianth.

Sometimes the stamina are shorter than the corolla or calyx, so as not to protrude; in which case they are said to be *Included* (*Stamina inclusa*), as in the Primroses, Narcissuses, Daphnes, &c.

On the other hand, they are named *Exserted* or *Protruded* (*Stamina exserta*), when they extend beyond the corolla or calyx; as in *Lycium europæum*, the Mints, the Plantains, &c.

With reference to their direction, the stamina are named,

Erect (*St. erecta*), when they are straight and parallel to the axis of the flower; as in the Lily, Tobacco, &c.

Inflected (*St. inflexa*), when they are bent in the form of an arch, with their summit inclined towards the centre of the flower; as in the Sages and Fraxinella.

Reflected (*St. reflexa*), when they are bent outwards and downwards; as in the Common Pellitory (*Parietaria officinalis*), the Paper-Mulberry (*Broussonetia papyrifera*), &c.

Spreading (*St. patentia*), when they spread out horizontally; as in the Ivy.

Pendulous (*St. pendentia*), when their filament is very slender, and too weak to support the anther; as in most of the Gramineæ.

Ascending (*St. adscendentia*), when they are all directed towards the upper part of the flower; as in the Sage.

Declinate or *decumbent* (*St. declinata, decumbentia*), when they are all directed towards the lower part of the flower; as in the Horse-Chestnut and Fraxinella.

The stamina are sometimes connected by their filaments or by their anthers. At other times they are united to the pistil, and in a manner blended with it. We shall speak of these modifications when we come to treat of the filament and anther considered separately.

In certain flowers we find a determinate number of stamina, which are always abortive. In most cases, the stamina which are wanting are substituted by appendages of various forms, which are named *staminodia ;* as in the Virginian Spider-wort (*Tradescantia virginica*), most of the Orchideæ, &c.

One stamen is always abortive in *Antirrhinum* and many of the Personatæ; two in the Sage, Lycopus, Rosemary, &c., and in all the diandrous Labiatæ, as well as in all the Orchideæ, with the exception of *Cypripedium ;* three in *Bignonia* and *Gratiola ;* five in *Erodium*, &c.

1. *Of the Filament.*

The *Filament (filamentum)*, as we have already seen, is not an essential and indispensable part of the stamen, it being in many cases entirely wanting.

Its form generally corresponds to its name, it being elongated, slender, and thread-like.

It is *Flattened* (*Filamentum planum, compressum*) in *Allium fragrans*, the Periwinkle, &c.

Cuneiform (*F. cuneiforme*), having the form of a wedge; as in *Thalictrum petaloideum.*

Subulate or *Awl-shaped* (*F. subulatum*), when it is elongated, and tapers towards the summit; as in the Tulip, &c.

Capillary (*F. capillare*), when it is slender like a hair; as in Wheat, Barley, and most of the Gramineæ.

It is *Petaloid* (*F. petaloideum*), when it is broad, thin, and coloured like the petals; as in *Nymphæa alba*, the Amomeæ, &c.

Sometimes it is *dilated* at its base (*F. basi dilatatum*); as in *Ornithogalum pyrenaicum*.

At other times it is *arched* at the base (*F. basi fornicatum*); as in the Asphodel, the Bell-flowers, &c.

The summit of the filament is commonly *acute;* as in the Tulip, the Lily, &c.

At other times it is *obtuse*, and even enlarged into a *capitulum* or head; as in *Cephalotus*, &c.

The anther is more usually attached to the tip of the filament; but it sometimes happens that the latter is prolonged above the insertion of that organ. In this case it is said to be *prominent* (*F. prominens*); as in *Paris quadrifolia*, &c.

The stamina are commonly free of all adhesion, and distinct from each other; but it sometimes happens that they are united by their filaments into one or more bodies, which we shall follow M. Mirbel in designating by the name of *Androphorum*.

When all the filaments are connected into a single androphorum, the stamina are said to be *Monadelphous* (*St. monadelpha*), as in the Mallows. (Fig. 118.)

Fig. 118.

In this case, the androphorum forms a more or less perfect tube. Sometimes, however, the union of the filaments takes place only by their base, so that they remain free in the greater part of their extent; as in *Geranium* and *Erodium*.

At other times, they are united for half their length; as in several species of Oxalis. (Fig. 118.)

When all the stamina are united into two androphora; in other words, when their filaments are united into two distinct bodies, they are said to be *Diadelphous* (*St. diadelpha*); as in the Fumitory (*Fumaria officinalis*), the *Phaseoli*, *Acaciæ*, and most of the Leguminosæ. (Fig. 119.)

Fig. 119.

When the filaments are united into three or more androphora, the stamina are said to be *Polyadelphous* (*St. polyadelpha*). There are three androphora in *Hypericum ægyptiacum;* five and a greater number in the *Melaleucæ.*

The nature and organic structure of the filament of the stamina appear to be entirely similar to those of the corolla. In fact, these two organs are very frequently seen changing into each other. Thus in the White Water-lily (*Nymphæa alba*), the filaments of the stamina are successively seen to become gradually larger and thinner, from the centre of the flower towards its circumference, while, at the same time, the anthers diminish in size, and finally disappear altogether, when the filaments become completely converted into petals. This gradual change of the filaments into petals has led some botanists to consider the corolla, and the segments of which it is composed, as nothing but abortive stamina, the filaments of which have acquired an extraordinary development.

This opinion, which we are unwilling either to admit or to reject entirely, seems to be strengthened by the formation of *double* and *full* flowers. Thus, the Rose, in its original and wild state, has only five petals, but a very large number of stamina. In our gardens, through the care of the cultivator, the stamina are seen to become converted into petals, and the flower ultimately becomes sterile. Here the transformation of the stamina into petals is manifest, and appears to confirm the opinion of those botanists who consider the corolla as consisting of abortive stamina.

2. *Of the Anther.*

The *Anther* (*anthera*) is the essential part of the stamen which contains the pollen or fecundating powder, previously to the act of fecundation. It is more generally formed of two membranous bags, directly in contact with each other by one of their sides (Fig. 120.), or united by means of a peculiar interposed body, to which the name of *connective* is given. (Fig. 121. *b b* the membranous bags, *a* the connective).

Fig. 120.

Fig. 121.

Each of these small membranous bags, which are named the *cells* of the anther, is divided internally into two parts by a longitudinal partition, and opens at the period of fecundation, to allow the pollen to escape.

The anthers are therefore most commonly *Bilocular* (*Antheræ biloculares*), or formed of two cells; as in the Lily, the Hyacinth, &c.

Sometimes they consist of only a single cell, in which case they are said to be *Unilocular* (*Antheræ uniloculares*); as in the Coniferæ, the Epacrideæ, Malvaceæ, the Hasel, &c.

More rarely still, the anther is composed of four cells, and is named *Quadrilocular* (*Anthera quadrilocularis*); as in *Butomus umbellatus*, &c.

Each cell of an anther commonly presents on one of its surfaces a longitudinal groove, at which it opens in most cases. The part of the anther on the side of which the grooves are situated is named the *face*. The opposite part, by which the anther is attached to the filament, is named the *back*.

The anther is commonly fixed to the summit of the filament. This insertion, which furnishes excellent characters, may take place in three different ways.

1. The anther may be attached to the summit of the filament by its base, as in *Iris*, *Gladiolus*, &c.; in which case it is said to be *Basifixed* (*A. basifixa*).

2. It may be fixed by the middle part of its back, as in the Lily; when it is called *Mediifixed* (*A. mediifixa*).

3. Not unfrequently, it is attached by its summit, in which case it is mobile and vacillating, and is named *Apicifixed* (*A. apicifixa*).

When the face of the anthers is turned towards the centre of the flower, they are said to be *Introrse* or *turned inwards* (*A. introrsæ*); as is observed in most plants.

On the contrary, they are named *Extrorse* or *turned outwards* (*A. extrorsæ*), when their face looks towards the circumference of the flower; as in the Irideæ, the Cucumber, &c. This disposition is less common than the other.

The anthers vary greatly as to form. Thus they are named:

Spheroidal or *subglobose* (*A. spheroidales, subglobosæ*), when they approach the spherical form; as in *Mercurialis annua*.

Didymous (*A. didymæ*), when they have two spheroidal lobes, connected by a small portion of their circumference; as in Spinach (*Spinacia oleracea*), the Euphorbiæ, &c.

Ovoidal or Egg-shaped (*A. ovoideæ*). This is one of the most common forms.

Oblong (*A. oblongæ*); as in the Lily, &c.

Linear (*A. lineares*), when they are very elongated and narrow; as in the *Campanulæ*, *Magnoliæ*, &c.

Sagittate (*A. sagittatæ*) or arrow-shaped; as in the Rosebay (*Nerium oleander*), the Saffron (*Crocus sativus*), &c.

Cordiform (*A. cordiformes*) or heart-shaped; as in Sweet Basil (*Ocymum basilicum*), &c.

Reniform (*A. reniformes*), or kidney-shaped; as in Foxglove (*Digitalis purpurea*), many species of *Mimosa*, &c.

Tetragonal (*A. tetragona*), having the form of a four-sided prism; as in the Tulip (*Tulipa Gesneriana*).

At its summit, the anther may be terminated in various ways. Thus it is:

Acute (A. apice acuta), as in Borage *(Borago officinalis)*.

Bifid (A. bifida), slit at its summit into two narrow and separated lobes, which may also be the case at its base; as in many Gramineæ.

Two-horned (A. bicornis), terminated at its summit by two elongated horns; as in the Bilberry *(Vaccinium Myrtillus)*, and the Round-leaved Winter-green *(Pyrola rotundifolia)*.

Appendiculate (A. appendiculata), crowned with appendages, the form of which is very variable; as in Elecampane *(Inula Helenium)*, and the Rose-bay *(Nerium Oleander)*.

The two cells of which a *bilocular* anther is composed may be attached to each other in various ways:

1. They may be directly united together without the intervention of any other body; as in the Gramineæ. (See Fig. 120.)

When the two cells are directly united, they may present two different modifications. Sometimes their union takes place by one of their sides, in such a manner that the two grooves are still on the same face, and parallel to each other. The cells are then said to be *apposite (Loculi appositi)*; as in the Lily, &c.

At other times, they are united by the face opposite to the groove, so that the two grooves are situated one on each side of the anther. The two cells are then said to be *opposite (Loculi oppositi)*. This disposition, however, is less frequent than the other.

2. They may be united immediately by the upper part of the filament, which is prolonged between them; as in many *Ranunculi*.

3. Lastly, they may be more or less separated from each

other, by the intervention of another body, obviously distinct from the summit of the filament. This body has received the name of *Connective (connectivum)*, because it serves as a means of union between the two cells. (Fig. 121 *a*.)

Fig. 121.

The *connective* is sometimes perceptible only at the back of the anther, and is then called *dorsal;* as in the Lily, &c.

At other times, it is apparent on the two faces of the anther, the two lobes of which it separates in a distinct manner; as in *Melissa grandiflora*, the Virginian Spiderwort, &c. (See Fig. 121 *a*.)

Sometimes, again, the connective is so large, that it is only by analogy that its nature is determined. In this case it receives the name of *Distractile Connective.* Thus in the Sage, the connective presents itself in the form of a long recurved thread, placed transversely on the summit of the filament. At one of its extremities is seen one of the cells of the anther, filled with pollen. At the other extremity is seen the second cell, which, however, is almost always abortive, and in a rudimentary state.

This singular conformation also occurs in the genus *Melastoma*, and in several species of Labiatæ and Scrophularinæ.

Each of the cells of an anther may open in different ways, in different genera of plants; and the characters derived from this dehiscence, are in some cases useful for distinguishing certain genera.

Most commonly the dehiscence takes place at the seam or suture of the longitudinal groove which runs along the surface of each cell. In this case it is said that the cells are *longitudinally dehiscent (Loculi longitudinaliter dehiscentes);* as in the Lily, the Tulip, and many other plants.

The dehiscence may take place by *pores* or slits situated in different parts. Thus in the genera *Erica*, *Solanum*, &c., each cell opens by a small hole placed at its summit *(Lo-*

culi apice dehiscentes). (Fig. 122 *a a*.) In the genus *Pyrola*, this hole is placed at the lower part *(Loculi basi dehiscentes)*.

At other times, the dehiscence takes place by means of small valves, which open from below upwards; as in the Laurels, the Barberry, the *Epimedium alpinum*, &c. (Fig. 123, *a a* the pores; *b b* the valves).

We have hitherto been examining anthers, free of all adhesion; but, like the filaments, they may approximate each other, and unite so as to form a kind of tube. This remarkable arrangement is met with in the whole of the vast family of Synanthereæ, to which the name of *Compound Flowers* was formerly given, such as Thistles, Artichokes, Marigolds, &c. Linnæus, in his system, gave the name of *Syngenesia* to the class which contains all the plants that have their anthers united by the sides. (Fig. 124.)

Fig. 122.

Fig. 123.

Fig. 124.

Fig. 125.

There are many plants in which the stamina, in place of being free, or simply united together by their filaments or anthers, are incorporated with the pistil; in other words, are intimately united to the style and stigma. These plants are named *Gynandrous*. (Fig. 125.)

The stamina never coalesce with the ovary. The filaments and the style are the only parts that unite; so that the anthers and stigma are borne upon a common support, with which they are blended. This is observed to be the case in the Aristolochiæ, Orchideæ, Zingiberaceæ, &c. In the Orchideæ, the name of *Gynostemium* is given to the common support of the stigma and anthers.

3. *Of the Pollen.*

The *Pollen*, or the substance contained in the cells of the anther, and which is subservient to fecundation, generally presents the appearance of a powder, composed of extremely minute grains. Sometimes it is in solid masses of greater or less size; but as, in this state, it occurs in only a few plants, we shall first examine the pollen in the powdery form.

Previous to the improvement of our optical instruments, the knowledge which had been obtained respecting the varied forms of the grains of pollen, and especially respecting their internal structure, was extremely vague. A great diversity had indeed been perceived in those which had been examined with powerful lenses, but their differences had been pointed out without deriving from them any inferences that might tend to the advancement of science. The structure of the pollen had also engaged the attention of most of the older botanists, who had long disputed, without coming to any settled determination, respecting the internal composition of bodies of so elementary a nature. The microscopic examination of the pollen was therefore a subject that required revision, and which could not fail to attract the attention of modern observers. M. Amici, of whom we have had occasion to speak so favourably in the present work, published, in vol. xvii. of the Acts of the Italian Society, a chapter on the pollen, in which he details some very interesting circumstances, which we shall describe as we proceed. With the assistance of M. Selligue's achromatic microscope *, our friend M. Guillemin, in the summer of 1824, made numerous observations on the pollen, the principal results of which we shall communicate.

The grains of the pollen are utricles of various forms,

* See a description and figure of this instrument in *Annales des Sciences Naturelles*, Nov. 1824, t. iii.

having no adhesion to the anther at the period of maturity, and containing a multitude of granules of extreme minuteness.

The utricular membrane is sometimes smooth, sometimes marked with eminences or asperities. Sometimes it presents little flat surfaces or prominences symmetrically arranged. When the pollen is perfectly smooth at its surface, it is not at the same time covered with any viscous coating, whereas the slightest eminences are indications of viscosity. The papillæ, mammillary eminences, &c. which cover certain grains of pollen, are true secreting organs, of which the viscous and usually coloured envelope with which they are invested is the product. The powdery pollens may therefore be arranged under two principal orders, the *viscous* pollens, and the *non-viscous*. Characters derived from the general form are of less importance, the differences between those which are spherical, elliptical, cycloid, polyhedral, &c., being less observable.

M. Guillemin has been convinced, by a great number of observations, that the nature of the grains of pollen is the same in each natural family of plants; or, in other words, that in one of these families there never occur viscous pollens and others which are not viscous. He has found moreover that all the genera of a family present only modifications in the forms of their grains of pollen; although families very remote from each other in respect to other characters agree in having the same kinds of pollen. We shall be satisfied with describing the nature and forms of this organ in a few remarkable families.

The pollen of the *Malvaceæ* and *Convolvulaceæ* is formed of papillar spherical grains, of a silvery white colour. In the *Cucurbitaceæ*, they are spherical, papillar, and of a beautiful gold-yellow. Those of the tribe of *Heliantheæ*, in the family of *Synanthereæ*, are also spherical, papillar, and of a fine orange-yellow. The tribe, or rather order, of the *Cichoraceæ*, presents spherical grains, which are viscous, but are bounded by minute plain surfaces. In *Cobœa scandens*, the pollen is covered with mammillar eminences, each surmounted by a shining point. The pollen of the genus *Phlox* very much resembles that mentioned last; and this circumstance is corroborative of the opinion of those who consider the two genera as belonging to the same natural family. Lastly, not to occupy too much time in enumerating the viscous pollens, the grains have a very distinct trigonal form, with a considerable depression in their centres in the *Onagrariœ.*

The families in which grains that are not viscid are found are very numerous. It will suffice to mention the *Solaneœ, Scrophularineœ, Gentianeœ, Caryophylleœ, Gramineœ, Euphorbiaceœ,* &c. These grains have always an elliptical form, and are marked with a longitudinal groove. Their usual colour is yellow, although they are sometimes red, as in *Verbascum.* In the *Papilionaceous Leguminosœ,* the pollen, although not viscous, is of a very distinct cylindrical form.

When grains of pollen which are not viscous are submitted to the action of water, they instantly change their form, which, from being elliptical, becomes perfectly spherical. The viscous grains first lose their coating, then burst more or less quickly, and project a fluid denser than water, and in which are seen moving myriads of minute grains, which their greenish colour renders perceptible, when they are magnified to several hundred diameters. M. Amici saw a grain of pollen of *Portulaca oleracea,* in contact with a hair of the stigma, burst, and project a kind of bowel, in which the *granules* circulated for more than four hours. Gleichen, who had already observed the granules contained in the grains of pollen, considered them as performing the principal part in the act of fecundation; and M. Guillemin, reasoning from the resemblance of these organs to the spermatic animalcules of animals, is inclined to adopt the same opinion.

Such was the state of our knowledge respecting the nature and organization of the grains of the pollen, when our friend M. Adolphe Brongniart undertook his examination of the generation of vegetables. His opinion respecting the nature and organization of the grains of pollen we shall here make known. When one examines the interior of the cells of a yellow anther in a flower-bud, long before its expansion, he sees that it is filled with a cellular mass distinct from the walls of the cells. By degrees the cellules of which the cellular mass is composed, and which are generally very small, separate from each other, and at length form the granules, which are named pollen. Sometimes these particular cellules or grains of pollen are enclosed in other larger vesicles, which become torn, and of which traces may still be perceived.

Each grain of pollen, whose form, as we have already said, is very variable, presents a uniform organization. It is composed of two membranes, the one external, thicker, and furnished with pores, and sometimes more or less prominent appendages; the other internal, thin, transparent, and having no adhesion to the first. When submitted to the action of water, the inner membrane swells, the outer bursts at some part of its surface, and through the opening thus formed there issues a tubular prolongation, which forms a kind of hernia, and which was first observed by Needham. M. Amici has also seen it in the pollen of *Portulaca pilosa*. Sometimes there issue two prolongations at two opposite points, as in *Œnothera biennis*. The cavity of the inner membrane is filled with spherical granules, of extreme minuteness, which appear to perform the most important part in the act of fecundation.

We shall now speak of the pollen of the Asclepiadeæ and Orchideæ, which presents very remarkable modifications. In several genera of these two families, all the pollen contained in a cell is united into a body, which has the same form as the cell in which it is contained. To this united pollen is given the name of *Pollen-mass (Massa pollinica).* When these masses are divided into several smaller masses, the latter are named *Massules (Massulæ).* The pollen-masses of the Orchideæ are sometimes formed of solid grains, united together by a kind of elastic network. They are then named *Sectile Masses (Massæ sectiles)*, as in the genera *Orchis* and *Ophrys.* At other times they are entirely *granular* or *farinaceous (Massæ granulosæ)*; as in the genera *Epipactis*, *Loroglossum*, &c. Lastly, they are sometimes *solid* and *compact (Massæ solidæ)*; as in the genera *Corallorhiza* and *Malaxis.* These three forms are never united or confounded in the same genus.

When the pollen is thrown on red-hot charcoal, it burns and enflames with rapidity. In many plants, it diffuses an odour, which has the most striking resemblance to the substance to which it is compared in animals, as is very distinctly observed in the Chestnut, the Barberry, &c.

The pollen, when it begins to be developed, that is, long before the expansion of the flower, presents itself under the form of a cellular mass, sometimes covered with an extremely thin membrane, which, however, has no attachment to the walls of the cavity. The utricles of which this mass is composed, are at first very intimately united together. Some scattered granules are perceived in their interior. By degrees the utricles separate, the granules which they contain unite, and soon after, by their successive development, burst the utricles which contain them, assume the form which they are to retain, and finally become grains of pollen. It will be seen that this mode of development is perfectly similar to that of the cellular tissue, which we described when treating of the elementary part of vegetables.

CHAPTER XI.

OF THE PISTIL OR FEMALE SEXUAL ORGAN.

The *Pistil (Pistillum)*, as we have already said, is the female organ in plants. It almost invariably occupies the centre of the flower, and is composed of three parts, the *ovary*, the *style*, and the *stigma*.

In most cases we find only a single pistil in a flower : as in the Lily, the Hyacinth, the Poppy, &c. At other times, there are several pistils in the same flower ; as in the Rose, the Ranunculi, &c.

The pistil, or the pistils, when there are more than one, are often attached to a particular prolongation of the receptacle, to which the name of *Gynophorum* is given.

We must not confound the *gynophorum* with the *podogynum*, a contraction of the base of the ovary which raises the pistil a little above the bottom of the flower. The gynophorum, in fact, does not essentially belong to the pistil ; but remains at the bottom of the flower when the pistil is detached. The podogynum, on the contrary, which forms part of the pistil, accompanies it through all the stages of its development. There is a gynophorum in the Strawberry and Rasp, and a podogynum in the Caper and Poppy.

When there are several pistils in a flower, it is not unusual to see the gynophorum becoming thick and fleshy. This is particularly observable in the Raspberry, and especially in the Strawberry. The part of the latter which is pulpy and sweet, and which is eaten, is merely a very large gynophorum ; the little shining grains which cover it are so many pistils. It is easy to satisfy one's self as to the nature of these different parts, by following their gradual development in the flower.

The *base* of the pistil is always represented by the point at which it is attached to the receptacle. The *summit*, on the other hand, always corresponds to the point where the styles or the stigma are inserted upon the ovary. As this insertion is sometimes lateral, it will be perceived that the *organic summit* of the ovary does not always agree with its *geometrical summit.* The latter, in fact, is the highest point of the axis of the ovary, or of the imaginary line which passes through its central part.

1. *Of the Ovary.*

The *Ovary (Ovarium)* always occupies the lower part of the pistil. Its essential character is that, when divided in the longitudinal or transverse directions, it presents one or more cavities, named *cells*, in which are contained the rudiments of the seeds, or the *ovules*. It is in the interior of the ovary that the *ovules* acquire all their development, and are converted into *seeds*. This organ may therefore be considered, with respect to its functions, as analogous to the ovary and uterus in animals.

The usual form of the ovary is the ovoidal; but it is more or less compressed and elongated in certain families of plants, as in the Cruciferæ, Leguminosæ, &c.

The ovary is generally *free* at the bottom of the flower; in other words, its base corresponds to the point of the receptacle, into which are inserted the stamina and the floral envelopes, although it does not contract any adhesion with the calyx; as is observed in the Hyacinth, the Lily, the Tulip, &c. (Fig. 126.)

Fig. 126.

Sometimes, however, the ovary is not met with in the bottom of the flower, but seems to be placed entirely beneath the insertion of the other parts; in other words, it is united in every part of its circumference with the tube of the calyx, its summit alone being free in the bottom of the flower. In this case, the ovary has been named *adherent* or *inferior (Ovarium inferum)*, to distinguish it from that in which it is *free* or *superior (Ovarium superum)*. The genera *Iris*, *Narcissus*, *Myrtus*, and *Ribes*, have an inferior ovary. (Fig. 127.)

Fig. 127.

When the ovary, therefore, is not met with at the bottom of the flower, but when the centre of the latter is occupied by a style and a stigma, it will be necessary to examine if there be not at the bottom of the flower a particular bulging, distinct from the top of the peduncle. If this enlargement, on being cut across, presents one or more cavities, containing ovules, it is clear that there is an inferior ovary.

The position of the ovary, considered as to its being *inferior* or *superior*, furnishes the most valuable characters for grouping genera into natural families.

Whenever the ovary is inferior, the calyx is necessarily *monosepalous*, since its tube is intimately united to the circumference of the ovary.

Sometimes the ovary is not entirely inferior, but is free in some portion of its upper part, a third, a half, or two-thirds. These different gradations are observed in the genus *Saxifraga*.

But there is a position of the ovary which, although almost always confounded with the inferior ovary, requires to be distinguished from it. It is when several pistils, existing together in a flower, are attached to the inner wall of a calyx which is very narrow at its upper part, so that at first sight it might seem to represent an inferior ovary. These ovaries are named *Parietal (O. parietalia)*; as in the genus Rosa, and many other plants of the same family. (Fig. 128.)

Fig. 128.

We must also point out a modification of the ovary, to which the name of *Gynobasic Ovary* is given. Examples of it are presented by a great number of families; the Labiatæ, the Boragineæ, the Ochnaceæ, the Simaroubeæ, &c. The ovary, applied upon a hypogynous disk, which, in this case, has received the name of *Gynobasium*, is more or less deeply divided into a certain number of lobes corresponding to the number of the cells, and its central axis is so depressed, that it appears in a manner obliterated, the style seeming to spring immediately from the disk; so that, at the period of maturity, each of the parts or cells of which the ovary is composed separates, and seems, as it were, to form a distinct fruit.

The *inferior* ovary being that which is united with the tube of the calyx at every part of its circumference, there results from this circumstance a general law to which no attention has been paid, and which is, that the inferior position of the ovary necessarily excludes a multiplicity of pistils in the same flower. In fact, in the case of parietal ovaries, it is seen that they touch the calyx only in a single point, it being utterly impossible that it should envelope several in their whole circumference. It follows from this, that these ovaries are not inferior, but only parietal, as they are not united to the tube of the calyx at every part of their surface. This modification deserves to be particularly noticed.

The ovary is *Sessile* at the bottom of the flower *(Ovarium sessile)*, when it is not raised upon any peculiar support; as in the Lily, Hyacinth, &c. (Fig. 129.)

It may be *Stipitate (O. stipitatum)*, when it is borne upon a very elongated *podogynum*; as in the Caper *(Capparis spinosa.)*

When cut across, the ovary often presents a single internal cavity or *Cell (loculamentum)* containing the *ovules*. It is in this case said to be *Unilocular (O. uniloculare)*; as in the Almond, the Cherry, the Pink, &c.


Fig. 129.

It is named *Bilocular (O. biloculare)*, when it is composed of two cells; as in the Lilac, the Toadflax, the Foxglove, &c.

Trilocular (O. triloculare); as in the Lily, the Iris, the Tulip, &c. (Fig. 130.)

Fig. 130.

Quadrilocular (O. quadriloculare); as in *Sagina procumbens.*

Quinquelocular (O. quinqueloculare); as in the Ivy.

Multilocular (O. multiloculare), when it presents a great number of cells; as in the Water-lily.

But each cell may contain a number of ovules, which varies in different plants. Thus there are cells which never contain more than a single ovule, and are named *Uniovulate (Loculi uniovulati);* as in the Gramineæ, Synanthereæ, Labiatæ, Umbelliferæ, &c.

At other times, each cell contains two ovules, or is *Biovulate (Loculus biovulatus).* In the cases in which each cell of an ovary contains only two ovules, it is of the greatest importance to study their relative position. Sometimes, in fact, the two ovules arise from the same point, and at the same height; in which case they are *apposite (Ovula apposita);* as in the Euphorbiaceæ. At other times, they come off one above the other, and are named *superimposed (Ovula superposita);* as in *Tamus communis.*

On the other hand, they are said to be *alternate (Ovula alterna),* when their points of attachment are not on the same level, although they are laterally in contact; as in the Apple and Pear.

When we come to speak of the seed, we shall treat more in detail of the various positions of the ovules with respect to each other, and with relation to the ovary.

Lastly, in some cases, each cell of an ovary contains a great number of ovules; as in the Tobacco, the Poppy, &c.; but these ovules may be variously disposed. They are not unfrequently regularly superimposed upon each other, along a longitudinal line; as in *Aristolochia Sypho.*

They are then named *uniseriate* or *single-rowed (Ovula uniseriata).* At other times, they are disposed in two longitudinal rows, or are *biseriate (Ov. biseriata);* as in the Iris, the Lily, the Tulip, &c.

Sometimes they are *scattered* without order; as in the Thorn-apple. At other times they are *conglobate*, or packed close together, so as to form a globular body; as in many Caryophylleæ.

The ovules, when fecundated, become seeds; but it frequently happens that a certain number of ovules regularly become abortive in the fruit. Several of the partitions are even sometimes destroyed and disappear. It is therefore necessary to seek the true structure of the fruit in the ovary. It is by this means alone that we can bring near each other, in the series of natural orders, certain genera which at first sight seem to be widely different in the structure of their fruits and the disposition of their seeds.

2. *Of the Style.*

The *Style (Stylus)* is the filiform prolongation of the summit of the ovary which supports the stigma (See Fig. 126, 129). Sometimes it is entirely wanting, and then the stigma is *sessile;* as in the Poppy, the Tulip, &c.

The ovary may be surmounted by a single style, as in the Lily, and the Leguminosæ; by two styles, as in the Umbelliferæ; by three styles, as in the Way-faring-tree *(Viburnum Lantana)*, &c. There are four styles upon the ovary in *Parnassia;* five in *Statice*, *Linum*, &c.

In other cases, again, there is only a single style for several ovaries; as in the Apocineæ, &c.

The style almost always occupies the highest part, or the geometrical summit, of the ovary; as in the Cruciferæ, Liliaceæ, &c. It is then said to be *Terminal (Stylus terminalis).*

It is named *Lateral (S. lateralis)*, when it arises from the lateral parts of the ovary; as in most of the Rosaceæ, in the genus *Daphne*, &c. It then indicates the organic summit of the ovary, which, in this case, is different from the geometrical summit.

In some much rarer cases, the style appears to spring from the base of the ovary. It then obtains the name of *basal* or *basilar style (S. basilaris).* It has this position in the Lady's-mantle *(Alchemilla vulgaris)*, and the Bread-fruit Tree *(Artocarpus incisa).*

In some cases also, the style, in place of springing from the ovary, seems to arise from the receptacle; as in the Labiatæ, certain Boragineæ, &c. This circumstance occurs wherever there is a gynobasium.

The style may be *Included (S. inclusus)*, that is, contained within the flower, so as not to appear externally; as in the Lilac *(Syringa vulgaris)*, the Jasmine *(Jasminum officinale)*, &c.

It may be *Protruded (S. exsertus);* as in Red Valerian *(Centranthus ruber).*

The forms of the style are not less numerous than those of the other organs which we have already examined. In fact, although it is generally slender and filiform, it yet, in certain plants, has quite a different appearance. Thus it is:

Trigonal (Stylus trigonus) in *Ornithogalum luteum*, *Lilium bulbiferum*, &c.

Claviform, or club-shaped *(S. claviformis)*, in *Leucojum æstivum*.

Hollow or *Fistular (S. fistulosus)*, in the White-lily, *(Lilium candidum).*

Petaloid (S. petaloideus), broad, thin, membranous, and coloured like the petals, in the genus *Iris*, &c.

Viewed with reference to its direction, in respect to the ovary, it is *Vertical (S. verticalis)*, in the Lily.

Ascending (S. ascendens), forming an arch, the convexity of which is turned towards the upper part of the flower; as in Sage, and several other Labiatæ.

Declinate (S. declinatus) *, when it inclines towards the lower part of the flower; as in *Dictamnus alba*, and certain Labiatæ and Leguminosæ.

The style may be *simple (S. simplex)*, and without any division; as in the Periwinkle and Lily.

It is *bifid (S. bifidus)*, in the Red Currant *(Ribes rubrum)*; *trifid* in *Gladiolus communis*; *quinquefid* in *Hibiscus*; *multifid*, in the Mallow; according as it is slit into two, three, five, or a greater number of shallow divisions.

When the divisions are very deep, and reach to beneath the middle, it is *bipartite* (*S. bipartitus*), as in the Gooseberry *(Ribes Grossularia)* (See Fig. 127); *tripartite*, *quinquepartite*, *multipartite*, &c. according to the number of its divisions.

The style sometimes seems as if articulated to the summit of the ovary, so as to fall off after fecundation, leaving no traces of it on the ovary; as in the Cherry, Plum, &c. In this case it is named *caducous (S. caducus)*. Sometimes, on the contrary, it is *persistent (S. persistens)*, when it remains after fecundation. Thus in the Cruciferæ, the Box, the genera *Anemone* and *Clematis*, the style continues, and forms part of the fruit.

Lastly, it sometimes not only remains after fecundation, but continues to increase in size; as in the Pasque-flower, the genera *Clematis*, *Geum*, &c.

3. *Of the Stigma.*

The *Stigma* is the usually glandular part of the pistil, placed at the summit of the ovary or style, and destined to receive the influence of the fecundating substance. Its surface is generally uneven and more or less clammy.

The stigma, considered in an anatomical point of view,

* Not unfrequently the stamina and the pistil are *declinate* in the same flower, in which case it is said that the sexual organs are *declinate (Genitalia declinata)*, as in Fraxinella.

is composed of elongated utricles, converging from the surface of the stigma towards the style, and loosely attached to each other by a mucilaginous substance. These utricles are generally naked, although, in some cases, they are covered by a very thin and transparent membrane.

The *number* of stigmas is determined by that of the styles, or of the divisions of the style, the former always corresponding to the latter.

The stigma is *sessile*, or directly attached to the summit of the ovary, when the style is wanting; as in the Poppy and Tulip.

There is only *one* stigma in the Cruciferæ, Leguminosæ, Primulaceæ, &c.

There are *two* in the Umbelliferæ and a great number of Gramineæ.

Three in the Irideæ, the genera *Silene*, *Rheum*, *Rumex*, &c.

There are *five* in the Flax; *six*, and even a greater number, in many other plants, such as the Mallows.

The stigma is generally *terminal (Stigma terminale)*, that is, situated at the summit of the style or ovary; as in the Lily, the Poppy, &c. (See Figs. 126, 129).

It is *Lateral (S. laterale)*, when it occupies the sides of the style, or, when that part is wanting, of the ovary; as in the Ranunculaceæ, the Plane-tree, &c.

With respect to the *substance* of which it is composed, it is *Fleshy (S. carnosum)*, when it is thick, firm, and succulent; as in the Lily.

Glandular (S. glandulare), when it is evidently formed of small glands, more or less approximated to each other.

Membranous (S. membranaceum), when it is flat and thin.

Petaloid (S. petaloideum), when it is thin, membranous, and coloured like the petals; as in the genus *Iris*, &c.

According to its *form*, the stigma may be:

Globular or *Capitate (S. globosum, capitatum)*, rounded like a little head; as in the Cowslip *(Primula veris)*, Belladonna *(Atropa Belladonna)*, and Marvel-of-Peru *(Nyctago hortensis)*.

Hemispherical (S. hemisphericum), having the form of a hemisphere; as in the Yellow Henbane *(Hyoscyamus aureus)*.

Discoid (S. discoideum), flat, broad, and in the form of a shield; as in the Poppy, &c.

Claviform or *Club-shaped (S. clavatum)*, as in *Jasione montana*, &c.

Capillar or *Filiform (S. capillare, filiforme)*, slender and very elongated; as in the Maize.

Linear (S. lineare), narrow and elongated; as in the *Campanulæ* and many Caryophylleæ.

Trigonal (S. trigonum), having the form of a three-sided prism; as in the Wild Tulip *(Tulipa sylvestris)*.

Trilobate or *Three-lobed (S. trilobum)*, formed of three rounded lobes; as in the Lily. (See Fig. 126.)

Stellate (S. stellatum), flat and cut into several lobes, so as to resemble a star; as in the Ericineæ, the genus *Pyrola*, &c.

Umbilicate (S. umbilicatum), having a depression in its centre; as in the Lily, *Viola rothomagensis*, &c.

Semilunar or *Crescent-shaped (S. semilunatum)*; as in the Yellow Fumitory *(Corydalis lutea)*.

Like the style, the stigma may be *Simple* or *undivided;* as in *Borago officinalis*, the Cowslip, &c.

Bifid (S. bifidum), having two narrow divisions; as in Sage, and many Labiatæ, Synanthereæ, &c.

Trifid (S. trifidum), in *Cneorum tricoccum*, the genus *Narcissus*, &c.

Quadrifid (S. quadrifidum), in *Plumbago europæa*, &c.

Multifid (S. multifidum), when the number of its divisions is greater.

It is *Bilamellate (S. bilamellatum)*, formed of two laminæ moveable upon each other, in *Mimulus*.

With respect to its *direction* the stigma is said to be:

Erect (S. erectum) when it is elongated, and has the same direction as the axis of the flower.

Oblique (S. obliquum), when its direction is oblique with relation to the axis of the flower.

Twisted (S. tortum), rolled like a screw; as in *Nigella hispanica*, &c.

The surface of the stigma is sometimes *smooth*, sometimes velvety; as in *Chelidonium Glaucium*, *Mimulus aurantiacus*, &c. It is *downy* in the Plane-tree.

The stigma is *Feathery (S. plumosum)*, when it is filiform, and has on each side a row of hairs disposed like the barbs of a feather; as in many Gramineæ.

Penicelliform, or *Pencil-shaped (S. penicelliforme)*, when the hairs are collected into small tufts; as in *Triglochin maritimum*, &c.

We have now examined and described the organs of florescence, namely, the pistil, the stamina, and the floral envelopes. We have remarked that the essence of the flower resides solely in the presence of the sexual organs, and that the calyx and corolla can only be considered as accessory, in other words, as merely favouring the exercise of the functions which nature has confided to the flower, but not contributing directly to it. Accordingly, they are not unfrequently found to be wanting, without their absence appearing to have any influence upon the phenomena and reciprocal action of the sexual organs.

The principal use of the floral envelopes seems, therefore, to be that of protecting the organs of generation until they have attained their full growth, or until the period when they are fit for fecundation.

Before proceeding to describe the phenomena of this important function, we have still to revert to some general considerations respecting the flower.

The name of *Anthesis* has been given to the phenomena which take place at the period when all the parts of a flower, having acquired their full development, open, separate from each other, and expand.

All plants do not flower at the same period of the year. There are, in reference to this circumstance, very remarkable differences, which depend upon the nature of the plant, the influence of heat and light, and the geographical position of the vegetable.

Flowers form one of the finest ornaments of nature. Were they to come out all in the same season, and at the same period, they would disappear too soon, and vegetables would remain too long destitute of their greatest beauty.

Even winter, notwithstanding the cold which accompanies it, is not without flowers. The Snowdrop, the Leucojum, the Hellebores, and the Mezereons, unfold their flowers when the ground is still covered with snow. These examples, however, may be considered as exceptions to the general order. Cold, in fact, appears to oppose the development and expansion of flowers, whereas a gentle and moderate heat favours and maintains them. Accordingly, in countries where the temperature continues in a mean state the whole year, a kind of perpetual spring prevails, and the earth is always covered with new flowers.

In the temperate parts of Europe, it is in spring, when a gentle and vivifying heat has succeeded to the cold of winter, that the flowers, gradually separating their envelopes, expand and disclose their beauties to our view. The months of May and June are those which see the greatest number of flowers expand.

According to the season in which they develope their flowers, plants have been distinguished into four classes:

1. *Vernal (Plantæ vernales, vernæ)*, those which flower during the months of March, April, and May; such as Violets, Primroses, &c.

2. *Æstival* or Summer plants *(P. æstivales)*, those which flower from the beginning of June to the end of August. There are more of this kind than of any other.

3. *Autumnal (P. autumnales)*, those which expand their flowers from September to December. Of this kind are many species of *Aster*, the Meadow Saffron *(Colchicum autumnale)*, *Crysanthemum indicum*, &c.

4. *Hibernal* or Winter plants *(P. hibernales, hibernæ)*, those which flower from about the middle of December to the end of February; such as many Mosses and Jungermanniæ, *Galanthus nivalis*, *Helleborus niger*, &c.

From the consideration of the period at which different plants produce their flowers, Linnæus formed his Calendar of Flora. In fact, there are many plants whose flowers always appear regularly at the same period of the year. Thus, in the climate of Paris, the Christmas Rose *(Helleborus niger)* flowers in January; the Hazel and Mezereon in February; the Almond, the Peach, and the Apricot, in March; the Pear, Tulips, and Hyacinths, in April; the Lilac and the Apple in May, &c.

Not only do the flowers show themselves at different periods of the year, in different plants, but there are many flowers which open and close at determinate hours of the day, while some expand only at night. Hence flowers are distinguished into *diurnal* and *nocturnal*. The latter are much less numerous than the former. Thus the Marvel-of-Peru *(Nyctago hortensis)* opens its flowers only when the sun has sunk beneath the horizon.

There are even flowers which have the habit of opening and closing at certain periods of the day, with so much regularity, that one may tell the hour by them. Linnæus, who was so ingenious in detecting the most interesting circumstances respecting flowers, made use of the periods at which some species are well known to expand, for the purpose of forming a table, to which he gave the name of

Flora's Timepiece. In this table, the plants are arranged according to the hour at which their flowers expand.

The state of the atmosphere appears to have a decided influence upon the flowers of certain plants. Thus, *Calendula pluvialis* closes its flower when the sky is overcast, or when a thunder-storm threatens to burst. *Sonchus sibiricus*, on the other hand, opens and expands only when the weather is hazy, and the atmosphere loaded with clouds.

The light of the sun appears to be one of the causes which act most powerfully upon the expansion of flowers. Its absence produces a kind of sleep in flowers, as it does in the leaves of the family of Leguminosæ. By very ingenious experiments, my friend M. Bory de St Vincent succeeded in causing to flower certain species of Oxalis, the flowers of which never expanded naturally, by illuminating them strongly at night, and collecting upon them the rays of light by means of a lens.

The duration of flowers also exhibits some very remarkable differences. Some expand in the morning, and are withered before the end of the day. Such flowers are called *ephemeral*. Of this kind are most of the species of *Cistus*, *Tradescantia virginica*, some species of *Cactus*, &c. Others, on the contrary, retain their splendour unimpaired for several days, often even for several weeks.

Lastly, there are flowers whose colour varies at the different periods of their development. Thus the Hortensia begins with having green flowers. By degrees they assume a beautiful rose-colour, which, before they are entirely faded, becomes of a more or less deep blue.

CHAPTER X.

OF THE NECTARIES.

By the general name of *Nectaries* (*nectaria*), Linnæus designated not only the glandular bodies which are observed in certain flowers, and which secrete a sweet or *nectareous* fluid, but also all the parts of the flower which, presenting irregular and unusual forms, appeared to him not to belong to the floral organs properly so called, that is, to the pistil, stamina, or floral envelopes.

It may easily be conceived, that the great extension given by Linnæus to the term *Nectary* could not but render it extremely vague. In fact, it is utterly impossible to give a strict definition of it, as employed by him. A few examples will show the truth of our assertion.

Whenever one of the constituent organs of the flower presented some irregularity in its form or development, or some alteration of its usual aspect, Linnæus called it a nectary. It will readily be imagined that, in this manner, he must have confounded a multitude of organs very different from each other.

Thus, in the Columbine, Linnæus describes five nectaries in the form of recurved spurs, hanging between the five sepals. In the Larkspurs there are two which are prolonged into a point at their hind part, and are contained in the spur which is observed at the base of the upper sepal. In the Hellebores we find a great number of nectaries, which are tubular and two-lipped. Now, these alleged nectaries of the Hellebores, Columbines, and in general of all the other genera of the family of Ranunculaceæ, are nothing but the petals.

In the Tropæolum, the nectary is a spur which arises from the base of the calyx. In the Toadflax, this nectary or spur is a prolongation of the base of the corolla. This is also the case in the Violet, Balsamine, &c.

Linnæus also gave the name of *nectaries* to masses of glands placed in different parts of the flower. Accordingly, he confounded the *disks* under that name; as in the Cruciferæ, Umbelliferæ, Rosaceæ, &c. In the Lily, the nectary has the form of a glandular groove placed at the internal base of the divisions of the calyx. In the genus *Iris*, it is a tuft of glandular hairs, placed on the middle of the outer divisions of the calyx.

In the Gramineæ, the nectary is composed of two small scales, varying greatly in form, and situated on one side of the base of the ovary. These two scales or paleolæ form the *glumella*, an organ which performs no secretion. In the Orchideæ, the nectary is the lower and inner division of the calyx, which other botanists, and Linnæus himself, have designated as the *lip*.

We might adduce many other examples of genera in which nectaries have been described; but what we have mentioned will suffice to show how vaguely and indefinitely the term is used, since it has been applied to petals, calyces, stamina, abortive and deformed pistils, and to hypogynous, perigynous, and epigynous disks.

Were it necessary to retain the term *Nectary*, we think it should be exclusively applied to the little masses of glands situated on different parts of the plant, and destined to secrete a sweet juice, care being at the same time taken not to confound these bodies with the different kinds of disk, which are never secreting organs. By this means the uncertainty and confusion which the term carries with it might be avoided, and it would be restored to its true signification.

In commencing the examination of the floral organs, we mentioned that the most complete flower is only the aggregation of four verticils of variously modified leaves. It is a true bud; but one which, in place of giving origin to a scion, has its merithalli so close upon each other, that the different parts which compose this bud seem to spring from a single point, which is named the receptacle. Let us explain this idea at length. In the first place, we think it necessary to remark that the number of floral verticils varies according as the flower is more or less complete. Thus, in a purely female flower, destitute of floral envelopes, there would be but a single verticil. There would be two in a hermaphrodite flower without perianth, three in one with a simple perianth, and four in a complete flower, or one, which, together with a double perianth, has stamina and one or more pistils. Each of these verticils, we have said, is composed of a variable number of variously modified leaves. This leafy nature of the constituent parts of the flower is easily demonstrated in the case of the calyx. In fact, the sepals generally have the appearance and structure of true leaves, being usually green, and traversed by prominent nerves, in which are found spiral vessels. When all the leaves of the verticil remain distinct from each other, the calyx is said to be *polysepalous;* but these leaflets may be more or less united to each other, and then the calyx is said to be *monosepalous* or *gamosepalous.* The corolla, in like manner, is formed of a verticil of leaves more internal than the calyx, and which, for that reason, is already more altered in its nature. But it is still very easy to recognise in the petals of a great number of flowers the same structure as in the calyx, with some modifications of considerable importance. Thus, for example, the tracheæ and stomata which exist in the calyx as well as in the other leaves properly so called, are entirely wanting in the corolla. The leaflets which form the corollar verticil may remain distinct from each other, or may be united; whence the expressions *polypetalous* corolla and *monopetalous* or *gamopetalous* corolla. The stamina form the third verticil of the flower. Their analogy to the petals is very great, their filaments being frequently seen to expand into petals, as, for example, in all the flowers which become double. Thus the filament of a stamen may be considered as a petal reduced to its middle nerve. The anther, again, is a leaf, the edges of which are curved towards the middle nerve, and which thus forms two small bags filled with a cellular tissue, the vesicles of which ultimately separate from each other and form the pollen. The pistil may, in like manner, be considered as the result of one or more verticillate leaves. When it is unilocular, and the ovules which it contains are only attached to a single point of its interior, it is formed by a single leaf, the edges of which converge towards each other, and unite to form the cavity of the ovary. On the other hand, when the ovary has several cells, or even when it has only one cell, but when the ovules are attached to several parietal trophosperms, it is then composed of as many leaves as there are cells or valves. In the first case, or that in which there are several cells, the edges of the leaves have converged towards the axis of the flower, and by uniting laterally to each other by a part of their outer surface, have formed the partitions. In the case where the ovary is unilocular, the ovarian leaves have united in their whole circumference. Lastly, the ovules themselves are to be considered as a kind of small buds composed of several leaves variously modified.

Let it not be imagined that the theory which we have here very briefly stated, respecting the nature of the flower, and the parts of which it is composed, is one of those speculative notions with which the study of the sciences is too frequently encumbered. It is founded on the observation of nature, and it is not uncommon to see flowers, which are confounded under the name of monstrosities, presenting more or less completely the various parts of the flower in their normal and original state, in other words, presenting the aspect and structure of true leaves. There is no botanist who has not had several occasions of observing such phenomena. To adduce only one very striking example, we shall mention that we have in our possesion a flower of *Tropæolum majus*, which M. Du Petit Thouars had the goodness to present to us, and in which the calyx, corolla, stamina, pistil and ovules, had the form of leaves, presenting the natural and relative position of the different constituent parts of the flower. A like phenomenon is also observed in several Cruciferæ, and among others in *Turritis glabra*.

Thus, then, it may be said that the flower is a true terminal bud, composed of a variable number of verticils of variously modified leaves.

CHAPTER XI.

OF FECUNDATION.

The discovery of the male and female organs in plants opened a new field to observation, by directing attention to the phenomena of the action which they exercise upon each other. It is only since that period that the mechanism of fecundation has been rightly understood. We would here observe, however, that the great truths which are useful to man have been always in some degree perceived, before they were properly discovered, by a kind of peculiar instinct, even by those who were unable to give any explanation of them. Thus, although the discovery of sexes in vegetables was made not more than two centuries ago, yet the Arabians, from time immemorial, had observed that, before the Date and the Pistachio could produce fruit, it was necessary that they should be near plants of the same kind on which fruit had never been seen. Accordingly, they often went to great distances in quest of branches bearing male flowers, to shake them over the female flowers, which were then converted into perfect fruits. But they were entirely ignorant of the cause of these phenomena, not having any idea of the existence of two sexes in plants.

Until of late years, the *mechanism* of fecundation in plants, as well as in animals, was as little understood. It was known, however, that the female organ is fecundated; that the ovules or rudiments of the seeds contained in the ovary become fit for being developed, and for subsequently reproducing precisely similar individuals, whenever the pollen, contained in the cells of the stamen, has exercised its influence upon the stigma. But the nature of the influence which the pollen exercises upon the stigma was entirely unknown. The recent inquiries of various observers, and especially those of Amici and M. Brongniart, have thrown much light on this important question, and have shewn that, in plants, fecundation appears to have the same mechanism as in animals.

Here, as in her other works, we find occasion to admire the wisdom of Nature, and the perfection which she gives to the instruments which she employs. Animals, possessed of the faculty of moving, and able to shift at will from one place to another, generally have the organs of generation separated on two individuals of the same species. The male, at determinate periods, excited by an internal feeling, seeks out and approaches the female.

Plants, on the other hand, destitute of the locomotive faculty, irrevocably fixed to the place in which their existence has commenced, and destined to grow and die in it, generally have the two sexes combined, not only in the same individual, but in most cases even in the same flower. Thus hermaphrodism is very common in plants.

There are some, however, which might at first sight seem less favourably situated, and in which fecundation might appear to be left by nature to chance. It will be perceived that I allude to the monœcious and diœcious plants. In them the two sexual organs are separated from each other, and often removed to great distances. But here also we find reason to admire the wisdom of Nature. As in animals the fecundating substance is fluid, the male organ must in them act directly upon the female organ before fecundation can be effected. If it had been of the same nature in plants as in animals, fecundation would doubtless have experienced the greatest obstacles in the monœcious and diœcious species. But in vegetables the pollen exists in the form of a powder, whose particles are light and extremely minute, so that they can be transported in the atmosphere to distances which are often inconceivable.

We may also remark, that, in monœcious plants, the male flowers are generally situated at the upper part of the plant, so that the pollen, on escaping from the cells of the anther, falls naturally, and by its own weight, upon the female flowers, which are placed lower.

Hermaphrodite flowers are unquestionably those in which all the accessory circumstances are most favourable to fecundation, the two sexual organs being in them placed in the same flower. The function commences the moment the cells of the anther open to allow the pollen to escape. There are plants in which the dehiscence of the anthers, and consequently fecundation, take place before the perfect expansion of the flower; but, in the greatest number of vegetables, this phenomenon does not happen until after the floral envelopes have opened and spread out. In certain hermaphrodite flowers, the length or shortness of the stamina, compared with the pistil, might at first seem to present an obstacle to fecundation; but, as Linnæus ingeniously remarks, when the stamina are longer than the pistil the flowers are generally erect, whereas in those which have the stamina shorter than the pistil they are reversed. We need not remark how much this arrangement must facilitate the act of fecundation. When the stamina are as long as the pistils, the flowers are either erect or pendulous.

To favour the emission of the pollen, and place it in contact with the stigma, the sexual organs of many plants perform very sensible motions.

At the period of fecundation, the eight or ten stamina which compose the flowers of the Rue (*Ruta graveolens*) rise successively towards the stigma, deposit part of their pollen upon it, and then fall outwards.

The stamina of *Sparmannia africana* and the Barberry, when irritated with the point of a needle, contract and approach each other.

In several genera of the family of Urticeæ, in the Pellitory, the Paper Mulberry, &c., the stamina are inflected towards the centre of the flower and beneath the stigma. At a certain period, they rise elastically, like so many springs, and cast their pollen upon the female organ.

In the genus *Kalmia*, the ten stamina are placed horizontally at the bottom of the flower, and their anthers are enclosed in an equal number of small pits which are perceived at the base of the corolla. To produce fecundation, each of the stamina bends a little upon itself, in order to disengage its anther from the little cavity which contains it. It then rises above the pistil, and pours its pollen upon it.

The female organs of certain plants appear in like manner to perform motions which depend upon their greater irritability during the period of fecundation. Thus the stigma of the Tulip, and several other Liliaceæ, swells and appears moister at that time. The two laminæ which form the stigma of the Mimulus come together whenever a little mass of pollen, or a foreign body of any kind, happens to touch them.

It even appears, according to the observations of MM. Lamarck and Bory St Vincent, that some plants develope a very sensible heat at this period. Thus, in *Arum italicum*, and some other plants of the same family, the spadix which supports the flowers disengages a quantity of heat sufficient to be felt by the hand that touches it.

Many aquatic plants, such as the genera *Nymphæa*, *Villarsia*, *Menyanthes*, &c., have their flower-buds at first under water. They are seen gradually to approach the surface, emerge, and expand, to descend again after fecundation has taken place, and ripen their seeds under the water.

Fecundation may be effected, however, in plants that are entirely submersed. Thus M. Ramond found, in the bottom of a lake among the Pyrenees, the *Ranunculus aquatilis* covered with water to the height of several feet, and yet bearing flowers and perfectly ripe fruits. Fecundation had therefore been effected in the midst of the liquid. My friend M. Batard, author of the *Flore de Maine-et-Loire*, afterwards found the same plant in similar circumstances. He made the curious remark that each flower, thus submersed, contained a quantity of air within its membranes, previous to its expansion, and that fecundation was effected through the medium of that fluid. The air which he thus found enclosed in the floral envelopes was evidently derived from vegetable expiration, the phenomena of which we have already examined.

This observation, the accuracy of which has since been repeatedly verified, explains perfectly the mode in which submersed plants are fecundated, when they are furnished with floral envelopes; but it is totally inapplicable to vegetables destitute of the calyx and corolla, such as *Ruppia*, *Zostera*, *Zannichellia*, and others, the fecundation of which is effected, although their flowers are entirely submersed.

But in what manner does the pollen act upon the stigma? The opinion hitherto most generally adopted by botanists is, that each grain of pollen represents a kind of small vesicle filled with a kind of fluid in which there exists a multitude of small grains, which are considered as the true fecundating substance. The moment these grains of pollen escape from the anthers, they attach themselves to the stigma, the surface of which is generally uneven, clammy, or covered with hairs. There they swell, and burst. The liquor which they contain spreads over the stigma, and fecundation takes place.

The curious observations of M. Adolphe Brongniart respecting the generation of plants, have thrown quite a new light upon this subject. When the grains of pollen are placed in contact with the surface of the stigma, they project their tubular appendage. The latter, when the surface of the stigma is naked, insinuates itself more or less deeply within the utricles of the stigma. The granules of the pollen quickly collect near the free extremity of the appendage, which swells and assumes a slight degree of opacity. The grain of pollen then shrivels and withers. Soon after, the extremity of the appendage opens, and the granules of pollen are laid bare, and come into contact with the mucilaginous substance of which we have already spoken, and which connects the utricles of the stigma. They are there seen in the form of little masses, which successively penetrate to a greater depth in the direction of the style. When the utricles of the stigma are covered by an epidermis, the tubular appendage is applied to the surface of this epidermis, and sticks to it by its extremity. Both then open, and the granules of pollen come into contact with the intercellular matter of the stigma.

The spermatic granules, adds M. Brongniart, therefore penetrate into the intercellular intervals of the stigma; but there they meet with no vessel for their conveyance, as some authors have alleged. Link thought they were transmitted through the walls of the cellules. M. Brongniart, on the contrary, says they pass through the intercellular spaces. In *Pepo macrocarpus*, he says, the utricular tissue which connects the stigma and the ovules does not shew globules in its intervals previous to fecundation; but, when the latter has taken place, the brownish streak produced by the spermatic granules may be very clearly traced in the yellow utricular tissue, and the granules are seen to reach the ovules. The spermatic granules are never contained in the cellules, but always appear in their intervals. This transmission appears to be effected in consequence of the hygroscopic qualities of the granules. When they have thus arrived at the ovule, the granules of pollen penetrate, by the opening which exists in its two membranes, as far as the kernel, passing either directly through the aperture, or, as M. Brongniart thinks, through a delicate membranous tube, which, issuing from the kernel, applies itself upon the placenta, and there takes up the fecundating granules, to convey them into the interior of the ovule. This tube terminates interiorly at the point where the embryo is to be formed, that is to say, at the vesicle which Malpighi named the *sac of the amnios.* This vesicle is, as it were, the mould in which the embryo obtains its form. After impregnation, there are seen to form in it opaque granules, often of a green colour, which ultimately constitute the embryo. The neck by which the vesicle was attached to the sac of the kernel contracts, breaks, and forms the radicle of the embryo.

Such is the theory of the generation of vegetables, as resulting from the observations of Needham, Smith, Amici, Robert Brown, and particularly M. Adolphe Brongniart. It will be seen to have a great analogy to the same phenomenon as observed in animals, especially if we admit the theory of spermatic animalcules.

This explanation appears to be in accordance with nature, in the greatest number of cases; but there are other circumstances in which the phenomena of fecundation are not produced in the same manner. In plants which are always submersed, it is evident that the grains of pollen do not attach themselves to the stigma and burst upon it; yet fecundation takes place in them as in other plants. The surface of the stigma of many plants is extremely smooth, and by no means clammy. That of the Chestnut is hard and leathery. In these plants, the pollen cannot adhere to the stigma. In many Orchideæ and Apocineæ, the pollen, in place of presenting a powdery substance, composed of an innumerable multitude of minute and light particles, forms an entirely solid mass. The anther opens; the mass of pollen retains its place, and remains perfectly entire; and yet fecundation is effected. Now, in this case, the pollen has not left the interior of the anther to be carried to the stigma, and there pour out its fecundating fluid. By the opening of the anther, it is merely placed in contact with the atmospheric air, and yet the plant is fecundated.

To account for these facts, several authors have supposed that, in plants, fecundation may, in some circumstances, be effected without the direct contact of the pollen with the stigma, and merely through the influence of a kind of emanation or *aura pollinaris*. But this question still remains undecided.

In the monœcious and diœcious plants, although the two sexes are separated, and often placed at a distance from each other, fecundation is not on that account prevented from taking place. In the case of diœcious plants, the pollen, or *aura pollinaris*, by which they are to be fecundated, is transported, often to great distances, by the air. Insects of various kinds, flying from flower to flower, also assist in transmitting the pollen.

In diœcious plants, the Palms, for example, fecundation may be artificially effected. In the botanic garden at Berlin, there had long been a female individual of *Chamærops humilis*, which flowered every year, but produced no fruit. Gleditsch procured some panicles of male flowers from Carlsruhe, and shook them over the female flowers, after which perfect fruits were obtained. The experiment was repeated several times.

This artificial mode of fecundation has been practised from time immemorial, in Egypt and the other parts of Africa, where the Date Palm is cultivated in abundance. At the period when the flowers expand, persons ascend upon the female trees, and shake over the clusters of flowers bunches of male flowers, which cover them with their pollen. M. Delisle relates, that during the campaign in Egypt, this practice having been interrupted by the continual hostilities carried on between the two parties, the Date harvest entirely failed.

Linnæus even maintained that not only may a single flower of a plant be artificially impregnated by this method, but that even a single cell of a multilocular ovary may be fecundated, by placing the pollen in contact with only one of the divisions of the stigma. It has been proved, however, that although the pollen should touch only one of the lobes of a stigma, all the cells of the ovary are equally fecundated.

It has also been proved by experiment, that, in diœcious plants, fecundation may take place at very great distances. We have many examples of this fact. In the Garden of Plants at Paris, two female Pistachia trees had long been cultivated, which, although every year covered with a profusion of flowers, never produced fruits. What was the surprise of the celebrated Bernard de Jussieu, when one year he saw the two trees setting their fruits, and bringing them to perfect maturity! He conjectured that there must have been a male tree bearing flowers in Paris or its vicinity; and, on making enquiry, learned that at the same period a male Pistachia tree had flowered in the nursery of Chartreux, near Paris. In this case, as in the above, the pollen, conveyed by the wind over the buildings of part of the city, had fecundated the female plants.

Vallisneria spiralis, a diœcious plant, which I have observed in abundance in the canal of Languedoc, and the brooks in the neighbourhood of Beaucaire, exhibits one of the most wonderful phenomena at the period of fecundation. This plant is fixed to the bottom of the water, and entirely submersed. The male and female individuals grow promiscuously. The female flowers, attached to peduncles about two or three feet long, and spirally twisted, rise to the surface to expand. The male flowers, on the contrary, are enclosed several together in a membranous spatha, supported upon a very short peduncle. When the time of fecundation arrives, they burst the spatha, detach themselves from their support and from the plant, and rise to the surface of the water to expand and fecundate the female flowers. Soon after, the latter, by the retraction of their spiral peduncles, redescend, and perfect their fruits in the water.

But in whatever manner fecundation has been effected, it always announces its influence by visible phenomena. The flower, which until then was fresh, and often adorned with the most lively tints, soon loses its beautiful colouring, and resigns its transient splendour. The corolla fades, the petals wither and fall off. The stamina, having performed the functions for which nature had called them into existence, share the same fate. In a short time the pistil remains alone in the centre of the flower. The stigma and style, now become useless, also disappear. The ovary alone continues, it being in it that nature has deposited, to be there brought to maturity, the rudiments of future generations.

The ovary, when developed, forms the fruit. It is not uncommon to see the calyx remaining and accompanying it, until it attains its full maturity. It is to be remarked, that this takes place chiefly when the calyx is *monosepalous*. If the ovary is inferior or parietal, the calyx is then necessarily persistent, as it is intimately united to the ovary.

In the Winter-cherry *(Physalis Alkekengi)*, the calyx remains after fecundation, becomes red, and forms a vesicular shell, in which the fruit is contained. In the Narcissus, the Apple, the Pear, in short, in all plants which have the ovary inferior or parietal, the persistent calyx forms the outer wall of the fruit.

Shortly after fecundation has taken place, the ovary begins to enlarge. The ovules which it contains, and which are at first of a watery, and in some degree inorganic substance, gradually acquire consistence. The part which is to constitute the perfect seed, in other words, the embryo, gradually assumes development. All its organs acquire a decided form, and, in a short time, the ovary possesses the characters necessary to constitute a fruit.

We here conclude what relates to the flower properly so called, considered in a general point of view, and with reference to its constituent parts. Before commencing our examination of the fruit, we have to describe an accessory organ of the flower, which is sometimes wanting, but which, when present, is of the greatest importance for the arrangement of plants in natural families. This organ is the *Disk*. We shall afterwards speak of the *Insertion*, or the relative position of the different parts of the flower, and especially of the sexual organs.

Of the Disk.

The *Disk (Discus)* is a fleshy body, of a glandular nature, generally of a yellowish colour, but sometimes green, placed beneath the ovary, or upon its summit, or on the inner wall of the calyx.

It is distinguished into *hypogynous*, *perigynous*, and *epigynous*.

1. The *Hypogynous Disk* bears the name of *Podogynum* when it forms a fleshy body, distinct from the receptacle, and which raises the ovary above the bottom of the flower; as in the Rue, and the other species of the family of Rutaceæ. It is named *Pleurogynum*, when it comes off under the ovary and rises upon one of its lateral parts; as, for example, in the Periwinkle. It is called *Epipodium*, when it is formed of several tubercles which come off upon the support of the ovary. This variety of disk is observed especially in the plants of the family of Cruciferæ.

2. The *Perigynous Disk* is formed by a more or less thick fleshy substance, spread out upon the inner wall of the calyx; as in the Cherry, the Almond, and certain species of *Diosma*, which, in this respect, differ from the other species of the same genus.

3. The *Epigynous Disk* is that which is observed upon the summit of the ovary, when the latter is inferior, that is, when it is attached by every part of its outer surface to the tube of the calyx; as in the Umbelliferæ, Rubiaceæ, &c.

Of the Insertion.

The *Insertion* of the stamina is distinguished into *absolute* and *relative.* The first of these terms applies to the position of the stamina, without reference to the pistil. Thus we say: stamina inserted into the corolla, the calyx, &c. The second applies to the position of the stamina or of the staminiferous monopetalous corolla, with relation to the pistil. Thus we say: stamina inserted beneath the ovary, around the ovary, or upon the ovary.

There are thus distinguished three kinds of insertion, which are named *Hypogynous*, *Perigynous*, and *Epigynous.*

The *Hypogynous Insertion* is that in which the stamina, or the monopetalous corolla bearing the stamina, are inserted under the ovary; as in the Cruciferæ, Labiatæ, &c.

The *Perigynous Insertion* is that in which the stamina are inserted into the calyx; as in the Rosaceæ.

Lastly, in the *Epigynous Insertion*, which takes place whenever the ovary is inferior, the stamina or the staminiferous monopetalous corolla are inserted upon the summit of the ovary. The Umbelliferæ, Rubiaceæ, &c., afford examples of this kind of insertion.

The position of the disk generally determines the insertion. Thus, whenever there is a hypogynous disk, the insertion is hypogynous. It is perigynous, when the disk is so. Lastly, it is epigynous, whenever there is an epigynous disk upon the summit of the ovary.

Sect. II.—Of the Fruit, or the Organs of Fructification properly so called.

Fecundation has taken place, the floral envelopes have faded and disappeared, the stamina have fallen, and the stigma and style have left the ovary, which alone has received, from the influence of that function, a new life, through which it has to pass. This new epoch of the plant commences at the moment when the ovary has been fecundated, and terminates with the dissemination of the seeds. It has received the name of *Fructification.*

The *Fruit,* then, is the fecundated and enlarged ovary. It consists essentially of two parts: the *pericarp* and the *seed.*

CHAPTER XII.

OF THE PERICARP.

The *Pericarp (Pericarpium)* is that part of a ripe and perfect fruit, formed by the walls of the fecundated ovary, and containing one or more seeds. It determines the form of the fruit.

The pericarp is never wanting; but it is sometimes so thin, or so intimately united to the seed, that it can hardly be distinguished in the ripe fruit. In this case, many authors, imagining it not to exist, have said that the seeds are *naked;* as in the Labiatæ, Umbelliferæ, Synanthereæ, &c. But it is now proved that there are no *naked* seeds, and that the pericarp is never wanting.

The pericarp commonly presents, on some part of its outer surface, generally towards the highest part, the remains of the style or stigma, which indicate the *organic summit* of the *pericarp*, and consequently of the *fruit*.

The pericarp is always formed of three parts, viz. 1*st*, The *Epicarp*, an external thin membrane, or kind of epidermis, which determines its form, and constitutes its outer covering; 2*dly*, An internal membrane which is spread over its seed-bearing cavity, and which has received the name of *Endocarp;* 3*dly*, Between these two membranes, a parenchymatous and fleshy part, which is named *Sarcocarp* or *Mesocarp*. These three parts, intimately united, form the pericarp.

When the ovary is inferior, that is, whenever it is united to the tube of the calyx, the *Epicarp (epicarpium)* is formed by the tube of the calyx, the parenchyma of which is confounded with that of the *sarcocarp*. In this case it is always easy to distinguish the beginning of the *epicarp*, as at its upper part, at a variable distance from the point of origin of the style and stigma, it presents a more or less prominent rim, formed by the remains of the limb of the calyx, which disappeared after fecundation.

The *Sarcocarp* or *Mesocarp (Sarcocarpium, Mesocarpium)* is the parenchymatous part, in which are found collected all the vessels of the fruit. It is excessively developed in fleshy fruits; such as Peaches, Apples, Melons, Pumpkins, &c. In fact, all the fleshy part of these fruits is formed by the sarcocarp.

The *Endocarp (Endocarpium)*, or internal parietal membrane of the fruit, is that which lines its internal cavity. It is almost always thin and membranous. Sometimes, however, it is thickened externally by a greater or less portion of the *sarcocarp*. When this part of the sarcocarp becomes hard and bony, it envelopes the seed, and constitutes what is called a *nut*, when there is only one seed in the fruit, and *nucleus* when there are several.

When the pericarp is dry and thin, it might at first be thought that there is no *sarcocarp*. Were this term always to imply a thick, fleshy, and succulent part, no doubt it would very frequently be wanting; but the peculiar and distinctive character of the sarcocarp consists in its being the truly vascular body of the *pericarp*; in other words, it is formed by the vessels which nourish the whole fruit. Now, as the pericarp always contains vessels, the sarcocarp is never wanting, although it is sometimes very thin when the fruit, having attained its full maturity, has dried. But, if the pericarp be examined with attention, there will be seen between the *epicarp* and *endocarp*, ruptured vessels by which they were connected, and which are the remains of the *sarcocarp*; for, as that part is always full of aqueous juices previous to the maturation of the fruit, when the fluid which it contains has evaporated, it seems at first sight to have entirely disappeared.

The internal cavity of the pericarp, or that which contains the seeds, may be *simple*, in which case the pericarp is said to be *unilocular (Pericarpium uniloculare)* or *one-celled;* as in the White Poppy *(Papaver somniferum).* At other times, there are several *cells* or partial cavities *(loculi);* whence the terms *bilocular, trilocular, quinquelocular, multilocular,* applied to the pericarp, according as it has two, three, five, or more distinct *cells.*

The *cells* of a pericarp are separated from each other by vertical laminæ, which take the name of *partitions* or *dissepiments.*

All true *partitions (Dissepimenta)* are formed in the same manner. The *endocarp* is prolonged into the interior of the cavity of the pericarp, in the form of two lamellar processes, placed back to back, and connected by usually a very thin prolongation of the *sarcocarp.* This is the mode of formation of all the *true* dissepiments. Those which are differently constructed must be considered as *false.*

In certain dissepiments, it sometimes happens that the parenchymatous part of the sarcocarp, which unites the two laminæ of the endocarp, dries up, when the two laminæ disunite and separate to some distance, so as to present the appearance of an additional number of cells. But these spaces may easily be distinguished from true cells, by observing that the two laminæ of the endocarp have one of their sides covered with broken vessels.

Besides their mode of origin and formation, another distinctive character of the *true partitions* is, that they always alternate with the stigmas or their divisions.

Certain fruits, on the other hand, present *false partitions* in their internal cavity. Such are those of some Cruciferæ, many Cucurbitaceæ, the Poppy, &c. The *false* are distinguished from the *true* partitions: 1*st*, By their not being formed by a duplicature of the *endocarp* properly so called; and, 2*dly*, By their generally corresponding to the stigmas or the divisions of the stigma, instead of being alternate, as the true partitions are.

The partitions are further distinguished into *complete* and *incomplete.* The first are those which extend internally from the upper part of the cavity of the pericarp to its base, without any interruption. The incomplete partitions are not continuous from the base to the summit, but leave a communication between the two cells. *Datura Stramonium* presents an example of both these kinds of partitions existing together in the same fruit. If the fruit of that plant be cut across, it presents four *cells,* and consequently four *partitions;* but of these partitions two only are *complete,* while the other two do not reach the top of the internal cavity of the pericarp, but rising only to two-thirds of its height, allow the two cells, which they separate below, to communicate together at their upper part.

To be able to know and name correctly the different parts which compose the pericarp, and to distinguish them from those which belong to the seed, it is of the greatest importance to establish the precise limits between these two organs. As every seed must receive its nourishment from the pericarp, it necessarily follows that it must communicate with it by some part of its surface. This point of communication has been named the *Hilum* or *Umbilicus* by botanists. The *hilum* is to be considered as the precise limit between the pericarp and the seed; in other words, all the parts which occur externally of and above the hilum belong to the *pericarp,* while all those which are situated beneath the hilum, are to be considered as forming part of the *seed.*

The seeds are attached within the pericarp, to a peculiar fleshy body, varying in size and form, to which the name of *Trophosperm* (the *placenta* of authors) is given. The *endocarp* is always perforated at the internal point of the pericarp, to which the *trophosperm* is attached, because the *sarcocarp*, being the only vascular part of the pericarp, and the only one that can furnish the materials required for the nutrition of the seed, it is necessary that the *endocarp* should have an opening to allow a passage to the vessels which go to that organ.

The *trophosperm* sometimes bears only a single seed, but at other times supports a great number. When its surface presents obvious prolongations, each of which supports a seed, these prolongations are named *podosperms ;* as, for example, in the Leguminosæ, Caryophylleæ, Portulaceæ, &c.

The *trophosperm*, or the *podosperm*, commonly stop short around the hilum of the seed. When they are prolonged beyond that point, so as to cover the seed to a greater or less extent, the prolongation takes the name of *arillus.*

The *arillus*, being merely an expansion of the *trophosperm*, does not belong to the seed, as it is generally said to do, but to the pericarp.

Let us now examine, in succession, the different internal parts of the pericarp ; namely, the *dissepiments*, the *trophosperm*, and the *arillus.*

1. *Of the Dissepiments or Partitions.*

We have already mentioned that the name of *Dissepiments* has been given to parts very different from each other; but we at the same time explained the manner in which the true dissepiments are formed. All those, therefore, which have not such an organization, that is, are not formed of two laminæ of the *endocarp*, connected by a prolongation of the *sarcocarp*, are to be considered as false dissepiments.

The *Dissepiments* are usually *longitudinal*, so as to extend from the base to the top of the pericarpal cavity.

In some very rare cases, as in *Cassia Fistula*, and a few other Leguminosæ, they are *transverse.*

The *dissepiments*, as we have already said, have further been distinguished into *complete* and *incomplete*. We shall not here insist upon this distinction, as we have already sufficiently explained it.

The origin of the *false dissepiments* is exceedingly variable. Sometimes they are formed by a more or less considerable projection of the trophosperm, as in the Poppy: sometimes by a prolongation inwards of the edges of the pericarpal *valves*, &c.

2. *Of the Trophosperm or Placenta.*

The *Trophosperm* is that part of the *pericarp* to which the seeds are attached. Sometimes it presents at its surface a greater or less number of small projecting mammillæ, each supporting a single seed, and which are named *podosperms*.

When a pericarp is *multilocular*, the trophosperm generally occupies its centre, and is then named *central*. In this case, it is formed by the meeting and union of the dissepiments, and in the re-entrant angle of each cell presents a greater or less projection.

The trophosperm varies greatly in *form*. It is *spherical* and almost *globular* in many Primulaceæ, in *Anagallis arvensis*, for example.

Cylindrical, in several Caryophylleæ, such as *Silene Armeria*, *Cerastium arvense*, &c.

Trigonal in *Polemonium cæruleum*.

Radiating (Trophospermum radiatum), in the *Cucurbitaceæ*, &c.

With respect to *consistence*, it may be,

Fleshy (T. carnosum); as in *Ruta graveolens* and *Saxifraga granulata*.

Leathery (T. coriaceum), and hard; as in the Poppy.

Corky (T. suberosum); as in the Thorn-apple *(Datura Stramonium)*, the Tobacco *(Nicotiana Tabacum)*, &c.

According to its *position*, it is said to be *Central* or *Axil-*

lar, when it occupies the centre or axis of the pericarp; as in the Bell-flowers, Fox-glove, &c.

Parietal, attached to the walls of the cells of the pericarp. In this case, it is called *unilateral*, when it is only attached to one side of the pericarp; as in most of the *Leguminosæ* and *Apocineæ*.

Bilateral, attached to two sides of the internal cavity of the pericarp; as in the genus *Ribes*, &c.

The podosperm may also present very diversified *forms*. Sometimes it is slender and *filiform*; as in the Wallflower, the Gooseberry, the Ash, &c.

Unciform, or *hook-shaped*, in *Acanthus mollis*, &c.

At other times, on the contrary, it is thicker and larger than the seed.

3. *Of the Arillus.*

The *Arillus*, as we have said, belongs essentially to the pericarp, it being merely a prolongation of the trophosperm. It is therefore incorrect to consider it, as many botanists do, as forming part of the seed, upon which it is merely applied, without at all adhering to it, excepting around the hilum.

Few parts of plants exhibit so many varieties in their form and nature as the arillus. It is consequently very difficult to give a strict definition of it, which may be applicable in every case.

In the Nutmeg *(Myristica officinalis)*, the arillus forms a fleshy covering, of a light red colour, divided into narrow and unequal shreds. This is the part which is used in pharmacy, and is known by the name of Mace. *Polygala vulgaris* has a three-lobed arillus of small size, forming a kind of little crown at the base of the seed. In the common Spindle-tree *(Euonymus europæus)*, and the Broad-leaved species of the same genus *(Euonymus latifolius)*, the arillus, which is of an orange colour, envelopes and conceals the seed on all sides. In *Euonymus verrucosus*, it forms an irregular cup, which is open above.

From the small number of examples given above, it will be seen that the arillus varies exceedingly in colour as well as in form and consistence; but, as its origin is the same in all cases, it is easily distinguished, notwithstanding the numerous forms under which it may present itself.

Various parts have often been taken for arilli: for example, the outer, obviously fleshy part of the proper integument of the seed, in the Jasmine, *Tabernæmontana*, &c.; the *endocarp*, as in the Coffee (*Coffæa arabica*), the Rutaceæ, &c.

It is a general law, to which no exception has yet been found, that the arillus is never met with in plants which have a *monopetalous corolla*. The *Tabernæmontana* might seem to form an exception; but, when better examined, its alleged arillus is merely the outer part of the proper integument of the seed, which is soft and fleshy.

Having examined the component parts of the pericarp, the dissepiments, the cells, the trophosperm and the arillus, let us return to the pericarp considered in a general point of view.

In the pericarp, as in the ovary, there are distinguished: 1*st*, The *base*, or the point by which it is fixed to the receptacle or the peduncle; 2*dly*, The *summit*, which is indicated by the place formerly occupied by the style or the sessile stigma; 3*dly*, The *axis*. Sometimes the axis is not merely imaginary, but has a real existence, and is named the *Columella*. At other times it is fictitious, or is represented by an imaginary line, passing through the centre of the pericarp, from its base to its summit.

The *Columella* forms a kind of little pillar, on which are supported the different pieces of the fruit, and which remains at the centre of the pericarp, when these have fallen off; as in the Euphorbiæ, Umbelliferæ, &c.

The seeds being enclosed in the pericarp, it becomes necessary, to allow them to issue at the period of their maturity, that the pericarp should open in some manner. The name of *dehiscence* is given to the action by which a pericarp naturally opens. There are pericarps, however, which do not open, and which are termed *indehiscent;* as in the Synanthereæ, Labiatæ, Gramineæ, &c.

Among the pericarps which open naturally at the period of maturity, there are distinguished: 1*st*, The *ruptile pericarps*, or those which burst into irregular pieces, of which the number and form are very variable; 2*dly*, Those which open only by holes formed at their upper part, as in the genus *Antirrhinum;* 3*dly*, Those which open at their summit by teeth, which are at first close together, but which separate from each other, as in many Caryophylleæ; 4*thly*, Those which separate into a determinate number of distinct pieces, which are named *valves*. These latter are the truly *dehiscent pericarps*. The number of valves in a pericarp may always be learned by the number of longitudinal seams or *sutures*, which are observed upon its outer surface. The true valves are of the same number as the cells of the pericarp. Thus a *dehiscent* fruit, which is *quadrilocular*, has *four* valves. There are some exceptions, however. The capsule of the Violet is a single cell, and opens into three valves. In some fruits, each of the valves separates into two pieces, so that the number of the former seems double what it ought naturally to be.

A Pericarp is called *Bivalve (Pericarpium bivalve)*, when it separates of itself into two equal and regular valves; as in the Lilac *(Syringa vulgaris)*, the Speedwells, &c.

Trivalve (P. trivalve), when it opens into three valves; as in the Tulip, the Lily, the Violet, &c.

Quadrivalve (P. quadrivalve), or with four valves; as in the genus *Epilobium*, and the Thorn-apple.

Quinquevalve (P. quinquevalve), opening with five valves.

Multivalve (P. multivalve), when it divides into a greater number of valves or distinct segments.

The dehiscence of the valves may take place in different ways, agreeably to the relative position of the valves and dissepiments. Three species of *dehiscences* are distinguished.

1. The dehiscence may take place at the middle of the cells, or between the dissepiments which then correspond to the middle part of the valves *(Valvæ medio septiferæ)*. This species is termed *loculicide (Dehiscentia loculicida)*. It is observed in most of the Ericineæ.

2. At other times the dehiscence takes place opposite the dissepiments, which it usually divides into two laminæ. It is then named *septicide (D. septicida)*. It is seen in the Scrophularineæ, Rhodoraceæ, &c.

3. Lastly, it receives the name of *septifragous* dehiscence *(D. septifraga)*, when the bursting takes place towards the dissepiment, which remains free and entire at the moment when the valves separate; as in the *Bignoniæ* and *Calluna vulgaris*.

Most commonly the dehiscence takes place by longitudinal sutures. In some cases, however, these sutures are transverse, and the valves are superimposed upon each other. This species of fruit has received the name of *Pyxidium*. Examples of it are seen in the Henbane, the Pimpernel, the Plantain, &c.

The pericarp, or the fruit considered generally, is one of the organs which are most diversified in their forms. Thus, it is often:

Spheroidal or globular; as in the Peach, the Apricot, the Orange, &c.

Ovate or Egg-shaped; as in many species of Oak, &c.

Lenticular, or approaching the form of a lentil; as in many Umbelliferæ.

Prismatic, or having the form of a prism with several sides; as in *Oxalis*.

Its summit may be *acute* or *obtuse*. Sometimes the style is persistent, and forms a more or less prominent point on the fruit. At other times, the stigma remains and enlarges, as in most species of *Clematis* and many Anemones, in which it forms a kind of feathery appendage at the top of the fruit.

The fruit may be crowned by the teeth of the calyx, when the ovary is inferior or parietal, as in the Pomegranate *(Punica Granatum)*, the Apple, the Pear, &c.

At other times, it is surrounded by a tuft of bristly hairs (the *pappus*), which is to be considered as a true calyx. This is the case in almost all the species of the extensive tribe of Synanthereæ. Excellent generic characters are derived from the form and structure of the *pappus*.

Thus it may be *sessile (Pappus sessilis)*, or applied directly upon the summit of the ovary, without the aid of an intervening body; as in the genera *Hieracium*, *Sonchus*, *Prenanthes*, &c. (Fig. 131).

Fig. 131.


Fig. 132.

In other genera, it is supported upon a small pivot or stalk, which is named the *Stipe (Stipes)*, and the pappus is said to be *stipitate (P. stipitatus)*; as in *Lactuca*, *Tragopogon*, &c. (Fig. 132.)

The *hairs* of which the pappus is composed, may be *simple*, or undivided, in which case the *pappus* is said to be *pilose* or *hairy (P. pilosus)*; as in *Lactuca*, *Prenanthes*, &c. (Fig. 132.)

At other times, they are *feathery*, or have on their sides other shorter and finer hairs, resembling the barbs of a feather. The *pappus* is then named *plumose* or *feathery (P. plumosus)*; as in the genera *Leontodon*, *Tragopogon*, *Picris*, *Cynara*, &c. (See Fig. 131 *a*, an enlarged hair.)

In the Valerians, the *pappus*, which is obviously nothing but the limb of the calyx, is at first rolled up within the flower, and appears in the form of a small circular rim at the upper part of the ovary; but, some time after fecundation, it is seen to stretch out, elongate, and form a true *feathery pappus.*

The pericarp also not unfrequently presents membranous appendages in the form of *wings;* as in the Elm and Maple. (Fig. 133.) According to the number of these appendages, it is named *dipterous, tripterous, tretrapterous,* &c. Many genera of the family of Sapindaceæ and Acerineæ, afford examples of these different species of fruits.

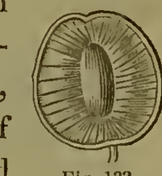

Fig. 133.

Sometimes it is covered with long, stiff hairs, as in *Lontarus;* or is stuck over with spines, as in the Horse-chestnut, the Thorn-apple, &c.

The organization of the pericarp and seed being one of the most difficult subjects in the science, we shall, with the view of affording a distinct conception of the various organs which have been described in this chapter, analyze a few well-known fruits, and name the different parts of which they are composed; after which we shall take a brief review of the objects which we shall have successively examined.

Let us take the fruit of the Peach *(Amygdalus persica)* as an example. (Fig. 134.)

As every *fruit* is composed of two parts, the *pericarp* and the *seed,* we have first to distinguish these two parts from each other. We know that the seed is always contained within the pericarp. Let us therefore try to find it in the centre of that organ. If we cut a peach in two, we shall find its centre occupied by a cavity or *cell,* containing a single seed, rarely two. The *seed* once distinguished, all that is placed externally of it belongs to the *pericarp.* Let us name its different parts. In the first place, we find, at the outside of the whole, a

Fig. 134.

thin, coloured pellicle, covered with a very short down, which is easily removed. This pellicle is the *epicarp*. The internal cavity of the *pericarp* is lined by a smooth membrane, intimately united to, and confounded with, the hard part which forms the nut or shell. This membrane is the *endocarp*. All the thick, fleshy, parenchymatous part, contained between the endocarp and the epicarp, forms the *sarcocarp*. But to which of these three parts belongs the bony shell which we observe within? Is it, as was long supposed, a proper integument of the seed, a thick and woody *endocarp*, or is it part of the *sarcocarp?* It is very easy to solve these questions. Let us examine how this hard part is formed. If we take a young peach, long before it is ripe, and cut it through, we find no resistance, there being as yet no solid shell in it. Now, at this period, the three parts of the *pericarp* are extremely distinct from each other, and the *endocarp* is here evidently under the form of a mere membrane applied upon the internal surface of the sarcocarp. But, shortly after, we see the part of the sarcocarp nearest this inner membrane gradually becoming whiter and denser, and passing through all the intermediate stages, before acquiring the bony solidity which it presents at the period of maturity. Now, in this case, although this portion of the *sarcocarp* is intimately united and confounded with the *endocarp*, it cannot by any means be referred to the latter, but belongs to the sarcocarp, as it is really formed by it. The shell, or the bony part which is found at the centre of the peach, is therefore formed by the *endocarp*, to which is joined an ossified portion of the *sarcocarp*. What we have here said of the Peach is equally applicable to the Apricot, the Prune, the Cherry, the Almond, &c.


Fig. 135

If we now take the fruit of the Common Pea *(Pisum sativum)* (Fig. 135.), and analyze it, we find it to be elongated and compressed so as to present two short edges, along which run two longitudinal *sutures*. This circumstance shews that, when ripe, it will open in two segments or *valves*. It is, therefore, a bivalve pericarp. On cutting it longitudinally, we find only a single internal cavity, containing from eight to ten seeds. Thus it is *unilocular* and *polyspermous*. The seeds are all fixed, along the upper suture, to a small thick margin, running along the suture, and giving off a distinct prolongation to each seed. All that occurs externally of the seed forms part of the pericarp. At the outer surface is a thin membrane, which adheres closely to the adjacent part: it is the *epicarp*. The internal cavity is lined by another membrane, not quite so closely adhering: it is the *endocarp*. The fleshy, green, and vascular part, which is observed between these two membranes, although of no great thickness, is the *sarcocarp*. The small longitudinal prominence which runs along the *suture*, and to which the seeds are attached, is the *trophosperm*. Each little prolongation connecting a seed with that body is a *podosperm*.

We thus see that the pericarp is the part of the fruit which forms the walls of the simple or multiple cavity in which the seeds are contained; that it is always composed of three parts, 1*st*, The *epicarp*, or membrane by which it is covered externally; 2*dly*, The *endocarp*, or internal parietal membrane lining its internal cavity; 3*dly*, A more or less thick and fleshy part, which, however, is sometimes thin, and not easily perceived, but always vascular, and which is named the *sarcocarp* or *mesocarp*; and that the pericarp is often divided internally by *dissepiments* or *partitions* into a greater or less number of *cells*, when it is called *bilocular*, *trilocular*, *quadrilocular*, *multilocular*, &c. The point of the pericarpal cavity to which the seeds are attached presents a fleshy prominence, of variable size, coming off from the sarcocarp, which has received the name of *trophosperm*. The *podosperm*, again, is the little process of the *trophosperm* which supports the seed. When the *trophosperm* or the *podosperm* cover the seed, so as to embrace it over a considerable extent, the peculiar prolongation by which this is effected bears the name of *Arillus.*

These are all the parts of which the pericarp is composed. We now proceed to the examination of the seed.

CHAPTER XIII.

OF THE SEED.

We have seen that the fruit is essentially composed of two parts, the *pericarp* and the *seed.*

The *Seed (Semen)* is that part of a perfect fruit which is found in the internal cavity of the pericarp, and which contains the body that is destined to reproduce a new individual. There are no naked seeds, strictly so called: in other words, none which are not covered by a pericarp. But this latter organ is sometimes so thin, or adheres so closely to the seed, that it cannot easily be distinguished at the period when the fruit is ripe, on account of their being intimately attached to each other, and confounded, although the two parts were perfectly distinct in the ovary after fecundation. Hence it is absolutely necessary to examine the structure of the ovary with attention, in order to understand the structure which the fruit is to have.

Thus in the Gramineæ and Synanthereæ, the pericarp is very thin and intimately adherent to the seed, from which it is very difficult to distinguish it. This is equally the case in many Umbelliferæ, and other plants; whereas if we examine them in the ovary, these two parts are very distinct from each other.

Every seed comes from a fecundated ovule. Its essential character consists of its containing an organized body, which, on being placed in favourable circumstances, is developed and converted into an individual perfectly similar to that from which it derived its origin. This body is the *embryo*, which is therefore the essential part of the seed.

It is, in our opinion, erroneous to give the name of seeds to the reproductive corpuscules of the Ferns, Mosses, Fungi, and other *agamous* plants, there being nothing in their interior that resembles an embryo. Yet, on being developed, they form a plant in every respect similar to that from which they have been derived. But the embryo is not the only part susceptible of such development. The buds of perennial plants, and especially the bulbils which form on different vegetables, often even in the interior of the pericarp itself, in the place of seeds, are also capable of giving rise to a perfect plant; yet, notwithstanding this great similarity of functions, no one has ever proposed to consider them as true seeds. The reproductive corpuscules of agamous plants being perfectly analogous to buds and bulbils, have no more right than they to be named seeds.

The seed is formed of two parts, 1*st*, The *episperm*, or proper integument; 2*dly*, The *kernel* contained within the episperm*.

We shall examine these two parts separately, after speaking generally of the direction and position of the seeds with respect to the pericarp.

The part of the seed by which it is attached to the pericarp, is named the *umbilicus* or *hilum*. The hilum is always marked, on the proper integument, by a kind of cicatrix or scar of greater or less extent, which never occupies more than a part of its surface, and by means of which the vessels of the *trophosperm* communicate with those of the proper integument of the seed.

The centre of the hilum always represents the *base* of the seed. Its *summit* is indicated by the point diametrically opposite to the hilum.

When a seed is compressed, the surface which looks to the axis of the pericarp is the *face*, and that which is directed towards the wall of the pericarp is named the *back*. The margin or *edge* of the seed is represented by the meeting of the face and back.

* The *perisperm* of Jussieu; the *albumen* of Gœrtner.

When the *hilum* is situated on some part of the edge of the seed, the latter is said to be *compressed* (*Semen compressum*). It is *depressed (S. depressum)*, when the hilum is placed on its face or back. This distinction is of great importance.

The position of the seeds, and especially their direction with relation to the axis of the pericarp, are circumstances which require to be noticed, when the seeds are of a determinate number, as they furnish excellent characters for the natural arrangement of plants.

Thus every seed connected by its extremity with the bottom of the pericarp, or of one of its cells, when it is multilocular, and following the same direction in a more or less decided manner, is named *erect (S. erectum);* as in all the Synanthereæ, &c.

On the contrary, it is said to be *reversed (S. inversum)* when it is attached in the same manner to the summit of the cell of the pericarp; as in the Dipsaceæ. In these two cases, the trophosperm occupies the base or the summit of the cell.

When, on the other hand, the trophosperm, being axillar or parietal, the seed has its summit (or the part diametrically opposite to its point of attachment), directed towards the upper part of the cell, it is said to be *ascending (S. ascendens);* as in the Apple, the Pear, &c. (Fig. 136.)

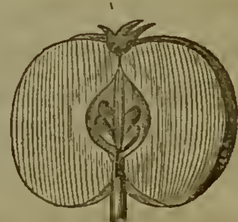

Fig. 136.

When its summit is directed towards the base of the cell, it is said to be *appended (S. appensum);* as in the Jasmineæ, many Apocineæ, &c.

It is *peritropal (S. peritropum)*, when its imaginary axis, or the line passing through its base and summit, is transverse to the walls of the pericarp.

1

1. *Of the Episperm.*

The *Episperm*, or proper integument of the seed, is almost always single. Sometimes, however, when it is pretty thick, and slightly fleshy in its interior, its inner wall becomes detached and separates, so that it seems to be composed of two coats, an outer, thicker, sometimes hard and solid one, to which Gœrtner has given the name of *testa*, and an inner one of less thickness, which is named the *tegmen*. This disposition is very distinctly seen in the seed of *Ricinus communis;* but these two membranes are not more distinct from each other than the three parts which compose the pericarp.

The *hilum* is always situated upon the episperm. It varies in its appearance and extent. Sometimes it has the form of a hardly perceptible dot. At other times, it is very large, as in the Horse-chestnut, in which its whitish colour renders it easily distinguishable from the rest of the *episperm*, which is dark-brown.

Towards the central part of the hilum, sometimes on one of its sides, there is observed a very small aperture, to which M. Turpin has given the name of *Omphalode*, and through which the nutritious vessels pass from the *trophosperm* into the tissue of the *episperm*. When the fasciculus of vessels is continued some time before it ramifies, it forms a prominent line, to which the name of *vasiduct* or *raphe* has been given. The internal point at which the vasiduct ends is named the *internal chalaza* or *umbilicus*. The vasiduct is often not easily perceptible at the outside, and only discoverable by the aid of dissection, as in many Euphorbiaceæ; while, at other times, it is prominent and easily seen, as in the genus *Citrus*, in which it extends from one end of the *episperm* to the other.

In many seeds there is observed near the hilum, often on the side next the stigma, a perforated organ, which M.

Turpin has designated by the name of *Micropyle.* Some authors are of opinion that the fecundating fluid makes its way to the young embryo through the aperture in this organ.

Mr Brown considers it as the base of the seed *. The radicle of the embryo always corresponds exactly to it.

There is sometimes observed, at a greater or less distance from the *hilum* of some seeds, a kind of inflated body, to which Gœrtner has given the name of *embryotegium ;* as in the Date, the Asparagus, Commelina, &c. During ger-

* Such, in fact, is the usual structure of the fecundated and ripe seed ; but it is very different from that which the ovule presents before it has been impregnated, and which we shall here describe, from the curious observations recently published by our friend the celebrated Mr Robert Brown. Previous to fecundation, the ovule is composed of two membranes and a kernel. The outer membrane, or *testa,* has, sometimes near the hilum, sometimes at a greater or less distance from it, a small punctiform aperture, which had been noticed by some of the older observers, and to which M. Turpin gave the name of *micropyle.* This aperture has no direct communication with the walls of the ovary. According to Mr Brown, it indicates the true base of the ovule ; and the point which is opposite to it, its summit. The nutritious vessels of the pericarp, which arrive at the ovule through the hilum, creep in the substance of the testa until near its summit, where they form a kind of expansion communicating with the inner membrane, and which is named the *Chalaza.* This inner membrane has a direction the reverse of that of the outer, being inserted by a broadish base upon the summit of the latter, the only point at which the two membranes communicate with each other. The summit of the inner membrane is also perforated with a small aperture, exactly corresponding to that in the base of the testa. The kernel contained within the two integuments of the ovule is a cellular body, having always the same direction as the internal membrane, or, in other words, inserted at its base, or the point opposite to its perforated summit. It consists of two parts, an outer, thick and cellular part, the *chorion* of Malpighi ; and an internal part, forming a kind of small cellular sac, often filled at first with a mucilaginous fluid. This inner part is the *amnios,* and its fluid the *liquor amnii.* It is in the internal sac that the embryo begins to make its appearance. Its radicle always corresponds to the summit of the kernel, or to the aperture or base of the outer integument of the ovule. The endosperm, which often accompanies the embryo, may be formed by the sac of the amnios, or by the chorion, the amnios being absorbed, or by both organs at once.

mination this body separates, and allows the embryo to pass.

The episperm is in general merely applied upon the *kernel*, from which it is easily separated; but, in some cases, it adheres so intimately that it can be removed only by scraping it off.

The *episperm* never has cells or partitions in its interior, its cavity being always simple, although, in some rare cases, it may contain several embryos. But this superfetation is an anomaly, a kind of *lusus naturæ*, in which there is no constancy or regularity.

2. *Of the Kernel.*

The *Kernel (nucleus)* is all that part of a ripe and perfect seed which is contained in the cavity of the episperm. It has no vascular communication with the episperm, unless when the two organs are intimately united, in which case it is difficult to determine whether they may not have some communication of this kind.

The entire kernel may be formed by the *embryo*, as in the Kidney-bean, the Lentil, &c. In other words, the embryo exclusively fills the whole internal cavity of the episperm.

At other times, the kernel contains, together with the embryo, another body, which is named the *endosperm;* as in *Ricinus communis*, the Wheat, &c.

The structure of these two organs is so different, that they are easily distinguished at first sight. The *embryo*, in fact, is an organized body, which is destined to become enlarged and developed by germination. The *endosperm*, on the contrary, is a mass of cellular tissue, sometimes hard and horny, at other times soft and fleshy, which, after germination, shrivels and generally diminishes in size, instead of enlarging. Thus, then, germination will remove all doubt as to the nature of the two bodies contained within the episperm, when it may not have been satisfactorily determined by analysis and dissection.

3. *Of the Endosperm.*

The *Endosperm* is that part of the kernel which forms, around or on the side of the embryo, an accessory body, which has no continuity of vessels or of tissue with it. It is generally formed of vascular tissue, in the meshes of which is contained amylaceous fecula, or a thick mucilage.

This substance affords nutriment to the young embryo. Before germination, it is entirely insoluble in water; but at that first period of vegetable life it changes its nature, becomes soluble, and contributes to the nutrition and development of the embryo.

It is always easy to separate the endosperm from the embryo, as they do not in the least cohere.

The colour of the endosperm is generally white, or whitish. It is green in the Misseltoe *(Viscum album).*

The substance of which it is formed varies greatly. Thus it is—

Dry and *farinaceous,* in many Gramineæ; Wheat, the Oat, Barley, &c.

Coriaceous, and, as it were, *cartilaginous,* in many Umbelliferæ.

Oleaginous and *fleshy,* or thick and greasy to the touch; as in *Ricinus communis,* and many other Euphorbiaceæ.

Horny, tenacious, hard, and elastic; as in the Coffee and many other Rubiaceæ, most of the Palms, &c.

Thin and membranous; as in many Labiatæ, &c.

The presence or absence of the endosperm affords a very good generic character, especially in the Monocotyledones. This organ is therefore of great importance in the arrangement of the natural families of plants.

The endosperm may exist in a seed, although its embryo be abortive, or entirely wanting.

It is always single, even in cases where there are several embryos in the same seed.

4. *Of the Embryo.*

The *Embryo* is the already organized body, existing in a perfect seed after fecundation, and which constitutes the compound rudiment of a new plant. When placed in favourable circumstances, it is converted, by the act of germination, into a plant perfectly similar, in every respect, to that from which it derived its origin.

When the embryo exists by itself in the seed, that is, when it is immediately covered by the *episperm* or proper integument, it is said to be *epispermic* (*Embryo epispermicus)*; as in the Kidney-bean. (Fig. 137.)

When, on the contrary, it is accompanied by an *endosperm,* it takes the name of *endospermic (E. endospermicus);* as in the Gramineæ, *Ricinus communis,* &c. (Figs. 138, 139).

The *endospermic* embryo may be differently placed with respect to the *endosperm.* Thus it is sometimes simply applied upon a point of its surface, and lodged in a small superficial cavity which the latter presents, as in the Gramineæ; or it is wrapped round the endosperm, which it envelopes more or less completely; as in the Marvel of Peru. In this case it is named *extrary (E. extrarius).* (Fig. 140, *Ricinus communis : b,* the endosperm; *c,* the embryo.)

Fig. 139.

Fig. 137.

Fig. 138.

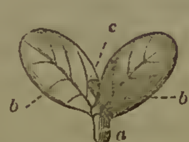

Fig. 140.

At other times it is wholly contained within the endosperm, which it envelopes on all sides, and is then named *intrary (E. intrarius).* (Fig. 141, section of a Kidney-bean: *a*, the radicle; *b*, the gemmule; *c*, one of the cotyledones.

Fig. 141.

The embryo being a plant already formed, all the parts which it is one day to develope already exist in it, but only in the rudimentary state. In this, as we have said, consists the true difference between the embryo and the reproductive corpuscules of agamous plants.

The embryo is essentially composed of four parts; 1. The *radicular body*; 2. The *cotyledonary body*; 3. The *gemmule*; 4. The *caulicle.*

1. The *Radicular Body* or *Radicle*, constitutes one of the extremities of the embryo. When germination takes place, it gives rise to the root, or forms it by its development. (See Figs. 137, 140 *a*).

In the embryo in the state of rest, that is, before germination, the radicular extremity is always simple and undivided. When it begins to be developed, it often sends off several small knobs, which constitute so many radicular filaments; as in the Gramineæ.

If, in some cases, it is difficult, before germination, to distinguish the radicle, it becomes easy to do so when the embryo begins to grow. In fact, the radicular body always tends towards the centre of the earth, whatever impediments may be put in its way, and changes into a root, while the other parts of the embryo take an opposite direction.

In a certain number of plants, the radicular body itself elongates, and changes into a root, in consequence of the development which germination induces in it. This is what is observed in many Dicotyledones.

When the radicle is external and exposed, the plants are named *Exorhizous.* Of this kind are the Labiatæ, Cruciferæ, Boragineæ, Synanthereæ, &c. and most Dicotyledonous plants. (See Fig. 137.)

In other plants, again, the radicle is covered and entirely concealed by a particular envelope which bursts at the period of germination, to allow it to escape. This body has received the name of *Coleorhiza*. In this case the radicle is internal or *coleorhizous*, and the plants which present this disposition are named *Endorhizous*. To this division belong most of the true Monocotyledones, such as the Palms, the Gramineæ, the Liliaceæ, &c. (Fig. 142, *Canna indica* : *a*, episperm ; *b*, endosperm ; *c*, embryo).

Fig. 142.

Lastly, in some less frequent cases, the radicle is incorporated with the endosperm. Plants in which this organization is observed, are named *Synorhizous*. Of this kind are the Pines, Firs, all the other Coniferæ, the Cycadeæ, &c.

All the known phanerogamous plants belong to these three great classes, which might with advantage be substituted for those of *Monocotyledones* and *Dicotyledones*, these latter being subject to numerous exceptions, as we shall presently show.

2. The *Cotyledonary Body* may be simple and perfectly undivided. In this case, it is formed by a single *cotyledon*, and the embryo is named *monocotyledonous (Embryo monocotyledoneus)*; as in the Rice, the Barley, the Oat, the Lily, Rushes, &c. (Fig. 142). At other times, it is formed of two bodies united base to base, which are named *Cotyledons*, and the embryo is then said to be *Dicotyledonous (Embryo dicotyledoneus)*; as in *Ricinus communis*, the Bean, &c. (Fig. 143.)

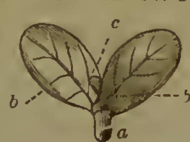

Fig. 143.

All plants whose embryo has a single cotyledon are named *Monocotyledonous*. All those which have two cotyledons are called *Dicotyledonous*.

Sometimes there are more than two cotyledons in the same embryo. Thus there are three in *Cupressus pendula;* four in *Pinus inops*, and *Ceratophyllum demersum ;* five in *Pinus laricio ;* six in *Taxodium distichum ;* eight in *Pinus Strobus ;* and lastly, ten and even twelve in *Pinus pinea*.

We thus see that the number of cotyledons is not the same in all plants, and that the division into Monocotyledones and Dicotyledones, if strictly observed, is incapable of including all known vegetables. Besides, it not unfrequently happens, that the two cotyledons unite and adhere together, so that, at first sight, it is difficult to say whether an embryo is monocotyledonous or dicotyledonous, as, for example, in the Horse-chestnut.

These considerations induced my father to found the primary division of the vegetable kingdom upon another organ than the cotyledons. The circumstance of the radicle being naked, contained in a coleorhiza, or, lastly, united to the endosperm, affording more fixed and unvarying characters, and he employed them for the purpose of forming three great classes in the Embryonate or Phanerogamous plants. These classes are named and characterized as follows:

The ENDORHIZÆ, or those in which the radicular extremity of the embryo presents a *coleorhiza*, under which are one or more radicular tubercles which burst it, at the period of germination, and change into roots. The true Monocotyledones belong to this class.

The EXORHIZÆ, or those of which the radicular extremity of the embryo is naked, and becomes itself the root of the new plant. Of this kind are most of the Dicotyledones.

The SYNORHIZÆ,[1] or plants in which the radicular extremity of the embryo is intimately united to the endosperm. This class, which is of less extent than the other, contains the Coniferæ and Cycadeæ, which differ so much in their characters from other plants, and which are excluded by the number of their cotyledons from the classes of Monocotyledones and Dicotyledones.

The cotyledons appear to be destined by nature to favour the development of the young plant, by supplying it with the first materials of its nutrition. In fact, the cotyledons are almost always very thick and fleshy, in plants which have no *endosperm*, whereas they are thin, and as it were leafy, in those which are furnished with that organ. These differences may easily be seen on comparing the thickness of the cotyledons in the Kidney-bean and the *Ricinus communis*.

At the period of germination, the cotyledons sometimes remain concealed under ground, without appearing at the surface. In this case, they bear the name of *Hypogeal cotyledons (Cotyledones hypogæi)*, as in the Horse-chestnut.

At other times they emerge from the ground, in consequence of the elongation of the neck, which separates them from the radicle. In this case, they are named *epigeal (C. epigæi);* as in the Kidney-bean and most of the Dicotyledones. When the two cotyledons are epigeal, or rise above the ground, they form the two *seminal leaves (Folia seminalia).* (Fig. 144 *a a.*)

Fig. 144.

3. The *Gemmule (Gemmula)*, is the simple or compound body which arises between the cotyledons, or in the very cavity of the cotyledon when the embryo has only one. It was formerly called the *Plumule (Plumula).* As this organ, in most cases, bears no similarity to the body (a *feather*) which it was thus supposed to resemble; but, on the other hand, always forms the first bud *(gemma)* of the young plant which is about to be developed, the name gemmule is infinitely more suitable, and deserves preference.

The *gemmule* is the rudiment of all the parts which are to be developed in the open air. It is formed of several small leaves variously folded upon themselves, which, being developed by germination, become the *primordial leaves (Folia primordialia).* (See Fig. 144 *b, b.*)

Sometimes it is free, and to be seen at the exterior, previous to germination. At other times, on the contrary, it becomes apparent only when germination has commenced. Lastly, in some rare cases, it is concealed under a kind of envelope, in some degree similar to that which covers the radicle of the *Endorhizæ*, and which is named *Coleoptile*. The gemmule is then named *Coleoptilous*. This envelope of the radicle is, in most cases, to be considered only as a thin cotyledon, covering the gemmule in the manner of a sheath.

4. The *Caulicle (Cauliculus)*. This organ is not always very obvious. It is confounded, on the one hand, with the base of the cotyledonary body, and on the other with the radicle, of which it is a kind of prolongation. It is by the growth which the caulicle acquires during germination, that the cotyledons, in some plants, are raised out of the ground, and become *epigeal*.

Having now examined, in succession, the four parts which enter into the composition of the embryo, viz. the radicular body, the cotyledonary body, the gemmule, and the caulicle, let us see what are the different positions which the embryo may affect with relation to the seed which contains it, or to the pericarp itself.

We have already seen, that the embryo may be endospermic or epispermic, according as it is accompanied with an endosperm, or forms of itself the mass of the kernel; and that, in the case in which it is endospermic, it may be intrary or extrary, when it is contained in the interior of the endosperm, or merely applied upon some part of its surface.

It is by means of these two extremities of the embryo that its proper direction and its relative direction may be determined. The radicular extremity always forms the base of the embryo. With reference to this circumstance, the embryo is said to be:

Homotrope (Embryo homotropus), when it has the same direction as the seed, that is, when its radicle corresponds to the hilum, as is observed in many Leguminosæ, Solaneæ, and a great number of monocotyledones. The homotrope embryo may be more or less curved. When it is rectilineal, it obtains the name of *orthotrope (E. orthotropus)*; as in the Rubiaceæ, Synanthereæ, Umbelliferæ, &c.

The embryo is called *antitrope (E. antitropus)*, when its direction is the reverse of that of the seed; in other words, when its cotyledonary extremity corresponds to the hilum. This is observed to be the case in the Thymeleæ, Fluviales, *Melampyrum*, &c.

The name of *amphitrope* embryo *(E. amphitropus)* is given to that which is so much bent upon itself that its two extremities come near each other, and are directed towards the hilum; as in the Caryophylleæ, the Cruciferæ, several Atripliceæ, &c.

As the monocotyledonous embryo and the dicotyledonous embryo differ greatly from each other, in the number, form, and arrangement of the parts which enter into their composition, we shall give a separate account of the characters peculiar to each.

1. *Of the Dicotyledonous Embryo.*

The Dicotyledonous Embryo, or that whose cotyledonary body has two very distinct lobes, presents the following characters: Its *radicle* is cylindrical or conical, naked, and projecting. It elongates at germination, and becomes the true root of the plant. Its two *cotyledons* are attached at the same height upon the caulicle; they have, in many cases, a thickness proportionate to the thinness of the endosperm, or its total absence. The *gemmule* is contained between the two cotyledons, which cover it, and, in a great degree, conceal it. The *caulicle* is more or less developed.

Such are the characters common to the dicotyledonous embryos in general. Some of them, however, present anomalies which might at first seem to remove them from this class. Thus the two cotyledons are sometimes so intimately united, as to look like a single one; as in the Horse-chestnut, and usually in the Chestnut. But it will be remarked that this union is merely accidental, for in some cases it does not take place. This, in fact, is observed with respect to the Horse-chestnut, on which account it is considered as having the general organization of the dicotyledonous embryos. Besides, every embryo, the base of the cotyledonary body of which is entirely cleft, or divided into two, although it should itself appear simple and undivided at its summit, is to be considered as truly dicotyledonous.

2. *Of the Monocotyledonous Embryo.*

The Monocotyledonous Embryo is that which, previous to germination, is perfectly undivided, and has no cleft or incision.

If, in most cases, it is easy enough to distinguish, in the dicotyledonous embryo, the different parts of which it is composed, it is not always so in the monocotyledonous embryo, in which all its parts are often so united and confounded, as to form a single mass, in which germination alone enables us to distinguish any thing. For this reason, the organization of the embryo of the Monocotyledones is much less perfectly known than that of plants that have two cotyledons.

In the monocotyledonous embryo, the radicular body occupies one of its extremities. It is more or less rounded, often has very little prominence, and forms a kind of indistinct papilla. At other times, on the contrary, it is extremely broad and flat, and forms the greatest part of the mass of the embryo, as in most of the Gramineæ. The embryo is then said to be *macropode (Embryo macropodus).* (See Fig. 140.)

The *radicle* is contained in a *coleorhiza*, which it bursts at the period of germination. This radicle is not always simple, as in the Dicotyledones, but is commonly formed of several radicular filaments, which sometimes separately perforate the coleorhiza which contains them, as is observed chiefly in the Gramineæ.

The cotyledonary body is simple, and presents no incision or cleft. Its form is extremely variable. It is always lateral, with respect to the total mass of the embryo. Most commonly the *gemmule* is contained in the interior of the cotyledon, which envelopes it on all sides, and forms a kind of *coleoptile* for it. (Fig. 145 *b*. See Fig. 142 *b*). It is composed of small leaves enclosing each other. The outermost usually forms a kind of sheath closed on all sides, which embraces and covers the rest. M. Mirbel gave it the name of *Pileolus*.

Fig. 145.

The *caulicle* in most cases does not exist, or is intimately confounded with the cotyledon or the radicle.

Such is the more usual organization of the monocotyledonous embryos; but, in many circumstances, there occur modifications peculiar to certain plants. Thus, for example, the family of the Gramineæ presents some peculiarities in the structure of the embryo. It is, in fact, composed of two parts, the *first* a thick, generally discoid, fleshy body, applied upon the endosperm. This body, which has received the name of *Hypoblastus* *, does not enlarge during germination. It may be compared to the radicular body. The second part is the *Blastus*, which is the one that is to be developed. It is applied upon the *hypoblastus*, and is formed of the caulicle and the gemmule, contained in the cotyledon, which constitutes a kind of seed or sheath that envelopes them on all sides. The inferior extremity of the blastus, through which one or more radicellar tubercles are to issue, bears the name of *radiculode*.

Lastly, the name of *Epiblastus* is applied to an anterior appendage of the blastus, which sometimes covers it in part, and which seems to be merely a prolongation of it.

* To this body Gœrtner gave the name of *Vitellus*. Most authors consider it as the cotyledon; but this supposition is refuted by analogy. See my father's Memoir on the Endorhizal Embryos, in the 17th volume of the *Annales du Muséum*, 1811.

CHAPTER XIV.

OF GERMINATION.

The term *Germination* is applied to the series of phenomena through which a seed passes, which, having arrived at a state of maturity, and being placed in favourable circumstances, swells, bursts its envelopes, and tends to develope the embryo which it contains.

Before a seed can germinate, there must be a concurrence of circumstances dependent upon the seed itself, or which are foreign and accessory to it, but which yet exercise an undeniable influence upon the phenomena of its development.

The seed must be in a state of maturity: it must have been fecundated, and must contain an embryo perfect in all its parts. Moreover, it must not be too old, otherwise it may have lost its faculty of germination. There are seeds, however, which retain it for a great number of years, and especially those belonging to the family of Leguminosæ. Thus, Kidney-beans have germinated after being kept for sixty years; and some seeds of the Sensitive-plant are said to have been perfectly developed about a hundred years after they were gathered. But, before seeds that have been long kept can germinate, they must have been defended against the contact of air, light, and moisture.

The external agents which are essential to germination are water, heat, and air.

1. *Water*, as we have already seen, is indispensably necessary for producing vegetation and the phenomena of nutrition in plants. It is not merely as an alimentary substance that it acts in this case: its solvent faculty, and its fluidity, qualify it to become a menstruum and a vehicle to the substances which afford nutriment to the vegetable.

In germination, its action is precisely the same. It penetrates into the substance of the seed, softens its envelopes, causes the embryo to swell, and produces changes in the nature of the endosperm or cotyledons, which often render them fitted for supplying the young plant with the first materials of its nutrition. It moreover conveys the gaseous or solid substances which are to furnish aliment to the plant which is beginning to grow. It also contributes to the development of the plant by means of the decomposition which it undergoes: its disunited elements combine with carbon, and give rise to the different immediate principles of plants.

The quantity of water, however, must not be too great, otherwise the seeds would undergo a kind of maceration, which would destroy their germinative faculty, and prevent their development. We here speak of the seeds of land plants, for those of aquatic vegetables germinate when entirely immersed in water. Some of the latter, however, although of such there is but a very small number, ascend to the surface to germinate there in the open air, being incapable of receiving development under water.

It is therefore obvious, that water has two modes of action in germination: 1*st*, It softens the envelope of the seed, and renders it more easy for the embryo to burst it; 2*dly*, It affords a solvent and a vehicle to the substances which form the aliment of the young plant.

2. *Heat* is not less essential to germination. In fact, it exercises a very decided influence upon all the phenomena of vegetation. If a seed be put in a place, the temperature of which is under zero, it exhibits no germinative action, but remains inactive, and, as it were, torpid; whereas a gentle and regular heat greatly accelerates germination. The heat, however, must not exceed certain limits; for, if it does, instead of favouring the development of the germs, it will dry them up and destroy their vital principle. Thus a heat of from 45° to 50° of the centigrade thermometer

prevents germination, while a heat not higher than from 25° to 30°, especially if accompanied by a certain degree of humidity, accelerates the evolution of the different parts of the embryo.

3. *Air* is as useful to plants, in contributing to their germination and growth, as it is necessary to animals for respiration and the general functions of life. Were a seed totally withdrawn from contact with air, it would acquire no kind of development. Homberg, however, says he got some seeds to germinate in the vacuum of an air-pump; but although the experiment has frequently been repeated, the same results have never been obtained. It is, therefore, certain that air is indispensably necessary for germination. M. Theodore de Saussure, whose testimony is of such weight in the experimental part of vegetable physiology, is of opinion that Homberg's experiments cannot in the least invalidate this truth, and that the conclusions which he has drawn from them must be considered as imperfect, and possessed of little accuracy.

Seeds buried too deeply in the ground, and thus withdrawn from the action of atmospheric air, have often remained for a very long time without exhibiting any sign of life; but when, by some cause, they have been brought nearer the surface of the ground, so as to come into contact with the ambient air, their germination has been effected.

As air is not a simple body, but is formed of oxygen and azote, does it owe its action to the mixture of these two gases, or is it only one of them that determines the influence which it exercises upon the phenomena of germination?

The action of air upon plants, at this first period of their development, presents the same circumstances as in the respiration of animals. It is the oxygen of air that, in the act of respiration, is the principal agent in giving the blood the qualities which are to render it fitted for the development of all the organs; and the same oxygen aids and facilitates the germination of plants. Seeds placed in azotic gas or carbonic acid gas are unable to germinate, and quickly perish. We know that animals placed in similar circumstances cease to respire, and die. But it is not in a pure and separate state that oxygen produces so favourable an effect upon the evolution of the germs. In this state it accelerates germination at first, but soon puts a stop to it by the too great activity which it communicates. Accordingly, seeds, plants and animals, are unable to germinate, respire or live, in pure oxygen gas. Another substance must be mixed with it to moderate its activity, before it can be rendered fit for respiration and vegetation. It has been found that a mixture of hydrogen or azote renders it better qualified to perform this office, and that the best proportions for the mixture are one part of oxygen to three parts of azote or hydrogen.

The oxygen absorbed during germination combines with the excess of carbon which the young plant contains, and forms carbonic acid, which is expelled. By this new combination, the principles of the endosperm being no longer the same, the fecula of which it is composed, and which was insoluble before germination, becomes soluble, and is often partly absorbed, to afford the first materials of nutrition to the embryo.

Certain substances appear to have a decided influence in accelerating the germination of plants, as we learn from the experiments of Humboldt. That illustrious naturalist, to whom almost every department of human knowledge is indebted for some improvement, and in many cases for the perfection which it has now attained, has shewn that the seeds of the cultivated Cress *(Lepidium sativum)*, when placed in a solution of chlorine, germinate in five or six hours; whereas, if placed in pure water, they would require thirty-six hours to attain the same state. Certain exotic seeds, which had resisted every method that had been tried to make them germinate, became perfectly developed in a solution of the same substance. He further observed, that all substances which readily yield a part of their oxygen to water, such as many metallic oxides, nitric and sulphuric acids sufficiently diluted, accelerated the evolution of seeds, but at the same time produced the effect which we have remarked as resulting from pure oxygen, that of exhausting the young embryo and quickly destroying its vitality.

Although seeds are usually placed in earth, to germinate there, this circumstance is not absolutely necessary for their development, as we every day see seeds germinating very well, and with great rapidity, in fine sponges, or other bodies which are kept soaked with water. But let it not be imagined that earth is entirely useless or unnecessary for vegetation; for the plant extracts from it, by its roots, substances which, after converting them into nutritious elements, it is enabled to assimilate.

Light, so far from accelerating the development of the organs of the embryo, retards it in an evident manner. In fact, seeds always germinate much more rapidly in darkness than when exposed to the light of the sun.

All seeds do not take the same time in beginning to germinate. Very remarkable differences are exhibited in this respect. Thus some seeds germinate in a very short period: the Cress in two days; Spinach, Turnips, and Kidney-beans in three days; the Lettuce in four; Melons and Gourds in five; most of the Gramineæ in a week; Hyssop at the end of a month; others remain for a very long period without showing signs of germination; some, and chiefly those which have the episperm very hard, or are surrounded by a woody endocarp, germinate only at the end of a year; while the seeds of the Hasel, the Rose, the Cornel, and others, are not developed until two years after they are placed in the ground.

Having now given a brief account of the circumstances by which germination is effected or favoured, let us examine the general phenomena of that function, after which we shall present some details relating to the peculiarities which it presents in monocotyledonous and dicotyledonous plants.

The first visible effect of germination is the swelling of the seed, and the softening of the envelopes which cover it. These envelopes burst at a period which varies in different plants. The bursting of the episperm sometimes takes place in a manner quite irregular, as in the Kidney-bean and Common Bean; while, at other times, it takes place with a uniformity and regularity which are presented by all the individuals of the same species. The latter circumstance is chiefly observed in seeds which are furnished with an *embryotegium*, a kind of operculum which separates from the episperm to allow the embryo to pass; as, for example, in the Virginian Spiderwort (*Tradescantia virginica*), *Commelina communis*, *Phœnix dactylifera*, and several other monocotyledonous plants.

The embryo takes the name of *Plantule*, or young plant, as soon as it begins to be developed. There are then distinguished in it two extremities, which always grow in opposite directions. One of these extremities, which is formed by the gemmule, tends upwards to the region of air and light, and is named the *ascending caudex*. The other, which passes deeper into the earth, and thus follows a direction the reverse of the first, bears the name of *descending caudex*. It is formed by the radicular body.

In most cases, it is the descending caudex or the radicle, that first experiences the effects of germination. That extremity is observed to become gradually more prominent, elongate, and constitute the root, in the *Exorhizæ*. In the *Endorhizæ*, on the contrary, the *coleorhiza*, pushed out by the radicellar tubercles which it contains, sometimes elongates, and undergoes considerable distension before bursting, while, at other times, it yields directly, and allows the radicellar tubercles which it covered to protrude.

During this time, the gemmule does not remain inert and stationary. From being at first concealed between the cotyledons, it rises upwards, elongates, and proceeds in the direction of the surface of the ground, when it has been covered with earth. If it has a coleoptile, it elongates and dilates; but the gemmule, which grows more rapidly, presses upon it, perforates it at its upper and lateral part, and makes its appearance at the outside.

When the ascending caudex begins to be developed beneath the point of insertion of the cotyledons, it raises them, and carries them out of the ground. Cotyledons which exhibit this phenomenon, are then named *epigeal* *. They enlarge, sometimes even become thinner, assume a foliaceous appearance, and are then named *seminal leaves.*

When, on the contrary, the ascending caudex commences above the cotyledons, the latter remain concealed in the ground, and, in place of acquiring any increase of size, diminish, wither, and at length disappear entirely. They are then named *hypogeal* cotyledons †.

When the gemmule has reached the open air, the leaflets of which it is composed are unrolled, spread out, and presently acquire all the characters of leaves, the functions of which they speedily perform.

But what are the uses of the accessory parts of the seed, in other words, of the episperm and endosperm?

The use of the episperm, or proper covering of the seed, is to prevent the water, or other substances in which a seed germinates, to act too directly upon the matter of which the embryo is composed. It performs, in some measure, the office of a sieve, through which there can pass only the finest *earthy* molecules. Duhamel, in fact, remarked that seeds, from which their proper integument is

* From επι, upon, above, and γη, earth;—rising above the surface of the ground.

† From υπο, under, and γη, earth;—remaining under ground,

stripped, seldom germinate, or produce slender and deformed plants.

The endosperm, which is not always present, is nothing but the residuum of the water contained in the cavity of the ovule, where the embryo was developed. This fluid, which Malpighi compared to the liquor amnii, when it had not been entirely absorbed during the formation and growth of the embryo, gradually acquires consistence, thickens, and at length forms a solid mass, in which the embryo is enclosed, or upon the surface of which it is merely applied. This mass is the *endosperm*. This is the reason why that body has always an inorganic aspect. Sometimes all the fluid contained in the interior of the ovule, and which has not been employed in nourishing the embryo, does not harden, part of it remaining fluid. This is very well seen in the Cocoa-nut, for example, which contains within its kernel a greater or less quantity of a kind of mild emulsion of a white colour, which is known by the name of *Cocoa-milk*.

The origin and first uses of the endosperm show of themselves the uses to which nature has intended it to be applied in germination. It, in fact, supplies the young plant with its first aliment. The changes which it then undergoes in its chemical composition, and the nature of its elements, render it perfectly fit for this use.

In some plants, however, the endosperm is so hard and compact, that it requires a long period to soften and be reduced to a more or less fluid substance, which can be absorbed by the embryo. But this phenomenon always takes place.

If an embryo be deprived of, or separated from, the endosperm which accompanies it, it becomes incapable of being developed. It is therefore evident, that the endosperm is intimately connected with its growth.

The cotyledones, in many cases, appear to perform functions similar to those of the endosperm. For this reason, the celebrated naturalist Bonnet called them *vegetable mammæ*. If the two cotyledons be removed from an embryo, it fades, and ceases to receive any further development. If only one be removed, it may still vegetate, but only in a feeble and languishing manner, like a sickly and mutilated object. It is a very remarkable fact, that a dicotyledonous embryo, that of the Kidney-bean, for example, may be split and separated into two lateral parts, without detriment; for, if each part contain a perfectly entire cotyledon, it will germinate as well as an entire embryo, and give rise to as strong and vigorous a plant.

Lastly, as has been proved by the experiments of MM. Desfontaines, Thouin, Labillardiere, and Vastel, it is sufficient to water the cotyledons to see the whole embryo grow and develope its parts.

The great difference of structure between the monocotyledonous and dicotyledonous embryos, has a remarkable influence upon their peculiar mode of germination. It is therefore necessary to examine the phenomena of germination as exhibited in each, that we may the better understand the mechanism of that function in these two great classes. We shall begin with the exorhizal or dicotyledonous embryos, it being more easy to observe in them the successive development of the various organs of which they are composed.

1. *Germination of the Exorhizal or Dicotyledonous Embryos.*

In the dicotyledonous embryo, the radicle is generally conical and protuberant; the caulicle is cylindrical; and the gemmule is naked and concealed between the bases of the two cotyledons, which are placed face to face, and are directly applied upon each other *.

* In some very rare cases, the two cotyledons, instead of being applied directly face to face, are separated in a considerable degree, and more or less divergent. This is observed, for example, in the genera *Monimia* and *Ruizia* or *Bodlea* of the family of Monimiaceæ.

Such is the disposition of the constituent parts of the embryo previous to germination. Let us observe the changes which they undergo when that function begins to be performed; and, in order that what we have to say may be more readily understood, let us take the Kidney-bean for an example (Fig. 146. *a* the hilum, *b* the micropile), and follow its development through its different stages. The entire mass of the seed becomes first impregnated with humidity and swells. The episperm becomes torn in an irregular manner (Fig. 147.) Presently, the radicle (Fig. 148 *a*, 149 *a*), which formed a small conical prominence, begins to elongate, penetrates into the ground, and gives rise to small lateral ramifications of extreme delicacy. Soon after,

Fig. 146.


Fig. 147.

Fig. 148.

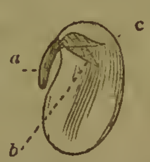

Fig. 149.

Fig. 150.

the gemmule (Fig. 149 *b*), which, until now, has remained concealed between the two cotyledons (Fig. 148 *b b*), rises upwards, and becomes apparent at the exterior. The caulicle (Fig. 150 *b*) elongates, and raises the cotyledons out of the ground, while the radicle (Fig. 150 *a*) proceeds farther into it and ramifies there. The two cotyledons then separate, and the gemmule is entirely free and uncovered (Fig. 150 *c c*), the leaflets of which it is composed spread out, enlarge, become green, and already begin to extract from the atmosphere a portion of the fluids which are to be employed in effecting the growth of the young plant.

Germination is now ended, and the second period of the life of the plant commences.

When the embryo is endospermous, that is, when it is accompanied by an endosperm, the phenomena take place in the same manner, but the endosperm acquires no enlargement, but, on the contrary, softens, and gradually disappears.

Some dicotyledonous plants have a peculiar mode of germination. Thus, for example, we very often find embryos that have already germinated, in the interior of certain fruits, which are entirely closed all round. This is not unfrequently seen in the fruits of the Lemon tree, in which it is not rare to find several seeds already in a germinating state.

The Mangrove *(Rhizophora Mangle)*, a tree which inhabits salt marshes and the shores of the sea in the equinoxial regions, presents a peculiar kind of germination, which is not less remarkable. Its embryo begins to be developed, while the seed is still contained in the pericarp. The radicle presses against the pericarp, which it wears, and at length perforates. It elongates at the outside, sometimes more than a foot. The embryo then becomes detached, and, leaving the cotyledonary body in the seed, falls off, the radicle first, sinks into the mud, and there continues to grow.

In the Horse-chestnut, the Common Chestnut, and some other dicotyledonous plants, the two cotyledons, which are very large and thick, are, in most cases, directly united. Germination takes place in the following manner: the radicle, as it sinks into the ground, elongates the base of the two cotyledons, and thus disengages the gemmule, which soon shows itself above ground; but the two cotyledons are not raised by the gemmule, but remain *hypogeal.*

2. *Germination of the Endorhizal or Monocotyledonous Embryos.*

Monocotyledonous embryos generally undergo fewer changes, during germination, than those of dicotyledonous plants; which is caused by the uniformity of their internal structure. In fact, they have very frequently the appearance of a fleshy body, in which the organs that enter into their composition can with difficulty be distinguished. Embryos of this kind must, therefore, be submitted to germination, before their structure can be properly understood.

As in the Dicotyledones, the radicular extremity is that which is first developed. It elongates, and its coleorhiza bursts to allow a passage to the radicular tubercle, which enlarges, and passes downwards into the ground. Several radicels usually spring from the lateral and inferior parts of the cauliele. When they have acquired a certain development, the principal radicle is destroyed, and disappears. Accordingly, monocotyledonous plants never have a tapering root like the dicotyledonous.

The cotyledon which contains the gemmule, always enlarges more or less before it is perforated by that organ, which generally issues at the lateral part of the cotyledon, scarcely ever at the summit. In fact, the gemmule is always nearer one of its sides, and its summit is always oblique. When the gemmule has perforated the cotyledon, the latter changes into a kind of sheath which embraces the gemmule at its base. It is to this sheath that the name of *coleoptile* has been given. Fig. 151. represents a seed of the Maize in a state of germination : *a* is the body of the seed, formed by the farinaceous endosperm;

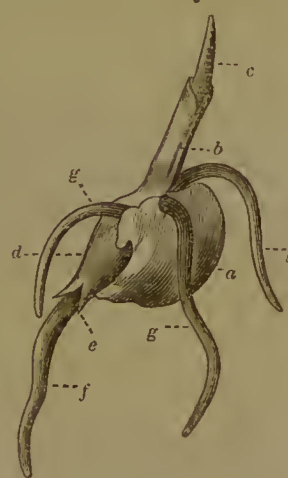

Fig. 151.

b the cotyledon, which has become elongated, and contains within it the gemmule *c*, which has perforated its upper and lateral part; *d* the coleorhiza, which contained the principal radicle; *e* the point at which the radicle *f* has perforated the coleorhiza; *g g g* radicels.

But it not unfrequently happens that a part of the cotyledon remains engaged, either in the interior of the endosperm, or in the episperm; so that it is only the part nearest the radicle that is drawn forth by the development of the latter. Figs. 152. and 153. represent the seed of the Indian Shot *(Canna Indica)*. Fig. 152. a longitudinal section; *a* the episperm; *b* the endosperm; *c* the monocotyledonous embryo. Fig. 153. the embryo; *a* the cotyledon; *b* the gemmule enclosed within the cotyledon, which, at germination, elongates, perforates the cotyledon laterally, and becomes *b′*; *c* the radicle contained within a coleorhiza, which it perforates at *c′* to pass into the ground.

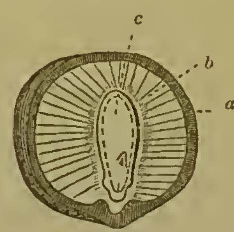

Fig. 152.

Fig. 153.

CHAPTER XV.

CLASSIFICATION OF THE DIFFERENT SPECIES OF FRUITS.

In the two preceding chapters, we have examined somewhat in detail the various organs which enter into the composition of a ripe and perfect fruit, and have shown that it always consists of two parts, the *pericarp* and the *seed*. We have now to describe the different modifications presented by the fruit, considered as a whole, or viewed in reference to the aggregate of its constituent parts.

It will easily be conceived that there must be many species of fruits, all more or less distinct from each other, when we consider the varieties of form, structure, and consistence, the variable number, and relative position of the seeds and other parts, which fruits present. Their classification, in fact, is one of the most difficult parts of botany; and, notwithstanding the efforts and labours of the many celebrated botanists who have made it a special object of study, is still far from having attained the degree of accuracy and precision exhibited by most of the other branches of the science. Some authors have brought together, under a common denomination, species which are essentially different in their form and structure; while others, by multiplying in too great a degree the number of divisions, and establishing them upon characters too minute and too variable, have done equal injury to the advancement of this department of carpology. In this work we shall describe only the species of fruit which are truly distinct, and have good characters; those, in short, which have been established by common use, or which have been adopted by the greater number of botanists.

Fruits, considered in a general point of view, have been divided in various ways, and have received particular names. Thus, the name of *simple* fruit has been given to that which proceeds from a single pistil, contained in a flower; of which kind is the Peach, the Cherry, &c. A *multiple* fruit, on the contrary, is that proceeding from several pistils contained in the same flower: for example, the Rasp, the Strawberry, the fruit of the genera *Ranunculus*, *Clematis*, &c. Lastly, the name of *compound* fruit is given to that which results from a greater or less number of pistils placed close together, and often united, but all coming from distinct flowers situated very near each other; as in the Mulberry.

According to the nature of their pericarp, fruits are distinguished into *dry* and *fleshy*. Dry fruits are those whose pericarp is thin, or formed of a substance generally containing little juice. Fleshy fruits, on the contrary, have a thick and succulent pericarp, and their sarcocarp in particular is very large. Of this kind are Melons, Peaches, Apricots, &c.

Fruits may remain entirely closed in all parts, or may open into a determinate number of pieces named *valves*. From these circumstances, fruits are distinguished into *dehiscent* and *indehiscent*. The latter, when they are dry, are also named *capsular* fruits.

According to the number of seeds which they contain, fruits are divided into *oligospermous* and *polyspermous*. Oligospermous fruits are those which contain only a small number of seeds, which, in most cases, is precisely determined: whence the epithets *monospermous*, *dispermous*, *trispermous*, *tetraspermous*, *pentaspermous*, &c., applied to the fruit, to denote that the number of its seeds is one, two, three, four, five, &c. *Polyspermous* fruits are all those which contain numerous seeds, the precise number of which it is unnecessary to determine.

There are fruits in which the pericarp is so thin, and adheres so closely to the seed, as to become confounded with it. Linnæus considered these fruits as naked seeds. They have obtained the name of *Pseudosperms*. Such are the seeds of the Gramineæ, the Labiatæ, the Synanthereæ, &c.

It is of great importance to possess an accurate knowledge of the different species of fruit, and to be able to distinguish them. In fact, the fruit very often affords a basis to the arrangement of plants into natural families; and the characters which are obtained from an attentive examination of it generally lead to the most happy results in the methodical classification of plants.

To simplify the study of the nomenclature of fruits, we shall divide them into three classes. In the first class, we shall bring together all the *simple* fruits, or those originating from a single pistil contained in a flower. This class we shall subdivide into two sections, in one of which will be placed the dry fruits, and in the other the fleshy fruits. The second class will contain the fruits produced by the collocation of several pistils in the same flower, in other words, the *multiple* fruits. Lastly, in the third class, we shall treat of the *compound* flowers, or those formed by several flowers, which are at first distinct, but which unite so as to constitute a single fruit.

CLASS FIRST.—SIMPLE FRUITS.

Sect. I.—Dry Fruits.

* *Indehiscent Dry Fruits.*

Dry and Indehiscent Fruits are generally oligospermous, or contain a very small number of seeds. Their pericarp is usually rather thin, or adheres to the proper integument of the seed; a circumstance which induced the older botanists to consider them as naked seeds, or seeds destitute of pericarp. They are the true pseudosperms. The following species are distinguished:—

The *Cariopsis* (Rich.); a monospermous, indehiscent fruit, of which the pericarp is very thin, and intimately confounded with the seed, so as not to be distinguishable from it. This species belongs to nearly the whole family of the Gramineæ, such as Wheat, Barley, Rice, &c.

Its form varies considerably. It is ovoidal in the Wheat *(Triticum)*, elongated and narrower in the Oat *(Avena)*, irregularly spheroidal in the Indian Corn *(Zea)*.

2. The *Akenium* (Rich.); a monospermous indehiscent fruit, the pericarp of which is distinct from the proper integument of the seed; as in the Synanthereæ, such as the Sunflower *(Helianthus annuus)*, Thistles, &c.

Not unfrequently the Akenium is crowned by bristles or chaffy substances, which constitute what we have designated by the name *Pappus* (Fig. 154, 155.).

Sometimes the pappus forms a small simple membranous crown, which margins the upper part of the fruit in a circular manner *(Pappus marginalis)*.

Fig. 154.

Fig. 155.

At other times the pappus is *feathery* or *bristly*, according to the nature of the hairs of which it is composed.

3. The *Polakenium* (Rich.). This name is given to a simple fruit, which, when perfectly ripe, separates into two or a greater number of cells, which may be considered each as containing an akenium; whence the names *diakenium*, *triakenium*, *pentakenium*, according to the number of these parts. The Umbelliferæ, such as Parsley and Hemlock, the Araliaceæ, &c., furnish examples of this kind of fruit.

4. The *Samara* (Gærtner) (Fig. 156); an oligospermous, coriaceous, membranous fruit, much compressed, having one or two indehiscent cells, which are often prolonged laterally into wings or broad appendages.

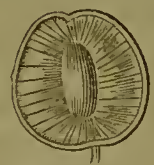

Fig. 156.

Fig. 157.

The *Acorn* or *Gland (Glans)* (Fig. 157.); a single-celled, indehiscent fruit, one seeded (in consequence of the constant abortion of several ovules), always proceeding from an inferior, many-celled and many-seeded ovary, of which the pericarp is intimately attached to the seed, and always presents at its summit the very minute teeth of the limb of the calyx, and is in part, seldom entirely, contained in a kind of scaly or leafy involucre, named the *Cup (cupula)*; as in the Oaks, the Hazel, &c.

The form of acorns is, in general, very variable, some being elongated, others round and more or less spherical. In some the cupula is scaly and very short, while in others it is very large, and almost entirely covers the fruit.

6. The *Carcerulus* (Desvaux); a dry, many-celled, many-seeded, indehiscent fruit, of which that of the Lime-tree is an example.

7. *Gynobasic* fruits are those whose cells are so separated from each other, that they seem to constitute so many distinct fruits; and the style appears to spring immediately from the disk or gynobasis, in consequence of the great depression which the axis of the fruit has experienced. Of this kind is the fruit of the Labiatæ and Boragineæ, which is formed of four akenia united at their base upon a common receptacle, and that of the Simaroubeæ, &c.

* * *Dehiscent Dry Fruits.*

Dehiscent dry fruits are generally polyspermous. The number of their valves and cells is very variable. They are designated by the general name of *capsular* fruits.

1. The *Follicle* (*Folliculus*) (Fig. 158.); a twin or, through abortion, solitary fruit, usually membranous, one-celled, one-valved, opening by a longitudinal suture, to which is internally attached a sutural trophosperm, which becomes free through the dehiscence of the pericarp. The seeds are rarely attached to the two edges of the suture. This species of fruit is peculiar to the family of the Apocineæ, such as the Rose-bay *(Nerium Oleander)*, *Asclepias syriaca*, *Asclepias vincetoxicum*, &c.

2. The *Siliqua* (Fig. 159.); a dry, elongated, bivalve fruit, the seeds of which are attached to two sutural trophosperms. It is commonly separated into two cells by a false partition parallel to the valves, which is merely a prolongation of the trophosperms, and which often remains upon the plant after the valves have fallen off. This fruit belongs to the Cruciferæ. The Wallflower, the Cabbage, the Turnip, &c., afford examples of it.

3. The *Silicula* (Fig. 160.) scarcely differs from the last, being merely a siliqua whose length is not four times as great as its breadth. The silicula sometimes does not contain more than one or two seeds. Examples of the silicula, which also belongs to the Cruciferæ, are seen in the fruits of the genera *Thlaspi*, *Lepidium*, *Isatis*, &c.

4. The *Pod* or *Legume (Legumen)* (Fig. 161.), is a two-valved dry fruit, the seeds of which are attached to a single trophosperm, which follows the direction of one of the sutures. This fruit belongs to the entire family of the Legu-

Fig. 158.

Fig. 159.

Fig. 160.

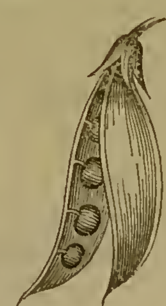

Fig. 161.

minosæ, of which it forms the principal character; for example, the Pea, the Bean, &c.

The pod is naturally one-celled; but sometimes it is divided into two or a greater number of cells by false dissepiments. Thus it is *bilocular* in *Astragalus*. In the genus *Cassia*, the pod is separated into a great number of cells by transverse false dissepiments or diaphragms. This character belongs to the whole genus.

Sometimes the pod seems to be formed of articulated pieces, and is then said to be *lomentaceous;* as in the genera *Hippocrepis*, *Hedysarum*, &c.

At other times it is inflated and vesicular, with thin, semitransparent walls; as in the genus *Colutea*.

The number of seeds which the pod contains varies greatly. Thus there is only one in *Medicago lupulina;* there are two in the true species of *Ervum*, &c.

Sometimes the pod is entirely indehiscent, as in *Cassia Fistula* and other species of the same genus; but these variations are rare, and do not destroy the characters peculiar to this species of fruit.

The *Pyxidium* (Erh.) (Fig. 162.), is a dry capsular fruit, generally globular, opening transversely into two hemispherical valves; as in the genera *Lysimachia*, *Hyoscyamus*, &c. Authors usually designate it by the name of *Capsula circumscissa*.

Fig. 162.

6. The *Elaterium* (Rich.); a fruit often raised into ridges, and separating naturally, when ripe, into as many distinct *cocca*, which open longitudinally, as in the Euphorbiaceæ; whence the expressions *tricoccous*, *multicoccous*, applied to this kind of fruit.

The cocca are commonly connected by a central columella, which remains on the plant after they have dropped.

7. The *Capsule (Capsula):* this is a general name ap-

plied to all dry and dehiscent fruits which cannot be referred to any of the above species. It will easily be imagined that the capsules must be exceedingly variable. Thus there are some which open by pores or apertures formed at their upper part; as in the genera *Papaver* and *Antirrhinum*. At other times these pores are situated near the base of the capsule. Several are dehiscent only at their summit, it being closed by approximated teeth, which separate when the fruit is ripe. This is observed in many genera of the family of Caryophylleæ (Fig. 163.).

Sect. II.—Fleshy Fruits.

Fleshy fruits are indehiscent. Their pericarp is thick and pulpy, and they contain a variable number of seeds. The principal are the following.—

1. The *Drupe (Drupa)* (Fig. 164.); a fleshy fruit, which contains a *nucleus*. This nucleus is formed by the indurated and ossified endocarp, to which is joined a part of the sarcocarp of greater or less thickness; as, for example, in the Peach, the Plum, the Cherry, &c.

2. The *Nut (Nux)* differs from the drupe only in having the sarcocarp thinner, which is then named the *shell (naucum.)* Of this kind is the fruit of the *Almond (Amygdalus communis)*, and the Walnut *(Juglans regia)*.

3. The *Nuculanium* (Rich.) is a fleshy fruit proceeding from a free ovary, that is, an ovary not crowned by the lobes of the adherent calyx, and containing within it several

Fig. 163.

Fig. 164.

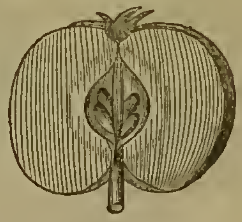

Fig. 165.

nuclei, which bear the name of *nucules* (*Nuculæ*, Rich.) Of this kind are the fruits of the Elder, the Ivy, the Rhamneæ, and the *Achras Sapota*.

4. The *Melonida* * (Rich., Fig. 165), is a fleshy fruit, proceeding from several parietal ovaries placed close together, and attached to the tube of the calyx, which, being often think and fleshy, is confounded with them; as in the Pear, the Apple, the Medlar, the Rose, &c.

In the melonida, the really fleshy part of the fruit is not formed by the pericarp itself, but is produced by a great thickening of the calyx; as may easily be seen by attentively examining the fruit in the different stages of its growth.

The endocarp which covers each cell of a melonida is cartilaginous or osseous. In the latter case, there are as many nucules as there are ovaries; as is observed in the Medlar. This circumstance has caused the melonida to be divided into two varieties.

1. The melonida with nucules, or that of which the endocarp is osseous; as in the genera *Mespilus* and *Cratægus*.

2. The pippin melonida, or that whose endocarp is simply cartilaginous; as in the Pear, the Apple, &c.

* This species of fruit has hitherto been incorrectly defined by authors, it having been described as proceeding from an inferior multilocular ovary, with distinct cells. But we have already demonstrated the great difference that exists between the truly inferior and the merely parietal ovary. When the ovary is inferior, there is never more than one in the same flower. Now, in most of the true Rosaceæ, there are several pistils, the different degrees of lateral adhesion of which to the inner wall of the calyx may be gradually traced. Thus, for example, in the genus *Rosa*, the pistils, which are twelve or fifteen in number, are attached to the tube of the calyx only by a small pedicel at the base of their ovary. In the genera *Cratægus* and *Mespilus*, the ovaries are united to the calyx by their whole outer side. In the genera *Pyrus*, *Malus*, &c., these ovaries are not only united to the calyx at their outer side, but are attached to each other in every other part. But it sometimes happens in certain Pears, that the ovaries remain distinct at their inner side, so that a cavity of greater or less extent is observed at the centre of the fruit.

The melonida belongs exclusively to the family of Rosaceæ, in which it is associated with some other species of fruits, which are frequently mere varieties of it.

5. The *Balausta*, a many-celled, many-seeded fruit, always proceeding from an ovary which is truly inferior and crowned by the teeth of the calyx; as in the Pomegranate, and all the true Myrteæ.

6. The *Peponida* (Rich.); a fleshy, indehiscent or ruptile fruit, with several cells scattered in the pulp, each containing a seed which is so united to the internal parietal membrane of each cell, as to be separable from it only with difficulty. This fruit is observed in the Melon, the Pumpion, and the other Cucurbitaceæ, and in the Nymphæaceæ and Hydrocharideæ.

It sometimes happens that the fleshy parenchyma which occupies the centre of the peponida is burst and torn by the rapid growth of the pericarp. In this case, the central part is occupied by an irregular cavity, which has, although erroneously, been considered as a true cell. This is observed particularly in the Pumpion *(Pepo macrocarpus)*. But when this alleged cell is carefully examined, it is found not to be lined by an internal parietal membrane or endocarp, which evidently shows it to be merely accidental and not a true cell. In fact it does not exist in all the species; and, in those in which it occurs, it does not make its appearance until they begin to ripen.

The true organization of the peponida may be seen in the Water Melon *(Cucurbita Citrullus)*. In this species, the central part always remains full and fleshy at every period of its growth. Each seed is contained in a separate cell, to the walls of which it adheres only by its point of attachment, the hilum. In this case, it would seem as if Nature, which in almost all the other species of this family, alters and modifies, in some degree, the true structure of this fruit, had determined to preserve one of them which might disclose the natural and original type of the others.

7. The *Hesperidium* (Desvaux); a fleshy fruit, with a very thick envelope, and divided internally into several cells by membranous dissepiments, which may be separated without laceration; as in the Orange and Melon.

8. The *Berry (Bacca).* Under this general name are comprehended all the fleshy fruits, destitute of a nucleus, which do not belong to the preceding species. Such, for example, are Grapes, Gooseberries, and Currants.

CLASS SECOND.—MULTIPLE FRUITS. *

Multiple fruits are those which result from the aggregation of several pistils contained in the same flower.

The *Syncarpium* (Rich.); a multiple fruit, proceeding from several ovaries belonging to the same flower, which are united together, even before fecundation; as in the genera *Magnolia*, *Anona*, &c.

The fruit of the Strawberry and Raspberry plants is formed of a greater or less number of small drupes, whose sarcocarp is very thin, although very obvious in the Strawberry, placed close together upon a fleshy gynophorum, which is more or less developed.

The fruit of the Ranunculi, &c. is formed of several small akenia placed close together.

CLASS THIRD.—AGGREGATE OR COMPOUND FRUITS.

Aggregate fruits are those which are formed of a number of small fruits, placed close together, and often united to each other, all proceeding from flowers which were at first separate, but which have ultimately cohered. Of this kind are the following species:

* It is to this class that the Melonida really belongs, although, to avoid differing from the usual practice, we have left it in the preceding.

1. The *Cone (Conus, Strobilus)*, a fruit composed of a great number of membranous utricles, concealed in the axil of very large, dry bracteas, disposed in the form of a cone. Such is the fruit of the Pines, the Firs, the Alder, the Birch, &c.

2. The *Sorosis.* M. Mirbel gives this name to an aggregate fruit formed of several small fruits united into a single body through the medium of their large, fleshy and intergrafted floral envelopes, so as to resemble a tuberculated berry. Of this kind is the fruit of the Mulberry, Ananas, &c.

3. The *Syconium.* By this name M. Mirbel designates the fruit of the genera *Ficus*, *Ambora*, and *Dorstenia.* It is formed of a monophyllous involucre, internally fleshy, of a flat or ovoidal form, and containing a great number of small drupes, which proceed from so many female flowers.

The twenty-five species of fruits of which we have above given the essential characters, contain nearly all the types to which may be referred the numerous varieties of that organ presented by plants. The list is by no means complete. This part of botany still requires long and laborious researches, and must be submitted to a careful and scrupulous analysis before it can be reduced to a perfectly satisfactory state. Our intention here was merely to present the species which are best known and most accurately determined, that we might avoid throwing doubt or obscurity on a subject in itself so difficult.

To conclude what relates to the organs of fructification, we have still to speak of dissemination, and of the advantages which medicine, the arts, and domestic economy may derive from fruits, and the various parts of which they are composed.

CHAPTER XVI.

OF DISSEMINATION.

When a fruit has attained its full maturity, it opens; the different parts of which it is composed separate, and the seeds which it contains burst the bands that, until now, kept them confined in the cavity in which they were developed. This action, by which the seeds are naturally dispersed over the surface of the ground, at the period when they are ripe, is called *Dissemination.*

In the wild or natural state of plants, the dissemination of the seeds is the most powerful agent in the reproduction of species. In fact, were the seeds contained in a fruit not to issue in order to be dispersed over the earth and there be developed, species would cease to be reproduced, and entire races would disappear; and, as all plants have a determinate duration, a period would necessarily arrive when all would have ceased to live, and when vegetation would have for ever disappeared from the surface of the globe.

The commencement of dissemination indicates the termination of life in annual plants. In fact, before it can take place, it is necessary that the fruit should have attained maturity, and that it should have become in some degree dried. Now, this phenomena does not take place, in annual herbaceous plants, until the period when vegetation has entirely ceased. In woody plants, dissemination always takes place during the period of rest which they enter when their liber has become exhausted, and is no longer able to give rise to leaves or organs of fructification.

The fecundity of plants, in other words, the astonishing number of germs or seeds which they produce, is one of the causes which are most powerful in facilitating their reproduction, and in effecting their surprising multiplication. Ray counted 32,000 seeds on a Poppy, and 360,000 on a plant of Tobacco. Let one imagine the regularly increasing progression of this number, merely to the tenth generation of these plants, and he will hardly conceive how the whole surface of the earth should not be covered by them.

But many causes tend to neutralize, in part, the effects of this astonishing fecundity, which, by its very excess, would soon prove injurious to the reproduction of plants. In fact, all the seeds are not placed by nature in circumstances favourable to their development. Besides, numerous animals, and man himself, deriving their principal nutriment from fruits and seeds, destroy incalculable quantities of them.

Various circumstances favour the natural dispersion of seeds. Some of these result from the structure of the pericarp, and others depend upon the seeds themselves.

Thus, there are pericarps which open naturally with a kind of elasticity, by means of which the seeds contained by them are projected to greater or less distances. The fruits of *Hura crepitans*, *Dionæa muscipula*, the Fraxinella, and Balsamine, separate their valves rapidly, and by a kind of spring, projecting their seeds by this means to some distance. The fruit of *Ecballium Elaterium*, when ripe, separates from the peduncle which supported it, and projects its seeds with surprising rapidity through the cicatrix of its point of attachment.

Many seeds are thin and light, and can easily be conveyed by the wind. Others are furnished with particular appendages in the form of crowns or wings, which render them lighter by enlarging their surface. Thus, Maples, Elms, and many Coniferæ, have their fruits furnished with membranous wings, which enable the wind to transport them to a great distance.

Most of the fruits of the vast family of Synanthereæ are crowned with a pappus, the slender and delicate hairs of which, becoming separated by desiccation, answer as a kind of parachute for supporting them in the air. This is also the case with the Valerians.

The winds sometimes transport the seeds of certain plants to distances which are almost inconceivable. *Erigeron canadense* overruns and lays waste all the fields of Europe. Linnæus was of opinion that this plant had been conveyed by the winds from America.

Rivers and the waters of the ocean also effect the distant migration of certain plants. Thus there are sometimes found on the shores of Norway and Finland, fruits that have been conveyed by the waters from the New World.

Man and various animals also contribute to the dispersion of seeds, some of which, as those of the Cleavers and Agrimonies, stick to their clothes or fleeces, by means of the hooks with which they are covered; while others, which are used as food, are conveyed to the places which they inhabit, and spring up when they have been left there, and are placed in favourable circumstances.

Uses of Fruits and Seeds.

The fruits, and especially the seeds of many plants, contain alimentary substances possessed of the most nutritious qualities, and frequently medicines of the greatest power. The family of Gramineæ is unquestionably one of those from which man procures the most abundant supplies of food, and herbivorous animals their most usual pasture. In fact, who is not acquainted with the general use which all the civilized nations of Europe, and of the other parts of the world, make of bread, which is prepared from the farinaceous endosperm of the Wheat, the Barley, and many other Gramineæ? For this reason alone, had it no other claims upon our notice, this natural family of plants is one of the most interesting in the vegetable kingdom.

The pericarps of many fruits furnish food as agreeable as useful. Every one knows the economical uses to which many fleshy fruits, such as Peaches, Apples, Melons, Strawberries, Gooseberries, Currants, &c., are applied.

The pericarp of the Olive *(Olea europæa)* yields the purest and most esteemed oil.

Wine, so useful to man, when used in moderate quantity, is prepared of the juice obtained by pressure from the fruits of the Vine, by submitting it to fermentation. Several other fruits, such as Apples, Pears, Rowans, &c., afford fermented liquors, which supply provinces and entire nations with their ordinary drink.

In the interior of several pericarps of the family of Leguminosæ, there is found an acidulous or sweetish, but sometimes nauseating substance, which possesses laxative properties; as is observed in the Cassia, the Tamarind, the follicles of the Senna, &c.

Dates, Figs, Jujubes, and dried Raisins are alimentary substances which are remarkable for the great quantity of saccharine principle which they contain.

The fruits of the Lemon and Orange-trees contain citric acid nearly in a pure state.

The small nuculania of the Buckthorn *(Rhamnus catharticus)* are highly purgative.

Seeds are not less rich in nutritious principles than pericarps. In fact, those of the Cereal plants or Gramineæ, of many Leguminosæ, &c., contain a large quantity of amylaceous fecula, which renders them highly nutritive.

The seeds of the Common Flax, the Quince, and the Psyllium, also contain a very abundant mucilaginous principle, which renders them essentially emollient.

Many seeds are distinguished by possessing a highly aromatic stimulant principle. Such are those of the Anise *(Pimpinella Anisum)*, the Fennel *(Anethum Fœniculum)*, the Coriander *(Coriandrum sativum)*, and the Caraway *(Carum Carui)*, which are named *Carminative* seeds. Others, again, produce a *refrigerant* or sedative effect upon the animal economy; such as those of Calabash *(Cucurbita lagenaria)*, the Cucumber *(Cucumis sativa)*, the Melon *(Cucumis Melo)*, and the Water-melon *(Cucurbita Citrullus)*.

The carminative seeds all belong to the family of Umbelliferæ; the refrigerant to the Cucurbitaceæ.

Who is not aware of the habitual use that all civilized nations make of the roasted seeds of the Coffee, Cocoa, &c.?

From the seeds of the Almond, Walnut, Beech, Ricinus, Hemp, Poppy, Colza, &c., an abundant oil is obtained, which possesses properties modified in each of these plants by its being mixed with other substances.

The seeds of *Bixa orellana* are used for dying reddish brown.

It is impossible to enumerate here all the advantages which man may derive from fruits or their component parts, as the attempt would lead us from our subject. We shall therefore be contented with having pointed out, although in a very imperfect manner, some of the numerous uses of fruits and seeds, in domestic economy and therapeutics.

We now conclude all that relates to the department of Botany, which we have designated by the name of *Organography*. In it we have described all the organs of phanerogamous plants, and the functions which they perform. We now proceed to make known the various modes of classification which have been proposed for arranging and distributing the immense number of plants already known and described by authors. To this part of the science the name of *Taxonomy* is given.

OF TAXONOMY,

OR OF

BOTANICAL CLASSIFICATIONS IN GENERAL.

We have already seen that, by the name *Taxonomy*, is designated that part of General Botany to which belongs the application of the laws of classification to the vegetable kingdom.

At the period when the sciences were as yet in their infancy, when their domain consisted of but a small number of facts, those who devoted themselves to their cultivation required but very little exertion, and a tolerable memory, to enable them to embrace the entire knowledge, and retain the names of the objects, in the study of which they were engaged. The first philosophers who treated of botany speak of plants without adopting any order or methodical arrangement. In the time of Theophrastus, for example, who first wrote particularly on vegetables, the functions of the organs were misunderstood, the genera and species were entirely confounded, and their distinctive characters were unknown. In a word, although that philosopher may be said to have been the first who wrote on botany, it may also be said that, in his time, the science had no real existence. The characters of plants rested merely on empirical knowledge, or on simple tradition ; for their number was then so limited, that it was easy to know them all individually, without its being necessary to distinguish them otherwise than by imposing a particular name upon each of them, with which, however, no idea of character or comparison was connected. Such was the state of botany during many ages, when, from its intimate connection with medicine, it found a place only in the works of those who wrote on the healing art. But when, in consequence of more judicious inquiries, and of journeys made to distant countries, the number of objects belonging to natural history was increased, it became necessary to employ more precision in naming these different objects, and to distinguish them by characters of some kind, that they might be more easily recognised. In a short time, the memory was unable to retain the names of the numerous objects which accumulated, and which were mostly new and previously unknown.

At this period, naturalists began to be sensible of the necessity of arranging objects in some order, which might facilitate research, by furnishing the means of arriving more readily, and with more certainty, at the names which had been given to them individually. But the arrangements followed were at first entirely empirical, and have no title to be regarded as true methods. In fact, they were not at all founded on the knowledge derived from characters peculiar to these objects individually, and which might serve to distinguish them from each other, but rested merely upon some external circumstances, which were often foreign to the nature of the object. Thus the alphabetical order in which plants were arranged, could be of no advantage excepting to those who were already acquainted with them, and were desirous of examining some of them more particularly. This is equally the case with the arrangements founded upon the economical or medicinal properties of plants, which always suppose a previous knowledge of the virtues of the plants whose names it is proposed to discover.

It will easily be perceived that, upon such foundations, there could only be raised classifications of the most defective character, as they generally rested upon circumstances unconnected with the nature and organization of plants. They were, therefore, incapable of affording any satisfactory idea of them.

Experience, however, soon shewed the necessity of deriving the characters by which plants might be made known and distinguished from their own organization and the parts of which they are composed. From this period, botany assumed the rank of a science; for it was then that the organization of plants began to be studied, in order to educe from it the characters by which these objects might be made known and distinguished.

Methods now began to assume a regular form. But, as the organs of vegetables are numerous, the number of methods became correspondingly great, as each author imagined some one of the former to supply the most solid foundation for a good arrangement. Thus some of them founded their methods on the consideration of the roots, and of all the modifications which these organs are capable of presenting; others upon the stems; some, like Sauvages, on the leaves; others on the inflorescence, &c.

In the sixteenth century, Gessner, a native of Zurich, first demonstrated that the characters derived from the flower and fruit are the most certain and the most important for obtaining from them a good classification of plants. He also shewed the existence, among plants, of groups, composed of several species, connected by common characters. This first idea of grouping vegetables into genera had the greatest influence upon the ulterior progress of botany.

Soon after, Cæsalpinus, who was born in 1519, at Arezzo, in Tuscany, presented the first model of a botanical method. In fact, all the species were arranged in it according to the consideration of characters which may be derived from most of the organs of plants, such as their duration, the presence or absence of the flowers, the position of the seeds, their adhesion to the calyx, the number and situation of the cotyledons, &c. The invention of such a method, imperfect as it is, must be considered as the first step towards the discovery of a natural classification.

The number of known vegetables, however, was daily receiving augmentation from new discoveries, and the works that existed were becoming more and more insufficient. Several authors, among whom may be mentioned with approbation the two brothers Bauhin, Ray, Magnol, and Rivinus, successively gave proofs of extraordinary merit in their works. Some of them even invented new methods, which, however, were all eclipsed by that of Joseph Pitton de Tournefort, which was published about the end of the seventeenth century.

That celebrated botanist, one of those whose writings have most redounded to the honour of his native country, was born at Aix, in Provence, on the 5th June 1656. He was Professor of Botany at the Garden of Plants, in Paris, in the reign of Louis XIV., who, in 1700, sent him on an important mission to the Levant. Tournefort, at that time, traversed Greece, the shores of the Black Sea, and the Islands of the Archipelago. He returned to Paris, and published an account of his journey, which may be mentioned as one of the most perfect models of its kind. Previous to his departure, he had already promulgated, in a work entitled *Institutiones Rei Herbariæ*, his new method, in which were described ten thousand one hundred and forty-six species, which were referred to six hundred and ninety-eight genera.

Tournefort's merit was not solely that of having invented an ingenious method, in which were described and arranged all the plants then known. His principal title to renown is his having been the first who distinguished, with more strictness and precision than had previously been done, the genera, the species, and the varieties which might be referred to them.

Before his time, in fact, the science was nothing but a mass of confusion. The species were not clearly distinguished from those to which they were allied. He first reduced the chaos of botany to order, separated the genera and species by characteristic phrases or definitions, and, by means of his ingenious system, arranged all the plants then known in methodical array.

After Tournefort, appeared a great number of botanists, who enjoyed a certain degree of reputation. Some of them proposed new methods, none of which, however, had the least tendency to eclipse that of Tournefort. This glory seemed reserved for the immortal Linnæus, whose system, which was published in 1734, had the most surprising success, on account of its extreme simplicity, and the singular facility which it affords for attaining a knowledge of the names of plants.

Linnæus had moreover the merit of reforming, or rather of creating, the nomenclature and synonymy of botany, which his predecessors had left in so imperfect a state. Tournefort himself had traced the path to be pursued, without, however, clearing away all the obstacles. In fact, each species was still named by a characteristic phrase, in which the distinctive characters were frequently not included. These phrases were so long that it was very difficult to retain any number of them in the mind. Linnæus gave a proper or generic name to each group or genus, in so far following the example of Tournefort. He further designated each species of these genera by a specific name added to the generic; and, by this ingenious contrivance, greatly simplified the already very extensive study of botany.

The sexual system of Linnæus, which was rendered so seductive by its extreme simplicity, produced a sudden revolution in the science, and was every where received with an enthusiasm which it would be difficult to describe.

When the first emotions of admiration which a great discovery always inspires, had somewhat subsided, it was soon perceived that this system, ingenious as it was, yet possessed some disadvantages, and was not entirely unobjectionable. Being founded upon the absolute consideration of a single organ, it often separated plants which all their other characters seemed to unite beyond the possibility of their ever being disjoined: for it had already been perceived that certain genera of plants possess so many points of contact and of mutual resemblance, and are so united by their general characters, that they seem, as it were, members of the same family. Thus the Gramineæ, Labiatæ, Umbelliferæ, Leguminosæ, Cruciferæ, and several other groups equally natural, had already been brought together in the form of distinct tribes. The separation of plants which it might be considered so necessary to keep together, was therefore a great defect in the artificial system of Linnæus. Thus the Gramineæ were dispersed in the first, second, third, sixth, twenty-first, and twenty-third classes of his system. The Labiatæ were placed partly in the second class, and partly in the fourteenth. Most of the natural tribes which had already been admitted as such by a great number of botanists, were separated in the same manner, as Linnæus found himself obliged to adhere strictly to the principles of his system.

Another method, which, retaining the already acknowledged affinities of plants, might present their general distinctive characters, was, therefore, preferable to a system, which, however ingenious, was faulty in one of the most important points.

Adanson gave the first sketch of such a method. Bernard de Jussieu searched, during forty years, for the most solid and constant characters, on which to found it. He studied with the greatest care the natural affinity of the species and genera. But his nephew, Antoine Laurent de Jussieu, bringing together the rich materials collected by his uncles, and adding to them the numerous observations which he had made himself, was the real author of the method of natural families, which we shall presently exhibit. It was in his *Genera Plantarum*, a work stamped with the impress of genius, and one of the finest monuments of the progress of Botany, that he laid the foundations of a method, which must one day be the only one adopted and followed by all unprejudiced minds, it being unquestionably superior to any that has hitherto been published.

In fact, it has not as its basis the consideration of a single organ, but examines all the characters furnished by every part of a plant, and brings together all those which bear the greatest affinity and resemblance to each other. It is owing to this method that Botany, within the last forty years, has made such rapid progress, and has assumed the first rank among the natural sciences.

We judged it necessary to enter into some details on the subject of methods in general, before entering upon the exposition of any particular system. It appeared to us useful to cast a brief glance upon the principal epochs of Botany, that we might be the better enabled to make known the impulse and the new aspect which the three systems of Tournefort, Linnæus, and Jussieu, have individually given to Botany.

In concluding these general remarks, we have to observe, that there are two very distinct kinds of classification in Natural History. In one, the consideration of a single organ is taken as the basis. Thus Tournefort employed the corolla, and Linnæus the stamina, for establishing their principal divisions. The name of *Systems* has been given to these purely artificial arrangements. It will easily be conceived that a system, having no other object than that of enabling one to find out the name of a plant with facility, affords no idea of its organization. Thus, when we have found that a plant belongs to the first class of the system of Linnæus, or of that of Tournefort, all that we know is, that, in the former case, it has a single stamen, and that in the latter, its corolla is monopetalous, regular and bell-shaped; but these systems disclose to us nothing respecting the other parts which compose the plant, of which they have taught us only the name. In the second kind of classification, which has received the name of *Method* properly so called, as the basis of each class rests upon the total sum of all the characters derived from the different parts of the plants, when we come to one of these classes, we already know the more prominent points of the organization of the plant whose name we are desirous of knowing. Should we, for example, have found, by means of analysis, that the plant which we are examining belongs to the fourth class of Jussieu, this circumstance apprises us that it is a Phanerogamous plant, that its embryo has only a single cotyledon, that it has only one floral envelope, that is to say, a monosepalous calyx adherent to an inferior ovary, that its stamina are inserted upon the ovary, &c. It will thus be seen how much more correct and philosophical are the ideas respecting the structure and organization of plants which the method of natural families affords. It therefore justly deserves to be preferred to every other system hitherto invented.

It would be as tedious as useless to give an account of all the methods which have been proposed by botanists for grouping and arranging in classes all known vegetables. In fact, the number of these methods is so great, that even a brief exposition of them would form the subject of an entire work. We shall therefore content ourselves with an account of the three most important classifications, those of Tournefort, Linnæus, and Jussieu.

OF THE

METHOD OF TOURNEFORT.

Tournefort's system is founded chiefly upon the consideration of the various forms of the corolla. He is generally blamed for not having followed the example of Rivinus, and for continuing to separate herbaceous and woody plants. This system is very defective in this respect, as these two modifications of the stem frequently occur in the same genus, and, as we have already shown, circumstances may sometimes act so directly upon the same species as to render it at one time woody and at another herbaceous. This we remarked to be the case in *Ricinus communis* and *Nyctanthes hortensis*.

This system consists of twenty-two classes, of which the characters are taken—1. From the consistence and size of the stem; 2. From the presence or absence of the corolla; 3. From the separation of the flowers, or their union within a common involucre, in which latter case they are compound; 4. From the circumstance of the corolla being entire or divided into separate segments, in other words, from the consideration of the monopetalous or polypetalous corolla; 5. From its regularity or irregularity.

1. With reference to the consistence and duration of their stem, Tournefort divides vegetables into herbs and suffruticose plants, shrubs, and trees. The herbs and suffruticose plants together are contained in the first seventeen classes. The last five classes contain the shrubs and trees.

2. Agreeably to the presence or absence of the corolla, herbs are distinguished into petalous and apetalous. The first fourteen classes of herbs contain all those which are furnished with a corolla, the other three those which are destitute of one.

3. The herbs which have a corolla have their flowers separated and distinct, or united to form compound flowers. The first eleven classes contain the herbs which have simple flowers, the three next those which present compound flowers.

4. Of the herbaceous plants with simple flowers, some have a monopetalous corolla, while in the others it is polypetalous. In the first four classes Tournefort has brought together the plants which have a monopetalous corolla, and in the next five those with a polypetalous one.

5. But this monopetalous or polypetalous corolla may be regular or irregular, and these circumstances have furnished subdivisions.

The plants which have a woody stem are, as we have said, contained in the last five classes of the system. Tournefort has divided them according to the same principles as in the herbaceous plants. Thus they are apetalous or furnished with petals; their corolla is monopetalous or polypetalous, regular or irregular.

It is of importance to remark, that Tournefort gave the name of corolla to the single and coloured perianths, as in the Tulip and Lily, which, according to his ideas, have a regular polypetalous corolla.

Such are the principles by which Tournefort was guided in forming the classes of his system, of the characters of which we shall now give a brief view.

FIRST DIVISION.—HERBS.

§ I.—With Simple Flowers.

* *Corolla monopetalous, regular.*

Class I. Campaniformes. Herbs with a regular monopetalous corolla, resembling a bell, as in the Bellflower, Convolvulus, the Lily of the Valley, the Heath, &c.

Class II.—Infundibuliformes.—Herbs with a regular monopetalous corolla, resembling the form of a funnel, as in the Tobacco; that of an ancient cup (that is, hypocrateriform), as in the Lilac, or that of a wheel (rotaceous corolla), as in Borage.

* * *Corolla monopetalous, irregular.*

Class III. Personatæ.—Corolla monopetalous, irregular, resembling in form a calf's mouth or an antique mask; as in the genus *Antirrhinum*, &c.; or having the limb more or less open, as in the Foxglove and Figwort. Plants of this class always present a simple ovary in the bottom of their calyx.

Class IV. Labiatæ.—Corolla monopetalous, irregular, the limb as if divided into two lips:—plants having an ovary divided into four very distinct lobes, which are considered as naked seeds. Such are the Sage, Rosemary, Betony, Thyme, &c.

* * * *Corolla polypetalous, regular.*

Class V. Cruciformes.—Corolla polypetalous, regular, composed of four petals, placed crosswise. The fruit is a siliqua or a silicula. Of this kind are the Wallflower, Cabbage, Shepherd's-purse, &c.

Class VI. Rosaceæ.—Corolla polypetalous, regular, composed of from three to ten petals arranged in the form of a rose; as in the Pear-tree, the Apple-tree, the Wild Rose, the Strawberry, the Rasp, the Cistus, &c.

Class VII. Umbelliferæ.—Corolla polypetalous, regular, composed of five petals, which are often unequal; the flowers arranged in an umbel. Such are Angelica, Parsnip, Fennel, &c.

Class VIII. Caryophylleæ.—Corolla polypetalous, regular, formed of five petals with long claws, contained in a monosepalous calyx; the limb expanded; as in the Pink, Soapwort, Corn-Cockle, and the Caryophylleæ in general.

Class IX. LILIACEÆ.—Flowers with the corolla generally polypetalous, composed of six or only three petals, sometimes monopetalous, with six divisions. The fruit is a trilocular capsule or berry. Examples: the Lily, the Tulip, the Hyacinth, &c.

**** *Corolla polypetalous, irregular.*

Class X. PAPILIONACEÆ, or LEGUMINOSÆ.—Corolla polypetalous, irregular, composed of five petals, an upper one named the Standard, two lateral named the Wings, two lower, sometimes united, forming the Keel. Examples: the Pea, the Kidney-bean, Lucerne, &c. The fruit is always a legume.

Class XI. ANOMALÆ.—This class contains all the herbaceous plants whose corolla is polypetalous, irregular, and not papilionaceous; such as the Violet, Nasturtium, &c.

§ § WITH COMPOUND FLOWERS.

Class XII. FLOSCULOSÆ.—Flowers composed of small, funnel-shaped, regular monopetalous corollas, having their limb divided into five segments. Each of these small flowers is named a floret. Of this kind are Thistles, Artichokes, Knapweeds, &c.

Class XIII. SEMIFLOSCULOSÆ.—Flowers composed of a great number of small, irregular monopetalous corollas, whose limb is thrown to one side, and to which the name of semiflorets has been given. Examples: the Lettuce, the Goatsbeard, the Dandelion, &c.

Class XIV. RADIATÆ.—Flowers composed of florets at the centre, and semiflorets at the circumference; as in the Sunflower, the Daisy, &c.

§ § § APETALOUS PLANTS.

Class XV. APETALÆ.—Plants whose flowers have no true corolla, as the Gramineæ, Barley, Rice, the Oat, Wheat, &c. In some, there is around the sexual organs a simple perianth or calyx, which often remains after the flowering is over, and grows with the fruit, as in Docks.

Class XVI. Apetalæ, entirely destitute of flowers.—Plants which have no sexual organs or floral envelopes properly so called, but which have leaves. Of this kind are the Ferns, such as Polypody, Osmunda, &c.

Class XVII. Apetalæ, without apparent flowers or fruit; as Mushrooms, Mosses, Lichens, &c.

SECOND DIVISION.—TREES.

* *Apetalous.*

Class XVIII. Apetalous Trees or Shrubs, having their flowers destitute of corolla. These trees are either hermaphrodite or monœcious, as the Box, many Coniferæ, &c.; or diœcious, as in the genera *Terebinthus* and *Lentiscus.*

Class XIX. Amentaceæ. Apetalous trees, whose flowers are disposed in catkins. They are monœcious, as the Oak, the Walnut, &c.; or diœcious, as the Willows.

* * *Monopetalous.*

Class XX. Trees with a regular or irregular monopetalous corolla, such as the Lilac, the Elder, the Catalpa, the Arbutus, &c.

* * * *Regular polypetalous.*

Class XXI. Trees or shrubs with *rosaceous* polypetalous corolla; as the Apple-tree, the Pear-tree, the Orange and Cherry trees.

* * * * *Irregular polypetalous.*

Class XXII. Trees or shrubs whose corolla is *papilionaceous*; as in the Acacia, Laburnum, &c.

Such are the twenty-two classes proposed by Tournefort for the arrangement of all known vegetables. Although, at first view, this system may appear simple and easily reducible to practice, it yet in many cases presents difficulties which are not easily overcome. In fact, the form of the corolla is not always so decided as to enable one immediately to determine the class to which it really belongs; for where is the precise point of separation between a hypocrateriform and an infundibuliform corolla, or between the latter and a companulate corolla?

The greatest objection that can be offered to this system is, that it separates the herbaceous from the woody plants. The most natural relations are by this means mistaken, and plants which bear the greatest resemblance to each other are often widely separated, on account of their differing in this respect only.

Each of these classes has been subdivided into a greater or less number of sections or orders, whose characters have been taken from particular modifications which the form of the corolla may undergo, from the consistence, composition and origin of the fruit, the form, arrangement and composition of the leaves, &c.

Lastly, each of these sections contains a greater or less number of genera, to which are referred all the species that were known up to the period at which Tournefort wrote.

KEY TO THE METHOD OF TOURNEFORT.

					Classes.
Herbs with the Flowers	Petalous	Simple	Monopetalous	Regular	1. Campaniform.
					2. Infundibuliform.
				Irregular	3. Personate.
					4. Labiate.
			Polypetalous	Regular	5. Cruciform.
					6. Rosaceous.
					7. Umbelliferous.
					8. Caryophyllous.
					9. Liliaceous.
				Irregular	10. Papilionaceous.
					11. Anomalous.
		Compound			12. Flosculous.
					13. Semiflosculous.
					14. Radiate.
	Apetalous				15. With stamina.
					16. Without flowers.
					17. Without flowers or fruits.
Trees with the Flowers	Apetalous				18. Apetalous-proper.
					19. Amentaceous.
	Petalous		Monopetalous		20. Monopetalous.
			Polypetalous	Regular	21. Rosaceous.
				Irregular	22. Papilionaceous.

OF THE

SEXUAL SYSTEM OF LINNÆUS.

The sexual system of Linnæus is principally founded on the different characters which may be derived from the male organs or stamina, in the same manner as Tournefort's system is founded upon the various forms which the corolla presents. It consists of twenty-four classes.

Linnæus first divides all the known vegetables into two great sections. In the first he places all those which have sexual organs, and consequently distinct flowers. These are the phanerogamous or phænogamous plants. The second section comprehends those in which the sexual organs are not apparent, or in which they are entirely wanting. There are thus two primary sections in the vegetable kingdom :—

1. Phanerogamous Plants.
2. Cryptogamous Plants.

But, as the number of vegetables belonging to the first section is infinitely greater than that belonging to the second, the phanerogamous plants have been divided into twenty-three classes, whereas the cryptogamous form only the twenty-fourth and last class of this system.

Of the phanerogamous plants, some have hermaphrodite flowers, that is, having the two sexes united, while the rest are unisexual.

The first twenty classes of the sexual system contain the phanerogamous plants, with hermaphrodite or monoclinous flowers. In the next three are placed the diclinous plants, or those with unisexual flowers.

3. Phanerogamous monoclinous Plants.

   .... diclinous Plants.

The monoclinous plants have the stamina free and detached from the pistil; or the stamina are united to the pistil.

4. Monoclinous Plants with free stamina.
.... with stamina united to the pistil.

The stamina, when disunited from the pistil, may be free and distinct from each other; or they may be united together.

5. Stamina not united to the pistil, free and distinct.
.... united together.

The free and distinct stamina are equal or unequal to each other.

Those which are free and equal exist in determinate or indeterminate number.

6. Stamina free and equal, in determinate number.
.... in indeterminate number.

It was upon considerations of this kind that Linnæus laid the foundations of his system. Accordingly, it will be seen that it is founded: 1*st*, Upon the number of stamina (the first thirteen classes); 2*dly*, Upon their relative proportion (the fourteenth and fifteenth); 3*dly*, Upon their connexion by means of the filaments (the sixteenth, seventeenth, and eighteenth); 4*thly*, Upon their union by means of the anthers (the nineteenth); 5*thly*, Upon their union with the pistil (the twentieth); 6*thly*, Upon the separation of the sexes (the twenty-first, twenty-second, and twenty-third); 7*thly*, Upon the absence of sexual organs (the twenty-fourth).

We shall now examine the characters of these different classes, each of which has received a particular name.

1. *Stamina in determinate number, and equal to each other.*

Class I. MONANDRIA.—It contains all the plants whose flowers have only a single stamen; for example, *Hippuris vulgaris*, *Blitum*, *Canna indica*, &c.

Class II. Diandria.—Two stamina: the Jasmine, the Lilac, the genus *Veronica*, the Sage, the Rosemary, &c.

Class III. Triandria.—Three stamina: most of the Gramineæ, the genus *Iris*, &c.

Class IV. Tetrandria.—Four stamina: the Madder, the Bedstraw, the Woodruff, the genus *Scabiosa*, &c.

Class V. Pentandria.—Five stamina: the Boragineæ, such as the Borage and Lungwort; the Solaneæ, such as the Bitter-sweet, the Belladonna, the Potato, the Winter-cherry, &c.; the exotic Rubiaceæ, as the genera *Cinchona*, *Psychotria*, &c.; the Umbelliferæ, as the Parsnip, the Hemlock, the Opoponax, the Coriander, &c.

Class VI. Hexandria.—Six stamina. To this class belong most of the Liliaceæ, the Lily, the Tulip, the Hyacinth; many Asparagineæ, as the Asparagus, the Lily of the Valley, &c., and the Rice.

Class VII. Heptandria.—Seven stamina. This is a very small class. It contains the Horse-chestnut, the Saururus, &c.

Class VIII. Octandria.—Eight stamina: the genera *Rumex*, *Polygonum*, and *Erica*.

Class IX. Enneandria.—Nine stamina. To this class are referred the different species of *Laurus* and *Rheum*, *Butomus umbellatus*, &c.

Class X. Decandria.—Ten stamina. In this class we find nearly all the Caryophylleæ, such as the Pink, the genera *Lychnis* and *Silene*, the Rue, *Phytolacca decandra*, &c.

2. *Stamina not strictly determinate as to number.*

Class XI. Dodecandria.—From eleven to twenty stamina. For example, *Asarum europæum*, *Reseda luteola*, *Agrimonia Eupatoria*, *Sempervivum tectorum*, &c.

Class XII. Icosandria.—More than twenty stamina inserted upon the calyx. To this class belong the true Rosaceæ, the Plum, the Almond, the Rose, the Strawberry, &c.; the Myrtle, the Pomegranate, &c.

Class XIII. Polyandria.—From twenty to a hundred stamina, inserted under the ovary. In this class are contained the true Ranunculaceæ, such as *Anemone*, *Clematis*, *Ranunculus*, *Helleborus*, &c.; most of the Papaveraceæ, such as the Common Poppy, Chelidonium, &c.

3. *Relative length of the Stamina.*

Class XIV. Didynamia.—Four stamina, of which two are always smaller and two longer, all inserted upon an irregular monopetalous corolla. This class contains the Labiatæ and Personatæ of Tournefort; such as Thyme, Lavender, the Bugle, Betony, Snapdragon, Foxglove, Scrophularia, Catalpa, &c.

Class XV. Tetradynamia.—Six stamina, of which two are always smaller than the other four: the corolla polypetalous; the fruit a siliqua or silicula. This class corresponds entirely to the Cruciferæ of Tournefort.

4. *Union of the Stamina by their filaments.*

Class XVI. Monadelphia.—Stamina in variable number, united into a single body by their filaments; as in the Mallow and Marsh-mallow.

Class XVII. Diadelphia.—Stamina varying in number, united by their filaments into two distinct bodies. Of this kind are the Fumitory, the Milkwort, and most of the Leguminosæ, as the Acacia, Laburnum, Liquorice, Melilot, &c.

Class XVIII. Polyadelphia.—Stamina united by their filaments into three or more bundles. For example, the genera *Hypericum*, *Cistus*, *Melaleuca*, &c.

5. *Union of the Stamina by the anthers.*

Class XIX. Syngenesia.—Five stamina united by the anthers: flowers generally compound, rarely simple. This class contains the Flosculosæ, Semiflosculosæ, and Radiatæ of Tournefort. It also contains certain other plants, such as the genera *Lobelia*, *Viola*, &c.

6. *Union of the Pistil and Stamina.*

Class XX. Gynandria.—Stamina united into one body with the pistil. To this class belong all the Orchideæ, the genus *Aristolochia*, &c.

7. *Flowers unisexual.*

Class XXI. Monœcia.—Male flowers and female flowers distinct, but both occurring on the same individual. For example, the Oak, the Box, the Maize, the Arrow-head, the Castor-oil plant, &c.

Class XXII. Diœcia.—Male flowers and female flowers existing on two separate individuals of the same species; as in *Mercurialis*, the Date-palm, the Misselto, Willows, the Pistacia, &c.

Class XXIII. Polygamia.—Hermaphrodite flowers, male flowers and female flowers occurring together on the same individual, or on different plants. For example, the Ash, the Pellitory, the Crosswort, &c.

8. *Flowers invisible.*

Class XXIV. Cryptogamia.—Plants whose flowers are invisible, or very indistinct. This class contains the Ferns, such as the Polypody, Osmunda, &c.; Mosses, Lichens, Equiseta, Algæ, Fungi, &c.

We have now given a brief account of the characters of each of the twenty-four classes established by Linnæus in the vegetable kingdom. It will be seen that the arrangement of this system is simple, and easily understood. In fact, one might at first think that he had nothing more to do than to count the number of stamina in a flower, to know the class to which it belongs. We have to observe, however, that, in many cases, this determination is not so easy as might at first be supposed, and that one is very often left in doubt, especially when the plant presents some unusual anomaly.

Let us now make known the considerations upon which the orders belonging to each class have been established.

In the first thirteen classes, the characters of which are taken from the number of the stamina, those of the orders have been obtained from the number of styles or distinct stigmas. Thus a plant belonging to the class Pentandria, such as the Parsnip or any other Umbelliferous plant which may have two styles or two distinct stigmas, is referred to the second order. Should it have three, it will belong to the third order, &c. These orders are designated as follows:—

Order 1. *Monogynia*, one style.
Order 2. *Digynia*, two styles.
Order 3. *Trigynia*, three styles.
Order 4. *Tetragynia*, four styles.
Order 5. *Pentagynia*, five styles.
Order 6. *Hexagynia*, six styles.
Order 7. *Heptagynia*, seven styles.
Order 8. *Decagynia*, ten styles.
Order 9. *Polygynia*, numerous styles.

It is to be remarked, that there are classes in which this entire series of orders does not occur. In *Monandria*, for example, there are only two orders: *Monogynia*, to which belongs the genus *Hippuris;* and *Digynia*, which contains the genus *Blitum*.

In *Tetrandria*, there are three orders, namely, *Monogynia*, *Digynia*, and *Tetragynia*. There are six in *Pentandria*, and in the classes following a variable number.

In the fourteenth class, *Didynamia*, Linnæus has founded the characters of the two orders into which he divides it, upon the structure of the ovary. The fruit is sometimes formed of four small akenia, situated at the bottom of the calyx, and which he considered as four naked seeds. Sometimes, on the other hand, it is a capsule, which contains a variable number of seeds. The first order bears the name of *Gymnospermia* (naked seeds), and contains all the true Labiatæ, such as the genera *Marrubium*, *Phlomis*, *Nepeta*, *Scutellaria*, &c. The second order, which is named *Angiospermia* (enclosed seeds), and of which a capsular fruit is characteristic, contains all the Personatæ of Tournefort, such as the genera *Rhinanthus*, *Linaria*, *Melampyrum*, *Orobanche*, &c.

Tetradynamia, the fifteenth class, has also two orders, derived from the form of the fruit, which is a siliqua or a silicula. Accordingly, we have first *Tetradynamia Siliculosa*, containing the plants of which the fruit is a silicula, such as the genera *Isatis*, *Cochlearia*, *Thlaspi*, &c.; and, secondly, *Tetradynamia Siliquosa*, containing those of which the fruit is a siliqua; as the Wallflower, Cabbage, the Water-cress, &c.

The sixteenth, seventeenth, and eighteenth classes *Monadelphia*, *Diadelphia*, and *Polyadelphia*, have been established on the union of the staminal filaments into one, two, or more distinct bundles, without regard to the number of stamina of which these bundles consist. Linnæus has, in this case, employed the characters derived from the number of the stamina to form the orders of these three classes. Thus the plants which belong to *Monadelphia*, are said to be triandrous, tetrandrous, pentandrous, or polyandrous, according as they contain three, four, five, ten, or a greater number of stamina united by their filaments into a single body. In *Diadelphia* and *Polyadelphia*, the same method is followed, the orders having the names of the first classes of the system.

Syngenesia, the nineteenth class of the sexual system is one of the most extensive. In fact, the Synantherceæ or Syngenesian plants form about the twelfth part of all the known vegetables. It was therefore necessary to divide this class into several orders, to facilitate the investigation of its different species. Linnæus, accordingly, instituted six orders. But here the number of the stamina could not be employed as the basis of these subdivisions, it being almost invariably five; for which reason he derived the characters of the orders from the structure of the little flowers which constitute the assemblages known by the name of compound flowers. In fact, in consequence of constant abortions, there occur along with the hermaphrodite flowers, male flowers, female flowers, and even sometimes perfectly neutral flowers. Linnæus, whose poetical fancy is observable in all the names which he imposed upon the different classes and orders of his system, looked upon these associations and mixtures of flowers as a kind of *Polygamy*. This name he accordingly gave to each of the six orders of Syngenesia, adding to it a distinctive epithet. The following are their characters:

Order 1. *Polygamia æqualis.* All the flowers are hermaphrodite, and in consequence are all equally fertile; as in Thistles and Goatsbeards.

Order 2. *Polygamia superflua.* The flowers of the disk are hermaphrodite, those of the circumference female; but both kinds furnish perfect seeds; for example, Wormwood and Tansy.

Order 3. *Polygamia frustranea.* The flowers of the disk are hermaphrodite and fertile, those of the circumference neutral or female, but sterile in consequence of their stigma, and therefore entirely useless; whereas in the preceding order they were only superfluous: for example, the Knapweeds and Sunflowers.

Order 4. *Polygamia necessaria.* The flowers of the disk are hermaphrodite, but sterile, in consequence of an imperfect formation of the stigma; those of the circumference are female, and fecundated by the pollen of the former. In this case, they are therefore necessary for the preservation of the species: the Marigold is an example.

Order 5. *Polygamia segregata.* All the flowers are hermaphrodite, and placed close together, but are separately contained each in a small involucre of its own; as in the genus *Echinops.*

Order 6. *Polygamia monogamia.* The flowers are all hermaphrodite, but they are simple, and are separated from each other; as in the Violet, Lobelia, Balsamine, &c.

The last order, as may easily be seen, has no affinity to the rest, possessing nothing in common with them but the union of the stamina by their anthers.

In *Gynandria*, the twenty-first class of the sexual system, there are four orders which are derived from the number of the stamina. Thus we have *Gynandria Monandria*, as in the genera *Orchis* and *Ophrys; Gynandria Diandria*, as in *Cypripedium ; Gynandria Hexandria*, as in *Aristolochia ; Gynandria Polyandria*, as in *Arum.*

Monœcia and *Diœcia* present in some measure a union of all the modifications which we have remarked in the other classes. Thus *Monœcia* contains monandrous, triandrous, decandrous, polyandrous, monadelphous, and gynandrous plants. Each of these varieties is used for the establishment of a distinct order in this class.

Diœcia contains a still greater number of varieties, the characters of which being the same as those of some of the classes previously established, are employed as designative of the orders.

The twenty-third class, *Polygamia*, which contains plants with hermaphrodite flowers and unisexual flowers intermingled, whether on the same individual, or on two or three distinct individuals, has, in accordance with these circumstances, been divided into three orders.

1. *Monœcia*, in which the same individual bears monoclinous flowers and diclinous flowers; 2. *Diœcia*, in which there are hermaphrodite flowers on one individual and unisexual flowers on the other; 3. *Triœcia*, in which the species is composed of three individuals, one bearing hermaphrodite flowers, another male flowers, and the third female flowers.

Cryptogamia, the twenty-fourth and last class, is divided into four orders: 1. Ferns; 2. Mosses; 3. Algæ; 4. Fungi.

We have now stated the principles of the sexual system, and presented a sketch of its twenty-four classes and numerous orders, such as they were established by Linnæus. In examining this system, one is struck by its extreme simplicity, and the ease with which the name of a plant may be discovered by means of it. The classes, in fact, are, for the most part, precisely limited and defined, especially those which have the stamina in determinate number. Not only does this system contain all the plants already known, but it is also capable of comprehending all that may yet be discovered. In consequence of its possessing these advantages, it was generally adopted at the period of its first publication.

But it must be admitted, that it labours under more than one serious disadvantage. It is not always easy to determine the precise class to which a plant ought to be referred. Thus the Rue *(Ruta graveolens)* has almost all its flowers furnished with eight stamina, there being only a single flower in the centre of each of its groups that presents ten. The beginner, in this case, would experience some embarrassment, and might be induced to place the plant in question in the eighth class of the system, *Octandria*, although Linnæus referred it to *Decandria*, as he considered the flower with ten stamina as the most perfect.

Dodecandria, in like manner, is not very strictly characterized. It contains all the plants which have from twelve to twenty stamina; but the Agrimony, which is referred to it, has often more than twenty.

Certain Labiatæ or Personatæ which belong to *Didynamia*, have their four stamina of equal length, and the irregularity of the corolla is, in many cases, hardly perceptible.

It is extremely difficult to determine with certainty the orders to which many plants belonging to *Syngenesia* should be referred. Besides, the intermixture of male flowers, female flowers, and hermaphrodite flowers, throws several of them into *Diœcia* and *Polygamia*. The sixth of these orders *Polygamia Monogamia*, contains plants which have no affinity to the Compositæ, such as the genera *Viola*, *Lobelia*, *Impatiens*, &c.

Polygamia, the twenty-third class, is a confused mixture of plants which almost all belong to some of the other classes.

If we now examine the plants brought together under each of these classes, we find that very frequently the natural affinities that have long been established are entirely disregarded. Thus one of the most natural families, the Gramineæ, is scattered through the classes *Monandria*, *Diandria*, *Triandria*, *Hexandria*, *Monœcia*, *Diœcia*, and *Polygamia*. The Labiatæ are partly placed in *Diandria*, partly in *Didynamia*. It is the same with many other families equally natural. But as the classification proposed by Linnæus is a *system*, that is, a methodical, but purely artificial arrangement, intended solely for facilitating the discovery of the name of a plant which one may be desirous of knowing, it would not be just to blame it for having thus separated plants which bear a great resemblance and affinity to each other. But the Linnæan system is not the one which is to be studied when the object is to obtain a knowledge of the mutual relations of plants, although, of all the artificial systems, it is unquestionably that which enables one to find the name of a plant with most ease.

Desirous of removing from this ingenious system some of the inconveniences which we have pointed out, and of rendering its application more easy in certain points, my deceased father made some important changes in it, which we now proceed to state. It was according to the modified system of Linnæus that the plants were arranged in the Garden of the Medical Faculty of Paris.

SEXUAL SYSTEM MODIFIED.

The first ten classes are retained unchanged.

The eleventh class is POLYANDRIA, thus characterized: More than ten stamina inserted beneath the simple or multiple pistil, that is, having a hypogynous insertion. This class, which is substituted for Dodecandria, corresponds entirely with Polyandria of Linnæus.

The twelfth class is CALYCANDRIA, which is thus characterized: More than ten stamina inserted into the calyx, the ovary being free or parietal; insertion perigynous. This class corresponds partly with Dodecandria, and partly with Icosandria. All the true Rosaceæ belong to it.

The thirteenth class is HYSTERANDRIA. It is characterized by more than ten stamina inserted upon the ovary, which is inferior, the insertion being thus epigynous. This class corresponds with part of Icosandria. It contains the genera *Myrtus*, *Punica*, *Philadelphus*, *Psydium*, &c.

These three classes, thus characterized, are much more precise, and at the same time preserve the natural relations better than those originally proposed by Linnæus, the characters of which, being derived from the number of stamina, were in many instances calculated to lead the beginner into error.

The fourteenth class is DIDYNAMIA, of which the orders named by Linnæus Gymnospermia (naked seeds), and Angiospermia (enveloped seeds), afforded an erroneous idea, there being no naked seeds in existence. They have been substituted by the following:

1. *Tomogynia*, (ovary split and divided).—Ovary deeply divided into distinct lobes; style arising from a central depression of the ovary; the ripe fruit *tetrakenious*. This order contains all the Labiatæ.

2. *Atomogynia* (ovary undivided).—Fruit capsular, polyspermous. To this order belong the Antirrhineæ, Bignoniaceæ, &c.

The nineteenth class SYNANTHERIA, substituted for Syngenesia, is thus characterized: Stamina united by the anthers only, so as to form a kind of small tube; ovary monospermous. From the above character, it will be seen that the class Synantheria can contain none but the true compound flowers, that is, the Flosculosæ, Semiflosculosæ, and Radiatæ of Tournefort.

The orders of the Linnæan Syngenesia, being derived from characters which are too minute, very difficultly distinguishable, and subject to variation in the same genus, have been changed into the following, which are very easily distinguishable:

Order 1. *Carduaceæ:* capitulum composed of florets which are indifferently hermaphrodite, male or female; phoranthium furnished with very numerous bristles, style having a slight enlargement beneath the stigma; connective sometimes continued above the anthers to form a five-toothed tube. To this order belong the Thistles, Knapweeds, &c.

Order 2. *Corymbiferæ:* capitulum floscular or radiate; phoranthium naked or furnished with chaffs, each of which accompanies a flower. (In the first order there were several at the base of each flower). To this order are referred the genera *Tussilago*, *Gnaphalium*, *Erigeron*, &c.

Order 3. *Cichoraceæ:* capitulum composed of semiflorets; as in *Lactuca*, *Cichorium*, *Scorzonera*, &c.

The twentieth class, SYMPHYSANDRIA, is formed of the sixth order of the Linnean Syngenesia, viz. Polygamia Monogamia. Its characters are: Stamina united by their anthers, sometimes by their filaments also, a polyspermous ovary, simple flowers. Examples, the Lobeliaceæ, and the genus *Viola*.

Gynandria, Monœcia, and Diœcia, are retained without change.

The twenty-fourth class, ANOMALŒCIA: hermaphrodite flowers or unisexual flowers on the same individual or on different individuals. This class corresponds to Polygamia of Linnæus.

The twenty-fifth class, AGAMIA, contains vegetables destitute of sexual organs, and reproducing by means of corpuscules of a peculiar nature, analogous to the bulbils of certain plants, and which are named *Sporules*.

Such are the changes which my father thought it expedient to make on the sexual system of Linnæus, with the view of diminishing, as much as possible, the difficulties that might occur in making use of it.

KEY TO THE SEXUAL SYSTEM OF LINNÆUS.

							CLASSES.
PLANTS with	Distinct sexual organs	Hermaphrodite flowers	Stamina distinct from the pistil	Free	Indeterminate proportion	Number . .	1. MONANDRIA. 2. DIANDRIA. 3. TRIANDRIA. 4. TETRANDRIA. 5. PENTANDRIA. 6. HEXANDRIA. 7. HEPTANDRIA. 8. OCTANDRIA. 9. ENNEANDRIA. 10. DECANDRIA. 11. DODECANDRIA.
						Number and insertion	12. ICOSANDRIA. 13. POLYANDRIA.
					Determinate proportion . . .		14. DIDYNAMIA. 15. TETRADYNAMIA.
							16. MONADELPHIA. 17. DIADELPHIA. 18. POLYADELPHIA.
				United			19. SYNGENESIA.
			Stamina united to the pistil				20. GYNANDRIA.
		Unisexual flowers					21. MONŒCIA. 22. DIŒCIA. 23. POLYGAMIA.
	Concealed sexual organs						24. CRYPTOGAMIA.

KEY TO THE SEXUAL SYSTEM, AS MODIFIED BY THE ELDER RICHARD.

								CLASSES.
PLANTS	With sexual organs	Flowers all hermaphrodite	Stamina separated from the pistil	Stamina free	Proportion indeterminate	Number of stamina, without regard to the insertion	One	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.
						Number of stamina, the insertion also considered	More than ten inserted under the ovary	11. POLYANDRIA.
							More than ten inserted upon the calyx, the ovary being free	12. CALYCANDRIA.
							More than ten inserted upon the calyx, the ovary being incorporated with the tube of the calyx	13. HYSTERANDRIA.
					Proportion determinate	Two large and two small		14. DIDYNAMIA.
						Four large and two small		15. TETRADYNAMIA.
				Stamina united	By the filaments	Into a single body		16. MONADELPHIA.
						Into two bodies		17. DIADELPHIA.
						Into more than two bodies		18. POLYADELPHIA.
					By the anthers, the ovary being monospermous			19. SYNANTHERIA.
					By the anthers alone, or by the filaments also, the ovary being polyspermous			20. SYMPHYSANDRIA.
			Stamina united to the pistil					21. GYNANDRIA.
		Flowers not all hermaphrodite	Unisexual flowers	Male flowers and female flowers on the same individual				22. MONŒCIA.
				Male flowers and female flowers on different individuals				23. DIŒCIA.
			Hermaphrodite flowers and unisexual flowers on the same, or on different individuals					24. ANOMALŒCIA.
	Without sexual organs							25. AGAMIA.

METHOD OF M. DE JUSSIEU,

OR OF NATURAL FAMILIES.

The method of Natural Families differs essentially in its course and characters from the systems of Tournefort and Linnæus, which we have already explained. In it the divisions are not founded upon the consideration of a single organ, but are derived from characters presented by all the parts of plants. Accordingly, the plants which are thus brought together are disposed in such a manner that they have a greater affinity to that which immediately precedes or follows them than to any other.

This classification is therefore much superior to all those which preceded it, on account of the general and philosophical ideas which it affords us respecting the productions of the vegetable kingdom. In fact, it does not consider objects separately, but collects and arranges them into groups or families, according to the greatest number of common characters which they possess.

Nature, in impressing upon the physiognomy of certain plants a peculiar character bearing relation to their internal organization, seems to have been desirous, as it were, of aiding the botanist in seeking out the affinities which exist among all vegetable productions. In fact, there are many plants which bear so great a resemblance to each other in the structure and conformation of their parts, that this similarity has at all times been perceived, and these different plants have been considered as in some measure belonging to the same family. Thus the Gramineæ, Labiatæ, Cruciferæ, and Synanthereæ, have always been kept together whenever the characters of affinity and mutual resemblance have not been sacrificed to the principles of an artificial system.

Accordingly, when botanists began to bring together plants into families, that is, into groups or series of genera, resembling each other in the greater number of characters, they had only to imitate nature, which had, as it were, created types of essentially natural families, as if to serve as models. Thus the Leguminosæ, Cruciferæ, Gramineæ, Umbelliferæ, Labiatæ, &c. stood forth to the view as so many examples which were to be imitated.

But as all plants have not, like those just named, external characters so precise or so decided as at once to disclose their resemblance to certain others, recourse was had to analysis, and it became necessary to search in all their organs for modifications which might furnish characters.

It is in the *Genera Plantarum* of Jussieu, the real inventor of the method of natural families, that the principles of this method must be studied, it being impossible, in so brief a view of it as that to which we must here confine ourselves, to enable the reader to enter into its true spirit. We shall merely endeavour to explain the manner in which the characters have been viewed by that author, and expose the principles on which the admirable classification in question has been founded.

The characters have to be considered with reference to their value, their number, and their affinity.

With respect to their value, it will easily be conceived that the characters derived from the most essential organs of plants must be less liable to variation, and more important than those derived from other organs. Now, we know that those organs which conduce to reproduction, perform the most important part in vegetable life, and that, among them, the embryo, which is in a manner the common end towards which all the organs of the plant direct themselves, is that which occupies the first rank in importance. The embryo, therefore, has supplied our author with his primary divisions. The stamina and the pistil occupy the second rank, and afford more constant and more valuable characters than the floral envelopes. These characters are the more fixed and important, that they are derived, not from the number and structure of these organs, which are very subject to variation, but from their relative position, which is fixed. Thus, next to the embryo, the relative position of the sexual organs, or their *insertion*, affords the best characters for the arrangement of plants. Lastly, the stems, the leaves, and the roots, can never be employed otherwise than as accessory characters.

With respect to their number, the characters are associated, grouped, and arranged; and, from the aggregation of simple characters, result general characters, which serve to unite a certain number of plants under a common denomination.

Some characters are mutually connected, and seem inseparable from each other. Those which are derived from the flower and fruit are chiefly of this kind. Thus for example, the inferior ovary always implies a monosepalous calyx and an epigynous insertion. A monopetalous corolla almost always indicates that the stamina are inserted upon it, and that they have a determinate number.

From the value and importance which the different characters possess, it is easy to see that those least liable to vary ought to have been employed for the fundamental divisions of the vegetable kingdom. Thus the embryo has furnished the first three great divisions in plants. The stamina and the floral envelopes have afterwards been employed for subdividing the first three sections, which were established upon the embryo.

Let us now endeavour to disclose the manner in which plants have been associated so as to form families or natural groups; and let us begin with explaining what is meant by the words *species*, *variety*, *genus*, *order*, and *family*.

The plants that occur scattered over the surface of the globe constitute the individuals of the vegetable kingdom. When we examine them with attention, we soon perceive that in the general mass there are numerous individuals, which always present themselves to our view under the same appearance, possess the same external and internal characters, and are always reproduced under the same form. To all these perfectly similar individuals, considered generally and abstractly, the name of *species* is given. The species, then, is the aggregate of individuals which are always reproduced in the same manner. A seed produced by any given species always gives rise to an individual perfectly similar to that from which it originated. The characters on which the distinction of the different species from each other is founded, are generally derived from the organs of vegetation, that is, from the leaves, the stem, and the roots. The species which present some differences with respect to the colour of their flowers, the place in which they grow, and their relative height, constitute *varieties*, which are distinguished from species properly so called, by the circumstance of their not being, in the natural state, reproduced from seeds with all their characters*. Thus, for example, the Lilac usually has the flowers of a delicate purple tint; but its flowers are sometimes white, although none of the other characters have been altered. The white Lilac, then, is merely a variety of the purple Lilac. In fact, if seeds taken from the white-flowered Lilac are sown, they give rise to individuals whose flowers are indifferently purple or white; which proves that varieties are not always preserved by means of seed.

The *genus* consists of a greater or less number of species, united by common characters derived from the organs of fructification, but all distinguished from each other by

* We have been careful in saying *in the natural state*, for in *cultivated* plants many varieties are propagated by the seed.

specific characters, peculiar to each of them, and furnished by the organs of vegetation. Thus, the genus *Anagallis* has for its characters a rotate monopetalous corolla, five stamina, and a *pyxidium* for its fruit, that is, a globular capsule opening in a circular manner by a kind of lid. All the species of this genus must possess these different characters; but they are distinguished from each other by the form of their stem and leaves, &c. The other genera are similarly constituted.

If we bring together the genera in the same manner as the species; in other words, if we place near each other all those which have common and similar characters, we form *orders* properly so called, if regard is had only to a single character, such as the number of the stigmas, the form of the fruit, &c.; and *natural families* or *orders*, if we include all the considerations that relate to the form, the structure, and the relative disposition of all the organs of the plants which we are arranging.

By a natural order or family of plants must therefore be meant a series or assemblage of genera, which all present the same characters in the organs of fructification.

Thus the family of Cruciferæ is characterized by a dicotyledonous embryo, a siliquose or siliculose fruit, usually four petals opposed to each other in pairs, stamina in determinate number, &c. All the genera of that family must present the same characters, but only with some slight modifications, which do not alter the primitive type, but afford distinctive characters for the genera which collectively constitute the family in question.

By following a course like this, botanists have brought together the various species of plants, so as to form them into groups or natural families. But, as these families are numerous, it was necessary to distribute them into classes, in which regard should be had to the same resemblance and affinity. It is to this classification of the families that the name of *Jussieu's Method*, or the Method of Natural Families, has been given. We now proceed to inquire what characters that celebrated author employed in forming these different classes.

This method has been divided into fifteen classes. The primary divisions are derived from the characters which may be obtained from the presence or absence of the embryo: whence the *Embryonate* and *Inembryonate* plants.

The Embryonate plants are distinguished according to the number of their cotyledons: 1*st*, Into monocotyledonous; 2*dly*, Into dicotyledonous. All vegetables are arranged under these three primary divisions: *Acotyledones*, *Monocotyledones*, *Dicotyledones*.

The second consideration, or that by which the classes properly so called are established, is founded upon the relative insertion of the stamina or of the staminiferous monopetalous corolla. Now, we have seen that there are three kinds of insertion:

1. The *hypogynous insertion*, or that in which the ovary being entirely free, the stamina or the staminiferous corolla are inserted close around its base.

2. The *perigynous insertion*, or that in which the ovary being free or parietal, the stamina or the staminiferous monopetalous corolla are inserted into the calyx at a certain distance from the circumference of the base of the ovary.

3. The *epigynous insertion*, or that in which the ovary is always inferior, and in which the stamina or the stamini ferous corolla are inserted upon the upper part of the ovary.

These three kinds of insertion serve to establish an equal number of classes.

The Acotyledones being destitute of embryos, and consequently of flowers and fruits, could not be brought under this division, but constitute the first class.

The Monocotyledones, possessing these three modes of insertion, have been divided into three classes: 1. Monocotyledones with hypogynous stamina; 2. Monocotyledones with perigynous stamina; 3. Monocotyledones with epigynous stamina.

The Acotyledones and Monocotyledones therefore form four classes, thus:

Acotyledones, ...		Class I.
Monocotyledones,	stamina hypogynous, .	Class II.
	stamina perigynous, .	Class III.
	stamina epigynous, .	Class IV.

The Dicotyledones being much more numerous than the Acotyledones and Monocotyledones together, it was necessary to increase the number of their divisions. Here, the insertion, although still attended to, becomes a secondary character. Thus, it has been observed, that these plants are destitute of a corolla or are apetalous, or that they have a staminiferous monopetalous corolla, or that their corolla is polypetalous. These distinctions have given rise to the three first divisions that have been established among the Dicotyledones, namely:

1. Apetalous Dicotyledones;
2. Monopetalous Dicotyledones;
3. Polypetalous Dicotyledones.

The insertion has been employed as a secondary character for subdividing these three sections into classes. Thus the Apetalæ form three classes, in which the insertion is epigynous, perigynous, and hypogynous.

The Monopetalæ, of which the corolla always bears the stamina, in like manner form three classes, according as their staminiferous corolla is hypogynous, perigynous, or epigynous. The last or epigynous class of the Monopetalæ has been further subdivided, according as the stamina are free or connected by their anthers, which carries the number of classes in the Monopetalous corollas to four, namely:

Monopetalæ	stamina hypogynous, ...		Class I.
	stamina perigynous, ...		Class II.
	stamina epigynous	anthers united,	Class III.
		anthers free,	Class IV.

These four classes, together with the three classes of the Apetalous Dicotyledones, and the four classes of the Monocotyledones and Acotyledones, form eleven.

The Polypetalæ have, in like manner, been divided into three classes, according to their mode of insertion, which is epigynous, perigynous, or hypogynous.

Lastly, in the fifteenth and last class, are placed all the dicotyledonous plants, whose flowers are essentially unisexual, and separated upon distinct individuals. They have been named irregular diclinous plants.

Such are the fifteen classes which M. Jussieu established in the vegetable kingdom, for the purpose of methodically arranging the different families of plants, which he had previously formed.

Each of these classes contains a greater or less number of natural families, all connected by the common character which constitutes the class. The number of these families is not definitively settled, and indeed cannot be so, as new discoveries, and more accurate observations, by making known new objects, or demonstrating the differences which exist between plants previously associated and confounded, continually augment the number of families. When M. de Jussieu published his *Genera Plantarum* *, in 1789, he described 100 families. We have now upwards of 160, the characters of which we shall presently give, and the number is still capable of being increased. M. de Candolle has also published a series of families arranged in an order of

* M. de Jussieu was censured for not giving a proper name to each of his fifteen classes, as Linnæus did in his system. That celebrated botanist was too sensible of the justice of this observation not to attend to it. He therefore gave a particular name to each of his classes. These names we take from a note with which he had the goodness to furnish us, and they will be found at the head of the different classes in the following list. The only change that we have made consists in having given them a substantive termination. Thus instead of *Monohypogynous, Peristaminous*, &c. we say *Monohypogynia, Peristaminia*, &c.

his own, which is nearly the reverse of that adopted by M. de Jussieu.

Without at all feeling disposed to offer an opinion as to the superiority of either mode, we shall here explain that of Jussieu, as being the most generally adopted, and as being, moreover, conformed to the classes which we have just pointed out.

KEY TO THE METHOD OF NATURAL FAMILIES OF M. A. L. DE JUSSIEU.

					CLASSES.
ACOTYLEDONES,					1. ACOTYLEDONIA.
MONOCOTYLEDONES,		Stamina hypogynous			2. MONOHYPOGYNIA.
		.... perigynous			3. MONOPERIGYNIA.
		.... epigynous			4. MONOËPIGYNIA.
DICOTYLEDONES,	Apetalous APETALIA	Stamina epigynous			5. EPISTAMINIA.
		.... perigynous			6. PERISTAMINIA.
		.... hypogynous			7. HYPOSTAMINIA.
	Monopetalous MONOPETALIA,	Corolla hypogynous			8. HYPOCOROLLIA.
		.... perigynous			9. PERICOROLLIA.
		.... epigynous	EPICOROLLA,	Anthers united	10. SYNANTHERIA.
				.... distinct	11. CORISANTHERIA.
	Polypetalous POLYPETALIA,	Stamina epigynous			12. EPIPETALIA.
		.... hypogynous			13. HYPOPETALIA.
		.... perigynous			14. PERIPETALIA.
	Irregular Diclinous				15. DICLINIA.

A TABLE

OF THE

FAMILIES OF THE VEGETABLE KINGDOM,

ARRANGED ACCORDING TO THE METHOD OF
ANTOINE LAURENT DE JUSSIEU.

FIRST DIVISION.

INEMBRYONATE PLANTS. *

This first division of the vegetable kingdom corresponds to the class Cryptogamia of Linnæus. It contains all the plants which, being destitute of true organs of generation, in other words, of stamina and pistils, have received the name of Agamous Plants, and are reproduced by means of corpuscules, in their structure and development resembling the bulbils which are observed on certain phanerogamous plants. Linnæus called these plants cryptogamous, because he imagined their fecundation to be effected by means of organs which were little known. M. De Candolle, observing that only a single anatomical element, the cellular tissue, enters into their composition, names them *Cellular* plants, in opposition to the name *Vascular* plants, which he gives to the phanerogamous species. We think they ought to retain the name of *Agamous* plants which Necker gave them, because, as we shall presently shew, they are really

* We shall here present some general considerations respecting the organization of the inembryonate plants, as they possess peculiarities which we had no opportunity of describing in the preceding part of the work.

destitute of organs of generation, or, at least, their organs of reproduction have a structure entirely different from that of the same parts in phanerogamous plants. Thus, we comprehend under the name of *Agamous Plants* all the acotyledonous plants of Jussieu, that is to say, all those which were referred by Linnæus to Cryptogamia, the last class of his system.

Several authors have divided them into two classes: Cryptogamous Plants, and Agamous Plants properly so called. To the former they refer the Salvineæ, Equisetaceæ, Musci, Hepaticæ, Lycopodiaceæ, and Filices, which they consider as provided with sexual organs, although very small and not readily perceptible. To the second class belong the plants which they consider as truly agamous, such as the Algæ, Lichens, and Fungi, in which is distinguished nothing that can be compared to stamina or pistils. But we do not admit this distinction. The organization of all these plants is so obviously different from that of the phanerogamous plants, that they cannot possess the same organs. We therefore agree with Necker in considering the plants designated by the name of *cryptogamous* as entirely destitute of sexual organs, and are of opinion that nothing in them can reasonably be compared to these parts as they exist in phanerogamous plants.

In the course of this work, we have more than once shewn the great difference that exists between all the parts of these plants and those of phanerogamous plants. We have shewn that the corpuscles which authors have considered as seeds, are not such in reality, as they are destitute of an embryo. Yet they give rise to plants perfectly similar to those from which they have separated. But, as we have already several times said, the bulbils of certain perennial plants, and a great number of buds, produce the same phenomenon, although they cannot on that account be compared to true seeds. Besides, how is this alleged germination of the agamous plants effected? Can it be compared to that of plants which are furnished with an embryo? A reproductive corpuscle of a Fern or a Mushroom, if placed on the ground, will be developed there; but it will not be, as in the embryo of a phanerogamous plant, parts already formed, only reduced as it were to their rudimentary state, that will successively acquire a greater development; but, on the contrary, parts entirely new will be produced. It is not a growth of organs already existing; but the tissue of the *sporule* or reproductive corpuscle, becomes elongated on the one hand to sink into the ground and form a root, when the vegetable is to have one, and on the other hand stretches up in the opposite direction to form a stem. In whatever position a sporule may be placed, the part in contact with the earth always elongates to form the root, and the opposite part becomes the stem. These two organs, therefore, do not exist previous to this development, but are produced by the influence of certain circumstances, which appear as if fortuitous and foreign to the very nature of the body which produces them.

If we now examine the parts which have been looked upon as the flowers by various authors, we shall find that their opinions respecting them are very discordant; some considering as male flowers what others describe as female flowers. Thus, in the Mosses, Linnæus considers the theca as a male flower, Hedwig as a female flower, and Palisot de Beauvois as a hermaphrodite flower.

Whenever these plants, as, for example, the Mosses, present two very distinct kinds of particular organs, which have been considered as those of fructification, authors could only have been embarrassed in selecting this or that for the function which they had to attribute to it. But, in the Jungermanniæ, where there are sometimes three or four kinds of fructifications differing from each other in their external form, as there are only two kinds of sexual organs, the male and the female, it would be necessary here to admit four. For, if the name of sexual organs has been given to two of these parts, why should it be denied to the other two, whose internal structure is the same, but which differ only in their external forms or in their disposition?

In the Ferns, on the contrary, in which there is evidently but a single species of fructification entirely formed of small grains, commonly enclosed in little membranous bags, and which have been considered as seminules or seedlets, where are the stamina? Where the stigma which has received the influence of the pollen? Where the pistil which has transmitted it to the ovules? Does it afford a satisfactory answer to these questions to say, as Micheli and Hedwig have done, that the hairs which are observed on the young leaves are the stamina; or, as Hill and Schmidel have asserted, that the male flowers are the rings which surround the receptacles in which the seminules are contained?

It must be admitted that opinions so discordant, and even contradictory, lead to an inference which appears to us inevitable, and which is, that the alleged flowers of agamous plants, sometimes considered as containing stamina, and sometimes as containing pistils, are not in reality flowers, but peculiar organs, constituting a kind of buds, to which nature has intrusted the reproduction of these singular plants. Why, in fact, should we wish to confine the power of nature within the narrow limits of our conceptions? Her means are as varied as her power is great; and if she has bestowed upon the agamous plants an aspect so different from that of the phanerogamous, and given them external organs which often bear no resemblance to those of the latter, why might she not also have accorded them a peculiar mode of reproduction, having nothing similar to that of phanerogamous plants but the effects which it produces, in other words, the formation of the organs by which the species is to be perpetuated?

FIRST CLASS.—ACOTYLEDONIA.

* Family I.—Hydrophyta.

Algæ *of authors.* *Part of the* Algæ, *Juss.*

In this family is seen the commencement of vegetable organization, the plants of which it is composed being the most simple with which we are acquainted. Some of them appear at first in the form of small globules or vesicles, separate or collected into groups, and which, by uniting end to end, or becoming variously aggregated, form filaments or tubes, which are simple or branched, continuous or articulate, plates of various forms, or reticulated structures. The Hydrophytes are all those plants which vegetate in fresh or salt water, and in inundated places. Their tissue appears in general to be homogeneous, to consist of cells of various forms, and, according to Lamouroux and Bory de St Vincent, of some vessels constituting longitudinal fibres. Their organs of fructification are dehiscent or indehiscent sporangia, containing very small sporules. These organs are variously grouped, and are placed in the interior of the tissue, seldom at its exterior, under the form of tubercles. Those of the tubular hydrophytes are sometimes collected into globules, sometimes disposed in spiral lines. The hydrophytes present all the shades of green or purple.

This family contains the plants generally known by the name of *Algæ,* marine plants, or sea-weeds. It is divided into two great tribes, which several authors have again subdivided, according as they grow in fresh or in salt water. These two tribes are the *Conferva* and *Thalassiophyta.* These plants have occupied the attention of several modern naturalists, of whom we shall mention Mess. Turner, Lyngbie, Lamouroux, Bonnemaison, Mertens, Agardh, and especially Bory de Saint-Vincent. To the works of these writers we refer those who are desirous of obtaining a more detailed account of the structure and classification of these plants.

The family of Hydrophytes forms the connecting link between the animal and vegetable kingdoms. In fact, the Oscillaria and Conjugata are a kind of mixed beings, which have been in turns referred to animals and to vegetables. The former, from the spontaneous and varied motions which they perform, and the latter from their mode of fecundation and development, seem to possess all the characters of animal life, while, in their structure and form, they are closely allied to the Confervæ, which are destitute of every kind of motion, and certainly belong to the vegetable kingdom. It is therefore impossible to find a very decided line of demarcation between the two kingdoms. It has been said that certain Algæ are alternately and successively animals and vegetables; in other words, that in them there is an actual transmutation of the one kingdom into the other. But recent observations, made by the most accurate naturalists, have proved that this alleged transformation does not take place.

[The Hydrophyta are not of great importance in a medical point of view, a very few species only having been used in the treatment of certain diseases. *Gigartina helminthocorton*, or Corsican Moss, a native of the Mediterranean, has been employed as an anthelmintic. The ashes of some species have been used in the treatment of goitre, their efficacy depending upon the iodine which they contain. Dr Greville, in his excellent *Algæ Britannicæ*, remarks, that the stems of a sea-weed, which he refers to the order Laminarieæ, are sold in the shops, and chewed by the inhabitants of South America, wherever that disease is prevalent. Many species are used for food, in different countries.—Tr.]

* Family II.—Fungi. *Juss.*

Plants extremely variable in their form, consistence, colour, &c. They are fleshy or corky bodies, having sometimes a form which may be compared to that of an umbrella; in other words, composed, 1. Of a pileus, which is generally convex, and is furnished beneath with perpendicular laminæ, tubes, or anastomosing lines; 2. A central or lateral stalk, at the summit of which is perceived a circular membrane (the *annulus*), which extends to the circumference of the pileus. The whole Mushroom is sometimes covered, previous to its development, by a kind of membranous bag, complete or incomplete, which is named the *Volva.* At other times they are globular, ovoidal, or elongated masses, cup-shaped bodies, simple or articulated filaments, coralliform trunks, or bodies irregularly branched in the manner of coral, and of extremely variable colours, sometimes presenting the most lively tints; but their internal tissue, which consists of irregular cells, is never green. The *sporules* or reproductive organs are sometimes naked, sometimes enclosed in a kind of small capsules, named *thecæ.* They are either scattered at the surface of the fungus, or enveloped in a *peridium* or conceptacle, which is fleshy, membranous, or hard and woody.

The Fungi are in general parasitical plants, which grow either on other vegetables still living, or on organic substances in a state of putridity, at the surface or in the interior of the ground. Their growth is sometimes effected with extraordinary rapidity, and their duration is often very fugitive; while others, as *Boletus igniarius, ungulatus,* &c., vegetate slowly, and during several successive years. A very small number of species grow in water.

The Fungi form several natural groups, which some authors consider as distinct families. These groups are the following:

1. Fungi or Mushrooms properly so called: Fleshy, corky, or woody plants, having the sporules placed in capsules which form collectively a membrane *(hymenium)* variously folded, and covering the surface of the fungus in whole or in part. For example: *Agaricus, Boletus, Merulius, Morchella, Clavaria,* &c.

2. The Lycoperdaceæ are formed of a fleshy or membranous peridium, at first closed, but afterwards opening and containing naked sporules, without capsules, and escaping from the peri-

dium or receptacle under the form of powder. Ex.: *Lycoperdon*, *Geastrum*, *Stemonitis*, *Desmodium*, &c.

3. The Hypoxyleæ, which have the appearance of tubercles or conceptacles, of very diversified forms, opening by a fissure or pore, and containing, in a kind of gelatinous pulp, small capsules *(thecæ)* full of sporules. Ex.: *Hysterium*, *Sphæria*, *Erysiphe*, &c.

Note.—From this group must be removed the Lichenoid Hypoxyleæ of De Candolle, which, with the exception of the genus *Hysterium*, belong to the Licheneæ.

4. The Mucedineæ.—Branched filaments crossing each other, and bearing sporules destitute of capsules. For example, all the species of *Mucor*, and the numerous genera into which they have been formed.

5. The Uredineæ.—The sporules are contained in capsules, which are either free, or placed without order upon the surface of a filamentous or pulverulent basis. Ex.: *Uredo*, &c.

The family of Fungi is distinguished from those of the Algæ and Licheneæ by the absence of any kind of frond or crust, bearing the organs of fructification.

[Several species of Fungi are used as food, such as the Common Mushroom *(Agaricus campestris)*, and various kinds of Truffles and Morels. Many kinds, however, are poisonous, and have often been productive of deleterious and even fatal effects. Salt and vinegar are said to destroy the virulence of certain species; but, in all suspected cases, the gratification to be derived from eating a mouthful of mushrooms is hardly a compensation for the risk incurred. *Boletus igniarus* has been employed as a styptic.—Tr.]

Family III.—Licheneæ, *Hoffm.*

Part of the Algæ *of Jussieu, and of the* Hypoxyla *of De Candolle.*

Fronds or *Thalli* extended in the form of membranes or membranous crusts of varied consistence, simple or variously lobed, or of simple or ramified stems, or, lastly, merely of a kind of powder. The sporules are enclosed in conceptacles which are named *apothecia*. These vary exceedingly in their form, which may be orbicular, elongated, linear, convex, concave, &c., in their colour, which is often brilliant, and in their position upon the thallus. They are further sessile or stipitate, with or without a marginal rim, &c. From these different modifications have been formed the numerous genera of this family, which were all included by Linnæus in the genus *Lichen*.

The Lichens are in general parasitic plants, living upon the bark of other trees, or sometimes upon the moist ground, or upon the most sterile rocks. Their substance is generally dry, and as if horny, and, on being boiled, is reduced to a jelly, which is sometimes employed as food. The genera of this family are exceedingly numerous, and have been differently arranged by every author who has studied it. As examples, we may mention *Parmelia*, *Sticta*, *Usnea*, *Opegrapha*, *Stereocaulon*, &c.

[The Iceland Moss (*Cetraria islandica*), which, in Iceland, is employed as an article of food, is also in common use as a nutritious and tonic aliment in phthisis and other pulmonary diseases. The *Tripe de roche* of the northern parts of America, which consists of several species of Gyrophora, is frequently had recourse to by the hunters and Indians as an article of food. Many species of Lichen, on being macerated in urine, afford dyes of various tints, chiefly red and brown. The more remarkable of these are *Lecanora perella* and *tartarea*, *Parmelia saxatilis* and *omphalodes*, *Roccella tinctoria* and *fusiformis*.—Tr.]

* Family IV.—Hepaticæ, *Juss.*

The Hepaticæ are intermediate between the Lichens and Mosses. They are sometimes spread out in the form of simple or lobed membranes, through which runs a middle nerve, which has been considered as a stem; and sometimes have a dendroidal form, or are composed of a small ramified stem bearing sessile leaves. The generative organs are very diversified, and are sometimes placed at the surface of the frond, sometimes axillar. They are either globules filled with a viscous fluid, and aggregated in a kind of capsule or perianth, or sporules varying in form, connected by spiral filaments, and contained in a capsule which opens either by a slit, or in four valves, and is accompanied by a membrane, which often entirely covers it previous to its development. This capsule is sessile or elevated upon a long filament or pedicel.

The generative organs are so diversified in this family, that five different forms of them occur in *Blasia pusilla.* Those authors who have supposed the existence of male flowers and female flowers in the Hepaticæ, have therefore judged erroneously. They have considered the globules filled with a viscous fluid as stamina, and the capsules filled with sporules as pistils. But what names are they to give to the five different organs which are observed in the above mentioned plant?

As examples of this family, we may mention the genera *Marchantia, Riccia, Blasia, Jungermannia,* &c.

[Of the properties of this family, nothing is known.—Tr.]

* Family V.—Musci or Mosses, *Juss.*

The Musci or Mosses are small plants which delight in moist and shady places. They grow on the ground, the trunks of trees, or on walls and old buildings. In their general aspect they resemble phanerogamous plants in miniature. Their roots are very delicate and tufted, their stem simple or branched, their leaves small, and of various forms, but commonly narrow and subulate. Their sporules are enclosed in a kind of capsules named *thecæ,* which are supported upon a slender thread *(seta),* and are at first enveloped in a kind of bag, which bursts circularly in the middle, and of which the lower part remaining at the base of the thread is named the *vaginula*, while the upper part which covers the top of the theca has received the name of *calyptra*. The theca itself presents internally a central axis named *columella*, and opens by means of a circular *operculum*. The circumference of the aperture of the theca is named the *peristome*, and is distinguished into internal and external. It may be furnished with teeth or ciliæ, closed by membranes, or entirely naked. Besides these organs, there are others of a different kind. These are irregularly oval and elongated bodies, supported upon a very short pedicel, and accompanied by articulated filaments.

The authors who have admitted in mosses the existence of flowers composed of the same organs as those of phanerogamous plants, have differed much respecting the functions of these organs, and the name which ought to be given to them. Thus Hedwig, whose labours have thrown so much light upon the history of plants of this family, considers mosses as furnished with male flowers and female flowers. The ovoidal and vesicular bodies, intermingled with articulated filaments, he considers as male flowers, of which each is composed of a naked and pedicellate grain of pollen. The thecæ, on the other hand, are female flowers. Palisot de Beauvois considers the theca as a hermaphrodite flower, of which the central columella is the pistil, and the granules which surround it the pollen. He considers what Hedwig calls male flowers as mere buds or bulbils of a peculiar nature. Dillenius, on the other hand, describes the theca as a male flower. Hill sees in it a hermaphrodite flower, the seminula of which are the ovules, and the ciliæ of the peristome are the stamina, &c.

But these theories, and many others which it is not my object to make known here, are contradictory, and in a manner destroy each other. In fact, numerous objections may be made to each of them. As to Hedwig's opinion, if the theca is only a fruit proceeding from a fecundated ovary, how should the fruit have already attained its state of maturity, when the alleged stamina, by which it ought to be fecundated, have scarcely begun to appear? How is fecundation effected in the species in which no male flowers have been discovered? &c.

If the theca is a hermaphrodite flower, the columella the pistil, and the seminules grains of pollen, how is the columella, in certain genera, entirely solid, and formed of a hard and perfectly homogeneous substance?

If, as Hill thinks, the teeth of the peristome are the stamina, where are these stamina in the genera in which the peristome is naked? &c.

Examples: *Sphagnum*, *Mnium*, *Hypnum*, *Buxbaumia*, *Tortula*, &c. The organization of the mosses is so peculiar, that it is impossible to confound them with the other families of the Inembryonate Plants.

[As food or medicine, no species of moss is now employed, although formerly *Polytrichum commune*, which is slightly astringent, was used as a stimulant.—Tr.]

* Family VI.—Lycopodiaceæ, *Rich.*

The Lycopodiaceæ are intermediate in their general appearance between the Mosses and the Ferns. They are furnished with a branched, often spreading and creeping stem, and very numerous small leaves. The organs of fructification present two modifications. Sometimes they are very small globular, trigonal or reniform, unilocular capsules, containing a great number of very small sporules. Sometimes these capsules are a little larger, open into two or three valves, and contain only three or four sporules of a large size. These two species of capsules, which may both occur on the same individual, are sometimes axillar and solitary, sometimes aggregated in the axil of bracteas, and then form simple or digitate spikes.

The genus *Lycopodium*, which forms the type of this family, was placed by Linnæus among the Musci, and by Jussieu among the Ferns. But the organization and position of the reproductive organs easily distinguish the Lycopodiaceæ from these families.

Many authors consider the smaller capsules filled with very numerous granules as male flowers, and the larger as female flowers. To us they appear to be neither, but to be receptacles perfectly similar to those which we have already observed in the other families of the inembryonate plants.

The genera of which this family is composed are the following: *Lycopodium*, *Psilotum*, and *Tmesipteris*. Professor De Candolle also unites to these the genus *Isöetes*, which, in our opinion, belongs to the *Marsiliaceæ*.

[The powder contained in the capsules of *Lycopodium clavatum* and *Selago* is very inflammable, and has been used in fireworks. No species of this family seems to be of any importance in a medical point of view.—Tr.]

* Family VII.—Filices or Ferns, *Juss.*

Herbaceous perennial plants, sometimes becoming arborescent in the tropical regions, and then rising in the manner of Palms. Their leaves or fronds are sometimes simple, sometimes more or less deeply cut, pinnatifid or decompound. These fronds present a common character, that of being rolled up like a crosier at their extremity, at the period when they begin to be developed. The organs of fructification are commonly situated on the lower surface of the leaves, along the nerves, or at their extremity. The sporules are naked or contained in a kind of small capsules. These capsules are aggregated into little masses, which are named *Sori*. These sori are in the form of orbicular, reniform, sessile or stipitate scales, sometimes surrounded by an elastic ring, opening either at their circumference, or by a longitudinal slit, or bursting irregularly. In the genus *Pteris*, the sporules are placed under the replicate margin of the leaves, which forms an uninterrupted line. In the species of *Adiantum*, they constitute small prominent and isolated plates, by means of the replicate margin of the leaves. In certain genera they are isolated, while in others they are aggregated, and form more or less elongated lines. The sori begin to be developed under the epidermis, which they raise in such a manner as to be covered by it. The portions of epidermis which thus form a covering to the sori are named *indusia*. In some Ferns, such as the *Osmundæ*, *Ophioglossa*, &c., the fructifications are disposed in clusters or spikes.

The genera of Ferns at present known are very numerous, and form five natural sections:

1. Polypodiaceæ.—Capsules free, bursting in an irregular manner, surrounded by a narrow and prominent elastic ring, which terminates in a pedicel of greater or less length. Ex.: *Polypodium*, *Aspidium*, *Asplenium*, *Pteris*, &c.

2. Gleichenieæ.—Capsules free, sessile, regularly arranged in a small number of groups, surrounded at the middle by a broad and flat elastic ring, opening by a transverse slit. Ex.: *Ceratopteris*, *Gleichenia*, *Mertensia*, &c.

3. Osmundaceæ.—Capsules free, opening by a longitudinal slit into two valves; no elastic ring; or, instead of one, a striated cup. Ex.: *Anemia*, *Lygodium*, *Osmunda*, &c.

4. Marattieæ.—Capsules sessile, aggregated, and united, so as to represent a many-celled capsule; no elastic ring. Ex.: *Danæa* and *Marattia*.

5. The Ophioglosseæ.—Capsules free, partly immersed in the frond, without elastic ring, and opening by a transverse fissure. Ex.: *Ophioglossum*, *Botrychium*.

Authors have varied much as to the nature of the reproductive organs in Ferns. Almost all have considered the capsules as female organs. But some, as Micheli and Hedwig, have considered as male organs the glandular hairs which are sometimes seen on the young leaves. Others, with Hill and Schmidel, have called the rings of the conceptacles, stamina; and, lastly, others have given this name to the miliary glands and indusia. But these different opinions may all be easily overthrown, as all the organs which have been considered as stamina, are by no means constant, but are very often wanting.

[Several species of Fern have been employed as food, such as *Pteris esculenta*, *Diplagium esculentum*, and *Nephrodium esculentum*. The leaves of many species are mucilaginous, with a slight astringency, and some aroma. They have accordingly been used as expectorants. *Polypodium Calaguala* and *crassifolium* are said to be sudorific, febrifugal, and antisyphilitic. The stems of other species, being bitter and astringent, have been used as anthelmintics. *Aspidium Filix-mas*, *A. Filix-fœmina*, and *Pteris aquilina*, have been thus employed.—Tr.]

* Family VIII.—Marsileaceæ, *Brown*.

Rhizospermeæ, *De Cand.*

Small aquatic plants, fixed at the bottom of the water, or floating at its surface, with or without apparent stem. The leaves are setaceous, or more or less broad. The reproductive organs are a sort of coriaceous involucres, sometimes of one kind, sometimes of two. They are thick, with one or more cells, separated by membranous dissepiments, indehiscent or opening by means of valves. They contain reproductive corpuscules, which sometimes are all organized in the same manner, and sometimes are of two different species, some being larger, and considered as female organs, the others smaller, and considered as stamina. These involucres are placed at the base of the leaves, and even sometimes adhere to them. When the involucres are of two kinds in the same plant, some are membranous, and contain a cluster of corpuscules, which have been considered as seeds; while the others, which have been described as male organs, contain a great number of spherical granules, attached by a long filament to a central columella.

This family has been divided into two sections: 1. The true *Marsiliaceæ,* which have only one kind of involucres, containing granules of two kinds, and composed of the genera *Marsilea, Pilularia,* and *Isöetes,* which last genus some authors refer to the *Lycopodiaceæ;* 2. The *Salvinieæ,* of which the involucres are of two different kinds, and contain differently organized granules. To this second tribe belong the genera *Salvinia* and *Azolla.*

[The properties of these plants are entirely unknown.—Tr.]

* Family IX.—Equisetaceæ, *De Cand.*

This small family is composed of the single genus *Equisetum.* All the species are herbaceous, perennial plants. Their stems, which are simple or branched, are generally hollow, longitudinally striated, and present at intervals knots or enlargements, from which arise sheaths which are slit into a number of shreds, and which seem to be verticillate leaves united together. Sometimes verticillate branches come off from these knots. The fructifications form terminal spikes. These spikes are composed of thick, peltate scales, similar to those which are observed in the male flowers of several Coniferæ, and among others of the Yew. At the lower surface of these scales, grow a kind of capsules, disposed in a single row, and opening by a longitudinal slit which looks towards the axis. These capsules are filled with minute granules, which are composed of a globular part, from the base of which arise four long articulated filaments, enlarged at their upper part, and spirally rolled around the globular body, which is a true sporule.

Influenced by the similarity of form which exists between the reproductive organs of the Equisetaceæ and the stamina of some Coniferæ, Linnæus named these organs stamina, without pointing out the organs which he considered as pistils. Hedwig, on the other hand, considered each granule as a hermaphrodite flower; the globular part was the pistil, and the filaments were four stamina, the pollen of which was situated externally. But these filaments are certainly analogous to those which are observed in the *Jungermanniæ*, the *Marchantiæ*, *Targioniæ*, &c.

[The Equisetaceæ are remarkable for the quantity of silica which they contain; but, although they possess a certain degree of astringency, none of them are now employed in medicine.—Tr.]

* Family X.—Characeæ, *Rich.*

The Characeæ are aquatic and submersed plants, whose slender, branched, green, and sometimes translucid stems, bear at intervals verticillate branches, from eight to ten in number. On the branches of the upper verticils are observed a kind of *sporangia*, or capsules, three, four, or five in number. Each of them is surrounded at its base by two or three bracteas or abortive branches, which Linnæus considered as a calyx. They are unilocular, and contain numerous sporules, collected into a single mass, which has been considered as a single seed. These sporangia are formed of two integuments, of which the outer is membranous, transparent, very thin, and terminated above by five spreading teeth; the inner hard, dry, opaque, and composed of five small narrow valves spirally twisted. Besides these organs, there are also observed on the branches sessile and rounded tubercles of a reddish colour. Most authors describe them as stamina. They consist of a reticulated, transparent membrane, forming a kind of vesicle filled with a mucilaginous fluid, in which are observed articulated filaments of a whitish colour, and others of a larger size filled with a reddish fluid, closed at one of their extremities, and appearing to open at the other. These tubercles, in the progress of vegetation, shrivel, but do not open.

This family is composed of the single genus *Chara*. It was established by Vaillant, in 1719, in the *Memoires de l'Academie des Sciences de Paris*. Linnæus at first placed it in the class Cryptogamia, close to the Lichens, but afterwards changed his mind, and referred it to Monœcia Monandria of the Phanerogamous Plants. M. de Jussieu, in his *Genera Plantarum*, associated it with the genera of which he formed his family of *Najades*. But Professor Richard (in Michaux's Flora of North America) made it the type of a distinct family, under the name of Characeæ, placing it among the Acotyledones. More recently, Mr Brown approximates this genus to the Hydrocharideæ; M. Leman to the Onagrariæ; and, lastly, Martius, Walroth, and Bory de St Vincent are of opinion that it has a great affinity to the Hydrophytes, to which family it ought to be referred. But if we compare the structure of the reproductive organs of the Characeæ with that of the other acotyledonous plants, we find a very great similarity in them to those of the Marsiliaceæ in particular, from which they differ only in having their sporangia smaller, with five teeth, and a double integument, and in the reddish tubercles which are also observed on the branches.

[The Characeæ are remarkable for the quantity of calcareous matter with which some of them are encrusted; but, like most of the other families of acotyledonous plants, they are of no utility to man as food or medicine. —Tr.]

SECOND DIVISION.

EMBRYONATE OR PHANEROGAMOUS PLANTS.

This great branch of the vegetable kingdom consists of all the plants whose structure is more complex, which are furnished with male and female sexual organs, that is, stamina and pistils, and which are reproduced by means of true seeds, which require to be fecundated in order to become qualified to give origin to new individuals. According to the structure of the embryo, they have been divided into two groups, the *Monocotyledones* and the *Dicotyledones*.

MONOCOTYLEDONOUS PLANTS.

The essential characters of the plants which compose this group resides in the structure of the embryo, which is monocotyledonous *. But independently of the characters derived from the embryo, there are others also derived from the organs of vegetation and floration, by which a monocotyledonous plant may be distinguished, should the former be wanting. These we shall here very briefly point out.

1. The internal structure of the stem, which is composed of a mass of cellular tissue, in which are scattered the vascular fasciculi †.

2. The nerves of the leaves are generally parallel in the Monocotyledones, and irregularly ramified in the Dicotyledones.

3. The perianth is always simple in monocotyledonous plants, in other words, there is only a calyx, which is sometimes coloured like a corolla.

4. In monocotyledonous plants the floral organs are generally three, or a multiple of that number; whereas five is the predominating number in dicotyledonous plants.

5. But it is especially in their general aspect that these two great branches of the vegetable kingdom differ; and after one has properly understood the characters of the principal families of the monocotyledonous plants, such as the Gramineæ, Junceæ, Liliaceæ, Irideæ, Amomeæ, Orchideæ, Palms, &c., he can afterwards with the greatest ease distinguish the monocotyledonous from the dicotyledonous plants.

* See the characters of the monocotyledonous embryo at page 294.

† See the organization and mode of growth of the stem of the Monocotyledones, at pages 69, 89.

The Monocotyledones are divided into three classes, according as their insertion is hypogynous, perigynous, or epigynous.

CLASS SECOND.—MONOHYPOGYNIA.

* Family XI.—Najadeæ, *Juss.*

Fluviales, *Vent.* Potamophilæ, *Rich.*

The Najadeæ, as is indicated by their mythological name, are plants which grow in the water or float at its surface. Their leaves are alternate, often amplexicaul at their base. Their flowers, which are very small, are unisexual, monœcious, or more rarely diœcious. The male flowers consist of a stamen, which is naked, or accompanied by a scale, or enclosed in a spatha, containing two or more flowers. The female flowers consist of a pistil, which is naked or enclosed in a spatha. They are sometimes solitary, sometimes geminate, or, lastly, several together, sometimes surrounded by male flowers, within a common envelope, so as collectively to resemble a hermaphrodite flower. The ovary is free, with a single cell, containing a single pendent ovule, (in the genus *Najas* it is lateral and nearly basilar). The style is generally short, terminated by a stigma, which is sometimes simple, discoid, flat, and membranous (in *Zanichellia*), sometimes with two or three long, linear divisions. The fruit is dry, monospermous, indehiscent. The seed contains under its proper integument an embryo, which is most commonly bent upon itself, and has its radicle very large and opposite to the hilum.

Examples: *Najas*, *Zostera*, *Ruppia*, *Zanichellia*, and *Potamogeton*.

These genera are all that compose the family of Najadeæ, the characters of which we have greatly modified, our account of its structure being different from any that has previously been given. There must be excluded from it several genera which have erroneously been referred to it, such as *Hippuris* and *Myriophyllum*, which form the family of Halorageæ; *Ceratophyllum*, which belongs to the Salicarieæ; *Saururus* and *Aponogeton*, forming the family of Saurureæ; *Callitriche*, a dicotyledonous genus, allied to the Euphorbiaceæ; and *Chara*, an acotyledonous genus, constituting the family of Characeæ.

The family of Najadeæ is closely allied to the Aroideæ, to which it approaches in general aspect and characters. The Aroideæ differ from it especially in their erect ovule, and in having their embryo contained within a fleshy endosperm.

[The root of *Zostera marina* contains a sweetish juice; its leaves have been prepared for making mattresses, and as a substitute for hair and wool in stuffing sofas and chairs. The other plants of this family are not known to possess any very remarkable properties.—Tr.]

* Family XII.—Aroideæ, *Juss.*

Perennial herbaceous plants, generally with a tuberous root. Leaves often all radical, or alternate on the stem; flowers disposed in spadices, generally surrounded by a spatha of variable form, unisexual, monœcious, destitute of floral envelopes, or hermaphrodite and surrounded by a calyx with four, five, or six divisions. In the first case, the pistils generally occupy the lower part of the spadix, and must be considered each as a female flower, and the stamina as so many male flowers. The stamina and pistils are rarely intermingled. In the second case, the flowers, in place of being considered as hermaphrodite, may be described as an aggregation of unisexual flowers. Thus each stamen and its scale constitute a male flower, and the central pistil a female flower. The ovary has generally a single cell containing several seeds attached to the lower wall, or it is three-celled. The stigma is sometimes sessile, more rarely elevated upon a short style. The fruit is a berry, or more rarely a capsule, which is sometimes monospermous by abortion. The seed is composed, besides its proper integument, of a fleshy endosperm in which is placed a cylindrical, erect embryo.

The family of Aroideæ is divided into three tribes:

1. True AROIDEÆ: flowers naked, without scales; fruit fleshy. *Arum, Arisarum, Caladium, Culcasia, Calla, Richardia.*

2. ORONTIACEÆ: flowers surrounded by scales in the form of a calyx. *Dracontium, Pothos, Carludovica, Orontium, Acorus.*

3. PISTIACEÆ. Fruit dry and capsular. *Pistia, Ambrosinia.*

Allied to the Najadeæ and Typhineæ, this family is especially distinguished by its general aspect, the disposition of the flowers, its embryo contained in an endosperm and several other characters.

[Many species are acrid and poisonous. The roots generally contain a large quantity of fecula, for which reason several of them are used as articles of food in warm climates. In our own country a kind of sago has been made of the roots of *Arum maculatum*. In a recent state, the roots of several species have been used as stimulants and expectorants. The root of *Acorus Calamus* is aromatic.—TR.]

* FAMILY XIII.—TYPHINEÆ.

Typhæ, *Juss.* Pandaneæ, *Brown.*

AQUATIC or arborescent and terrestrial plants, with alternate leaves, sheathing at their base, and unisexual monœcious flowers. The male flowers form cylindrical or globular catkins, composed of numerous stamina, often united several together by their filaments, and intermingled with hairs or small scales, but without order and without a proper calyx. The female flowers, similarly arranged, sometimes have the scales united to the number of six around the pistil, forming a calyx with six sepals. The pistil is sessile or stipitate, with one, more rarely with two cells, each containing a pendent ovule. The style, which is not very distinct from the summit of the ovary, is terminated by a dilated stigma, which has a membranous appearance, and is marked by a longitudinal groove. The seed consists of a farinaceous endosperm, containing in its centre a cylindrical embryo, the radicle of which is superior, that is, has the same direction as the seed.

This little family is composed of only two genera: *Typha* and *Sparganium*. Mr Brown has united it to the family of the Aroideæ, to which it has, in fact, the greatest affinity; but it differs from that family in several characters, and especially in its reversed seeds, and in the structure of its flowers. The two families, however, might perhaps with propriety be united. Ought we to place in this family the genus *Pandanus*, which has so great a resemblance to the genus *Sparganium*, as to seem in some measure an arborescent species of it; or ought we to follow Mr Brown in forming a particular family of it under the name of *Pandaneæ*?

[The Typhineæ are of no importance in a medical point of view.—Tr.]

Family XIV.—Saurureæ, *Rich.*

Plants growing on the margin of water or floating at its surface. Their leaves are alternate, simple and petiolate. Their flowers are hermaphrodite, destitute of perianth, and having a simple scale instead of it, on which are inserted the stamina and pistils. The stamina are from six to nine, with subulate filaments, the anthers two-celled, and opening by a longitudinal groove. The pistils are from three to four in the centre of each flower. They are one-celled, and contain two or three erect or ascending ovules. The style is marked by a glandular groove on the middle of its inner side, which at its summit enlarges into a stigma. The fruit consists of small indehiscent capsules, each containing one or two seeds. The seeds contain under their proper integument a large endosperm, at the summit of which is applied a very small discoid embryo.

This family is composed of the genera *Saururus* and *Aponogeton*. The *Ouvirandra* or *Hydrogeton*, which has been referred to it, differs in having a calyx, and in its embryo being destitute of endosperm. This latter character, if correct, which we have not had the means of verifying, would remove this genus from the Saurureæ, to bring it near the Alismaceæ.

Family XV.—Cabombeæ, *Rich.*

A small family composed of only two genera, *Cabomba* and *Hydropeltis*, which contain herbaceous perennial plants, growing in the fresh waters of the New Continent. Their leaves, which float at the surface of the water, are entire and peltate, or divided into small lobes. The flowers are solitary, with long peduncles. Their calyx has six deep divisions, or six sepals disposed in two series. The stamina vary from six to thirty-six. The number of the pistils, which are collected in the centre of the flower, is from two or three to eighteen, that is, generally half the number of the stamina. Each pistil, which is more or less elongated, has a single cell containing two parietal and pendent ovules. The style varies in length, and is terminated by a simple stigma. The fruit is indehiscent, with one or two seeds. The seeds contain under their proper integument a very large fleshy or farinaceous endosperm, marked at its base with a small fossa, in which rests a nearly discoid embryo, in the form of a nail, and perfectly undivided.

This small family has a great resemblance to the Saurureæ in its ovary, fruit, and embryo; but in that family the flowers are naked. It also comes very near the Alismaceæ in the organization of its flower, but differs from them in its large endosperm and in the form of its embryo. M. de Candolle (*Syst. Nat. Veg.*) places the Cabombeæ among the Dicotyledones, and forms of them a tribe of the Podophylleæ; but this arrangement seems to us incorrect, the embryo of the Cabombeæ being assuredly monocotyledonous.

* Family XVI.—Cyperaceæ, *Juss.*

Herbaceous plants, generally growing in moist places, and on the margin of lakes and streams. Their stem is a cylindrical or triangular culm, with or without knots. The leaves are sheathing, and their sheath is entire and not slit, pretty frequently furnished at its orifice with a small membranous process named the *ligule.* The flowers form small scaly spikes or spikelets, composed of a variable number of flowers. Each flower is composed of a single scale, in the axil of which are generally found three stamina, and a pistil formed of a unilocular and monospermous ovary, surmounted by a style which is simple at its base, and generally bears three filiform downy stigmas. The stamina have their filaments capillar, their anther pointed at the summit, and bifid at the base. Externally of the ovary there are often hairs or scales varying in number, sometimes even a utricle which entirely covers it (as in *Carex*). The fruit is a globular, compressed, or triangular akenium. The embryo is small, and is situated towards the base of a farinaceous endosperm, which covers it with a very thin lamina.

This family, which is very natural, is composed of a great number of genera. The flowers are unisexual or hermaphrodite, and the stamina vary greatly in number. The genera *Scirpus, Cyperus, Schœnus, Mariscus, Papyrus,* &c., belong to it. It has a great affinity to the Gramineæ, but differs in certain characters, which we shall point out in speaking of that family.

[The Cyperaceæ are of little importance as affording food or medicine to man. The roots of *Cyperus longus* and *odoratus* are tonic. The Egyptians obtained their papyrus from a plant belonging to this family.—Tr.]

* Family XVII.—Gramina, *Juss.* Gramineæ, *Brown.*

Herbaceous plants, annual or perennial, rarely suffrutescent, having a peculiar and very characteristic aspect. Their stem is a culm, generally fistulous, and marked at intervals with solid knots, whence proceed alternate sheathing leaves. The sheath, which may be considered as a laterally extended petiole, is slit in its whole length, and at its junction with the leaf presents a kind of a small collar, of a membranous texture or formed of hairs, and which is named the *ligule.* The flowers are disposed in spikes or panicles, which are more or less branched. These flowers are either solitary, or aggregated so as to form little groups, which are named *spikelets.* At the base of the spikelets or of the solitary flowers are two scales, an outer and an inner, forming the *lepicene.* Sometimes, although rarely, the inner scale is wanting, and the lepicene is univalve. Each flower is composed of two other scales forming the *glume;* of usually three, sometimes fewer, rarely more stamina, with capillar filaments, and anthers bifid at both extremities; a pistil formed by a unilocular, monospermous ovary, marked by a longitudinal furrow on one of its sides, and surmounted by two styles which terminate two hairy and glandular stigmas, or more rarely by a simple style, or one which is forked at its upper part. Externally of the ovary, on the face opposite to the groove, are observed in many genera two small paleolæ of diversified forms, which constitute the *glumella* or *nectary.* The fruit is a cariopsis, more rarely an akenium, naked, or enveloped in the valves of the glume, which are detached and fall off along with it. The embryo has a discoid form, and is applied upon the lower part of a farinaceous endosperm.

This family is one of the most natural in the vegetable kingdom. It is composed of all those plants usually known by the name of *grasses* or *corn;* such as wheat, rye, oats, maize, panick, rice, millet, &c. The genera are very numerous, and their characters are founded upon the diversified form of the scales, which are sometimes naked, sometimes bear at their summit or on their back an awn or bristle, and sometimes several. We may mention as examples of this family, the genera *Triticum*, *Avena*, *Hordeum*, *Arundo*, *Poa*, *Saccharum*, &c.

The family of the Gramineæ has the greatest resemblance to that of the Cyperaceæ, in its general aspect, as well as in several of its characters. But, in the first place, the sheath of the leaves in the Cyperaceæ is entire, whereas it is slit in the Gramineæ. In the latter there are two scales for each flower, but in the Cyperaceæ there is only one. In the Gramineæ there are two stigmas, and generally three in the Cyperaceæ. The embryo is more complicated in the Gramineæ than in the Cyperaceæ.

[It is almost unnecessary to mention the extensive use that is made of the seeds of various species of Gramineæ, as affording a wholesome and abundant food. In fact, all the species, were their seeds sufficiently large, might be similarly employed, with the exception of *Lolium temulentum*, which produces deleterious effects. The ergot (a small parasitical fungus) of rye and maize causes depilation and debilitating effects in man and animals; and the former, possessing a stimulating power more especially directed towards the uterus, has been employed to aid parturition. The products of the Sugar Cane are well known. The cuticle of many grasses contains a large proportion of silica; and the Bamboo of India contains a siliceous secretion or deposition in its joints, which is known by the name of Tabasheer.—Tr.]

THIRD CLASS.—MONOPERIGYNIA.

Family XVIII.—Palmæ, *Juss.*

A large and beautiful family, as remarkable for the general aspect of the plants which compose it, as for the internal organization of their different parts. The Palms are generally large trees, with a simple, cylindrical, leafless stem, designated by the name of Stipe. At its summit, it is crowned by a bundle of very large, petiolate, persistent leaves, which are pinnate or decompound, with a greater or less number of leaflets of diversified form. The flowers are hermaphrodite, or more commonly unisexual, diœcious or polygamous, forming catkins, or a large cluster named regime, and enveloped previous to its expansion in a coriaceous, sometimes ligneous spatha. The perianth has six divisions, of which three are inner and three outer, so as to resemble a calyx and a corolla. The stamina are six, rarely three. The pistil is simple, or formed by the aggregation of three distinct or united pistils. It presents one or three cells, each containing a single seed. Each pistil is terminated by a style, surmounted by a more or less elongated stigma. The fruit is a fleshy or fibrous drupe, containing a very hard bony nucleus, with one or three monospermous cells. The seed, besides its proper integument, consists of a fleshy or cartilaginous endosperm, sometimes presenting a central or lateral cavity. The embryo is very small and cylindrical, and is placed horizontally in a small lateral depression of the endosperm.

With the exception of the Fan-palm (*Chamærops humilis*), all the plants of this family are extra-European, inhabiting especially the intertropical regions of the old and new continents. These trees are not only remarkable for the elegance of their form, and the prodigious height which several of them attain, but are also of the greatest importance on account of the numerous services which they render to the inhabitants of the countries in which they naturally grow. The fruits of many species, as the Cocoa, the Date, and the terminal bud of the Cabbage-palm are eaten by the inhabitants of Northern Africa and India. Several species furnish an amylaceous fecula named Sago; others an astringent principle, similar to Dragon's-blood. Some again yield a fixed oil, as *Ælais guineensis*, from which the palm-oil is procured.

The principal genera of this family are: *Cocos, Phœnix, Chamærops, Ælais, Areca, Sagus,* &c.

[To the inhabitants of the intertropical regions of the globe, the palms are the most important tribe of vegetables, yielding food, wine, sugar, ropes, and numerous utensils. The Betel-nut, which possesses an intoxicating and narcotic power, is the fruit of *Areca Catechu.*—Tr.]

* Family XIX.—Restiaceæ, *Brown.*

Plants having the habit of Rushes, or of some Cyperaceæ, perennial-herbaceous, or even suffrutescent. Their leaves are narrow, and sometimes wanting. Their culms are naked, or covered with sheathing scales, the sheath slit on one side. The flowers, which are generally unisexual, are collected into spikes or capitula, and are often surrounded by spathæ. Their calyx, which is rarely wanting, has from two to six deep divisions. The stamina vary from one to six. When they are half the number of the sepals, they are opposite to the inner sepals (the reverse being the case in the family of Junceæ). The pistils are free or united, with a single cell, containing a pendent ovule. The style is simple, and terminated by a subulate stigma. The fruits are small capsules opening longitudinally on one side, or a kind of indehiscent nuts. The seed is reversed. The endosperm is farinaceous, and the embryo, which is discoid, is applied upon the extremity of the endosperm opposite to the hilum.

This family, which is composed of the genera *Restio, Eriocaulon, Desvauxia,* and a great number of new genera belonging to New Holland, is distinguished from the Junceæ by its embryo being extrary and opposite to the hilum, its solitary and pendent seeds, its stamina being opposite to the inner sepals, &c. It has also some affinity to the Cyperaceæ, from which it differs in its slit sheaths, and in the structure and position of its embryo.

[These plants possess no remarkable properties.—Tr.]

* Family XX.—Junceæ, *Delaharpe.*

Part of the Junci *of Authors.*

Perennial, rarely annual herbaceous plants, with a simple cylindrical, naked, or leafy stem. Their leaves are sheathing at the base, the sheath being sometimes entire, sometimes slit in its whole length. The flowers are hermaphrodite, terminal, disposed in the form of a panicle or cyme, and contained, before their expansion, in the sheath of the last leaf, which forms a kind of spatha for them. The calyx is formed of six glumaceous sepals, disposed in two rows. The stamina, which are six or only three in number, are inserted at the base of the inner sepals. When there are only three stamina, they correspond to the outer sepals. The ovary is unilocular and three-seeded, or trilocular and many-seeded, and is more or less triangular. The style is simple, and surmounted by three stigmas. The fruit is a capsule, with one or three incomplete cells, containing three or more seeds, and opening by three valves, each bearing a dissepiment on the middle of its inner face. The seeds are ascending, with a double tegument, and a hard, farinaceous endosperm, containing towards its base a small rounded embryo.

The genera of which this family is now composed are *Juncus, Luzula,* and *Abama.* Jussieu, in his *Genera Plantarum,* placed together in his family of Junci, a great number of genera very different from each other. These genera, on being more attentively examined, became the types of a number of distinct families, under the names of *Restiaceæ, Commelineæ, Alismaceæ, Pontederieæ, Colchiceæ.*

The family of Junceæ, as limited by M. de La Harpe (*Mongraph. des Joncées* in *Mem. Soc. Hist. Nat.,* Paris, vol. iii.), has some relations to the Cyperaceæ, from which it differs, in having the flower formed of six sepals and six stamina, as well as to the Restiaceæ; but the latter have their capsule with three complete cells, their seeds pendent, and their embryo extrary or opposite to the hilum.

Family XXI.—Commelineæ, *Brown.*

A small family, formed of the genera *Commelina* and *Tradescantia*, formerly placed among the Junceæ, and of some other new genera which have been united to these. The flowers have a calyx, with six deep divisions arranged in two rows, the three outer green and calycine, the three inner coloured and petaloid. The stamina, which are six, seldom fewer, are free. The ovary has three cells, each containing a small number of ovules inserted at their inner angle, and is surmounted by a style and a simple stigma. The fruit is a globular capsule, or with three compressed angles, three-celled, and opening by three valves, each bearing a dissepiment on the middle of its inner surface. The seeds are seldom more than two in each cell. The embryo, which is turbinate, is opposite to the hilum, and is placed in a small cavity of a hard and fleshy endosperm.

The plants of which this family is composed are herbaceous, annual, or perennial. Their root is formed of fleshy tubercles; their leaves are alternate, simple, or sheathing; their flowers naked or enveloped in a foliaceous spatha.

This family is distinguished from the Junceæ, by its habit or general aspect, by its calyx, of which the three inner sepals are coloured, and by the form of its embryo. It differs from the Restiaceæ also in its calyx, in the structure of its capsule, which has polyspermous cells, and in its seeds, which are axillar, and not pendent.

Family XXII.—Pontederiaceæ.

Pontedereæ, *Kunth.*

Plants living in the vicinity of water, bearing alternate, petiolate leaves, which are sheathing at their base, solitary flowers, or disposed in a spike or umbel, and springing from the sheath of the leaves, which is slit. The calyx is monosepalous, tubular, with six more or less deep, equal or unequal divisions. The stamina, which are three or six in number, are inserted into the tube of the calyx. Their filaments are equal or unequal. The ovary is free or semi-inferior, with three polyspermous cells. The style and stigma are simple. The fruit is a capsule, sometimes slightly fleshy, with three cells, rarely with one only, containing one or several seeds, attached at the inner angle. The capsule opens by three valves which bear dissepiments on the middle of their inner surface. The hilum is punctiform. The endosperm is farinaceous, and contains an erect embryo, placed in its central part, and having the same direction as the seed.

This little family consists of only two genera, *Pontederia* and *Heteranthera*. It has the greatest affinity on the one hand to the Commelineæ, and on the other to the Liliaceæ. It differs from the former, in its embryo having the same direction as the seed, the reverse of which is the case in the Commelineæ; in the hilum of the seed being punctiform and placed on a different side; in its tubular calyx, and in the polyspermous cells of its capsule. It is still more closely allied to the Liliaceæ, but the general aspect of the Pontederiaceæ is different, they being aquatic plants with fibrous roots, and a simple stigma. Notwithstanding, I am much disposed to think that the two families might be united.

* Family XXIII.—Alismaceæ.

Alismoides, *Vent.* *Part of the* Junci, *Juss.* Alismaceæ, Juncagineæ, Butomeæ, *and* Podostemeæ? *Rich.*

Annual or perennial herbaceous plants, most of which grow in moist places, and on the margins of pools and brooks. Their leaves are petiolate, sheathing at their base.

Their hermaphrodite, rarely unisexual flowers, are disposed in spikes, panicles, or sertules. The calyx, which is wanting in the genus *Lilæa* only, is formed of six sepals, of which the innermost three are generally coloured and petaloid. The stamina vary in number from six to thirty. There are several pistils in each flower, which remain distinct, or are more or less united together. The ovary, which is unilocular, contains one, two, or more erect ovules, pendent or fixed at the inner side. The fruits are small, dry, generally indehiscent carpels. Their seeds, which are ascending, or reversed, are composed of a proper integument, directly covering a large embryo, which is straight, or curved in the form of a horse's shoe.

We here unite into a single family the three which my father proposed under the names of *Alismaceæ, Juncagineæ,* and *Butomeæ,* but which he himself was somewhat disposed to consider as three natural sections of the same family. He was the first who properly described the structure of the ovary and embryo in these three groups, which here become sections of the same family. We shall divide the Alismaceæ into the three following sections:

1. Juncagineæ.—Calyx uniform, wanting in the genus *Lilæa;* one or two erect seeds; a straight embryo. *Lilæa, Triglochin, Scheuchzeria.*

2. Alismaceæ.—Calyx semipetaloid; one or two erect or ascending sutural seeds; embryo straight or curved in the form of a horse's shoe. *Sagittaria, Alisma, Damasonium.*

3. Butomeæ.—Calyx semipetaloid; seeds numerous, attached to veins which adhere to the interior of each cell; embryo straight or curved in the form of a horse's shoe. The mode of connexion of the seeds is very singular in this tribe, and is very rarely met with. The family of the *Flacourtianeæ* in the Dicotyledones affords another example of it. The genera which compose this section are: *Butomus, Hydrocleis,* and *Limnocharis.*

The family of Alismaceæ has many relations to the Najadeæ, especially in the embryo being destitute of endosperm. But the seed of the Najadeæ is reversed, while that of the Alismaceæ is erect; the radicle is turned towards the hilum in the latter, and is opposite to it in the former. The Junceæ, to which the Alismaceæ were formerly referred, differ especially in having the embryo always furnished with an endosperm.

Perhaps the family of *Podostomeæ* indicated by my father, and differing from the Juncagineæ only in having a polyspermous capsule, ought to be referred to the present family.

[Of some species the fleshy roots are catable, but of very little importance. The foliage is generally acrid.—Tr.]

* Family XXIV.—Colchicaceæ. *De Cand.*

Part of Junci *of Jussieu.*

Herbaceous plants, with a fibrous or bulbiferous root, and a simple or branched stem, bearing alternate sheathing leaves. The flowers are terminal, hermaphrodite, or unisexual. Their calyx is coloured, with six very deep divisions, sometimes tubular at its base. The stamina, which are six, are opposite to the divisions of the calyx. The ovaries are three in each flower, sometimes free, sometimes more or less connected, so as to represent a trilocular ovary. Each of them contains a great number of ovules attached to their inner angle. The summit of each ovary bears a style, which is sometimes very long, terminated by a glandular stigma. The fruit is composed of three distinct carpels, opening by a longitudinal and internal slit. Sometimes these three carpels unite, and form a three-celled capsule, but finally separate at the period of maturity, and open each by a suture placed at their inner angle. The seeds are composed of a membranous or reticulated integument, sometimes surmounted towards the hilum by a more or less bulky tubercle, and a fleshy endosperm, which contains a cylindrical embryo situated towards the point opposite to the hilum.

This family is in a manner intermediate between the Junceæ, of which it was formerly considered as a part, and the Liliaceæ. It is distinguished from the Junceæ by its calyx being coloured, and its capsules distinct or separating at maturity. The latter character, joined to the three styles and the membranous, never crustaceous, tegument of the seed, distinguish the Colchicaceæ from the Liliaceæ.

The principal genera of this family are: *Colchicum*, *Narthecium*, *Veratrum*, *Merendera*, *Melanthium*, *Bulbocodium*, &c.

[All the species of this family are more or less acrid. *Colchicum* is powerfully cathartic, and diuretic. The root of Veratrum, when powdered, excites sneezing. Used internally, it is a strong emetic.—Tr.]

* Family XXV.—Asparagineæ.

Part of the Asparagi *of Jussieu.* Smilaceæ, *Brown.*

Perennial, herbaceous, or frutescent plants, with fibrous roots, alternate, opposite or verticillate leaves, which are sometimes very small and squamiform. Flowers sometimes unisexual, variously disposed. Calyx, often coloured and petaloid, with six or eight more or less deep, spreading or erect divisions. Stamina of the same number as the divisions of the calyx, at the base of which they are attached; their filaments free, rarely monadelphous. The ovary is free, with three cells, rarely one, each containing one or more ovules inserted at its inner angle. The style is sometimes simple, surmounted by a three-lobed stigma, or it is tripartite, each division bearing a stigma. The fruit is a trilocular capsule or a globular berry, sometimes with a single cell, and a single seed, in consequence of abortion. The seeds, besides their proper integument, have a fleshy or horny endosperm, containing in a cavity, sometimes pretty large, and placed in the vicinity of the hilum, a very small embryo.

The family of Asparagineæ, such as we have above characterized it, differs from that proposed by Jussieu in his *Genera Plantarum*. Mr Brown, with great reason, has removed from this group the genera with inferior ovary, of which he has formed a distinct family under the name of Dioscoreæ. The same botanist unites with the Asphodeleæ many genera of the Asparagineæ, leaving in this family, which he names Smilaceæ, only the genera which have the style deeply trifid, or bear three or four distinct styles.

As above characterized, the family of Asparagineæ forms two sections or natural tribes:

1. True Asparagineæ: Stigma simple or three-lobed. *Dracæna*, *Cordylina*, *Dianella*, *Asparagus*, *Callixine*, *Lapageria*, *Convallaria*, *Polygonatum*, *Maianthemum*, *Ruscus*, *Smilax*, &c.

2. Parideæ: Three or four distinct stigmas. *Paris*, *Trillium*, *Medeola*, &c.

[Gum-dragon, a well-known styptic, is the concrete juice of *Dracæna Draco*. Most of the species are more or less acrid and stimulant. *Smilax Sarsaparilla* is well known as a diuretic and demulcent.—Tr.]

* Family XXVI.—Liliaceæ.

Lilia *and* Asphodeli, *Juss.* Hemerocallideæ, *Brown.*

Plants with bulbiferous or fibrous root. Their leaves, which sometimes are all radical, are flat, or cylindrical and hollow, or thick and fleshy. The stem or scape is generally naked, rarely bearing flowers. The flowers are sometimes solitary and terminal, sometimes in simple spikes, in branched racemes, or sertules. They are sometimes accompanied with a spatha which envelopes them previous to their expansion. The calyx is coloured and petaloid, of six sepals, which are distinct or united at their base, sometimes forming a tubular calyx. These six sepals are disposed in two rows, three being internal and three external. The stamina are six in number, inserted at the base of the sepals, when these are distinct, or on the upper part of the tube, when they are connected. The ovary has three cells, and three prominent ribs. Each cell contains a variable number of ovules attached to its inner angle, and disposed in two rows. The style is simple or wanting, and is terminated by a three-lobed stigma. The fruit is a three-celled capsule, opening by three valves, each bearing a dissepiment on the middle of its inner surface. Their seeds are covered by a sometimes black and crustaceous, sometimes merely membranous tegument. Their endosperm is fleshy, and contains a cylindrical embryo, the radicle of which is turned towards the hilum. The radicle is rarely twisted upon itself.

We here unite into a single group all the families proposed by Jussieu under the names of *Liliaceæ* and *Asphodeleæ*, and the *Hemerocallideæ* of Brown. In fact, the two first families presented absolutely the same organization in all their parts; and the only difference that existed between them, consisted solely in their mode of germination. Thus in the Asphodels the cotyledon remains engaged in the interior of the seed by one of its extremities, and forms a filiform prolongation which raises the gemmule. This character, joined to some differences in the general aspect, which habit alone can enable one to appreciate, are the only signs that distinguish the Asphodels from the Liliaceæ. We have therefore judged it proper to unite them.

The *Hemerocallideæ* of Brown cannot form a distinct family, as their only essential character would consist in the calyx being tubular at the base. This group was proposed by the celebrated English botanist for the genera of Jussieu's family of *Narcissi*, which have the ovary free; such as *Hemerocallis*, *Tubalgia*, and *Blandfortia*.

The insertion presents some differences in the genera which compose the Liliaceæ. This, while the stamina are attached to the calyx in a great number of genera, and in particular in the Hyacinths, Lachenaliæ, Asphodels, &c., and are consequently perigynous, they are certainly hypogynous in the genera *Lilium*, *Allium*, *Aloe*, *Tritoma*, &c.

[The Liliaceæ are generally more or less acrid. The bulb of *Scilla maritima* is emetic, purgative, diuretic, and expectorant. The different species of Allium are stimulant and diuretic. Aloes, in common use as a powerful purgative, are obtained from *Aloe spicata* and *perfoliata*. In Kamtschatka, the bulbs of *Lilium pomponium* are cultivated as an article of food.—Tr.]

Family XXVII.—Bromeliaceæ, *Juss.*

The Bromeliaceæ are parasitic perennial plants. Their leaves are alternate, and generally collected into a bundle at the base of the stem. They are elongated, narrow, often toothed, and spinous on the margins. In many species the whole plant is covered by a kind of ferruginous down. The flowers form scaly spikes, branched racemes, or capitula, in which they are so close together that they ultimately unite. In a small number of species, the flowers are terminal and solitary. Their calyx is tubular, sometimes adhering by its lower part to the tube of the calyx, sometimes entirely free. The limb presents six more or less deep divisions, disposed in two series, the three inner coloured and petaloid. The stamina are generally six, seldom more. The ovary has three cells, in each of which are inserted numerous ovules. The style is terminated by a stigma, with three flat or subulate divisions. The fruit is generally a berry crowned by the lobes of the calyx, with three polyspermous cells. Sometimes all the berries of the same spike unite together and form a single fruit, as in the Pineapple or Ananas. More rarely, the fruit is dry and dehiscent. The seeds are composed of a farinaceous endosperm, at the upper part of which is placed an elongated and recurved embryo.

We divide the genera of the family of Bromeliaceæ into two tribes:

1. Tillandsiæ.—Ovary free. *Tillandsia, Pitcairnia.*

2. Bromeliaceæ.—Ovary inferior. *Xerophyta*, *Guzmannia*, *Achmea*, *Bromelia*, *Agave*, *Furcræa*, &c.

The family of Bromeliaceæ is closely allied to the family of Narcisseæ, especially in its genera with inferior ovary, forming the tribe of true Bromeliaceæ; but it differs from them in its calyx, the divisions of which are in two rows, its fleshy fruits, and especially the general aspect of the plants of which it is composed.

[The Pine-apple, so well known for the richness of its fruit, belongs to this family.—Tr.]

CLASS FOURTH.—MONOËPIGYNIA.

Family XXVIII.—Dioscoreæ, *Brown.*

The Dioscoreæ are frequently sarmentaceous and climbing plants. Their leaves are alternate or sometimes opposite, with irregularly ramified nerves. Their flowers are hermaphrodite or unisexual. Their inferior ovary is adherent to a calyx, the limb of which is divided into six equal lobes. The stamina, six in number, are free, or rarely monadelphous, having their anthers directed inwards. The ovary has three cells, each containing one, two, or a greater number of ovules, which are sometimes ascending, sometimes reversed. The fruit is a thin, compressed capsule, or a globular, sometimes elongated berry, crowned by the limb of the calyx, and having from one to three cells. The seeds contain an embryo, situated towards the hilum, in the interior of a nearly horny endosperm.

This little family was proposed by Mr Brown for the reception of the genera of Jussieu's Asparagineæ with the ovary inferior; such as *Dioscorea*, *Tamnus*, *Rajania*, *Flaggea*, &c.

[The yams, which afford an important article of food in warm climates, belong to this family.—Tr.]

* Family XXIX.—Narcisseæ.

Amaryllideæ, *Brown.* *Genera of the* Narcissi *of Jussieu.*

Plants with a bulbiferous or fibrous root and radical leaves. The flowers are solitary, often very large, or disposed in sertules or simple umbels, enveloped before expansion in scarious spathæ. The calyx is monosepalous and tubular, adhering by its base to the inferior ovary, with six equal or unequal divisions. The stamina, six in number, have their filaments free, or connected by means of a membrane. The ovary has three polyspermous cells. The style is simple, and the stigma trilobate. The fruit is a capsule with three cells and three septiferous valves. Sometimes it is a berry which, through abortion, contains only from one to three seeds. The seeds, which not unfrequently present a cellular caruncula, contain, within a fleshy endosperm, a cylindrical and homotrope embryo.

Mr Brown has divided Jussieu's family of Narcissi into two natural orders, the *Hemerocallideæ*, consisting of the genera which have the ovary free, and the *Amaryllideæ*, which are the true *Narcisseæ* with inferior ovary. We have already united the Hemerocallideæ with the Liliaceæ. The genera which constitute the true Narcisseæ are: *Narcissus, Amaryllis, Pancratium, Leucojum, Galanthus,* &c. The English botanist has also removed from Jussieu's Narcissi the genus *Hypoxis,* of which he has formed a group under the name of *Hypoxideæ,* which appears to us to differ very little from the true Narcisseæ. M. Kunth has also separated from this family the genus *Pontederia,* which, with *Heteranthera,* forms the family of the *Pontederiaceæ,* the characters of which we have already traced.

[Bitter, and generally nauseous. The bulbs of several Narcissi are emetic.—Tr.]

* Family XXX.—Irideæ, *Juss.*

A very natural family, composed of plants generally herbaceous, with tuberous and fleshy, rarely fibrous roots. Their stem is cylindrical or compressed, bearing flat, ensiform, alternate leaves. Their flowers, which are often very large, are enveloped previous to expansion in a membranous, thin, or scariose spatha. These flowers are solitary or variously grouped. Their calyx is coloured, tubular, with six deep divisions, disposed in two series, and often unequal. The stamina, which are always three, are free or monadelphous, and opposite to the outer divisions of the calyx. The ovary has three polyspermous cells. The style is simple, terminated by three simple, bifid, or jagged stigmas, in the form of thin and petaloid laminæ. The fruit is a three-celled capsule, opening by three septiferous valves. The seeds are composed of a proper integument, and a cylindrical homotrope embryo, placed in a fleshy or horny endosperm.

This family, which is composed of a great number of genera, is divided into two sections, according as those genera have the stamina free or monadelphous. To the first belong the genera *Iris, Ixia, Gladiolus, Crocus, Antholyza, Watsonia,* &c.; to the other, *Sysyrinchium, Galaxia, Tigridia, Vieusseuxia, Ferraria,* &c.

The Irideæ are easily distinguished by their inferior ovary and their stamina, which are always three.

[The root of *Iris florentina* is stimulant. Saffron consists of the dried stigmas of a species of Crocus.—Tr.]

Family XXXI.—Hæmodoraceæ, *Brown.*

The Hæmodoraceæ are herbaceous, perennial plants, sometimes stemless, having simple distichous leaves, sheathing at their base, and flowers disposed in corymbs or spikes. Their calyx is monosepalous, with six deep divisions, adhering by its base to the inferior ovary, excepting in the single genus *Wachendorfia*. The stamina, which are inserted into the calyx, are six or three in number: in the latter case, they are opposite to the inner divisions. The ovary has three cells, each containing two or more ovules. The style and stigma are simple. The fruit is a capsule, sometimes indehiscent, or opening either by its summit, or by means of valves. The seeds contain a very small embryo in a rather hard endosperm.

This little family is much allied to the Irideæ in its general aspect, but differs from them in having six stamina, whereas they have only three, and in having the stamina opposite to the inner divisions of the calyx, and not to the outer, as in the Irideæ. It differs further from them in having the stigma always simple. The genera *Dilatris*, *Lanaria*, *Heritiera*, *Wachendorfia*, *Hæmodorum*, *Conostylis*, *Anigozanthos*, and *Phlebocarya*, compose this family.

[The roots of several species yield a red colour, which is used in dyeing.—Tr.]

Family XXXII.—Musaceæ, *Juss.*

Herbaceous or perennial plants, destitute of stem, sometimes furnished with a stype or cauliform bulb. Leaves on long petioles, amplexicaul at the base, entire at the margins. Flowers very large, often of the most brilliant colours, aggregated in great numbers, and contained in spathas. The calyx is irregular, coloured, petaloid, adhering by its base to the ovary; its limb, with six divisions, three outer and three inner. (In the genus *Musa*, five of the divisions are external, and form a kind of upper lip; one only is internal, and constitutes the lower lip.) The stamina, six in number, are inserted into the inner part of the divisions of the calyx; the anthers are linear, introrse, two-celled, generally surmounted by a coloured, petaloid membranous appendage, which is the termination of the filament. The inferior ovary has three cells, each containing a great number of ovules inserted at its inner angle. In the genus *Heliconia*, there is only a single ovule, springing from the bottom of each cell. The simple style is terminated by a sometimes concave, but more frequently three-lobed or tri-laminar stigma. The fruit is either a capsule, with three polyspermous cells, and three valves, each bearing one of the dissepiments on the middle of its inner surface, or a fleshy indehiscent fruit. The seeds, which are sometimes borne on a podosperm, and surrounded by circularly arranged hairs, are composed of a tegument which is sometimes crustaceous, and a farinaceous endosperm, containing an elongated, erect, axile embryo.

This family is composed of the genera *Musa*, *Heliconia*, *Strelitzia*, and *Urania*. Intermediate between the Narcisseæ and Amomeæ, it differs from the former in having the calyx always regular, and from the latter in having always six stamina.

[The juice of the stem of Musa is diaphoretic. The tender shoots of the Banana are eaten. The fruits of this family are highly nutritive.—Tr.]

Family XXXIII.—Amomeæ, *Rich.*

Cannæ, *Juss.* Scitamineæ *and* Cannæ, *Brown.* Drymyrhizeæ, *Vent.*

The Amomeæ are perennial herbaceous plants, having a very peculiar aspect, which assimilates them a little to the Orchideæ. Their root is often tuberous and fleshy; their leaves simple, terminated at their base by an entire or slit sheath, and sometimes furnished with a ligule. The flowers, which are rarely solitary, are accompanied with pretty large bracteas, and generally form dense spikes or panicles. Their calyx is double: the outer, sometimes tubular and shorter, has three equal divisions; the inner has its limb double, the three outer divisions generally equal; of the three inner one is larger and dissimilar, and forms a kind of lip, the two lateral are smaller, often abortive. There is only one stamen, the filament of which is often dilated, and in some degree petaloid. The anther has two cells, which are somewhat separated and distinct. The ovary has three polyspermous cells. The style is simple, terminated by a concave cup-shaped stigma. At the base of the style, on the summit of the ovary, is a small two-lobed tubercle, which may be considered as two abortive stamina. The fruit is a three-celled capsule, opening by three valves, each bearing a dissepiment on the middle of their inner surface. The seeds, sometimes accompanied by an arillus, consist of a cylindrical embryo placed in a farinaceous endosperm, and having its radicle turned towards the hilum.

The description which we have above given of the characters of the family of Amomeæ is similar to that which has been traced by most authors; but it might receive another, more in conformity with its natural affinities. Thus the Amomeæ, which have the greatest affinity to the Musaceæ, may be described as having six stamina and a perianth with six divisions, like the latter. One of these stamina is fertile, the other five are sterile; two are represented by the bilobate tubercle which exists at the base of the style, and the other three are converted into petaloid appendages, and are represented by the three innermost divisions of the calyx. This description of the flower of the Amomeæ accords with nature, and, in this manner, the family is naturally allied to the Musaceæ, on the one hand, which are, as it were, its regular type, and to the Orchideæ, on the other hand, in which are observed similar abortions and transformations. M. Lestiboudois, Professor of Botany at Lille, first directed the attention of botanists to the structure of the flower of the Amomeæ; but we by no means agree with him in thinking that this family ought to be united to the Musaceæ.

Mr Brown has proposed separating from the Amomeæ, some genera, such as *Canna, Maranta, Thalia, Phrynium*, and *Myrosma*, to form of them a distinct family under the name of *Canneæ*.

Besides the genera above mentioned, the Amomeæ include *Amomum*, *Zinziber*, *Hellenia*, *Costus*, &c.

[This family is remarkable for an aromatic, stimulating essential oil, found chiefly in the roots and seeds. Cardamoms are the seeds of several species of *Amomum*. Turmeric, which is a carminative, as well as a dye, is obtained from the roots of *Curcuma longa*. Ginger and Zedoary are the roots of *Zinziber officinalis* and *Curcuma Zedoaria*. The roots of several species of *Maranta* abound in fecula, which is extracted and employed as a delicate article of food under the name of Arrow-root.—Tr.]

* Family XXXIV.—Orchideæ, *Juss.*

Perennial herbaceous plants, sometimes parasitic on other vegetables, having a root composed of simple and cylindrical fibres, often accompanied by one or two fleshy, ovoidal or globular, entire or digitate tubercles. The leaves are always simple, alternate, and sheathing; the flowers, which are often very large, and of a peculiar form, are solitary, fasciculate, in spikes, or in panicles. Their calyx has six deep divisions, three inner and three outer. The outer, which are not unfrequently similar, are spreading, or placed close upon each other at the upper part of the flower, where they form a kind of helmet *(Calyx galeatus)*. Of the three inner divisions two are lateral, superior and similar, one inferior, of a peculiar form, and bearing the name of *lip*. It sometimes presents at its base a hollow prolongation named the *spur (Labellum calcaratum)*. From the centre of the flower there rises upon the summit of the ovary a kind of little column named *gynostemum*, which is formed by the style and the filaments of the stamina united, and which bears at its anterior and upper surface a glandular cavity, which is the stigma, and at its summit a two-celled anther, opening either by a longitudinal suture, or by an operculum which forms all its upper part. The pollen contained in each cell of the anther is united into a mass having the same form as the cavity which contains it. At the summit of the gynostemum, on the lateral parts of the anther, are two small tubercles which are two abortive stamina, and which are named *staminodia*. These two stamina are, on the contrary, developed in the genus *Cypripedium*, while the middle one is abortive. The fruit is a capsule with a single cell, containing a very large number of very small seeds attached to three parietal trophosperms, which are prominent and bifurcate on the inner side. The seeds have their outer integument formed of a slight web, and are composed of an endosperm, in which is a very small axile and homotrope embryo.

This family, which may be considered as one of the most natural of the vegetable kingdom, presents such remarkable peculiarities in the organization of its flower, that it cannot be confounded with any other. The union of the stamina with the filament and stigma, and especially the organization of the pollen which is united into a mass (a character observed only in the Asclepiadeæ and in some Mimosæ among the Dicotyledones), are the most prominent distinctive characters of this family. The pollen-masses present three principal modifications in their composition, which have served as the basis of three tribes in the family of Orchideæ. Sometimes they are formed of pretty large granules, cohering by means of a viscous matter, which, when one tries to separate them, elongates in the form of an elastic thread. These pollen-masses are named sectile. They characterize the first tribe, or the OPHRYDEÆ, which contains, among others, the genera *Orchis*, *Ophrys*, *Satyrium*, *Serapias*, *Habenaria*, &c. Sometimes the pollen-masses are pulverulent, that is, formed of a pultaceous kind of matter. This is the case in the second tribe, that of the LIMODOREÆ, which contains the genera *Limodorum*, *Epipactis*, &c. Lastly, each pollen-mass may be formed of granules so closely cohering and blended as to present the appearance of a mass of wax. In this case, which occurs in the third tribe, or that of the EPIDENDREÆ, they are said to be solid. Examples: *Epidendrum*, *Angræcum*, *Malaxis*, *Liparis*, &c.

The pollen-masses are sometimes prolonged at their lower part into a filiform appendage named the *caudicle*, which is often terminated by a viscous gland of diversified form, which is named *retinaculum*. The number of these pollen-masses varies from one to four in each cell of the anther. The anther is sometimes placed at the fore and upper surface of the gynostemum, from which it is not distinct, as in the tribe of Ophrydeæ; sometimes it is placed in a hollow which terminates the gynostemum at its summit, and which is named the *clinandrum*, and it opens and rises like a kind of lid *(anthera operculiformis)*, as in almost all the genera of the other two tribes.

[This beautiful and extensive family is not of much importance in an economical point of view. Salep, a nutritive substance, consisting almost entirely of bassorin, is prepared from the tubers of *Orchis mascula*, and some other species.—Tr.]

* Family XXXV.—Hydrocharideæ, *Juss.*

Aquatic herbaceous plants, having the stem-leaves entire or minutely toothed, sometimes spread out at the surface of the water. The flowers, which are contained in spathæ, are in general diœcious, very rarely hermaphrodite. The male flowers, usually placed several together, are sometimes sessile, sometimes pedicellate. The female and hermaphrodite flowers are always sessile and contained in a uniflorous spatha. The calyx has always six divisions, three inner, which are petaloid, and three outer. The number of stamina varies from one to thirteen. The ovary is inferior, sometimes attenuated at its upper part into a filiform prolongation, which rises above the spatha, and takes place of the style. The stigmas are from three to six, bifid or bipartite, rarely simple. The fruit is internally fleshy, presenting a cavity which is single, or divided by membranous dissepiments into as many cells as there are stigmas. The seeds, which are numerous and enveloped in a kind of pulp, are erect, having a very thin, membranous proper tegument, immediately covering the embryo, which is straight and cylindrical.

Of the genera of which this family is composed, we may mention *Vallisneria*, *Stratiotes*, *Hydrocharis*, *Limnobium*, and *Ottelia*.

This family is well characterized by its inferior ovary, its divided stigmas, the internal organization of its fruit, which is the same as that of the fruits of the Cucurbitaceæ, and its embryo, which is destitute of endosperm.

* Family XXXVI.—Nymphæaceæ, *Salisb.*

Large and beautiful plants, floating upon the water, and with their stem forming a creeping subterranean rhizoma. Their entire alternate leaves are cordiform or orbicular, and are supported on very long petioles. Their flowers are very large, solitary, and supported by very long cylindrical peduncles. The calyx is formed of a variable, sometimes very great number of sepals, disposed in several series, so as to represent in some measure a calyx and a polypetalous corolla. The stamina are very numerous, inserted in several series beneath the ovary, or even upon its outer wall, which is thus covered by the stamina and by the inner sepals, which are probably only transformed stamina, as is proved by the gradual dilatation of the filaments the more external they are. The anthers are introrsal, and furnished with two linear cells. The ovary is free and sessile at the bottom of the flower, divided internally into several cells by membranous dissepiments, on the walls of which are inserted numerous pendent ovules. The summit of the ovary is crowned by as many stigmas as there are cells to the ovary. These stigmas united form a kind of disk, which crowns the ovary. The fruit is indehiscent and internally fleshy, with several polyspermous cells. The seeds have a thick integument, sometimes developed in the form of a network, containing a large farinaceous endosperm, which bears at its summit an irregularly globular or napiform embryo, the radicle of which is always turned towards the hilum. The cotyledon is thin, and has the form of a peculiar envelope covering the gemmule, which is two-lobed.

This family, which is composed of the genera *Nymphæa* and *Nuphar*, is still a subject of controversy among botanists, some placing it among the Monocotyledones, others among the Dicotyledones, near the Papaveraceæ; but the structure of the embryo, and the germination, are certainly those of the other monocotyledonous plants. See the article *Nymphéacées* in *Dictionnaire Classique d'Histoire Naturelle*, vol. xii., in which we carefully discuss these different opinions. We here conclude the article referred to, by the following observation:—Should the genus *Nelumbium* be left in the family of Nymphæaceæ, or should it be made the type of a distinct family? We do not pretend to solve this question. The general aspect is absolutely the same; and it may appear very strange to separate, as distinct orders, two genera which some botanists, with Linnæus at their head, have considered as forming the same genus. But, on the other hand, we ask if it be possible to admit in the same family, two genera, one of which has a simple ovary, with several polyspermous cells, surmounted by as many stigmas as there are cells, and of which the numerous ovules are attached to the whole extent of the walls of the dissepiments, and of which the other having, at the centre of its flower, a very large receptacle or torus, in the form of a reversed cone, presents a great number of unilocular, monospermous, distinct pistils implanted in alveoli formed in the upper face of this receptacle;—two genera, one of which is furnished with a very large fleshy endosperm, which is totally wanting in the other. These differences appear to us so important, that we are disposed to consider them sufficient for establishing two distinct families, which, however, ought to remain close to each other.

[The stems and leaves are bitter and somewhat astringent, the roots more so. The latter have sometimes been used as food. In some parts of Scotland, the roots of *Nymphœa alba* are used for dying black, like those of *Tormentilla officinalis.*—Tr.]

Family XXXVII.—Balanophoreæ, *Rich.*

A small family, composed of parasitic plants of a peculiar aspect, having some resemblance to the Clandestinæ and Orobancheæ, and, like the latter, always living implanted upon the roots of other vegetables. Their stem, which is leafless, is covered with scales, or naked. The flowers are monœcious, forming very dense ovoidal spikes. In the male flowers the calyx has three deep, equal and spreading divisions. In some rare cases the calyx is substituted by a scale. The stamina are from one to three in number, seldom more. They are united both by their anthers and by their filaments. In the female flowers the ovary is inferior, one-celled, containing a single reversed ovule. The limb of the calyx which crowns the ovary is entire or formed of from two to four unequal divisions. There are one or two filiform styles, terminated by as many simple stigmas. The fruit is an umbilicate globular cariopsis. The globule contains a very small globular embryo, placed in a small superficial cavity of a very large fleshy endosperm.

The genera of which this little family is composed are *Helosis, Langsdorffia, Cynomorium* and *Balanophora.* It has relations to the Aroideæ and Hydrocharideæ.

DICOTYLEDONOUS PLANTS.

The Dicotyledonous Plants are all those whose embryo has two cotyledons. In a single family, that of the Coniferæ, there are often from three to ten verticillate cotyledons.

The internal organization of the stem, of which all the parts are disposed in concentric layers—the disposition and mode of branching of the nerves—the circumstance of five or one of its multiples being the prevalent number in almost every part of the flower—the very frequent presence of a calyx and a corolla—and, lastly, the general aspect, so different from that of the monocotyledons, are the principal characters which distinguish the dicotyledonous plants from those which are monocotyledonous.

The Dicotyledones have been primarily divided into Apetalous, Monopetalous, Polypetalous, and Diclinous.

I. APETALOUS DICOTYLEDONES.

FIFTH CLASS.—EPISTAMINIA.

* FAMILY XXXVIII.—ARISTOLOCHIÆ, *Juss.*

THIS family is composed of only two genera *Aristolochia* and *Asarum* *. It consists of herbaceous or frutescent and twining plants, bearing alternate, entire leaves, and axillar flowers. Their calyx is regular, with three valvar divisions, or irregular, tubular, and forming a lip of very diversified figure. The stamina, ten or twelve in number, are inserted upon the ovary. They are sometimes free and distinct, sometimes intimately united with the style and stigma, and thus forming a kind of nipple placed at the summit of the ovary. On its lateral parts this nipple bears the six stamina, which are bilocular, and at its summit is terminated by six small lobes, which may be considered as the stigmas. The fruit is a capsule, or a berry with three or six cells, each containing a very large number of seeds

* Mr Brown refers also to this family, which he names *Azamiæ*, the genera *Thottea* and *Bragantia*.

containing a very small embryo placed in a fleshy endosperm.

Jussieu united to this family the genus *Cytinus*, which has become the type of a distinct family, under the name of *Cytineæ*.

[The roots of the plants of this family are generally tonic and stimulant, and have also been employed as emenagogues. The root of *Aristolochia serpentaria*, which is aromatic, with a pungent taste, has been used with success in typhus. Asarabacca is diuretic, and is employed as an external application for ophthalmia.—Tr.]

Family XXXIX.—Cytineæ, *Brown*.

The flowers are unisexual, monœcious or diœcious. The calyx is adherent, rarely free *(Nepenthes)*. Its limb has four or five divisions. The stamina vary from eight to sixteen, sometimes a greater number. They are extrorsal and monadelphous. The ovary is inferior, excepting in *Nepenthes*, with one or four cells. The seeds are attached to parietal trophosperms. The style is cylindrical, rarely wanting, and is terminated by a stigma of which the lobes are equal to that of the trophosperms. The seeds have an axile cylindrical embryo, placed in the centre of a fleshy endosperm.

The genera which compose this small family are *Cytinus, Rafflesia*, and *Nepenthes*. The first two are parasitic, and destitute of leaves. The other is remarkable for having its leaves terminated by a kind of bottle, which shuts by means of a moveable lid. This family is distinguished from the Aristolochiæ by having its seeds attached to parietal trophosperms, by its unisexual flowers, and by the quaternary or quinary number of the different parts of the flower.

[Generally astringent, but their properties are little known. —Tr.]

Family XL.—Santalaceæ, *Brown*.

Herbaceous or frutescent plants, or trees with alternate, rarely opposite leaves, destitute of stipules, and small flowers, either solitary or disposed in a spike or sertule. Their calyx is superior, with four or five valvar divisions. The stamina, four or five in number, are opposite to the divisions of the calyx, and inserted at their base. The ovary is inferior, with a single cell, containing one, two or four ovules, which hang from the summit of a filiform podosperm, springing from the bottom of the cell. The style is simple, terminated by a lobed stigma. The fruit is indehiscent, monospermous, sometimes slightly fleshy. The seed presents an axile embryo in a fleshy endosperm.

This family, which was established by Brown, is composed of the genera *Thesium*, *Quinchamalium*, *Osyris*, and *Fusanus*, placed by Jussieu in the family of Eleagneæ, and of the genus *Santalum*, which formed part of the Onagrariæ. It differs especially from the Eleagneæ, in having the ovary inferior, and containing several pendent ovules; whereas, in the latter, the ovary is free, and contains a single erect ovule. It is also allied to the family of Combretaceæ, but this is distinguished by its ovules, which are pendent from the summit of the cell of the ovary, by its seeds, which are destitute of endosperm, and by the polypetalous corolla, which is observed in some of its genera.

SIXTH CLASS.—PERISTAMINIA.

* Family XLI.—Elæagneæ, *A. Rich*.

Some genera of Elæagni *of Jussieu.*

Trees or shrubs, with alternate or opposite leaves, which are destitute of stipules and entire. Their flowers are diœcious or hermaphrodite; the male ones sometimes disposed in a kind of catkin. The calyx is monosepalous and tubular; its limb entire, or with two or four divisions. The stamina, from three to eight in number, are introrsal and nearly sessile on the inner wall of the calyx. In the female flowers, the tube of the calyx directly covers the ovary, but without adhering to it. The entrance of the tube is sometimes partly closed by a variously lobed disk. The ovary is free, unilocular, and contains a single ascending, pedicellate, ovary. The style is short, the stigma simple, elongated, and linguiform. The fruit is a crustaceous akenium, covered by the calyx, which has become fleshy. The seed contains, in a very thin endosperm, an embryo which has the same direction.

The family of Elæagneæ, such as it was proposed by M. de Jussieu, consisted of rather discrepant genera. Mr Brown was the first who brought it within natural limits, by reducing it to the genera *Elæagnus* and *Hippophäe*, to which we have added the two new genera *Shepherdia* and *Conuleum*, all which have the ovary free and monospermous. Jussieu had already withdrawn from the Eleagnæ, the genera *Terminalia*, *Bucida*, *Pamea*, &c. to form of them the family of *Terminaliaceæ;* but Mr Brown has made three families of the genera originally referred to the Eleagneæ: 1. The true *Elæagneæ*, such as we have above characterized them; 2. The *Santalaceæ*, which have an inferior ovary, and one or more pendent ovules at the summit of a basilar podosperm; 3. The *Combretaceæ*, which comprehend most of the genera of Jussieu's *Terminaliaceæ*, and some genera previously placed among the Onagrariæ.

* Family XLII.—Thymeleæ, *Juss.*

Shrubs, rarely herbaceous plants, with alternate or opposite, entire leaves, having the flowers terminal or axillar, in sertules, spikes, solitary, or several together in the axils of the leaves. The calyx is generally coloured and petaloid, more or less tubular, with four or five divisions, which are imbricated before expansion. The stamina, generally eight in number, disposed in two series, or four, or only two, are inserted sessile upon the inner wall of the calyx. The ovary is unilocular, and contains a single pendent ovule. The style is simple, terminated by an equally simple stigma. The fruit is a kind of nut slightly fleshy externally. The embryo, which is reversed like the seed, is contained in a fleshy and thin endosperm.

The principal genera of this family are: *Daphne*, *Stellera*, *Passerina*, *Pimelia*, *Struthiola*, &c.

[The bark is extremely acrid, or caustic, blistering the skin. Decoction of Daphne Mezereon has been employed in constitutional syphilis. The Lace-tree, Daphne Laghetto, is remarkable for the reticulated appearance of the liber, which may be pulled out in many successive layers.—Tr.]

Family XLIII.—Proteaceæ, *Juss.*

The Proteaceæ are all shrubs or trees, which grow in abundance at the Cape of Good Hope, and in New Holland. Their leaves are alternate, sometimes nearly verticillate or imbricate. Their flowers, which are generally hermaphrodite, rarely unisexual, are sometimes grouped in the axillæ of the leaves, sometimes collected into a kind of cone or catkin. Their calyx consists of four linear sepals, sometimes united, and forming a tubular calyx with four more or less deep and valvar divisions. The stamina, four in number, are opposite to the sepals, and almost sessile at the summit of their inner surface. The ovary is free, with a single cell, containing a seed attached about the middle of its height. The style is terminated by a usually simple stigma. The fruits are capsules of various forms, unilocular and monospermous, opening on one side by a longitudinal suture, and by their aggregation sometimes forming a kind of cone. The seed, which is occasionally winged, consists of a straight embryo destitute of endosperm.

The genera of this family are numerous. We shall here mention as examples *Protea, Petrophila, Banksia, Grevillea, Embothrium, Hakea,* &c. This family, on account of the form of its calyx, its stamina sessile at the summit of the sepals, and especially its general aspect, cannot be confounded with any other.

Family XLIV.—Laurineæ, *Juss.*

Trees or shrubs with alternate, rarely opposite, entire or lobed, very frequently coriaceous, persistent, dotted leaves. The flowers, sometimes unisexual, are disposed in panicles or cymes. The calyx is monosepalous, with four or six deep divisions, imbricated by their edges previous to expansion. The stamina are from eight to twelve, inserted at the base of the calyx. Their filaments have at their base two pedicellate appendages, of diversified form, and appearing to be abortive stamina. The anthers are terminal, opening by means of two or four valves, which rise from the base to the summit. The ovary is free, unilocular, containing a single pendent ovule. The style is more or less elongated, and is terminated by a simple stigma. The fruit is fleshy, accompanied at its base by the calyx, which forms a kind of cupula. The seed contains under its proper integument a very large embryo, reversed like the seed, with extremely thick and fleshy cotyledons.

The type of this family is formed by the Laurel and some genera allied to it, as *Borbonia, Ocotea,* and *Cassytha.* The last mentioned genus is remarkable for being composed of herbaceous twining and leafless plants. Jussieu united *Myristica* with the Laurineæ, but Mr Brown has justly removed it to form a distinct family under the name of *Myristiceæ.* The family of Laurineæ is chiefly characterized by its peculiar aspect, and by its stamina, the anthers of which open by means of valves. The same character is observed in the Hamamelideæ and Berberideæ; but the last mentioned family belongs to the class of hypogynoüs polypetalous dicotyledones.

[Aromatic, pungent, stomachic. Cinnamon, cassia, and camphor are obtained from various species of Laurus. The bark of Laurus Benzoin is employed in America in intermittent fevers.—Tr.]

Family XLV.—Myristiceæ, *Brown.*

Tropical trees with alternate, entire leaves, which are not dotted, and diœcious axillar or terminal flowers, variously disposed. Their monosepalous calyx has four valvar divisions. In the male flowers there are from three to twelve monadelphous stamina, the anthers placed close together, often united, and opening by a longitudinal groove. In the female flowers the ovary is free, with a single cell, containing a single erect ovule. The style is very short, terminated by a lobed stigma. The fruit is a kind of capsular berry, opening with two valves. The seed is covered by a fleshy arillus, divided into a great number of shreds. The endosperm is fleshy or very hard, mottled, and contains towards its base a very small erect embryo.

The type of this family is the Nutmeg-tree. It is very distinct from the Laurineæ in having its calyx with three divisions; its stamina monadelphous, and opening by a longitudinal groove; its seed erect, and furnished with an arillus; and its embryo very small, and contained in a hard and marbled endosperm.

[Nutmeg and Mace, the fruit of *Myristica moschata*, are possessed of aromatic and stimulant properties.—Tr.]

* Family XLVI.—Polygoneæ, *Juss.*

Herbaceous, rarely suffrutescent plants, with alternate leaves, sheathing at their base, or adhering to a membranous and stipular sheath, rolled downwards upon their middle nerve when young. Flowers sometimes unisexual, disposed in cylindrical spikes or in terminal clusters. Calyx monosepalous, with from four to six segments, sometimes disposed in two rows, and imbricated previous to their evolution. Stamina from four to nine, free, and with anthers opening longitudinally. Ovary free, unilocular, with a single erect ovule; the fruit, which is pretty frequently triangular, is dry and indehiscent, sometimes covered by the persistent calyx. The seed contains, in a farinaceous, sometimes very thin endosperm, a reversed and often unilateral embryo.

This family is composed of the genera *Polygonum*, *Rumex*, *Rheum*, *Coccoloba*, &c. It is distinguished from the Chenopodeæ by the stipular sheath of its leaves, its erect ovule, and its reversed embryo.

[The roots of many species are astringent, as of the *Rumices* generally. Those of *Rheum* are well known as a common purgative. *Polygonum Hydropiper* is extremely acrid, and blisters the mouth when tasted. The seeds of *Polygonum Fagopyrum*, or Buck-wheat, which is extensively cultivated in France, are used as food. The leaves and young stems of *Rumex Acetosa* and *Acetosella* are agreeably acid, as are those of *Oxyria reniformis*.—Tr.]

* Family XLVII.—Atriplices, *Juss.* Chenopodeæ, *De Candolle.*

Herbaceous or woody plants, with alternate or opposite leaves, destitute of stipules. The flowers are small, sometimes unisexual, disposed in branched clusters, or grouped in the axilla of the leaves. The calyx is monosepalous, sometimes tubular at the base, with three, four or five, more or less deep, persistent lobes. The stamina vary from one to five. They are inserted either at the base of the calyx, or under the ovary, and are opposite to the lobes of the calyx. The ovary is free, unilocular, monospermous, containing a single erect ovule, which is sometimes supported upon a more or less long and slender podosperm. The style, which is rarely simple, has two, three or four divisions, each terminated by a subulate stigma. The fruit is an akenium, or a small berry. The seed is composed beneath its proper integument of a slender cylindrical embryo, curved back upon a farinaceous endosperm, or spirally twisted, and sometimes without endosperm.

This family is composed of the genera *Chenopodium*, *Atriplex*, *Salsola*, *Beta*, *Salicornia*, &c. It is closely connected, on the one hand, with the Polygoneæ, which differ from it in the stipular sheath of their leaves, their straight embryo, and their superior radicle; and, on the other, with the Amaranthaceæ, from which, in fact, they differ only in their general aspect, and in some characters of little importance. The Chenopodeæ present examples of genera having a perigynous insertion, such as *Beta*, *Blitum*, *Spinacia*, and others in greater number, which have the insertion hypogynous, such as *Rivinia*, *Salsola*, *Camphorosma*, *Chenopodium*, &c.

[The maritime species yield soda, and are employed in the manufacture of barilla. From the root of *Beta vulgaris* sugar is obtained. The roots and herbage of many species are employed as articles of food. *Chenopodium olidum* is remarkable for its abominable smell, resembling that of putrid fish.—Tr.]

SEVENTH CLASS.—HYPOSTAMINIA.

Family XLVIII.—Amaranthaceæ, *Brown.*

Part of the Amaranthaceæ *of Jussieu.*

The Amaranthaceæ are herbaceous or suffrutescent plants, bearing alternate or opposite leaves, sometimes furnished with scariose stipules. The flowers are small, often hermaphrodite, sometimes unisexual, disposed in spikes, panicles, or capitula, and furnished with scales, by which they are separated. The calyx is monosepalous, often persistent, with four or five very deep divisions. The stamina vary from three to five. Their filaments are sometimes free, sometimes monadelphous, and occasionally form a membranous tube, lobed at its summit, and bearing the anthers on its inner surface. The ovary is free, unilocular, containing a single erect ovule, sometimes borne upon a very long, recurved podosperm, at the summit of which they hang. The style is simple or wanting, and is terminated by two or three stigmas. The fruit, which is generally surrounded by the calyx, is an akenium or a small pyxidium, opening by means of a lid. The embryo is cylindrical, elongated, recurved around a farinaceous endosperm.

This family, which is composed of the genera *Amaranthus, Celosia, Gomphrena, Achyranthes*, &c., is so closely allied to the Chenopodeæ, that it is extremely difficult to trace the boundary by which they are separated. In fact, the insertion, which is generally perigynous in the Chenopodeæ, is also hypogynous in several genera, as we have already said; but the general aspect of these two families is entirely different. The stamina are often monadelphous in the Amaranthaceæ, which have also sometimes the leaves opposite. But, although these distinctive characters are not very important, it is yet difficult to unite two families which appear perfectly distinct, when we consider their general appearance only.

From the Amaranthaceæ are separated certain genera with perigynous stamina, as *Illecebrum, Paronychia*, &c., which, together with some others removed from the Caryophylleæ, form a distinct family under the name of Paronychieæ.

[Several species are used as salads, or pot-herbs.—Tr.]

Family XLIX.—Nyctagineæ, *Juss.*

The Nyctagineæ are herbaceous plants, shrubs, or even trees, with simple, generally opposite, sometimes alternate leaves. The flowers are axillar or terminal, often collected several together in a common, proper, and calyciform involucre. Their calyx is monosepalous, coloured, often tubular, bulging at its lower part, which is often thicker, and persists after the fall of the upper part. The limb is more or less divided into plaited lobes. The stamina vary from five to ten, and are inserted upon the upper edge of a kind of hypogynous disk, often in the form of a capsule. The ovary is one-celled, and contains an erect ovule. The style and stigma are simple. The fruit is a cariopsis, covered by the disk and the lower part of the calyx, which are crustaceous, and form a kind of accessory pericarp. The true pericarp is thin, and adheres to the proper tegument of the seed. The seed is composed of an embryo, curved upon itself, having its radicle bent back upon the face of one of the cotyledons, and thus embracing the endosperm, which is central.

The genera *Nyctago, Allionia, Pisonia, Boerhaavia,* &c., belong to this family. Some authors, setting out with the genera whose involucre is uniflorous, as in Nyctago, or the Marvel of Peru, have considered the involucre as a calyx, and the calyx as a corolla; but analogy, and especially the genera which have an involucre containing several flowers, prove the perianth to be really single.

[The roots generally purgative.—Tr.]

EIGHTH CLASS.—HYPOCOROLLIA.

* Family L.—Plantagineæ, *Juss.*

A small family of plants containing only the genera *Plantago* and *Littorella*, and characterized as follows:—

Flowers hermaphrodite, unisexual in *Littorella*, forming simple, cylindrical, elongated, or globular spikes; the flowers rarely solitary. The calyx has four deep, persistent divisions, or four unequal sepals, in the form of scales, two of them more external. The corolla is monopetalous, tubular, with four regular divisions, seldom entire at its summit. In the genus *Plantago*, the corolla gives attachment to four protruded stamina, which in *Littorella* spring from the receptacle. The ovary is free, with one, two, or very rarely four cells, containing one or more ovules. The style is capillar, terminated by a simple subulate stigma, rarely bifid at the tip. The fruit is a small pyxidium, covered by the persistent corolla. The seeds are composed of a proper integument, which covers a fleshy endosperm, at the centre of which is a cylindrical axile and homotrope embryo.

The Plantagineæ are herbaceous, rarely suffrutescent plants, often stemless, and having only radical peduncles which bear spikes of very dense flowers. Their leaves are often radical, entire, toothed, or variously incised. They grow in all latitudes. Jussieu, and most other botanists, consider the Plantagineæ as truly apetalous. That illustrious botanist views, as the calyx, the organ which we have described as the corolla, and our calyx as a collection of bracteas; but it seems to us that, from the constancy and regularity of these two organs, they ought rather to be considered as a double perianth, as the celebrated Mr Brown has more recently admitted.

The Plantagineæ are very nearly allied to the Plumbagineæ, from which they differ more especially in having the style simple, and the ovary with two cells, which are often polyspermous, whereas it is always unilocular, and contains a single ovule hanging from the summit of a basilar and erect podosperm in the Plumbagineæ.

[The seeds of *Plantago Ispaghula* and *Psyllium*, form, with water, a mucilage, which, in India, is employed as a demulcent. The herbage is bitter, but without remarkable properties.—Tr.]

* Family LI.—Plumbagineæ, *Juss.*

A natural family of dicotyledonous plants, placed by some among the Apetalæ, and by others among the Monopetalæ. They are herbaceous or suffrutescent plants, with alternate leaves, sometimes all collected at the base of the stem, and sheathing. The flowers are disposed in spikes, or in branched and terminal racemes. Their calyx is monosepalous, tubular, plicate and persistent, generally with five divisions. The corolla is sometimes monopetalous, sometimes formed of five equal petals, which not unfrequently are united together at the base. The stamina, generally five in number, and opposite to the divisions of the corolla, are epipetalous, when the corolla is polypetalous, and immediately hypogynous when the corolla is monopetalous (which is the reverse of the general disposition). The ovary is free, pretty frequently five-cornered, with a single cell, containing an ovule hanging to the summit of a filiform and basilar podosperm. The styles, from three to five in number, are terminated by an equal number of subulate stigmas. The fruit is an akenium enveloped by the calyx. The seed is composed of a proper integument and a farinaceous endosperm, in the centre of which is an embryo having the same direction as the seed.

This little family is composed of the genera *Plumbago*, *Statice*, *Limonium*, *Vogelia* of Lamarck, *Theta* of Loureiro, *Ægialitis* of Brown. It differs from the Nyctagineæ, which are monoperianthous, in having its ovule supported upon a long podosperm, at the summit of which it hangs, in having several styles and stigmas, in having the embryo straight and not bent upon itself, &c.

[Tonic, astringent, or acrid. The root of *Statice caroliniana* is powerfully astringent. Those of several species of *Plumbago* are extremely caustic, and have been employed as rubefacients and vesicatories, as well as in the treatment of ulcers.—Tr.]

* Family LII.—Primulaceæ, *Vent.* Lysimachiæ, *Juss.*

The Primulaceæ are annual or perennial plants, with opposite or verticillate, very rarely scattered, leaves. Their flowers are disposed in spikes, or in axillar or terminal racemes; sometimes they are solitary, or variously grouped. The calyx is monosepalous, with five or four divisions; the corolla monopetalous and regular, sometimes tubular at the base, sometimes very deeply divided into five segments. The stamina, five in number, are either free or monadelphous, and are inserted at the upper part of the tube of the corolla, or at the base of its divisions. They are opposite to the divisions, and their introrsal anthers open each by a longitudinal groove. The ovary is free, with a single cell, containing a very great number of ovules attached to a central trophosperm. The style and the stigma are simple. The fruit is a unilocular, polyspermous capsule, opening by three or five valves, or an operculate pyxidium. The seeds present a cylindrical embryo placed transversely to the hilum in a fleshy endosperm.

The principal genera which compose this family are: *Primula, Lysimachia, Hottonia, Anagallis, Cyclamen, Centunculus,* &c. *Samolus* has also been united to it, although its ovary is, to a great extent, adherent to the calyx. In all its other characters, however, it agrees with this family.

The Primulaceæ are very well characterized by their stamina being opposite to the divisions of the corolla, their unilocular capsule, the seeds of which are attached to a central trophosperm, and their embryo placed transversely before the hilum. In these different characters, they come very near the Myrsineæ, which differ in having the fruit fleshy, and the seeds immersed in pits of the trophosperm, which is fleshy and very large.

[The root of *Cyclamen* is acrid, but the family is not distinguished by any remarkable properties.—Tr.]

* FAMILY LIII.—LENTIBULARIÆ, *Rich.*

A SMALL family, consisting of only two genera, *Utricularia* and *Pinguicula,* which were formerly placed at the end of the Primulaceæ. They are small herbaceous plants, growing among water, or in moist and inundated places. Their leaves are either clustered in a rosaceous form, at the base of the stems, or divided into capillar, and often vesicular segments, in the species which grow immersed in the water. The stem is always simple, bearing one or several flowers at its extremity. The calyx is persistent, monosepalous, and as it were divided into two lips. The corolla is monopetalous, irregular, spurred, and also two-lipped. The stamina, two in number, are included, and are inserted at the very base of the corolla. The ovary is one-celled, and contains a great number of ovules attached to a central trophosperm. The style is simple and very short; the stigma bilamellate. The fruit is a unilocular, polyspermous capsule, opening either transversely, or by a longitudinal slit, which divides its summit into two valves. The seeds present an embryo immediately covered by the proper integument.

This small family is distinguished from the Primulaceæ by its irregular corolla, its two stamina, and its embryo destitute of endosperm; and from the Antirrhineæ by its one-celled fruit, of which the trophosperm is central, and its embryo destitute of endosperm.

FAMILY LIV.—GLOBULARIÆ, *De Cand.*

The genus *Globularia,* which was at first placed among the Primulaceæ, constitutes of itself this little family, of which the following are the principal characters. The calyx is monosepalous, tubular, persistent, with five divisions.

The corolla is monopetalous, tubular, irregular, with five narrow, unequal segments, disposed so as to form two lips. The stamina, four or five in number, are alternate with the divisions of the corolla. The ovary is unilocular, containing a single pendent ovule. The style is slender, and terminated by a stigma with two tubular and unequal divisions. At the base of the ovary is a small unilateral disk. The fruit is an akenium covered by the calyx. The embryo is nearly cylindrical, axile, and placed in a fleshy endosperm.

The Globulariæ are herbaceous or suffrutescent plants, with leaves all radical or alternate, and small bluish flowers collected into a globular capitulum, and accompanied with bracteas. They differ from the Primulaceæ in having their corolla irregular, their stamina alternate, and their ovary containing a single reversed ovule.

* Family LV.—Orobancheæ, *Vent.*

Plants sometimes parasitic on the roots of other plants, sometimes growing in the earth. Their stem is sometimes destitute of leaves, which are substituted by scales. The flowers, which are accompanied by bracteas, are terminal, sometimes solitary, sometimes disposed in a spike. The calyx is monosepalous and tubular, or divided to the base into distinct sepals. The corolla is monopetalous, irregular, often two-lipped. The stamina are generally didynamous. The ovary, which is applied upon a hypogynous and annular disk, has only one cell, which contains very numerous ovules attached to two parietal trophosperms, bifid on their free side. The style is terminated by a stigma with two unequal lobes. The fruit is a unilocular capsule, opening into two valves, each of which bears a trophosperm on the middle of its inner face. The seeds, which have a double integument, present a fleshy endosperm, which bears a very small embryo placed in a depression in its upper and lateral part.

The genera *Orobanche, Phelippea, Lathræa,* &c., form this family, which differs from the Scrophularinæ in its unilocular ovary, the position of the embryo, and especially the general appearance of the plants of which it is composed.

[Astringent, but of little importance in a medical point of view.—Tr.]

* Family LV.—Scrophularinæ, *Brown.*

Scrophulariæ *and* Pediculares, *Juss.*

Herbs or shrubs, with simple leaves, which are often opposite, sometimes alternate, and flowers disposed in spikes or terminal racemes. Their calyx is monosepalous, persistent, with four or five unequal divisions. The corolla is monopetalous, irregular, two-lipped, and often personate. The stamina, from two or four in number, are in the latter case didynamous. The ovary, applied upon a hypogynous disk, has two polyspermous cells. The style is simple, terminated by a two-lobed stigma. The fruit is a bilocular capsule, varying much in its mode of dehiscence. Sometimes it opens by holes formed towards the summit, sometimes by irregular plates, sometimes by two or four valves, each bearing the half of the dissepiment on the middle of its inner face, or opposite to the dissepiment which remains entire. The seeds contain, under their proper integument, a kernel, composed of a fleshy endosperm, which encloses a straight cylindrical embryo, having its radicle directed towards the hilum, or opposite to that point of attachment.

We have followed the example of Mr Brown, who unites into one the two families proposed by Jussieu under the names of *Scrophulariæ* and *Pediculares.* The principal difference which served to distinguish these two families, was derived from the mode of dehiscence of the capsule, which, in the Scrophulariæ, takes place by holes or valves opposite to the dissepiment, which remains untouched; whereas, in the Pediculares, each valve bears on the middle of its inner surface the half of the septum. But these differences, which appear very decided, present numerous shades; and, for example, in the genus *Veronica*, we find almost all modifications of them. But we have observed another difference between these two groups, which we have not had an opportunity of remarking in all the genera, but which has appeared to us constant in all those of which we have examined the seed, and which is, that in the Pediculares of Jussieu, the embryo has always a direction the reverse of that of the seed, that is, its cotyledons are turned towards the hilum, whereas the contrary happens in the Scrophulariæ.

1. Pediculares : *Pedicularis*, *Rhinanthus*, *Melampyrum*, *Veronica*, *Euphrasia*, *Erinus*, &c.

2. Scrophulariæ : *Antirrhinum*, *Linaria*, *Scrophularia*, *Digitalis*, *Gratiola*, &c.

[*Pedicularis*, *Rhinanthus*, *Melampyrum*, and *Euphrasia*, are slightly bitter, but possess no remarkable properties. Decoction of *Veronica officinalis* is recommended as a substitute for tea. The *Scrophulariæ* are generally bitter, acrid, and nauseating. *Digitalis* diminishes the force of the circulation, increases the secretion of the saliva and urine, and may produce vomiting, dejection, vertigo, and death.—Tr.]

* Family LVII.—Solaneæ, *Juss.*

In this family are found herbaceous plants, shrubs, and even small trees, sometimes furnished with prickles on several of their parts, having simple or compound leaves, which are alternate, or sometimes geminate towards the upper part of the twigs. Their flowers, which are often very large, are either extra-axillar, or form spikes or racemes. Their monosepalous, persistent calyx, has five shallow divisions. The corolla, which is monopetalous, and in most cases regular, presents very diversified forms, with five more or less plicate lobes. The stamina, which are equal in number to the lobes of the corolla, have their filaments free, rarely monadelphous at the base. The ovary is seated on a hypogynous disk, and has commonly two, rarely three or four polyspermous cells, the ovules of which are attached at the inner angle. The style is simple, terminated by a two-lobed stigma. The fruit is either a capsule, with two or four polyspermous cells, opening by two or four valves, or a two-celled or three-celled berry. The seeds, sometimes reniform, and having a granulated episperm, have a more or less curved embryo in a fleshy endosperm.

The Solaneæ are very intimately allied to the Scrophularinæ, but differ from them in having their leaves generally alternate, their corolla regular, their stamina of the same number as the lobes of the corolla, and especially in having their embryo curved upon itself. The last mentioned character is sometimes the only one which equally distinguishes the Solaneæ with irregular corollas from certain Scrophularinæ. The genera of this family form two sections, according as the fruit is fleshy or capsular.

1. Fruit capsular: *Nicotiana*, *Verbascum*, *Hyoscyamus*, *Datura*, &c.

2. Fruit fleshy: *Solanum*, *Atropa*, *Capsicum*, *Physalis*, *Lycium*, &c.

[The plants of this family may be considered generally as narcotic or poisonous. The properties of tobacco are too well known to require description. The leaves of Hyoscyamus, Datura, and Atropa, produce nausea and vertigo. *Datura Stramonium* has been employed in epilepsy and asthma. The juice of *Atropa Belladonna*, besides its general effects, dilates the pupil. The *Verbascums*, again, are mucilaginous and mild. *Solanum Dulcamara*, a poisonous or narcotic plant, belongs to the same genus as the Potato, the root and berry of which have no narcotic effect even when eaten raw, and of which the former is one of our most wholesome esculents. The fruits of *Solanum esculentum* and other species are also eaten.—Tr.]

Family LVIII.—Acanthaceæ, *Juss.*

The Acanthaceæ are herbs or shrubs, with opposite leaves, flowers disposed in spikes, and accompanied with bracteas at their base. Their calyx is monosepalous, with four or five divisions, regular or irregular. The corolla is monopetalous, irregular, commonly bilabiate. The stamina are two or four, in the latter case tetradynamous. The ovary has two cells, which contain two or a greater number of ovules, and is applied upon an annular hypogynous disk. The style is simple, terminated by a two-lobed stigma. The fruit is a capsule, with two cells, which are sometimes monospermous, and opens elastically into two valves, each of which carries with it half of the dissepiment. The seeds are generally supported upon a filiform podosperm, and their embryo, which is placed immediately under their proper integument, is destitute of endosperm, and has its radicle generally turned towards the hilum.

This family differs from the Scrophularinæ in having its seeds supported upon a long podosperm, in having its embryo destitute of endosperm, &c. Examples: *Justicia, Ruellia, Thunbergia*, &c.

[Generally bitter and tonic, but their properties little known.—Tr.]

* Family LIX.—Jasmineæ, *Juss.*

Jasmineæ *and* Lilaceæ, *Vent.* Oleineæ, *Link.*

This family is composed of shrubs, small trees, or even trees of very large size, with opposite, rarely alternate, simple, or pinnate leaves. The flowers are hermaphrodite, excepting in the genus *Fraxinus*, in which they are alternate. The calyx is monosepalous, turbinate in its lower part. The corolla is monopetalous, often tubular and irregular, with four or five lobes, which are sometimes so deep that the corolla seems polypetalous (*Ornus*, *Chionanthus*). It is sometimes entirely wanting. The stamina are only two. The ovary has two cells, each containing two suspended ovules. The style is simple, and terminated by a two-lobed stigma. The fruit is sometimes a two-celled capsule, indehiscent, or opening by two valves; sometimes it is fleshy, and contains an osseous nucleus. The proper integument of the seed is thin or fleshy. The endosperm is fleshy or hard, and contains an embryo having the same direction as the seed.

The genera of this family, of which three distinct families have been made, but which ought to remain entire, as we have demonstrated in *Mem. de la Soc. d'Hist. Nat.*, vol. xi., may be divided into two sections.

1. Fruit dry, LILACEÆ: *Lilas*, *Fontanesia*, *Fraxinus*, *Nyctanthes*.

2. Fruit fleshy, JASMINEÆ: *Jasminum*, *Olea*, *Ligustrum*, *Phillyrea*, &c.

[Manna is the concrete juice of several species of *Fraxinus*. The flowers of several species of *Jasminum* yield a fragrant essential oil used as a perfume. Olive-oil is obtained from the pericarps of the Common Olive. The flowers of *Olea fragrans* are used by the Chinese in flavouring tea.—TR.]

* FAMILY LX.—VERBENACEÆ, *Juss.*

THE Verbenaceæ are trees or shrubs, rarely herbaceous plants, usually with opposite, sometimes compound leaves. The flowers are disposed in spikes or corymbs: more rarely they are axillar and solitary. Their calyx is monosepalous, persistent, and tubular. The corolla is monopetalous, tubular, commonly irregular. The stamina are didynamous, sometimes only two in number. The ovary has two or four cells, containing one or two erect ovules. The style is terminated by a simple or bifid stigma. The fruit is a berry or drupe, containing a nut with two or four cells, which are often monospermous. The seed is composed of a proper integument, and a thin and fleshy endosperm, which covers a straight embryo.

This family, which is composed of the genera *Verbena*, *Vitex*, *Clerodendrum*, *Zapania*, &c., is distinguished from the preceding by its fruit being fleshy (excepting in *Verbena*), and by its seeds being usually solitary in each cell.

Family LXI.—Myoporineæ, *Brown.*

Shrubs generally glabrous, with simple, alternate, or opposite leaves, and axillar flowers, destitute of bracteas. Their calyx is persistent, with five deep divisions. Corolla monopetalous, nearly regular, or slightly two-lipped. The stamina are didynamous or sometimes five in number, one occasionally rudimentary. The ovary is free, applied upon a hypogynous and annular disk. It has from two to four cells, containing each one or two ovules hanging from its summit. The simple style is terminated by a simple stigma. The fruit is a drupe, containing a nucleus with two or four cells, each containing one or two seeds, composed of a cylindrical embryo, placed in the centre of a rather dense endosperm.

The Myoporineæ are allied to Verbenaceæ, from which they differ, especially in having their seeds pendent, and furnished with a thick endosperm. The family consists of the genera *Myoporum*, *Bontia*, *Pholidia*, *Stenochilus*, and *Eremophila*.

* Family LXII.—Labiatæ, *Juss.*

The Labiatæ form one of the most natural families in the vegetable kingdom. They are herbaceous plants, or sometimes shrubs, of which the stem is square, the leaves simple and opposite, the flowers grouped in the axillæ of the leaves, and thus forming spikes or branched racemes. Their calyx is monosepalous, tubular and irregular, and is divided into two lips, an upper and a lower. The stamina are four in number, and didynamous: sometimes the two shorter are abortive. The ovary, which is applied upon a hypogynous disk, is deeply four-lobed, and much depressed at its centre, from which springs a simple style, surmounted by a bifid stigma. A transverse section of the ovary presents four cells, containing each an erect ovule. The fruit is composed of four monospermous akenia, enclosed by the persistent calyx. The seed contains an erect embryo in the centre of a fleshy endosperm, which is sometimes very thin.

The very numerous genera of this family may be divided into two sections, according as they have two or four stamina.

Sect. I. Two stamina: *Salvia*, *Rosmarinus*, *Monarda*, *Lycopus*, &c.

Sect. II. Four didynamous stamina: *Betonica*, *Leonurus*, *Thymus*, *Ballota*, *Marrubium*, *Phlomis*, *Satureja*, &c.

[The plants of this family contain an aromatic volatile oil, camphor, and a bitter extractive, which render them stomachic, stimulant, and tonic. No poisonous or deleterious species has been found amongst them. The roots of *Stachys palustris* are eatable. Many species are used as aromatics in food, such as Mint, Marjoram, and Basil. From others agreeable perfumes are extracted, as Thyme, Lavender, Mint, and Rosemary.—Tr.]

* Family LXIII.—Boragineæ, *Juss.*

The Boragineæ are herbs, shrubs, or even sometimes tall trees, bearing alternate leaves, often covered, as well as the stems, with very stiff hairs. Their flowers form unilateral spikes, rolled in the form of a crosier at their summit, often aggregated, and forming a kind of panicle. Their calyx is monosepalous, regular, persistent, and five-lobed. The corolla is monopetalous, regular, five-lobed, and in a certain number of genera presents, near the throat, five projecting appendages, which are hollow within, and open externally at their base. The five stamina are inserted at the upper part of the tube of the calyx, and alternate with the appendages just mentioned, when these are present. The ovary, which is supported upon a hypogynous, annular and sinuous disk, is deeply four-lobed, with four monospermous cells, and deeply depressed at its centre. The style springs from this depression, and is terminated by a two-lobed stigma. The fruit is composed of four monospermous carpels, which are more rarely united, and form a dry or fleshy fruit, with two or four cells, which are sometimes osseous, or with only one cell through abortion. The seeds have their embryo reversed in a fleshy but very thin endosperm, which is sometimes wanting.

The family of Boragineæ is related to the Labiatæ in the structure of its pistil, which is the same, and to the Scrophularinæ. But it is distinguished from the former by its cylindrical stem, alternate leaves, regular corolla, stamina five in number, &c., and from the latter by the structure of its ovary and fruit.

We here mention as examples the following genera.

Sect. I. Genera without appendages to the corolla: *Echium*, *Lithospermum*, *Pulmonaria*, *Onosma*, *Cordia*, &c.

Sect. II. Genera furnished with appendages: *Symphytum*, *Lycopsis*, *Anchusa*, *Borago*, *Cynoglossum*, &c.

Ventenat proposed separating from the Boragineæ the genus *Cordia*, on account of its simple and fleshy fruit, and forming of it a family under the name of *Sebesteneæ*. Mr Brown, in *Prodr. Fl. Nov. Holl.* thinks that the genera *Hydrophyllum*, *Ellisia*, and *Phacelia*, which have a capsular fruit, a large horny endosperm, and compound or deeply-lobed leaves, form a distinct family, which he names *Hydrophylleæ*. Lastly, Professor Schrader, in his excellent Memoir on the Boragineæ, proposes to divide them into three distinct orders: *Boragineæ*, *Hydrophylleæ*, and *Heliotropiceæ*. But the differences which exist between the three groups appear to us of too little importance to justify their separation as distinct families.

[The plants of this family are mucilaginous and emollient, but possess no properties that qualify them to be of much importance as food or medicine. The roots of *Anchusa tinctoria*, *Lithospermum tinctorium*, *Anchusa virginica*, and some other species, are used to dye a red colour.—Tr.]

* Family LXIV.—Convolvulaceæ, *Juss.*

Herbaceous or suffrutescent plants, often voluble and climbing, having alternate leaves, which are simple, or more or less deeply lobed; axillar or terminal flowers; a monosepalous, persistent calyx, with five divisions; a monopetalous, regular corolla, with five plicate lobes; and five stamina inserted into the tube of the corolla. The ovary is simple and free, supported upon a hypogynous disk, and has from two to four cells containing a small number of ovules. The style is simple or double. The fruit is a capsule having from one to four cells, usually containing one or two seeds, attached towards the base of the dissepiments. It opens into two or four valves, the edges of which are applied upon the dissepiments which remain in place. More rarely the capsule remains closed, or opens into two superimposed valves. The embryo, of which the cotyledons are flat and plicate, is rolled upon itself, and placed in the centre of a soft and as it were mucilaginous endosperm.

The essential character of this family consists in its capsule, the sutures of which correspond to the dissepiments. This character being wanting in some genera formerly united with the Convolvulaceæ, such as *Hydrolca*, *Nama*, *Sagonea*, and *Diapensia*, Mr Brown has proposed forming them into a distinct family under the name of *Hydroleaceæ*. The principal genera of the Convolvulaceæ are *Convolvulus*, *Ipomæa*, *Cuscuta*, *Evolvulus*, *Cressa*, &c.

[The roots are generally acrid and purgative. Jalap is obtained from *Convolvulus Jalapa*, and Scammony from *C. Scammonia*. The root of *C. panduratus* is used as a purgative in North America, and those of many other species possess the same properties. On the other hand, those of *C. Batatas* and *edulis* are articles of food.—Tr.]

* Family LXV.—Polemoniaceæ, *Juss.*

Herbaceous or woody, sometimes twining plants, furnished with alternate or opposite leaves, often divided and pinnatifid, and axillar or terminal flowers, forming branched racemes. Each flower is composed of a five-lobed, monosepalous calyx; a regular, seldom irregular, monopetalous corolla, with five more or less deep divisions; five stamina inserted into the corolla; an ovary applied upon a disk which is often spread out at the bottom of the flower and lobed. This ovary has three cells, containing one, or more frequently several ovules. The style is simple, terminated by a trifid stigma. The fruit is a three-celled capsule, opening by three valves, which are septiferous on the middle of their inner face, or only bear the impression of the dissepiment, which remains untouched at the centre of the capsule. The seeds have an erect embryo in the centre of a fleshy endosperm.

This family is in some measure intermediate between the Convolvulaceæ and Bignoniaceæ. It differs from the former in having its valves septiferous in the middle of their inner surface, and not contiguous at their margins over the dissepiments, and in its erect embryo; from the latter, in having the corolla almost always regular, the ovary three-celled, its valves septiferous, &c. The genera which compose this family are in small number: *Polemonium*, *Phlox*, *Cantua*, *Bonplandia*, and probably *Cobæa*.

Family LXVI.—Bignoniaceæ, *Juss.*

Bignoniaceæ *and* Pedalineæ, *Brown.*

Trees, shrubs, or more rarely herbaceous plants, with the stem often sarmentose and furnished with cirri. The leaves are commonly opposite or ternate, rarely alternate, usually compound. The flowers, which are terminal, or axillar, and variously grouped, have a monosepalous, often persistent, five-lobed calyx, a monopetalous corolla, more or less irregular and with five divisions. The stamina are commonly four and didynamous, accompanied by a sterile filament, which is the indication of a fifth abortive stamen. In some genera the five stamina are equal, or two only are fertile. The ovary, which is placed upon a hypogynous disk, presents one or two cells usually containing several ovules. The style is simple and terminated by a bilamellate stigma. The fruit is a capsule with one or two cells, opening by two valves opposite to the dissepiment. In some rare cases the fruit is fleshy, or hard and indehiscent. The seeds, which are often margined with a membranous wing all round, contain beneath their proper integument an erect embryo, destitute of endosperm.

The principal genera of this family are *Bignonia*, *Catalpa*, *Jacaranda*, *Tecoma*, &c., of which the seeds are winged; and *Sesamum*, *Martynia*, and *Craniolaria*, of which the seeds are wingless, and which constitute M. Kunth's tribe of *Sesameæ*. The genera *Pedalium* and *Josephinia*, of which Mr Brown has made a distinct family under the name of *Pedalineæ*, we think have too many relations to the genera which form the tribe of *Sesameæ* to be separated from them.

* Family LXVII.—Gentianeæ, *Juss.*

Nearly all the Gentianeæ are herbaceous plants, rarely frutescent, bearing smooth, entire, opposite leaves. Flowers solitary, terminal or axillar, or collected into simple spikes. Calyx monosepalous, often persistent, with five divisions. Corolla monopetalous, regular, commonly with five lobes, which are imbricated previous to their development. The stamina are of the same number as the divisions of the corolla, and alternate with them. The ovary, sometimes contracted and in a manner fusiform at its base, has a single cell, containing a great number of ovules attached to two parietal and sutural trophosperms, bifid on the inner side. The style is simple and deeply bipartite; each division bearing a stigma. The fruit is a one-celled capsule, containing a very great number of seeds. It opens by two valves, the edges of which are more or less inflected to meet the trophosperms. The seeds are generally very small, and their embryo, which is erect, is contained in the axis of a fleshy endosperm.

This family is well characterized by its general appearance, its opposite entire leaves, and their glaucous green colour. It is allied, on the one hand, to the Proteaceæ, from which it differs in its opposite leaves, its two-celled ovaries, and the peculiar mode of dehiscence of its capsule; and, on the other hand, to the Scrophularinæ, which, however, are easily distinguished by their irregular corolla, their four didynamous stamina, and the dehiscence of their fruit. Of the genera of this family we may mention *Gentiana*, *Erythræa*, *Chironia*, *Exacum*, *Villarsia*, and *Menyanthes*. The two last are remarkable for their alternate leaves, which are ternate in *Menyanthes*.

[Generally bitter, stomachic, and tonic. The roots of *Gentiana lutea*, *purpurea*, *rubra*, and *Amarella*, are employed as such. *Menyanthes trifoliata* is also intensely bitter, as is *Villarsia nymphoides*. *Erythræa Centaurium* and *latifolia* yield an intense bitter, less nauseous than that of most others.—Tr.]

Family LXVIII.—Apocyneæ, *Juss.*

Apocyneæ *and* Asclepiadeæ, *Juss.* Strychneæ, *Juss.*

The Apocyneæ are very different in their aspect. They are herbaceous plants, shrubs, or even tall trees, and generally lactescent. Their leaves are simple and opposite.

Flowers axillar or terminal, solitary or variously aggregated. The calyx monosepalous, with five divisions, sometimes spreading, sometimes tubular. Corolla monopetalous, regular, of very diversified form, sometimes presenting five concave, petaloid appendages, which spring from the throat of the corolla, and are in part united to the stamina, which are five in number, sometimes free and distinct, sometimes united by the filaments and anthers, and forming a kind of tube which covers the pistil, and is often united at its summit to the stigma. The anthers are two-celled, and the pollen which they contain is pulverulent in those whose stamina are free, and in solid masses of the same form as the interior of the cell in those in which the stamina are united. Each pollen-mass is terminated at its summit by a gland, which is united to that of the pollen-mass next to it. Two free ovaries, applied upon a hypogynous disk, united together by their inner side or only by their summit, present each a cell which contains a great number of ovules placed at their inner suture. The two styles are sometimes united into one, and terminate in a more or less discoid, sometimes cylindrical and truncate stigma. The fruit is a simple or double follicle; more rarely it is fleshy and indehiscent. The seeds, which are attached to a sutural trophosperm, are naked or crowned by a pappus. They contain in a fleshy or horny endosperm a straight embryo.

This family has been divided by Mr Brown into two:

1. The true APOCYNEÆ, which have the corolla destitute of appendages, and the pollen powdery. Such are the genera *Apocynum*, *Vinca*, *Rauwolfia*, *Arduinia*, *Nerium*, &c.

2. The ASCLEPIADEÆ, the corolla of which is furnished with an appendage, and the pollen in solid masses, as in the Orchideæ. Such are the genera *Asclepias*, *Hoya*, *Cynanchum*, &c.

[Acrid, stimulating, or narcotic, frequently highly poisonous. Nux vomica is the seed of a species of *Strychnos* of that name. The seed of *Cerbera Tanghin* is a violent poison, as is that of many other species. Many of these plants, however, are employed as purgatives, diaphoretics, tonics, and febrifuges, and others as articles of food. It is probable that when their properties are better known, they will be found to be of eminent service in medicine and domestic economy.—Tr.]

Family LXIX.—Sapoteæ, *Juss.*

Trees or shrubs all extra-European and for the most part inter-tropical. Their leaves are alternate, entire, persistent, and coriaceous; their flowers hermaphrodite and axillar. Calyx persistent, monosepalous. Corolla monopetalous, regular, with lobes equal in number to those of the calyx, double or triple. The stamina are in definite number: some of them, of the same number as the lobes of the calyx, and opposite to the petals, are fertile; the rest, alternate with the others, sterile. The ovary has several cells, containing each an erect ovule. The style is terminated by a generally simple, sometimes lobed stigma. The fruit is fleshy, with one or several monospermous, sometimes bony cells. The embryo is erect, and is contained in a fleshy endosperm, which is rarely wanting.

The genera of this family are *Achras*, *Mimusops*, *Syderoxylon*, *Imbricaria*, *Lacuma*, &c. It is closely allied to the Ebenaceæ, which differ from it in having their flowers generally unisexual, their stamina disposed in two series, their style divided, and their seeds pendent.

[The fruits of some species contain a thick oil used for domestic purposes. Those of others are sweet and used as food.—Tr.]

Family LXX.—Myrsineæ, *Brown.*

Ardisiaceæ, *Juss.* Ophiospermiæ, *Vent.*

The Myrsineæ are trees or shrubs, with alternate, very rarely opposite or ternate leaves, which are glabrous, coriaceous, entire or toothed, and destitute of stipules. The flowers are disposed in racemes or a kind of umbels, or are simply grouped in the axilla of the leaves, or at the summit of the twigs. They are hermaphrodite, rarely unisexual. Their calyx is generally persistent, with four or five deep divisions. Their corolla is monopetalous, regular, with four or five lobes. The stamina, equal in number to the lobes of the corolla, and sometimes monadelphous, are attached to the base of the lobes, and are opposite to them. The filaments are short, the anthers sagittate. The ovary is free, unilocular, containing a variable number of ovules inserted upon a central trophosperm, in which they are sometimes more or less deeply immersed. The style is simple, terminated by a simple or lobed stigma. The fruit is a kind of dry drupe, or a berry containing from one to four seeds. The seeds are peltate, with their hilum concave; their simple integument covering a fleshy or horny endosperm, in which is contained a cylindrical embryo, little curved, and placed transversely to the hilum.

This family is closely related to the Sapoteæ and Ebenaceæ, in its general aspect, and in several of its characters. On the other hand, the structure of its ovary, and the circumstance of the stamina being opposite to the lobes of the corolla, give it some affinity to the Primulaceæ. The genera which compose the family of Myrsineæ are the following: *Myrsine*, *Ardisia*, *Jacquinia*, *Samara*, *Wallenia*, and *Ægicera*.

Family LXXI.—Ebenaceæ, *Rich.*

Guyacaneæ, *Juss.*

This family is composed of trees or shrubs, which are not lactescent, and of which the wood is very hard, and often of a dark colour in the centre. Their leaves are alternate, entire, often coriaceous, and shining. The flowers are generally axillar, rarely hermaphrodite, most commonly polygamous. Their calyx is monosepalous, with three or six equal and persistent divisions. The corolla is regular, monopetalous, its limb with three or six imbricated divisions. The stamina are in definite number, sometimes inserted upon the corolla, sometimes immediately hypogynous. They are in double or quadruple the number of the divisions of the corolla, very rarely in equal number, and then alternating with them. Most commonly the stamina are disposed in two rows, and have their anthers linear-lanceolate, and two-celled. The ovary is free, sessile, with several cells containing each one or two pendent ovules. The style is divided, more rarely simple; the stigmas are simple or bifid. The fruit is a globular berry, sometimes opening in a nearly regular manner, and containing a small number of compressed seeds. Their tegument covers a cartilaginous endosperm, in which is an embryo having the same direction as the seed.

My father removed from Jussieu's family of Guayacaneæ a certain number of genera which differ very much from it, and of which he formed the family of Styraceæ. As now limited, the family of Ebenaceæ is composed of the genera *Diospyros*, *Royena*, *Paralea*, &c. It is related to the Sapoteæ, but these have their stamina of the same number as the divisions of the corolla, to which they are opposite, and besides, present several other distinctive characters. In speaking of the Styraceæ, we shall point out the characters in which they differ from the Ebenaceæ.

[*Diospyros virginiana* affords fruits which are eatable when perfectly ripe; but the family, in general, is remarkable only for the hardness of the wood which it affords.—Tr.]

NINTH CLASS.—PERICOROLLIA.

Family LXXII.—Styraceæ, *Rich.*

Symploceæ, *Juss.*

This little family contains trees or shrubs with alternate leaves, destitute of stipules, and axillar, sometimes terminal flowers. The calyx is free, or adherent to the inferior ovary, its limb entire or divided. The corolla is monopetalous and regular. The stamina, which vary from six to sixteen, are free or monadelphous at their base. The ovary, as we have said, is sometimes superior, sometimes inferior, commonly with four cells, separated by very thin, membranous dissepiments. Each of these cells commonly contains four ovules attached to the inner angle of the cell, and of which two are erect, two reversed. The style is simple, terminated by a very small simple stigma. The fruit is slightly fleshy. It contains from one to four bony and more or less irregular nucules. The seed is formed of a proper integument, and a fleshy endosperm, which contains a cylindrical embryo, having the same direction as the seed.

This family is composed of the genera *Halesia, Symplocos, Styrax, Alstonia,* and *Ciponima,* which were formerly referred to the family of Ebenaceæ. My father separated them to form the new family of Styraceæ, which differs from the Ebenaceæ in having a perigynous insertion, a quadrilocular ovary with four ovules, two erect and two reversed, and a simple style..

[Storax and benzoin are obtained from *Styrax officinalis* and *Benzoin.*—Tr.]

* Family LXXIII.—Ericineæ.

Ericæ *and* Rhodora, *Juss.* Epacrideæ, *Brown.* Vaccinieæ, *Desv.*

Shrubs and small trees, of an elegant habit, having in general simple, alternate leaves, rarely opposite, verticillate or very small, and in the form of imbricated scales. Their inflorescence is very variable. The monosepalous calyx is sometimes free, sometimes adherent to the ovary, which is then inferior, with five divisions, which are sometimes so deep, that it appears formed of distinct sepals. The corolla is monopetalous, regular, with four or five lobes, sometimes with four or five distinct petals. The stamina, which are generally double the number of the divisions of the corolla, have their filaments free, rarely connected at their base. The anthers are introrse, one-celled or two-celled, sometimes terminated by two horn-shaped appendages at their summit or base, and generally opening by a hole near their summit. These stamina are generally attached to the corolla; but sometimes they are immediately hypogynous. The ovary is inferior or free; in the latter case, it is sessile at the bottom of the flower, or applied upon a hypogynous disk, which is more or less prominent, and sometimes has the form of lobes or scales. It has from three to five cells, each containing a considerable number of ovules attached at their inner angle. The style is simple, terminated by a stigma having as many lobes as the ovary has cells. The fruit is a berry, or more commonly a capsule, sometimes crowned by the limb of the calyx, and opening by as many valves as there are cells. Sometimes each of these valves carries with it one of the dissepiments on the middle of its inner face (loculicide dehiscence), and sometimes the dehiscence takes place opposite each dissepiment (septicide dehiscence). The seeds are composed of a fleshy endosperm, in the middle of which is an axile, cylindrical embryo, having the same direction as the seed.

We here unite the Rhodoraceæ of Jussieu, which differ from the Ericineæ only in their capsule, the valves of which carry with them the dissepiments on the middle of their inner surface, whereas in the Ericineæ in general the dehiscence takes place opposite the dissepiments. But both modes are observed in several genera of Ericineæ. The only difference that exists between the Epacrideæ of Brown and the Ericineæ is, that they have unilocular anthers, and a different habit. We have therefore united them to the Ericineæ, of which they merely form a section. We divide this family as follows:

1. VACCINIEÆ: Ovary inferior. *Vaccinium, Escallonia, Gaylussaccia*, &c.

2. ERICINEÆ: Ovary free, disk hypogynous, anthers bilocular. *Erica, Rhododendrum, Rhodora, Ledum, Clethra, Arbutus, Andromeda*, &c.

3. EPACRIDEÆ: Ovary free, disk in the form of five hypogynous scales, anthers unilocular. *Epacris, Styphelia, Leucopogon*, &c.

[The berries of the Vaccinieæ are generally eatable. The bark and leaves are slightly astringent. The Ericeæ are astringent and diuretic. The *Rhododendra* and *Azaleæ* are acrid and poisonous.—TR.]

FAMILY LXXIV.—GESSNERIACEÆ, *Rich.*

HERBACEOUS plants, rarely suffrutescent at their base, bearing opposite or alternate leaves, and axillar or terminal flowers. The calyx is monosepalous, persistent, with five divisions, adhering by its base to the ovary, which is generally inferior. The corolla is monopetalous, irregular, with five unequal lobes sometimes forming two lips. The stamina are two or four, inserted upon the corolla. The ovary, as we have said, is inferior or free: in the former case, it is crowned by an epigynous often lobed disk; in the latter case, the disk is hypogynous and often lateral. The style is simple, terminated by a simple stigma, concave in its centre. The ovary has a single cell in which the numerous ovules are attached to two parietal trophosperms, branched on the side of the cell. The fruit is either fleshy or dry, and forms a unilocular capsule opening by two valves.

The genera *Gessneria, Gloxinia, Besleria, Columnea*, and *Achimenes*, are referred to this family. But excepting the two first, which have the ovary inferior, the rest, to which may be added the genus *Ramondia*, formerly placed among the Solaneæ, do not appear to us to differ in any respect from the Orobancheæ. Perhaps the Gessneriaceæ might with propriety be reduced to the genera which have the ovary inferior.

* Family LXXV.—Campanulaceæ, *Juss.*

The Campanulaceæ are commonly herbaceous or suffrutescent plants, generally abounding in a white and bitter juice. Their leaves are alternate and entire, rarely opposite. Their flowers form spikes, thyrsi, or capitula. They have a monosepalous calyx, with four, five, or eight persistent divisions, and a regular or irregular monopetalous corolla, having its limb divided into as many lobes as there are divisions to the calyx, sometimes as if two-lipped. The stamina, five in number, are alternate with the lobes of the corolla Their anthers are free, or brought together in the form of a tube. The ovary is inferior or semi-inferior, with two or more polyspermous cells. The style is simple, terminated by a lobed stigma, sometimes surrounded by hairs or a kind of cupuliform cavity. The fruit is a capsule crowned by the limb of the calyx, with two or more cells, opening either by means of holes which are formed near the upper part, or by incomplete valves, which carry along with them part of the dissepiments on the middle of their inner surface. The seeds, which are very small and very numerous, contain an axile and erect embryo in a fleshy endosperm.

We here unite the families of Campanulaceæ, Lobeliaceæ, Goodenoviæ, and Stylideæ, which, being too intimately allied to form distinct families, we consider merely as tribes of the same natural order.

1. Campanulaceæ.—Corolla regular, stamina distinct, capsule with two polyspermous cells. Ex.: *Campanula*, *Phyteuma*, *Prismatocarpus*, *Jasione*, &c.

2. Lobeliaceæ, Rich.—Corolla irregular, stamina united by the anthers, stigma surrounded by hairs. Ex.: *Lobelia, Lysipomia*, &c.

3. Goodenovieæ, Brown.—Corolla irregular, stamina free or united by the anthers, stigma surrounded by a kind of cup, a bilocular capsule, or a monospermous nut. Ex.: *Goodenovia, Euthales, Lechenaultia*, &c.

4. Stylidieæ, Brown.—Corolla irregular; two stamina, of which the filaments are confounded with the style, and forming a kind of central column; stigma situated between the two anthers; capsule bilocular, bivalve. Ex.: *Stylidium, Leuwenhoekia*, &c.

[The roots and young shoots of *Campanula Rapunculus* and *Phyteuma spicata*, are eaten. The Lobeliaceæ are acrid and frequently poisonous. *Lobelia inflata* is a powerful emetic and diaphoretic, but produces great debility. *Lobelia longiflora* is extremely violent in its operation. The properties of the other divisions are unknown.—Tr.]

TENTH CLASS.—EPICOROLLIA.—SYNANTHERIA.

Family LXXVI.—Synanthereæ, *Rich.*

Cichoraceæ, Corymbiferæ, *and* Cynarocephalæ, *Juss.*
Compositæ *of Authors.*

This great family is one of the best defined and best characterized in the vegetable kingdom. It comprehends herbaceous plants, shrubs, or even small trees. Their leaves are commonly alternate, rarely opposite. Their flowers, which are generally small, form capitula or calathidia, which are hemispherical, globular, or more or less elongated. Each capitulum is composed: 1*st*, Of a common receptacle, thick and sometimes fleshy, convex or concave, which has received the names of *phoranthium* and *clinanthium;* 2*dly*, Of a common involucre which surrounds the capitulum, and is composed of scales, the form, number, and disposition of which vary in the different genera; 3*dly*, Of small scales or hairs, which are frequently found on the receptacle at the base of each flower. The flowers which form the capitula are of two kinds: some present a regular, monopetalous funnel-shaped corolla, generally with five regular lobes, and are named *florets*, *flosculi;* others have an irregular corolla, thrown to one side in the form of a strap, and are named *semiflorets*, *semiflosculi*. Sometimes the capitula are composed exclusively of florets (*Flosculosæ*), sometimes exclusively of semiflorets (*Semiflosculosæ*), and sometimes their centre is occupied by florets, and their circumference by semiflorets (*Radiatæ*). Each flower presents the following organization: The calyx, which is adherent to the ovary, has its limb entire, membranous, toothed, and formed of scales or hairs; the corolla monopetalous, regular or irregular; five stamina with distinct filaments, but with the anthers united, and forming a tube through which passes a simple style, terminated by a bifid stigma. The fruit is an akenium, naked at its summit, or crowned by a membranous margin, small scales, or a tuft of simple or feathery hairs, which is sessile or stipitate. The seed is erect, containing a homotrope embryo, without endosperm.

This family, which has much engaged the attention of botanists, may be divided into three principal tribes.

1. The Cynarocephalæ, of which all the flowers are *flosculi*, and which have their receptacle furnished with numerous hairs or alveolæ, the style enlarged, and furnished with hairs under the stigma. Such are the genera *Carthamus*, *Carduus*, *Cynara*, *Centaurea*, *Onopordum*, &c.

2. The Cichoraceæ, of which all the flowers are *semiflosculi*. Such are the genera *Lactuca*, *Cichorium*, *Sonchus*, *Hieracium*, *Prenanthes*, &c.

3. The Corymbiferæ, of which the capitula are generally composed of *flosculi* at the centre, and *semiflosculi* at the circumference. Examples: *Helianthus*, *Chrysanthemum*, *Anthemis*, *Matricaria*, &c.

[The Synanthereæ are generally bitter, and more or less stimulant and tonic. The Cinarocephalæ abound in bitter extractive, and many of them have consequently been used as stomachics and tonics; such as *Carduus benedictus, C. Marianus*, &c. *Arctium Lappa* is diaphoretic and diuretic. The young leaves possess little bitterness, and may be used as salad. The seeds are oily and aperient. The Cichoraceæ have a milky, bitter, narcotic juice, which, when inspissated, resembles opium in its action. *Lactuca virosa* and *sylvestris*, and *Cichorium Intybus*, are more especially remarkable for this narcotic juice. Cultivation deprives these plants of their bitter quality, and renders them eatable, as is the case with the Common Lettuce. Others, by being blanched, are rendered palatable, and are common articles of food. The Corymbiferæ resemble the Cynarocephalæ in their properties. *Tussilago Farfara, Eupatorium perfoliatum, Inula Helenium*, and Common Chamomile, are stomachic, stimulant, and tonic. They contain a resinous principle combined with bitter extractive. Others, in which the resinous matter predominates, are used as anthelmintics and emenagognes. *Artemisia, Tenacetum*, and *Santolina*, are of this kind.—Tr.]

Family LXXVII.—Calycereæ, *Rich.*

Boopideæ, *Cassini.*

Herbaceous plants, bearing a considerable resemblance to the Scabiosæ in their general aspect. Their stem bears alternate leaves, often divided and pinnatifid. The flowers are small, and form globular capitula, surrounded by a common involucre. The receptacle which bears the flowers is furnished with foliaceous scales, which are sometimes united to the flowers, so as not to be distinct from them. The calyx is adherent to the inferior ovary, and the divisions of its limb are sometimes rigid and spinous. The corolla is monopetalous, tubular, infundibuliform, and regular; beneath the five stamina are five nectariferous glands. These stamina are connected both by their filaments and anthers, and form a cylindrical tube, each anther opening by its inner surface. The inferior ovary has a single cell, from the summit of which hangs a reversed ovule. The summit of the ovary presents an epigynous disk, and a simple style terminated by a hemispherical stigma. In the genus Acicarpha, all the flowers are united together by their ovaries. The fruit is an akenium crowned by the spinous teeth of the calyx. The seed presents beneath its proper integument an endosperm, containing an embryo which is reversed like the seed.

This little family is composed of the genera *Boopis*, *Calycera*, and *Acicarpha*. It is intermediate between the Synanthereæ and Dipsaceæ, differing from the former by its reversed ovule, its stamina united both by their anthers and filaments, and its simple stigma; and from the Dipsaceæ by its alternate leaves and united stamina.

ELEVENTH CLASS.—EPICOROLLIA.—CORISANTHERIA.

* Family LXXVIII.—Dipsaceæ, *De Cand.*

Some genera of Dipsaceæ, *Juss.*

Stem herbaceous; leaves opposite, without stipules; flowers collected into hemispherical or globular capitula, accompanied at their base by an involucre of several leaflets. The calyx is double; the outer monopetalous, free, entire or divided into narrow, setaceous segments; the inner adherent to the ovary, and terminated by an entire or divided limb. The corolla is monopetalous, tubular, with four or five unequal divisions. The stamina are of the same number as the divisions, and alternate with them. The ovary is inferior, with a single cell, containing a single pendent ovule. The style and stigma are simple. The fruit is an akenium crowned by the limb of the calyx, and enveloped in the outer calyx. The seed is pendent, and its embryo, which has the same direction, is placed in a rather thin fleshy endosperm.

Professor De Candolle has removed from this family such as M. de Jussieu left it, the genus *Valeriana*, and some others, to form of them the family of Valerianeæ, which differs from the true Dipsaceæ, in not having the flowers collected into capitula, in its simple calyx, its lobed stigma, &c.

In their general aspect, and especially in their inflorescence, the Dipsaceæ have some resemblance to the Synanthereæ, but they differ from them in having the calyx double, the anthers free, and the seed reversed. The principal genera of this family are: *Dipsacus*, *Scabiosa*, and *Knautia*.

[The root of *Scabiosa succisa* is astringent.—Tr.]

* Family LXXIX.—Valerianeæ, *De Cand.*

Herbaceous plants, with opposite, simple, or more or less deeply incised leaves, and flowers destitute of a calyculus, usually disposed in terminal clusters or panicles. Their calyx is simple, adherent to the ovary, and having its limb toothed or involute, and forming an entire margin. The corolla is monopetalous, more or less irregular, and sometimes spurred at its base, and five-lobed. The stamina vary from one to five, and are alternate with the lobes of the corolla. The ovary is one-celled: sometimes there are two other empty cavities or false cells, so that the ovary seems trilocular. The cell contains a single pendent ovule. The style is simple, commonly terminated by a trifid stigma. The fruit is an akenium, crowned by the teeth of the calyx, or by a feathery pappus, formed by the unrolling of the limb. The seed contains an embryo destitute of endosperm.

This family is composed of the genera *Valeriana*, *Centranthus*, *Fedia*, *Patrinia*, &c. See the note appended to Dipsaceæ.

[The root of *Valeriana officinalis* is bitter, aromatic, and antispasmodic, as are those of some other species. The leaves of Fedia are eaten as salad.—Tr.]

* Family LXXX.—Rubiaceæ, *Juss.* Opercularieæ, *Juss.*

Herbaceous plants, shrubs, and large trees. Their leaves are either opposite or verticillate: in the first case, they have on each side an intrapetiolar stipule, which is often united to the sides of the petiole, and forms a kind of sheath. The flowers are axillar or terminal, sometimes collected into a capitulum. The calyx, which adheres by its base to the inferior ovary, has its limb entire or divided into four or five more or less deep and persistent lobes. The corolla is monopetalous, regular, epigynous, with four or five lobes. The stamina are of the same number as the lobes of the corolla, and alternate with them. The ovary is inferior, surmounted by a simple or bifid style. It has two, four, five, or a greater number of cells, containing each one or more ovules, which are erect or attached to the inner angle of the cell. The fruit varies greatly. Sometimes it is composed of two small monospermous and indehiscent cocca; sometimes it is fleshy, and contains two monospermous nuclei; in certain genera it is a capsule, with two or a greater number of cells, opening by as many valves; or a fleshy and indehiscent fruit. The fruit is always crowned at its summit by the limb of the calyx. The seeds, sometimes winged and membranous on their margin, contain, in a hard and horny endosperm, an axile embryo, which is erect, or sometimes placed transversely with respect to the hilum.

This family, which is highly natural and very easily distinguished, is divided into two principal sections. In one of these are placed all the genera with verticillate leaves, such as *Galium*, *Asperula*, *Rubia*, *Sherardia*, *Crucianella*, &c.; in the other the much more numerous genera, which have the leaves opposite and the stipules intermediate, as *Cinchona*, *Coffea*, *Cephaelis*, *Psychotria*, &c. In Europe we have only Rubiaceæ with verticillate leaves.

We unite with this family the group of *Opercularieæ*, which do not really differ from the other Rubiaceæ.

[The roots of *Rubia tinctorum*, *Galium verum*, and other species, afford a red dye. The seeds of *Galium Aparine* have been recommended as a substitute for coffee. The plants of the second section are remarkable for their powerful tonic or emetic qualities. The tonic and febrifuge properties of the bark of the Cinchonæ, depend upon the presence of two alkalies, cinchonia and quinin, which are combined with kinic acid. Ipecacuan is the root of *Cephaelis Ipecacuanha*. Several species of *Psychotria* possess similar properties. Coffee is the seed of *Coffea arabica*.—Tr.]

* Family LXXXI.—Caprifoliaceæ, *Rich.*

Shrubs with opposite, rarely alternate, generally simple, more rarely imparipinnate leaves, without stipules. The flowers are axillar, solitary, or often geminate, and in part united together by their calyx, disposed in cymes, or collected into a kind of capitulum. The calyx is always monosepalous, and is adherent by its lower part to the ovary, which is inferior. The limb has five persistent teeth. The corolla is monopetalous, commonly irregular; sometimes it is formed of five distinct petals. The stamina are five in number, alternating with the divisions of the corolla. The ovary has from one to five cells, each containing either a single pendent ovule, or several ovules attached at its inner angle. The style is simple, terminated by a very small and scarcely lobed stigma. The fruit is sometimes geminate, that is, formed by the union of two ovaries. It is fleshy, with one or two sometimes osseous cells, each containing one or more seeds. The seeds have a proper integument, sometimes covered by a nucleus and a fleshy endosperm, which contains an axile embryo, having the same direction as the seed.

This family may easily be divided into two natural tribes, according as the cells of its ovary are monospermous, or polyspermous.

1. HEDERACEÆ: Cells of the ovary monospermous. *Hedera, Cornus, Sambucus, Viburnum.*

2. LONICEREÆ: Cells of the ovary polyspermous. *Lonicera, Xylosteum, Symphoricarpos,* &c.

This family, which is allied to the Rubiaceæ, differs from them especially in its irregular corolla, and the absence of stipules between the leaves.

[The leaves of *Sambucus nigra* are emetic and purgative. Some fruits of the genera *Cornus, Sambucus,* and *Viburnum,* are eatable. The bark of *Cornus florida* has been used in intermittent fevers.—TR.]

* FAMILY LXXXII.—LORANTHEÆ, *Rich.*

THE Lorantheæ are mostly perennial-herbaceous, and generally parasitic plants. Their stem is woody and branched; their leaves simple and opposite, entire or toothed, coriaceous, persistent, and destitute of stipules. The flowers are variously disposed, sometimes solitary, sometimes in axillar or terminal spikes, racemes, or panicles. The flowers are generally hermaphrodite, sometimes diœcious. The calyx is adherent to the inferior ovary; its limb is entire or slightly toothed. It is accompanied externally by two bracteas, or by a second cup-shaped calyx, sometimes entirely enveloping the true one. The corolla is composed of from four to eight petals, inserted towards the summit of the ovary. These petals are occasionally united, so as to represent a monopetalous corolla. The stamina are of the same number as the petals, and opposite to them; the anthers sessile, or supported upon filaments varying in length. The ovary is one-celled, and contains a reversed ovule. It is crowned by an epigynous and annular disk. The style is often long and slender, sometimes entirely wanting; the stigma often simple. The fruit is generally fleshy, containing a single reversed seed, adherent to the pulp of the pericarp, which is thick and viscous. The seed contains a fleshy endosperm, in which is placed a cylindrical embryo, having the radicle directed towards the hilum.

This family, the genera of which formerly belonged to the Caprifoliaceæ, differs from them in having the corolla more frequently polypetalous; the stamina opposite to the petals; the ovary unilocular and monospermous. The principal genera are *Loranthus*, *Viscum*, *Aucuba*, &c.

[The bark is usually astringent.—Tr.]

TWELFTH CLASS.—EPIPETALIA.

Family LXXXIII.—Rhizophoreæ, *Brown.*

Extra-European trees, with opposite, simple leaves, and interpetiolar stipules, as in the Rubiaceæ. Their calyx, which is adherent to the ovary, has four or five valvar divisions to its limb, which is persistent. The corolla is composed of four or five petals. The stamina vary from eight to fifteen. The ovary, which sometimes is only semi-inferior, has always two cells, each of which contains two or a great number of pendent ovules. The style is simple, the stigma bipartite. The fruit, which is crowned at its summit by the calyx, is unilocular, monospermous, and indehiscent. The seed which it contains is composed of a large embryo destitute of endosperm. The embryo sometimes germinates and is developed within the fruit, which it perforates at its summit.

The genera *Rhizophora*, *Bruguiera*, and *Carallia*, are all that compose this family, which differs from the Caprifoliaceæ, to which these genera were formerly referred, in having the corolla polypetalous, the fruit coriaceous, and the embryo without endosperm; and from the Lorantheæ, in having the embryo destitute of endosperm.

* Family LXXXIV.—Umbelliferæ, *Juss.*

The Umbelliferæ, which form one of the most natural families in the vegetable kingdom, are herbaceous plants, of which the stem is often internally hollow; the leaves alternate, sheathing at their base, generally decompounded into numerous segments or leaflets. The flowers, which are always very small, white, or yellow, are disposed in umbels. Sometimes there are seen, at the base of the umbel, small leaflets, which collectively constitute the involucre; and, at the base of the umbellules, others which constitute the involucels. Each flower is composed of a calyx, which is adherent to the inferior ovary, and of which the limb is entire, or scarcely toothed; a corolla, formed of five more or less spreading petals; five epigynous stamina, alternating with the petals; an ovary with two cells, each containing a reversed ovule, and crowned at its summit by an epigynous and two-lobed disk; and two styles, terminated each by a small simple stigma. The fruit is a diakenium of very diversified form, separating, at maturity, into two monospermous akenia, connected by a small filiform columella. The seed is reversed, and contains, in a pretty large endosperm, a very small axile embryo.

The genera of which this family is composed are extremely numerous. We may mention as examples *Daucus*, *Carum*, *Amni*, *Scandix*, *Apium*, *Pastinaca*.

[The roots of the Wild Carrot *(Daucus Carota)*, are aromatic and rather pungent, but eatable. Those of the cultivated Carrot, Skirret, and Parsnip, are well known as articles of food. The root of *Bunium Bulbocastanum* is also eatable ; as are the stems of the Celery, and *Heracleum Sphondyllium*, and the leaves of the Parsley. But, in general, the stems and leaves of the plants of this order are nauseous, and often poisonous. Those of *Œnanthe crocata*, *Conium maculatum*, *Cicuta virosa*, and *Œthusa Cynapium*, are of the latter character. The fruits are often agreeably aromatic, as in *Carum Carui*, *Coriandrum sativum*, &c. Opoponax and Assafœtida, are procured from plants of this order, as are Galbanum and Gum Ammoniac. The species which produce aromatic seeds generally grow in dry soil, and those which are most virulent in their properties usually in watery, damp, or shady places.—Tr.]

Family LXXXV.—Araliaceæ, *Juss.*

The Araliaceæ form a group scarcely distinct from the Umbelliferæ. They are herbaceous plants, or sometimes very tall trees. Their flowers, which are also very small, are disposed in simple or paniculate umbels. Their calyx is adherent and toothed as in the Umbelliferæ. Their corolla is formed of five or six petals. Their ovary has from two to six monospermous cells, and is surmounted by as many styles, terminated by simple stigmas. The fruit is sometimes fleshy and indehiscent, sometimes dry, and separating into as many monospermous cocca, as the ovary has cells.

This family is very closely allied to the Umbelliferæ, from which it differs in having a greater number of cells and styles, or in having the fruit fleshy. Ex.: *Aralia*, *Panax*, *Gastonia*, &c.

[Ginseng, a tonic substance much used by the Chinese, is the root of *Panax quinquefolia*.—Tr.]

THIRTEENTH CLASS.——HYPOPETALIA.

* FAMILY LXXXVI.—RANUNCULACEÆ, *Juss.*

THIS great family is composed of herbaceous plants, bearing alternate leaves, amplexicaul at their base, most commonly divided into numerous segments. The leaves are opposite in the genus *Clematis* only. The flowers vary much in their disposition; sometimes they are accompanied with an involucre formed of three leaves, which may be distant from the flower, or placed near it and calyciform. The calyx is polysepalous, often coloured and petaloid, rarely persistent. The corolla is polypetalous, sometimes wanting. The petals are sometimes simple, with a small hollow or a glandular lamina at their inner base; more commonly diversiform, or irregularly hollowed in the shape of a horn, and abruptly unguiculate at their base. The stamina, which are generally numerous, are free, with anthers continuous with the filaments. The pistils are sometimes monospermous, and aggregated into a kind of capitulum, or polyspermous and circularly grouped, and sometimes more or less intimately united. The style is very short, commonly lateral; the stigma simple. The fruits are monospermous, indehiscent, disposed in capitula or spikes: or they are aggregated capsules, which are distinct or united, sometimes solitary, unilocular, polyspermous, opening by their internal suture, which bears the seeds; very rarely the fruit is a polyspermous berry. The seeds are not arillate; the embryo is very small, has the same direction as the seed, and is contained in the base of a fleshy or hard endosperm.

The numerous genera of this family may be divided into two great sections, according as the ovaries are monospermous or polyspermous.

1. Ovaries monospermous.

A. Genera furnished with a calyx and a corolla. *Ranunculus, Ficaria, Ceratocephalus, Myosurus, Adonis.*

B. Genera destitute of corolla. *Anemone, Clematis, Thalictrum.*

2. Ovaries polyspermous.

A. Genera destitute of corolla. *Pæonia, Caltha.*

B. Genera furnished with a corolla. *Trollius, Eranthis, Helleborus, Nigella, Garidella, Aquilegia, Delphinium, Aconitum, Actæa.*

[These plants are generally acrid and poisonous, and their properties are supposed to depend upon a volatile principle, removed by the application of heat or by drying. The fresh leaves and stems of *Ranunculus sceleratus* and *Flammula* are epispastic. The root of *Aconitum Napellus,* and *Pæonia officinalis,* are acrid and bitter. That of several species of *Helleborus* is purgative. *Anemone nemorosa* is supposed to produce the disease called Red-water in cattle.—Tr.]

Family LXXXVII.—Dilleniaceæ, *De Cand.*

Sarmentaceous trees or shrubs, having alternate, very rarely opposite leaves, without stipules, often amplexicaul at their base, and solitary or clustered flowers, sometimes opposite to the leaves. Their calyx is persistent, monosepalous, with five deep divisions, laterally imbricated. Their corolla is commonly of five petals. Their stamina are very numerous, free, disposed in several rows, sometimes unilateral and disposed in several bundles. The carpels, which vary from two to twelve, are generally distinct, but sometimes united. Their ovary is unilocular, containing two or more ovules, attached to the lower part of their inner angle, and erect. The styles are simple, and terminated each by a simple stigma. The fruits are distinct or united, fleshy or dry and dehiscent. The seeds have a crustaceous tegument, covering a fleshy endosperm, in which is a very small erect embryo, placed towards its base.

To this family belong the genera *Tetracera, Davilla, Delima, Pachynema, Pleurandra, Dillenia, Hibbertia,* &c. It is distinguished from the Magnoliaceæ and Anonaceæ by the quinary number of the parts of its flower.

[Generally astringent.—Tr.]

Family LXXXVIII.—Magnoliaceæ, *Juss.*

This family is composed of large and beautiful trees, or elegant shrubs, adorned with beautiful alternate leaves, often coriaceous and persistent, and furnished at their base with foliaceous stipules. The flowers, which are often very large, and diffuse a sweet scent, are generally axillar. The calyx is composed of from three to six caducous sepals. The petals vary from three to twenty-seven, and are disposed in several series. The stamina, which are very numerous and free, are disposed in several series, and attached to the receptacle which bears the petals. The pistils are numerous, sometimes collected in a circular form and in a single series in the centre of the flower, sometimes forming a more or less elongated capitulum. These pistils are composed of an unilocular ovary, containing one or more ovules, of a hardly distinct style, and a simple stigma. The fruits are composed of dry or fleshy carpels, aggregated circularly and in a stellate form, or disposed in capitula, and sometimes all united together. Each carpel is indehiscent, or opens by a longitudinal suture; and the seed is sometimes supported upon a sutural filiform trophosperm, which hangs at the exterior when the fruit opens. These seeds have their embryo erect in a fleshy endosperm.

The family of Magnoliaceæ is subdivided into two tribes in the following manner :

1. Illicieæ : Carpels verticillate, rarely solitary, through abortion; leaves marked with transparent dots. Ex. : *Illicium, Drimys, Tasmannia.*

2. Magnoliaceæ: Carpels disposed in capitula; leaves not dotted. Ex.: *Magnolia, Michelia, Talauma, Liriodendron*, &c.

This family is very nearly allied to the Anonaceæ, from which it differs especially in its stipules and the continuous structure of its endosperm. It is also allied to the Dilleniaceæ, which differ from it in the quinary number of the parts of the flower.

[The bark of *Magnolia* and *Liriodendron* is bitter and tonic. The flowers of the former are fragrant, but produce sickness and headach.—Tr.]

Family LXXXIX.—Anonaceæ, *Juss.*

The Anonaceæ are trees or shrubs having simple, alternate leaves, destitute of stipules, by which character they are distinguished from the Magnoliaceæ. Their flowers are commonly axillar, sometimes terminal. The calyx is persistent, with three deep divisions. The corolla is formed of six petals, disposed in two series. The stamina are very numerous, forming several series; their filaments short, their anthers almost sessile. The carpels, which are generally aggregated in great number in the centre of the flower, are sometimes distinct, sometimes connected; each of them has a single cell, which contains one or more ovules attached to their inner suture, and often forming as many distinct fruits (rarely one only in consequence of abortion); sometimes they are united together, and form a kind of fleshy and scaly cone. The seeds have their integument formed of two laminæ. Their horny endosperm is deeply grooved, and contains a very small embryo situated near the point of attachment of the seed.

This family, in which are placed the genera *Anona, Kadsura, Asimina, Uvaria*, &c., is very closely allied to the Magnoliaceæ, from which it differs especially in the absence of stipules, in the petals, the number of which never exceeds six, and in having the endosperm deeply and irregularly grooved.

[Generally aromatic. The fruit of several species is saccharine and mucilaginous.—Tr.]

* Family XC.—Berberideæ, *Juss.*

Herbs or shrubs with alternate, simple or compound leaves, accompanied at their base by stipules, which are often persistent and spinous. Their flowers are generally yellow, and disposed in spikes or racemes. They have a calyx of from four to six sepals, rarely of a greater or of a less number, accompanied externally with several scales. The petals are of the same number as the sepals, flat or concave and irregular, but always opposite to the sepals. They are often furnished at their inner base with small glands or glandular scales. The stamina are equal in number to the petals and opposite to them. The anthers, which are sessile or supported by a filament of variable length, have two cells, each of which opens by a kind of valve, such as we have already seen in the family of Laurineæ. The ovary has a single cell, which contains from two to twelve ovules, which are erect or laterally attached to the inner wall, and there forming one or two rows. The style, which is sometimes lateral, is short, thick, or wanting. The stigma is generally concave. The fruit is dry or fleshy, unilocular and indehiscent. The seeds are composed of a proper integument, covering a fleshy or horny endosperm, which contains an axile and homotrope embryo.

This family, from which have been removed several of the genera placed in it by M. de Jussieu, is composed of the following: *Berberis*, *Mahonia*, *Wandinia*, *Leontice*, *Caulophyllum*, *Epimedium*, and *Diphylleia*. It is very distinct from all the families allied to it, in having its stamina opposite to the petals, and in the mode of dehiscence of its anthers.

[The berries of *Berberis vulgaris* are acid, and used as a preserve.—Tr.]

Family XCI.—Menispermeæ, *Juss.*

This family is composed of sarmentaceous and climbing shrubs, of which the alternate leaves are generally simple, rarely compound. The flowers are small, unisexual, and most commonly diœcious. The calyx is composed of several sepals, arranged by threes, and forming several series. This is also the case with the corolla, which, however, is sometimes wanting. The stamina are monadelphous or free, of the same number as the petals, or of double or triple the number. The pistils, which are often very numerous, are free or united at their inner side, and are one-celled, containing one or more ovules. The fruits are small, compressed, oblique, somewhat reniform, monospermous drupes. The seed which they contain is composed of an embryo bent upon itself, and generally destitute of endosperm.

The Menispermeæ, which are composed of the genera *Menispermum, Cocculus, Cissampelos, Abuta, Lardizabala,* &c., are pretty closely allied to the Anonaceæ, but are distinguished from them by their general aspect, which is entirely different, by their stamina, which are generally in definite number, and by the structure of their fruits.

> [Columbo, which is astringent and tonic, is the root of *Menispermum palmatum.* Several species of *Cocculus* are employed as tonics in Brazil. *Cocculus indicus,* the seed of *Menispermum Cocculus,* is used in India for poisoning fishes.—Tr.]

Family XCII.—Ochnaceæ, *De Cand.*

Woody plants, very smooth in all their parts, having alternate leaves, furnished with two stipules at their base, pedunculate flowers, very rarely solitary, or more commonly disposed in branched racemes. Their peduncles are articulated towards the middle of their length. They have a calyx with five deep divisions, which are laterally imbricated previous to their expansion; and a corolla of from five to ten spreading petals, imbricated during præfloration. The stamina vary from five to ten, and even more, having their filaments free, and inserted like the petals beneath a very prominent hypogynous disk, on which the ovary is inserted. The ovary is depressed at its centre, and appears formed of several distinct pistils ranged around a central style, which seems to arise immediately from the disk. The style is simple, and bears at its summit a variable number of stigmatiferous divisions. The fruit is composed of the cells of the ovary, which are separated from each other, and form so many drupaceous carpels, supported upon the disk or gynobasis, which has become enlarged. These carpels, of which several are sometimes abortive, are unilocular, monospermous, and indehiscent. They appear as if articulated upon the gynobasis, from which they are easily separated. Their seed contains a large erect embryo destitute of endosperm.

To this family are referred the genera *Ochna*, *Gomphia*, *Walkera*, *Meesia*, &c. It has much affinity to the family of Rutaceæ, and more particularly to the tribe of Simarubeæ, from which it differs in having its leaves simple and furnished with stipules, its seeds erect, and its carpels indehiscent. On the other hand, the Ochnaceæ approach the Magnoliaceæ, and, in particular, the genus *Drymis*.

[The root and leaves of *Walkera serrata* are tonic and stomachic.—Tr.]

* Family XCIII.—Rutaceæ, *Adr. de Juss.*

Zygophylleæ *and* Diosmeæ, *Brown.* Simarubeæ, *Rich.*

A large family, composed of trees, shrubs, or herbaceous or frutescent plants, having opposite or alternate leaves, very frequently marked with transparent dots, with or without stipules. Flowers generally hermaphrodite, very rarely unisexual. Calyx of from three to five sepals, united at the base. Corolla of five petals, sometimes united together and forming a pseudo-monopetalous corolla, more rarely wanting. Stamina five or six, some of them occasionally abortive, and of various forms. The ovary is composed of from three to five carpels, more or less intimately united, and forming so many more or less prominent ribs. Each cell contains frequently two, more rarely one, or a considerable number of ovules, inserted at their inner angle, and there forming two rows. The styles are free or united. These carpels are generally applied upon a more or less prominent hypogynous disk, and sometimes form by their union a gynobasic ovary, the style of which seems to spring from a very deep depression of its central part. The fruit is sometimes simple, forming a capsule, opening into as many septiferous valves as there are cells; sometimes and more commonly it separates into as many cocca or carpels, which are usually monospermous and indehiscent, sometimes slightly fleshy, or dry and opening into two incomplete valves. The seeds, of which the common integument is often crustaceous, are composed of a fleshy or horny endosperm, containing an embryo having its radicle superior, rarely turned towards the hilum, which is lateral. Sometimes the embryo is destitute of endosperm.

We have adopted the family of Rutaceæ, such as it has been defined by our friend M. Adrien de Jussieu, in his excellent memoir on that family. He has united to it, as mere tribes, the Zygophylleæ of Brown, and the Simarubeæ proposed by my father, and has divided it into five natural tribes, as follows:

1. Zygophylleæ: Flowers hermaphrodite, cells of the ovary containing two or more ovules; endocarp not separating from the sarcocarp, endosperm cartilaginous, leaves opposite. Ex.: *Tribulus, Fagonia, Guaiacum, Zygophyllum*, &c.

2. Rutaceæ: Flowers hermaphrodite; two or more ovules

in each cell; endocarp not separating from the sarcocarp; endosperm cartilaginous; leaves alternate. Ex.: *Ruta, Peganum*, &c.

3. DIOSMEÆ: Flowers hermaphrodite; two or more ovules; endocarp separating from the sarcocarp. Ex.: *Dictamnus, Diosma, Boronia, Ticorea, Galipea*, &c.

4. SIMARUBEÆ: Flowers hermaphrodite or unisexual; cells with a single ovule; carpels distinct, indehiscent; embryo without endosperm. Ex.: *Simaruba, Quassia, Simaba*, &c.

5. XANTHOXYLEÆ: Flowers unisexual; cells containing from two to four ovules; embryo placed at the centre of a fleshy endosperm. Ex.: *Galvezia, Aylanthus, Brucea, Xanthoxylum, Toddalia, Ptelea*, &c.

This family is much allied to the Ochnaceæ, especially the section of Simarubeæ, which has, like them, a gynobasic ovary; but it differs from them in having reversed seeds, compound leaves, without stipules, &c.

[The plants of this family are generally characterized by being intensely bitter. *Ruta graveolens*, which is bitter, with a peculiar odour, is anthelmintic, diaphoretic, and emenagogue. Angustura bark is obtained from a plant of the tribe of Diosmeæ, which furnishes other equally powerful tonics. The Guaiacums are stimulating and tonic. The Quassias are intensely bitter.—TR.]

FAMILY XCIV.—PITTOSPOREÆ, *Brown*.

SHRUBS sometimes sarmentaceous and twining, with simple and alternate leaves, destitute of stipules. Flowers solitary, fasciculate, or disposed in terminal clusters. Their calyx is monosepalous, with five deep divisions. The corolla is composed of five equal petals, united at the base, so as to form a regular monopetalous corolla, which is tubular, or spread out in a rosaceous manner. The five stamina are erect, hypogynous, as is the corolla. The ovary is free, supported upon a kind of hypogynous disk. It has one or two cells, separated by incomplete dissepiments, which frequently do not join at the centre of the ovary, rendering that organ unilocular. The ovules are numerous, attached in two longitudinal and distinct series towards the middle of the dissepiment. The style is sometimes very short, terminated by a small two-lobed stigma. The fruit is a capsule, with one or two polyspermous cells, opening by two valves, or a fleshy indehiscent fruit. The seeds are composed of a somewhat crustaceous proper integument, a white and fleshy endosperm, and an extremely small embryo, situated towards the hilum, and having its radicle turned towards it.

The genera which compose this family, were formerly placed among the Rhamneæ; but their hypogynous insertion removes them to a wide distance. M. De Candolle places the Pittosporeæ between the Polygaleæ and the Frankeniaceæ; but, in our opinion, they ought to be placed near the Rutaceæ, which they singularly resemble in many of their characters. The following are the principal genera of this family: *Pittosporum, Billardiera, Bursaria, Senacia*, &c.

* Family XCV.—Geraniaceæ, *Aug. St Hilaire.*

Geraniaceæ, Oxalideæ, Tropæoleæ, *and* Linaceæ, *De Cand.*
Balsamineæ, *A. Rich.*

Herbaceous or suffrutescent plants, with simple or rarely compound, alternate leaves, with or without stipules at their base. The flowers are axillar or terminal. Their calyx is formed of five sepals, often unequal, and united together at their base, sometimes prolonged into a spur. The corolla is composed of five equal or unequal petals, free or slightly coherent, generally spirally twisted previous to their expansion. The stamina are from five to ten, rarely seven; they are free, or more frequently monadelphous by the base of their filaments. Their anthers are two-celled. The carpels are from three to five, more or less intimately united together. They have each a single cell, containing one, two, or a greater number of ovules, attached at its inner angle. The styles, which spring from the summit of each ovary, remain distinct, or are united together, and are each terminated by a simple stigma. The fruit is composed of from three to five cocca, containing one or two seeds, remaining indehiscent, or opening by their inner side; or it is a capsule, with five polyspermous cells, opening with five valves, sometimes elastically. The seeds, of which the proper integument is sometimes externally fleshy or crustaceous, is composed of a straight or more or less curved embryo, immediately covered by the proper integument, or placed in a fleshy endosperm.

We have adopted the opinion of M. Auguste de St Hilaire, who, in his *Flore du Brésil Méridional*, unites into one the families of Oxalideæ, Tropæoleæ, Linaceæ, and Geraniaceæ, of Professor De Candolle. These different families, as well as that which we have proposed under the name of *Balsamineæ*, in fact form only tribes of the same family, which ought to retain the name of Geraniaceæ.

1. Oxalideæ: Leaves usually compound, without stipules; flowers axillar, capsule with five polyspermous cells, styles distinct, embryo straight, in a fleshy endosperm. Ex.: *Oxalis*.

2. Tropæoleæ: Leaves simple, without stipules; flowers axillar, three indehiscent, monospermous cocca; embryo destitute of endosperm. *Tropæolum*.

3. Balsamineæ: Leaves simple, without stipules; flowers irregular; no style; capsule with five polyspermous cells, opening elastically; embryo without endosperm. *Balsamina*.

4. Linaceæ: Leaves simple, without stipules; flowers terminal, regular; three or five distinct styles; capsule with five two-seeded cells; endosperm thin. *Linum*.

5. Geraniaceæ: Leaves simple, furnished with stipules; flowers opposite to the leaves; styles united; cocca indehiscent; embryo generally without endosperm. *Geranium*, *Erodium*, *Pelargonium*, *Monsonia*.

[The true Geraniaceæ possess no properties of any importance in a medical point of view, although they are generally more or less astringent. The leaves and stems of the Oxalideæ are usually acid. The Tropæoleæ are acrid, and possess the properties of the Cruciferæ. *Linum catharticum* is purgative. The seeds of *Linum usitatissimum* are mucilaginous, oleaginous, and emollient.—Tr.]

* Family XCVI.—Malvaceæ, *Kunth.*

Part of the Malvaceæ *of Jussieu.*

This family contains herbaceous plants, shrubs, and even trees, with alternate, simple or lobed leaves, furnished with two stipules at their base. The flowers are axillar, solitary, or variously grouped, and forming a kind of spikes. The calyx is often accompanied externally with another, formed of leaflets, varying in number, and variously united. It is monosepalous, with three or five divisions, placed close together in the form of valves, previous to expansion. The corolla is generally composed of five petals, alternate with the lobes of the calyx, spirally twisted at first, often united together at their base, by means of the filaments of the stamina, so that the corolla falls off entire. The stamina are generally very numerous, rarely of the same number as the petals, or double their number. Their filaments are united, and form a tube, and their anthers are reniform and always unilocular. The pistil is composed of several carpels, which are sometimes verticillate around a central axis, and more or less united together, sometimes collected into a kind of capitulum. These carpels are unilocular, containing one, two, or a greater number of ovules attached at their inner angle. The styles are distinct, or more or less united, and bear each a simple stigma at their summit. The fruit presents the same modifications as the carpels, that is, the latter are sometimes united, in a circular manner, around an axis, sometimes collected into a head, or form, by their union, a many-celled capsule, which opens into as many valves as there are monospermous or polyspermous cells. At other times, the carpels open only by their inner side. The seeds, of which the proper integument is sometimes covered with cottony hairs, are composed of a straight embryo, generally without endosperm, having the cotyledons foliaceous and folded upon themselves.

The family of Malvaceæ, such as it is now limited by botanists, contains only part of the genera which were referred to it by Jussieu. Ventenat first separated from the Malvaceæ the genus *Sterculia*, of which he formed the type of the Sterculiaceæ. Mr Brown considers the Malvaceæ, not as a family, but as a great tribe or class, composed of the Malvaceæ of Jussieu, the Sterculiaceæ of Ventenat, the Chlenaceæ of Du-Petit-Thouars, the Tiliaceæ of Jussieu, and a new family which he names *Buttneriaceæ*. Our learned friend Professor Kunth places in the Malvaceæ only the three first sections of Jussieu, adopts the Buttneriaceæ of Brown, and connects with them the Sterculiaceæ of Ventenat. Lastly, he forms a new family, under the name of *Bombaceæ*, out of the genera *Bombax*, *Cheirostemon*, *Pachira*, *Helicteres*, *Cavanillesia*, *Matisia*, and *Chorisia*.

Thus defined, the family of the Malvaceæ is distinguished chiefly by its simple petals, its unilocular anthers, and its seeds generally destitute of endosperm. Of the genera of which it is composed, we may mention the following: *Malope*, *Malva*, *Althæa*, *Lavatera*, *Hibiscus*, *Gossypium*, *Palava*, *Lagunea*, &c.

[The Malvaceæ abound in mucilage, and are consequently demulcent. The Marsh-mallow (*Althæa officinalis*) has long been employed as such, but any of the other European species may be used with equal advantage. No plant belonging to this family is known to possess unwholesome qualities. The hairy covering of the seeds of several species of *Gossypium*, is the cotton of commerce.—Tr.]

Family XCVII.—Bombaceæ, *Kunth.*

Trees or shrubs, natives of intertropical countries, having alternate, simple, or digitate leaves, furnished at their base with two persistent stipules. The calyx, which is sometimes accompanied externally with some bracteas, is monosepalous, with five divisions, which are imbricated previous to their expansion, sometimes entire. The corolla, which is sometimes wanting, is composed of five regular petals. The stamina, five, ten, fifteen, or more, are monadelphous at their base, and form five bundles above, each bearing one or more unilocular anthers. The ovary is formed of five carpels, which are sometimes distinct, sometimes united together, and terminated each by a style and a stigma, which are sometimes united into one. The fruits are generally five-celled, polyspermous capsules, opening by five valves, or they are coriaceous, internally fleshy, and indehiscent. The seeds, which are often surrounded by hairs or down, sometimes have a fleshy endosperm, covering an embryo, of which the cotyledons are even or puckered. The endosperm is sometimes wanting.

This family, which is very nearly allied to the preceding, differs from it especially in having the calyx entire, or not having its lobes placed close together like valves previous to expansion, in having the filaments disposed in five fasciculi, and in the structure of the fruit. The genera of which it is composed are: *Bombax, Helicteres, Matisia, Cavanillesia, Adansonia,* &c.

[Mucilaginous like the Malvaceæ. The Baobab or Adansonia is the largest known tree, its diameter being from twenty to thirty feet at the base. The seeds of many species are enveloped in cottony hairs, which are used for various purposes, although they cannot be manufactured into thread.—Tr.]

Family XCVIII.—Buttneriaceæ, *Brown.*

Some genera of Malvaceæ, *and the* Hermanniæ *of Jussieu.*
Sterculiaceæ, *Vent.*

Trees or shrubs with simple alternate leaves, furnished with opposite stipules. Flowers disposed in more or less branched clusters, which are axillar or opposite to the leaves. The calyx, which is naked or accompanied with a calyculus, is formed of five petals, more or less united at their base, and valvar. The corolla is of five flat petals, spirally twisted before expansion, or more or less concave and irregular. The petals are sometimes wanting. The stamina, which are of the same number as the petals, double or multiple, are in general monadelphous, and the tube which they form by their union often presents petaloid appendages, placed between the antheriferous stamina, and which are so many abortive stamina. The anthers are always two-celled. The carpels, from three to five in number, are more or less completely united. Each cell contains two or three ascending ovules, or a greater number, attached to the inner angle of each cell. The styles remain free, or are more or less united together. The fruit is generally a globular capsule, accompanied by the calyx, with three or five cells opening into so many valves, which often bear the dissepiment on the middle of their inner face. The seeds have an erect embryo in a fleshy endosperm.

This family, which is distinguished from the Malvaceæ by its two-celled anthers, and by the circumstance that its seeds are generally furnished with a fleshy endosperm, has been divided into six sections or natural tribes :

1. Sterculiaceæ : Flowers often unisexual, calyx naked, no corolla ; ovary pedicellate, formed of five distinct carpels ; endosperm sometimes wanting. Ex.: *Sterculia*, *Triphaca*, *Heritiera*, &c.

2. Buttneriaceæ : Petals irregular, concave, often terminated at their summit by a kind of ligule; stamina monadelphous; ovary with five cells, generally containing two erect ovules: *Theobroma, Abroma, Guazuma, Buttneria, Ayenia,* &c.

3. Lasiopetaleæ : Calyx petaloid; petals very small, in the form of scales, or wanting; ovary with three or five cells, containing each from two to eight ovules. *Seringia, Thomasia, Keraudrenia,* &c.

4. Hermannieæ : Flowers hermaphrodite, calyx tubular, corolla of five flat petals, spirally rolled before expansion; five monadelphous or free stamina, opposite to the petals, cells polyspermous. *Melochia, Hermannia, Mahernia,* &c.

5. Dombeyaceæ: Calyx monosepalous; corolla of five flat petals, stamina equal, numerous, and monadelphous; ovary with three or five cells, containing two or more ovules. *Ruizia, Dombeya, Pentapetes,* &c.

6. Wallichieæ : Calyx surrounded by an involucre of from three to five leaflets; petals flat; stamina very numerous, monadelphous, unequal, and forming a column similar to that of the Malvaceæ, *Eriolæna, Wallichia, Gæthea.*

[The Buttneriaceæ, like the Malvaceæ and Bombaceæ, are remarkable for the mucilage which they contain. Cocoa is prepared from the seeds of *Theobroma Cacao.*—Tr.]

Family XCIX.—Chlenaceæ, *Du Petit Thouars.*

This little family is composed of small shrubs, all natives of the Island of Madagascar. Their leaves are alternate, furnished with stipules, entire and caducous. The flowers form branched racemes. They are furnished with persistent involucres, which contain one or two flowers. Their calyx is small, formed of three sepals. The petals vary from five to six: they are sessile, and sometimes united at their base. The stamina, which are ten, or in indeterminate number, are united by their filaments, and sometimes adhere to each other by their anthers. The ovary has three cells, surmounted by a simple style, and a trifid stigma. The fruit is a capsule, with three cells, rarely with only one, through abortion, containing each one or more seeds, inserted at their inner angle, and pendent. These seeds contain an axile embryo, in a fleshy or horny endosperm.

The Chlenaceæ, which are composed of the genera *Sarcolæna*, *Lepsolæna*, *Schizolæna*, and *Rhodolæna*, have been referred to the vicinity of the Malvaceæ by M. Du-Petit-Thouars, on account of their calyculus, monadelphous stamina, &c.; and by M. de Jussieu to that of the Ebenaceæ, on account of their petals being connected, and forming a kind of monopetalous corolla, as well as for some other characters.

* Family C.—Tiliaceæ, *Juss.*

Tiliaceæ *and* Elæocarpeæ, *Juss.*

Almost all the Tiliaceæ are trees or shrubs, a small number only being herbaceous plants. They bear alternate simple leaves, accompanied at their base by two caducous stipules. Their flowers are axillar, pedunculate, solitary, or variously grouped. They have a simple calyx, formed of four or five sepals, placed close together in the form of valves previous to the expansion of the flower; a corolla having the same number of petals, which are rarely wanting, and are often glandular at their base. The stamina are numerous, free, with bilocular anthers. A pedicellate gland is often seen on the face of each petal. The ovary has from two to ten cells, containing each several ovules attached, in two rows, to the inner angle. The style is simple, terminated by a lobed stigma. The fruit is a capsule, with several cells, containing several seeds, and sometimes indehiscent, or a monospermous drupe, through abortion. The seeds contain a straight or slightly curved embryo, in a fleshy endosperm.

We unite with this family the Elæocarpeæ of Jussieu, which differ only in two unimportant characters, viz. petals fringed at the tip, and anthers opening by two pores only. We therefore consider them merely as a tribe of the Tiliaceæ, which we divide into two sections.

1. The true TILIACEÆ, comprehending the genera *Tilia*, *Sparmannia*, *Heliocarpus*, *Corchorus*, *Triumfetta*, *Apeiba*, &c.

2. The ELÆOCARPEÆ, to which belong the genera *Elæocarpus*, *Vallea*, *Decadia*, &c.

The Tiliaceæ are allied to the Malvaceæ, from which they differ in having the stamina free, and the embryo placed at the centre of a fleshy endosperm; and to the Buttneriaceæ, from which they are distinguished by their stamina being free and numerous, their style simple, &c.

[The Tiliaceæ are mucilaginous, like the families to which they are allied. The properties of the Elæocarpeæ are unknown.—TR.]

FAMILY CI.—TERNSTRŒMIACEÆ.

Ternstrœmiaceæ *and* Theaceæ, *Mirbel.*

TREES or shrubs, with alternate leaves, destitute of stipules, often coriaceous and persistent. Flowers sometimes very large, axillar and terminal, having a calyx formed of five concave, unequal and imbricated sepals, and a corolla composed of five petals, sometimes united at their base, and forming a monopetalous corolla. The stamina are numerous, often connected by the base of their filaments, and united to the corolla. The ovary is free, sessile, generally applied upon a hypogynous disk, divided into from two to five cells, each containing two or a greater number of pendent ovules, inserted at the inner angle. The number of styles is the same as that of the cells; each of them is terminated by a simple stigma. The fruit has from two to five cells. It is sometimes coriaceous, indehiscent, a little fleshy internally; at other times dry, capsular, and opening by as many valves. The seeds, which are often only two in each cell, have their embryo naked or covered with a fleshy, often very thin endosperm.

We have judged it necessary to unite the two families proposed by Professor Mirbel under the names of Theaceæ and Ternstrœmiaceæ, as they do not differ essentially from each other. They are formed of the genera *Ternstrœmia*, *Thea*, *Camellia*, *Fraziera*, &c., which had been placed in the family of *Aurantiaceæ*, from which, however, they differ in their calyx, the number of their styles, the absence of translucid dots, and in having an endosperm, which, however, is sometimes wanting. On the other hand, this family has some affinity to that of the Ebenaceæ, placed among the Monopetalæ. But, in general, it requires to be re-examined, and we impatiently wait for the result of our friend M. Cambessedes's inquiries respecting this group and that of the Guttiferæ.

[The different kinds of tea in common use are obtained from several species of Thea and Camellia.—Tr.]

Family CII.—Olacineæ, *Mirbel.*

This little family, which has been formed of part of the Aurantiaceæ, is composed of woody plants, bearing simple, alternate, petiolate leaves, without stipules, and very small axillar flowers. The flowers are composed of a very small, monosepalous, persistent, entire or toothed calyx, often attaining a large size and becoming fleshy. The corolla is formed of from three to six petals, which are coriaceous, sessile, valvar, free or united at the base. These petals, which sometimes bear the stamina, are often united two and two, and only separated at their summit. The stamina are generally ten in number, several of them being sometimes abortive, and existing under the form of sterile filaments. They are immediately hypogynous, or are borne upon the petals. The ovary is free, one-celled, generally containing three ovules, which are pendent at the summit of a central, erect trophosperm. The style is simple, terminated by a very small, three-lobed stigma. The fruit is drupaceous, indehiscent, often covered by the calyx which has become fleshy, and one-seeded. The seed is composed of a large fleshy endosperm, in which is contained a small basilar and homotrope embryo.

This little family, which is composed of the genera *Olax*, *Fissilia*, &c., is very distinct from the Aurantiaceæ, in having its leaves without dots, its stamina definite, its ovary always unilocular, and its embryo contained in a very large endosperm.

According to Mr Brown, the genus *Olax* is apetalous, in other words, its flower is a calyciform involucre and a calyx formed of three sepals; and, on account of the internal structure of its ovary, it approaches the Santalaceæ.

FAMILY CIII.—MARCGRAVIACEÆ, *Choisy*.

SHRUBS very frequently sarmentaceous and climbing, parasitic in the manner of the Ivy, having the leaves alternate, simple, entire, coriaceous and persistent; the flowers generally disposed in a short spike resembling a cyme. The flowers are sometimes oblique at the summit of their long peduncle, which pretty generally bears an irregular bractea, hollow and cowl-shaped, or like a horn. They are hermaphrodite, with a calyx of from four to six or seven short, imbricated, and generally persistent sepals. The corolla is monopetalous, entire, rising like a kind of hood, or formed of five sessile petals. The stamina, which are usually numerous (five only in *Souroubea*), have their filaments free. The ovary is globular, surmounted by a sessile stigma, lobed in a stellate form, which is rarely supported upon a style. It has a single cell, which has from four to twelve parietal trophosperms, projecting in the form of half dissepiments, divided at their free edge into two or three variously contorted laminæ, and all covered with very small ovules. The fruit is globular, coriaceous, internally fleshy, indehiscent, or bursting irregularly into a certain number of valves, the dehiscence of which takes place towards the summit, and which bear a trophosperm on the middle of their inner face. The seeds are very small, and contain immediately under their proper integument a homotrope embryo.

The genera of which this family is composed are *Marcgravia*, *Antholoma*, *Noranthea*, and *Souroubea*. This group is related to the Guttiferæ; but it is also very intimately allied to the Bixineæ and Flacourtianeæ, which have also a polypetalous corolla and indefinite stamina, a unilocular fruit, and parietal trophosperms. But, in these two families, the leaves are accompanied with stipules, and the embryo is covered by an endosperm.

Family CIV.—Guttiferæ, *Juss.*

This family is composed of trees or shrubs, sometimes parasitic, and all abounding in yellow and resinous proper juices. Their leaves, which are opposite, or more rarely alternate, are coriaceous and persistent. Their flowers, which are disposed in axillar racemes or terminal panicles, are hermaphrodite or unisexual and polygamous. Their calyx is persistent, formed of from two to six rounded, often coloured sepals. The corolla is composed of from four to ten petals. The stamina, which are very numerous, rarely in definite number, are free. The ovary is simple, and surmounted by a short style, which is sometimes wanting, and which bears a peltate, radiate, or lobed stigma. The fruit is sometimes capsular, sometimes fleshy or drupaceous, and sometimes opens by several valves, of which the generally inflected margins are fixed to a single placenta, or to several thick placentas. The seeds are composed of a homotrope embryo destitute of endosperm.

The Guttiferæ comprehend a considerable number of genera, all extra-European, such as *Clusia, Godoya, Mahurea, Garcinia, Calophyllum,* &c. They differ from the Hypericineæ in having their stamina entirely free, in being furnished with a milky juice, in the absence of transparent dots, &c.

[The yellow juice in which these plants abound is acrid and purgative. Gamboge, which is a drastic purgative, and affords a yellow paint, is the concrete juice of a plant of this family. The fruit of Garcinia Mangostana is very highly praised.—Tr.]

* Family CV.—Hypericineæ, *Juss.*

Herbaceous plants, shrubs, or even trees, often resinous, and sprinkled with transparent glands. Leaves opposite, very rarely alternate, simple. Flowers axillar or terminal, variously disposed. The calyx has four or five very deep, somewhat unequal divisions. The corolla is composed of four or five petals, spirally twisted previous to their evolution. The stamina are very numerous, united into several fasciculi by the base of their filaments, sometimes monadelphous or free. The ovary is free, globular, surmounted by several styles, which are sometimes united into one. It has as many polyspermous cells as there are styles. The fruit is a capsule, or a berry with several polyspermous cells. In the former case it opens by as many valves as there are cells, the margins of the valves being continuous with the dissepiments. The seeds, which are very numerous and very small, contain a homotrope embryo destitute of endosperm.

This family is composed of a small number of genera: *Hypericum, Androsæmum, Ascyrum, Vismia,* &c. Most of the species have, in the substance of their leaves, transparent miliary glands, which, on being held between the eye and the light, look like so many little holes. This character, together with the very numerous stamina and the polyspermous cells of the fruit, perfectly distinguish the Hypericineæ from the families that are allied to it.

FAMILY CVI.—AURANTIACEÆ, *Correa.*

Some of the genera of Aurantia *of Jussieu.*

VERY smooth, sometimes spinous trees or shrubs, bearing alternate and articulated leaves, which are simple, or more frequently pinnate, and furnished with vesicular glands, filled with a transparent volatile oil. The flowers are fragrant, and generally terminal. The calyx is monosepalous, persistent, with three or five more or less deep divisions. The corolla is of from three to five sessile petals, which are free or slightly united. The stamina, sometimes of the same number as the petals, or double that number, or a multiple of it, are free, or variously united by their filaments, and are attached beneath to a hypogynous disk, on which the ovary is applied. The ovary is globular, with several cells containing a single suspended ovule, or several ovules attached to the inner angle of the cell. The style, which is sometimes very short and thick, is always simple, and terminated by a simple or lobed discoid stigma. The fruit is generally fleshy internally, separated into several cells by very thin membranous dissepiments, containing one or more seeds inserted at their inner angle, and generally pendent. Externally, the pericarp is thick and indehiscent, studded with vesicles filled with volatile oil. The seeds contain one, sometimes two embryos, without endosperm.

The genera of which this family is composed are especially distinguished by their articulate, often compound leaves, furnished with vesicular glands, which exist also in the substance of their petals and pericarp, by their simple style and the absence of endosperm in the seeds. Examples: *Citrus, Limonia, Murraya*, &c.

[The Orange, the Lemon, the Citron, and the Lime, are the fruits of different species of *Citrus*. The juice of the Lemon is employed in medicine, as a refrigerant.—Tr.]

Family CVII.—Ampelideæ, *Rich.*

Vites, *Juss.*

Shrubs or small trees, which are twining, sarmentaceous, and furnished with tendrils opposite to the leaves, which are alternate, petiolate, simple or digitate, with two stipules at their base. The flowers are disposed in racemes, which are opposite to the leaves. The calyx is very short, often entire and nearly flat. The corolla is of five petals, which are sometimes coherent at their upper part, and rise all together in the form of a hood. The stamina, five in number, are erect, free, and opposite to the petals. The ovary is applied upon a hypogynous annular disk, lobed at its circumference. It has always two cells, each containing two erect ovules. The style, which is thick and very short, is terminated by a stigma which is slightly two-lobed. The fruit is a globular berry, containing from one to four erect seeds, having their episperm thick, their endosperm horny, and containing near their base a very small erect embryo.

This little family, which is composed of the genera *Vitis*, *Cissus*, and *Ampelopsis*, is very distinct from those allied to it in having its leaves furnished with stipules, its tendrils opposite to the leaves, its stamina opposite to the petals, and in the structure of its fruit and seed.

[The most important plant of this family is the Vine, *Vitis vinifera*, the products of which are too well known to require description.—Tr.]

Family CVIII.—Hippocraticeæ, *Juss.*

Hippocrateaceæ, *Kunth*, *De Cand.*

Shrubs or small trees, generally glabrous and sarmentaceous, bearing opposite, simple, coriaceous, entire or toothed leaves, and small, axillar, fasciculate or corymbose flowers. The calyx is persistent, with five divisions. The corolla is composed of five equal petals. The stamina are generally three in number, rarely four or five, having their filaments united at the base, and forming a tubular androphorum. The ovary is trigonal, with three cells, each containing four ovules attached to their inner angle. The style is simple, terminated by one or three stigmas. The fruit is sometimes capsular, with three membranous angles, sometimes fleshy; each cell generally contains four seeds. The seed has an erect embryo, without endosperm.

This family, which is composed of the genera *Hippocratea*, *Anthodon*, *Raddisia*, *Salacia*, &c., is allied to the Acerineæ and Malpighiaceæ.

* Family CIX.—Acerineæ, *De Cand.*

This family is composed of the genus *Acer* alone, and presents the following characters: Flowers hermaphrodite, or unisexual. Calyx with five more or less deep divisions, or entire. Corolla of five petals. Stamina double the number of the petals, inserted upon a hypogynous disk, which occupies the whole bottom of the flower. Ovary didymous and compressed, with two cells, each containing two ovules, attached at its inner angle. Style simple, sometimes very short, terminated by two subulate stigmas. The fruit consists of two indehiscent samaras, which are each prolonged into a wing on one side. The seeds present a spirally twisted embryo beneath their proper integument.

The Acerineæ are trees with simple or pinnate, opposite leaves, and flowers disposed in racemes or in terminal cymes. They are in some measure intermediate, between the Malpighiaceæ, from which they differ chiefly in their membranous, winged, and only two-celled fruits, and the Hippocastaneæ.

The family of Acerineæ, such as it was established by Jussieu, contained several other genera, such as *Æsculus,* which forms the family of the Hippocastaneæ of De Candolle, and which appears to us to belong to that of Malpighiaceæ, and the genus *Hippocratea,* which belongs to the Hippocraticeæ.

[Sugar is obtained from the juice of several American species.—Tr.]

Family CX.—Malpighiaceæ, *Juss.*

Trees or shrubs, with opposite, simple, or compound leaves, often furnished with napiform hairs, and frequently accompanied at their base with two stipules. Flowers yellow or white, forming racemes, corymbs, or sertules, which are axillar or terminal. The pedicels which support the flowers are often articulated and furnished with two small bracteas near their middle. The calyx is monosepalous, often persistent, with four or five deep divisions. The corolla, which is sometimes wanting, is composed of five petals with long claws. The stamina, six in number, seldom fewer, are free or slightly united at the base. The pistil is sometimes simple, sometimes formed of three carpels, more or less united. Each carpel or cell contains either a single ovule suspended at the upper part of the inner angle, or two ovules attached to the angle. The styles, three in number, are sometimes united. The fruit, which is dry or fleshy, is composed of three distinct carpels, or forms a capsule or a nuculanium, with three, rarely with two or a single cell. The capsule is usually marked with very prominent membranous wings, or spinous points. The nuculanium sometimes contains three unilocular nucules, sometimes a nucleus, with three monospermous cells. Each seed is composed of a proper integument of no great thickness, immediately covering a somewhat curved embryo.

This family, in which, among others, are placed the genera *Malpighia*, *Brysonima*, *Hyptage*, *Gaudichaudia*, *Banisteria*, &c., is allied to the Acerineæ and Hypericineæ. It is distinguished from the former by its long-clawed petals, monadelphous stamina, and monospermous cells; from the Hypericineæ by its definite stamina, monospermous cells, &c. We here include the genus *Æsculus*, which forms the family of *Hippocastaneæ* of M. de Candolle.

[The properties of the Malpighiaceæ are little known. The hairs of some species are pungent. The fruit of several is eaten in the West Indies. The bark of the Horse-chestnut is bitter and astringent.—Tr.]

Family CXI.—Erythroxyleæ, *Kunth.*

Trees or shrubs with alternate or opposite, generally glabrous leaves, furnished with axillar stipules. The flowers are small, pedicellate, having a persistent calyx, with five deep divisions, and a corolla of five petals, which are destitute of claws, and furnished internally with a small scale. The stamina, ten in number, are monadelphous. The ovary is unilocular, containing a single pendent ovule, or it has three cells, of which two are empty. From the ovary spring three styles, which are sometimes distinct, sometimes united nearly to their summit. The fruit is a monospermous drupe, containing an angular seed, of which the hard and horny endosperm contains an axile and homotrope embryo.

This little family is composed of the genus *Erythroxylum*, which was formerly placed among the Malpighiaceæ, and a new genus established by M. Kunth, under the name of *Sethia*. It differs from the Malpighiaceæ in its appendiculate petals, its monospermous fruit, and in having an endosperm to its embryo.

Family CXII.—Meliaceæ, *De Cand.*

Cedreleæ, *Brown.*

Trees or shrubs with alternate, simple or compound leaves, destitute of stipules. Flowers sometimes solitary and axillar, sometimes variously grouped in spikes or racemes. Calyx monosepalous, with four or five more or less deep divisions. Corolla with four or five valvar petals. Stamina generally double the number of the petals, rarely of the same or a greater number. They are always monadelphous, and their filaments form a tube, which bears the anthers sometimes at its summit, sometimes at its inner surface. The ovary is supported upon a hypogynous annular disk. It has four or five cells, generally containing two collateral and superimposed ovules. The style is simple, terminated by a stigma which is more or less deeply divided into four or five lobes. The fruit is sometimes dry, capsular, opening by four or five septiferous valves; sometimes fleshy and drupaceous, and occasionally unilocular through abortion. The seeds are composed of an embryo, sometimes enveloped in a thin or fleshy endosperm, which is wanting in other genera.

The genera *Ticorea* and *Cusparia*, which were at first placed in this family, have been transferred by Mr Brown to the Rutaceæ. The same botanist has formed of the genera *Cedrela* and *Swietenia* a distinct family, under the name of *Cedreleæ.* But Professor De Candolle has merely made it a tribe of the Meliaceæ. This family is divided into two natural tribes:

1. True Meliaceæ: Cells of the fruit containing one or two seeds without wings or endosperm; embryo reversed; cotyledons flat and leafy, or thick and fleshy. Ex.: *Geruma, Humiria, Turræa, Quivisia, Strigilia, Sandoricum, Melia, Trichilia, Guarea,* &c.

2. Cedreleæ: Cells of the fruit polyspermous, seeds gene-

rally winged, furnished with a fleshy endosperm, embryo erect, cotyledons leafy. Ex.: *Cedrela*, *Swietenia*, &c.

This family, which is allied to the Sapindaceæ and Ampelideæ, differs from them in having its stamina always monadelphous, and in the structure of its fruit.

[The bark of *Canella alba* is aromatic and tonic. The root of *Melia Azedarach* is anthelmintic. Mahogany is the wood of *Swietenia Mahagoni*, the bark of which, and of *S. febrifuga*, is tonic. The pulpy pericarp of *Melia Azedarachta*, like that of the Olive, yields oil. The fruits of some Indian species are eaten.—Tr.]

Family CXIII.—Sapindaceæ, *Juss.*

This family is composed of large trees or shrubs, sometimes of herbaceous and twining plants, bearing alternate and generally imparipinnate leaves, sometimes furnished with tendrils. Their calyx is composed of four or five sepals, which are free, or slightly united at the base. The corolla, which is sometimes wanting, is generally formed of four or five petals, which are sometimes naked, sometimes glandular near their middle, where they sometimes bear a petaloid lamina. The stamina, which are double the number of the petals, are free, and applied upon a flat, lobed, hypogynous disk, which fills all the bottom of the flower. The ovary is three-celled, each cell generally containing two superimposed ovules, attached to its inner angle. The style is simple at the base, trifid at the summit, which is terminated by three stigmas. The fruit is a capsule, sometimes vesicular, with one, two, or three cells, each containing a single seed. The seeds are composed of a large embryo, having its radicle curved over the cotyledons, and destitute of endosperm.

This family has been divided into three tribes, in the following manner:

1. Paulliniæ: Petals appendiculate; disk formed of distinct

glands, placed between the petals and stamina; ovary with three monospermous cells; twining herbs or shrubs, furnished with tendrils. Ex.: *Cardiospermum, Urvillea, Sergania, Paullinia.*

2. SAPINDACEÆ: Petals not appendiculate, but glandular or bearded, rarely naked; disk annular, or sometimes glands united together; ovary with two or three monospermous cells; trees or shrubs not twining. Ex.: *Sapindus, Talisia, Schmidelia, Euphoria, Thoninia, Cupania,* &c.

3. DODONÆACEÆ: Petals furnished with a scale at their base; ovary with two or three cells, containing two ovules; pericarp vesicular or winged; embryo having its cotyledons spirally twisted. Ex.: *Kolreuteria, Dodonæa,* &c.

[The fruits of several species are eaten; but the leaves of many are poisonous. The fruit of *Sapindus Saponaria* is soapy, as its name implies, and used for washing linen. —TR.]

* FAMILY CXIV.—POLYGALEÆ, *Juss.*

IN this family we find herbaceous plants or shrubs, with alternate, simple, entire leaves, and solitary, axillar, or spiked flowers. The flowers are composed of a calyx of four or five sepals, laterally imbricated previous to the expansion of the flower, and of which two, sometimes more internal, are petaloid and coloured. The corolla is formed of from two to five petals, sometimes distinct, sometimes united together by means of the filaments of the stamina, which form a tube split on one side. The stamina, which are generally eight in number, are monadelphous. Their androphorum is divided above into two phalanges, each bearing four unilocular anthers, generally opening at the tip. More rarely, the stamina are from two to four, and free. The ovary is sometimes accompanied, at its base, by a hypogynous and unilateral disk, or formed of two lateral and lamellar appendages. It has two, more rarely one or three cells, each containing one or two ovules. The style is long, usually curved, and bearing a hollow, two-lobed, or unilateral stigma. The fruit is a capsule or a drupe. In the former case, it has two one-seeded cells, and opens into two septiferous valves. In the latter case, it is unilocular, one-seeded, and indehiscent. The seeds are pendent, generally accompanied by a kind of caruncle or arillus of diversified form. Their embryo is sometimes placed in a fleshy endosperm, and sometimes destitute of endosperm.

The genus *Polygala* was at first placed by Jussieu in the family of Pediculares. My father, shewing the corolla to be truly polypetalous, pointed out the necessity of forming of it a distinct family, which Jussieu afterwards established under the name of Polygaleæ. This family approaches in the general form of its flower to the Leguminosæ and Fumariæ; but, on account of its characters, it ought to be placed near the Droseraceæ and the Tremandreæ of Brown. Besides the genus *Polygala*, it contains the genera *Salomonia*, *Comesperma*, *Badiera*, *Soulamea*, *Krameria*, &c.

[The root of *Poygala Senega* is stimulant, diuretic, diaphoretic, and purgative. Extract of ratanhia, the root of *Krameria*, is used to adulterate or improve port wine. The roots of the plants of this family are generally bitter, and more or less astringent.—Tr.]

Family CXV.—Tremandreæ, *Brown*.

This little family, which is formed of the two genera *Tremandra* and *Tetratheca*, is composed of shrubs having the general appearance of heaths, all natives of New Holland, bearing alternate or verticillate leaves, without stipules, simple or toothed, and often furnished with glandular hairs. The flowers are axillar and solitary. The calyx is composed of four or five unequal sepals, placed close together in the form of valves, previous to the expansion of the flower, and caducous. The corolla is composed of four or five equal petals, alternate with the sepals, and longer than the stamina. The stamina, eight or ten in number, are placed in pairs opposite the petals. Their anthers, which have two or four cells, open at their summit by a small hole or a kind of tube. The ovary is ovoidal, compressed, with two cells, each containing two or three pendent ovules. The style is terminated by one or two stigmas; and the fruit is a compressed bilocular capsule, opening by two valves, which are septiferous in the middle. The seeds, which are inserted at the upper part of the dissepiment, are terminated by a carunculate appendage. The embryo is erect in a fleshy endosperm.

This family has many points of affinity to the Polygaleæ, from which it differs in having its stamina free, its anthers two or four-celled, its corolla regular, and to the Droseraceæ, from which it is distinguished by its anthers, the cells of its ovary, which contain only two or three ovules, &c.

* Family CXVI.—Fumariaceæ, *De Cand.*

The Fumariaceæ are all herbaceous plants, destitute of milky juice, and furnished with alternate compound leaves, having a great number of narrow segments. The flowers are rather small, and generally disposed in terminal spikes. Their calyx is composed of two very small, opposite, flat, and caducous sepals. The corolla is irregular, tubular, formed of four unequal petals, sometimes slightly united together at their base. The upper petal, which is the largest, is terminated, at its lower part, by a short, curved spur. The stamina, six in number, are diadelphous, or form two androphora, each of which carries at its summit three anthers, the middle anther two-celled, the others one celled. The ovary is unilocular, and contains four or a great number of ovules attached to two longitudinal trophosperms, corresponding to each suture. The style is short, surmounted by a depressed stigma. The fruit is sometimes a globular akenium, monospermous through abortion, sometimes a many-seeded, two-valved, occasionally vesicular capsule. The seeds are globular, furnished with a caruncula, and containing, in a fleshy endosperm, a small, somewhat lateral, sometimes curved and transverse embryo.

This family, composed of the genus *Fumaria* and the genera formed of its different species, as *Corydalis, Diclytra, Cysticapnos,* &c., is distinguished from the Papaveraceæ by the absence of milky juice, the irregular corolla, and the six diadelphous stamina.

[This family does not contain any noxious plants, but its properties seem to be of little importance, although some of the species are diaphoretic.—Tr.]

Family CXVII.—Papaveraceæ.

Genera of the Papaveraceæ *of Jussieu, and of the* Podophylleæ *of De Candolle.*

Herbaceous, or more rarely suffrutescent plants, with alternate leaves, which are simple or more or less deeply cut, generally abounding in a white or yellowish milky juice. The flowers are solitary, or disposed in cymes or branched racemes. The calyx is formed of two, very rarely three concave, very caducous sepals. The corolla, which is sometimes wanting, is composed of four, very rarely of six flat petals, which are plaited and puckered previous to their expansion. The stamina, which are very numerous, are free. The ovary is ovoidal or globular, or narrow and approaching to linear, one-celled, containing very numerous ovules attached to trophosperms, which project in the form of laminæ or false dissepiments. The style, which is very short or scarcely distinct, is terminated by as many stigmas as there are trophosperms. The fruit is an ovoidal capsule, crowned by the stigma, indehiscent, or opening by pores under the stigma; or it is elongated in the form of a pod, opening by two valves, or breaking across by articulations.

The seeds, which are usually very small, are composed of a proper integument, sometimes bearing a kind of small fleshy caruncula, and of a fleshy endosperm, in which is placed a very small cylindrical embryo.

M. de Jussieu united with his Papaveraceæ the genus *Fumaria*, which, on being better examined, has become the type of a distinct family. The genera of the Papaveraceæ are *Papaver, Argemone, Meconopsis, Sanguinaria, Pocconia, Ræmeria, Glaucium, Chelidonium,* and *Hypecoum.*

We unite to this family *Podophyllum* and *Jeffersonia*, which form one of the tribes of De Candolle's family of Podophylleæ, in which he unites moreover the genera *Cabomba* and *Hydropeltis*, which form an entirely distinct family, belonging to the Monocotyledones. See *Cabombeæ.*

[Many of the Papaveraceæ are possessed of a narcotic property. Opium is the concrete milky juice of *Papaver album.* The seeds of the Poppies, however, yield an oil which is perfectly free of deleterious properties, and is used in food. Other species of this family are purgative, emetic, and diaphoretic, as *Sanguinaria canadensis.*—Tr.]

* Family CXVIII.—Cruciferæ, *Juss.*

One of the largest and most natural families of the vegetable kingdom, composed of herbaceous or sometimes suffrutescent plants, most of which grow in Europe. Their leaves are alternate, simple, or more or less deeply incised; their flowers disposed in spikes, or in simple or paniculate racemes. The calyx is formed of four caducous sepals, two of which are sometimes swelled out at the base. The corolla consists of four unguiculate petals, placed opposite each other in pairs, so as to represent a cross (whence the name of the family). The stamina, six in number, are tetradynamous, that is, there are four larger placed close to each other in pairs, and two smaller, opposite to each other. At the base of the stamina there are seen upon the receptacle two or four glands, one between each pair of large stamina, and a larger one under each of the small stamina.

The ovary is more or less elongated, with two cells separated by a false dissepiment. Each cell contains one or more ovules attached to the outer edge of the membranous dissepiment, which is merely a prolongation of the two sutural trophosperms. The style is short or almost none, and seems a continuation of the dissepiment: it is terminated by a two-lobed stigma. The fruit is a siliqua or a silicula, of variable form, indehiscent, or opening by two valves. The seeds are attached on each side of the dissepiment. Their embryo is immediately covered by the proper integument, and is more or less bent upon itself.

The genera which compose this family are exceedingly numerous. Linnæus divided them into two orders, according as the fruit is a silicula or a siliqua. In the first of these orders we find among others the genera *Lepidium*, *Thlaspi*, *Isatis*, *Myagrum*, *Cochlearia*, *Iberis*, *Lunaria*, &c.; in the other the genera *Cheiranthus*, *Sisymbrium*, *Hesperis*, *Brassica*, *Eruca*, *Sinapis*, &c.

[The Cruciferæ are more or less acrid and stimulant, and are considered as antiscorbutic. Mustard, the seed of *Sinapis nigra*, is extremely acrid, and is applied externally as a rubefacient or epispastic. The Horse-radish, the Cress, the root of *Raphanus maritimus*, and many other species, are equally pungent; the seeds contain fixed oil, which is extracted from those of some species. When the acrid principle is corrected by an abundant mucilage, the plants become useful as food, as is the case with the Water-cress, the Sea-kale, the Field-mustard. Cultivation diminishes the acrimony, so as to render some species almost destitute of it, as in the numerous varieties of the Cabbage and Turnip.—Tr.]

Family CXIX.—Capparideæ.

Herbaceous or woody plants, bearing alternate, simple or digitate leaves, accompanied at their base by two foliaceous stipules. Their flowers are terminal, spiked or racemed, or axillar and solitary. The calyx is composed of four caducous sepals, very rarely united together at their base. The corolla is formed of four or five equal or unequal petals. The stamina are sometimes definite, more frequently indefinite. The ovary is simple, often raised upon a more or less elongated support, which bears the name of podogynum, at the base of which are inserted the stamina and petals. It has a single cell containing several trophosperms projecting in the form of plates or false dissepiments, bearing a great number of ovules. The fruit is dry or fleshy. In the former case, it is a kind of more or less elongated pod, opening by two valves, as in most of the Cruciferæ. In the latter case, it is a unilocular, many-seeded berry, of which the seeds are either parietal, or are scattered in the pulp of which the fruit is composed. These seeds are generally reniform, composed of a dry, crustaceous episperm, which immediately covers a somewhat curved embryo, destitute of endosperm.

Of the genera which compose this family, we may mention the following: *Capparis*, *Cratæva*, *Morisonia*, *Boscia*, *Cleome*, &c. M. de Jussieu placed in his family of Capparideæ several genera which have become the types of distinct families. Thus *Reseda* forms the family of Resedaceæ: *Drosera*, *Parnassia*, *Aldrovanda*, and *Dionæa*, the Droseraceæ; *Marcgravia* and *Norantea*, the Marcgraviaceæ.

The Capparideæ have the most intimate affinity to the Cruciferæ, but differ from them in having their leaves furnished with stipules, their numerous stamina, and the structure of their fruit.

[The properties of these plants are similar to those of the Cruciferæ.—Tr.]

Family CXX.—Resedaceæ, *De Cand.*

Plants generally herbaceous, rarely suffrutescent, with alternate leaves, destitute of stipules, and often having two glands at their base. The flowers form simple and terminal spikes. The calyx has from four to six deep and persistent divisions. The corolla is composed of the same number of petals alternating with the sepals. The petals are generally composed of two parts, a lower entire part, and an upper divided into a greater or less number of segments. The stamina are generally in indeterminate number (from fourteen to twenty-six); their filaments free and hypogynous, their anthers two-celled, each cell opening by a longitudinal groove. Externally of the stamina, that is, between them and the petals, is a kind of annular, glandular mass, more elevated on the upper side, and thus forming a hypogynous disk of a peculiar kind. The pistil, which is slightly stipitate at its base, appears formed by the intimate union of three carpels, and is terminated above by three horns, each bearing a stigma at its summit. The ovary has a single cell, open at the top, containing a great number of ovules, attached to three parietal trophosperms, which are remarkable for not corresponding to the stigmas, but alternate with them. The fruit, which is very rarely fleshy, is commonly a more or less elongated capsule, naturally open at the summit, which is terminated by three angles; it is one-celled, and the seeds are arranged upon three parietal trophosperms. The seeds, which are very frequently kidney-shaped, are composed of a rather thick integument, a very thin fleshy endosperm, and an embryo bent in the form of a horse's shoe.

This family contains only the genus *Reseda* and the *Ochradenus* of M. Delile. The genus Reseda was placed by Jussieu in the family of Capparideæ, and it must be allowed to have considerable affinity to that family, and especially to the genus *Cleome*. But M. Tristan *(Ann. du Mus. d'Hist. Nat.)* has made it the type of a new family, which has been adopted by M. de Candolle, and which, by the first of these botanists, was placed between the Passifloreæ and Cisteæ, but nearer the latter. In his *Collectanea Botanica*, t. xxii., Mr. J. Lindley has given quite a different explanation of the flower of the Reseda. He considers the calyx as a common involucre, each petal as a sterile flower, and the nectary or disk a proper calyx which surrounds a hermaphrodite flower composed of the stamina and pistil. Agreeably to this view, Mr Lindley brings the Resedaceæ near the Euphorbiaceæ, which present a somewhat similar disposition. We think, however, that this family cannot be separated from the Capparideæ and Cisteæ.

[*Reseda luteola* affords a yellow dye; but the properties of this family are little known.—Tr.]

Family CXXI.—Flacourtianeæ, *Rich.*

Bixineæ, *Kunth.*

Shrubs with alternate, simple, entire, often coriaceous, persistent leaves, destitute of stipules, and pedunculate, axillar, often unisexual and diœcious, at other times hermaphrodite flowers. Their calyx is formed of from three to seven sepals, which are distinct, or slightly connected at the base. The corolla, which is sometimes wanting, is composed of five or seven petals alternating with the sepals. The stamina, which are determinate or indeterminate in number, and inserted at the circumference of a hypogynous annular disk, which is rarely wanting, have their filaments free, and their anthers two-celled. The ovary is sessile or stipitate, globular, one-celled in all the genera of the family excepting *Flacourtia*, in which it has from six to nine cells. In the former case, it contains a considerable number of ovules attached to parietal trophosperms, the number of which is the same as that of the stigmas, or of the lobes of the stigma. The fruit is unilocular, except in *Flacourtia*. It is indehiscent, or dehiscent, and each of the valves bears a trophosperm on the middle of its inner face. In general the proper tegument of the seed is fleshy, and the embryo, which is homotrope and straight, is placed in the centre of the fleshy endosperm.

The genera which compose this family do not seem to us to be yet very well determined. Their general essential character consists in parietal placentas, simple or more frequently ramified in the form of veins, which line the inner wall of the ovary, as we have already remarked in the tribe of Butomeæ belonging to the family of Alismaceæ. Perhaps it might be expedient to unite with the Flacourtianeæ the family of Bixineæ, established by our learned friend Professor Kunth, and which seems to us not to differ essentially from it. The principal genera which compose the Flacourtianeæ are *Flacourtia*, *Roumea*, *Kiggellaria*, *Erythrospermum*, &c. This family is related to the Capparideæ, from which it differs chiefly in having the embryo destitute of a fleshy endosperm, and the seeds inserted on the middle and not on the edge of the valves. It has also some affinity to the Cisteæ and Tiliaceæ.

* Family CXXII.—Cisteæ, *De Cand.*

Some genera of the Cisti *of Jussieu.*

Annular or perennial herbaceous plants, or shrubs, bearing entire, often opposite leaves, sometimes furnished with stipules. The flowers are axillar or terminal, solitary or spiked, in racemes or in sertules. Their calyx has three or five very deep divisions, sometimes equal, sometimes unequal, with two more external. The corolla has five puckered, very caducous petals, spread out in a rosaceous form, and sessile. The stamina are very numerous and free ; the ovary globular, rarely unilocular, more commonly with five or ten cells, containing sevĕral ovules inserted at the inner edge of the dissepiments. In the unilocular ovary, the ovules are attached to parietal trophosperms. The style and stigma are simple. The fruit is a globular capsule enveloped in the calyx, which is persistent, with one, three, five, or even ten cells, and opening by three, five, or ten valves, each bearing one of the dissepiments and one of the trophosperms on the middle of its inner surface. The seeds, which are pretty numerous in each cell, contain an embryo, which is more or less curved, or spirally twisted, in a fleshy endosperm.

This small family contains only the genera *Cistus* and *Helianthemum*. As proposed by Jussieu in his *Genera Plantarum*, it contained the genera *Viola*, *Piparea*, *Piriqueta*, and *Tachibota*, which now form the family of Violarieæ.

[The resinous substance called Labdanum, used as an article of perfumery, is collected from *Cistus creticus*.—Tr.]

* Family CXXIII.—Droseraceæ, *De Cand.*

Herbaceous, annual or perennial, rarely suffrutescent plants, having alternate leaves, often furnished with glandular and pedicellate hairs, and rolled in the form of a crosier previous to their development. The calyx is monosepalous, with five deep divisions, or with five distinct sepals. The corolla is composed of five flat and regular petals. The stamina, five in number, sometimes ten, alternate with the petals, and are free. Sometimes there are appendages of various forms on the face of each petal. The stamina are generally perigynous, and not hypogynous, as they have hitherto been represented. The ovary is one-celled, rarely two or three-celled. In the former case, it contains a great number of ovules attached to three or five simple or bifid parietal trophosperms. In the other, the dissepiments appear formed by the trophosperms projecting in the form of plates, which meet and unite in the centre of the ovary. The stigmas, generally of the same number as the trophosperms or the cells, are sessile and radiating. The fruit is a capsule, with one or more cells, opening by its upper half only, into three, four, or five valves, bearing one of the trophosperms on the middle of their inner surface. The seeds, which are often covered with a loose tissue, contain an erect, nearly cylindrical embryo, in the interior of a thin endosperm, which is sometimes wanting.

The genera referred to this family by M. De Candolle are *Drosera*, *Aldrovanda*, *Romanzoffia*, *Byblis*, *Roridula*, *Drosophyllum*, *Dionæa*, and *Parnassia*. But in the article *Droseracées* in *Dict. Class. d'Hist. Nat.*, where we have treated somewhat fully of this family, we have shown that there ought to be removed from it, 1*st*, The genus *Dionæa*, which has the insertion really hypogynous, and the seeds all attached to the bottom of the capsule, and which, perhaps, comes nearer the Hypericineæ; and, 2*dly*, *Romanzoffia*, which belongs to the Scrophularinæ.

The family of Droseraceæ differs from the Violarieæ, to which it comes very near, by its perigynous insertion, the absence of stipules, the constant regularity of the flower, &c.

[The *Droseræ*, which are somewhat acrid, are said to be poisonous to cattle.—Tr.]

* Family CXXIV.—Violarieæ, *De Cand.*

Herbs or shrubs, with alternate, very rarely opposite leaves, furnished with two persistent stipules. The flowers are axillar and pedunculate. The calyx is composed of five sepals, which are equal or unequal, free, or slightly connected at the base, which is sometimes prolonged beneath their point of attachment. The corolla is composed of five unequal petals, of which the lower is prolonged at its base into a more or less elongated spur; very rarely the corolla is formed of five regular petals. The stamina, five in number, are almost sessile, placed close together, and in contact by the sides, with two introrsal cells. The two which are situated towards the lower petal, pretty frequently present an appendage in the form of a recurved horn, which arises from their dorsal part, and is prolonged into the spur. The ovary is globular, unilocular, and contains numerous ovules attached to three parietal trophosperms. The style is simple, a little geniculate at the base, enlarged towards its upper part, which is terminated by a somewhat lateral stigma, presenting a small semicircular pit. The fruit is a unilateral capsule, opening by three valves, each bearing a trophosperm on the middle of its inner surface. The seeds contain an erect embryo in a fleshy endosperm.

The Violarieæ, which are composed of the genera *Viola*, *Ionidium*, *Hybanthus*, *Noisettia*, *Conhoria*, *Alsodeia*, &c., are distinguished from the Cisteæ by their irregular corolla, their five stamina, their enlarged and concave stigma, &c. They are also allied to the *Polygaleæ*, *Droseraceæ*, &c.

[Part of the Ipecacuan of commerce is derived from South American species of *Viola*. The roots of several European species, as *V. canina* and *odorata*, possess similar properties, although in a less degree.—Tr.]

Family CXXV.—Frankeniaceæ, *Aug. St. Hil.*

The Frankeniaceæ are herbaceous or frutescent. Their leaves are alternate or verticillate, entire or serrate, with very close lateral nerves, and furnished at their base with two stipules, which are wanting only in the genus *Frankenia*. The flowers are axillar, disposed in simple or compound racemes, or in panicles. They are hermaphrodite: their calyx is formed of five sepals, slightly united at the base; the corolla of five equal or unequal petals. In the genus *Sauvagesia*, there is observed moreover a verticil of club-shaped filaments, and an internal corolla, which also exists in the genus *Luxemburgia*. The stamina are five, eight, or indefinite in number; they are free, with two-celled extrorsal anthers, opening by a longitudinal slit or a pore. The ovary is elongated, ovoidal, or trigonal, often placed upon a hypogynous disk. It has a single cell, containing three parietal trophosperms, each bearing a considerable number of ovules. The style is slender, terminated by an extremely small stigma. The fruit is a capsule, covered by the calyx, or by the inner corolla, with a single cell, which opens by three valves, the edges of which are slightly inflected, and form three incomplete valves, bearing the seeds, which, at the centre of a fleshy endosperm, contain a small cylindrical, homotrope, axile embryo.

This little family is composed of the genera *Frankenia*, *Lavradia*, *Sauvagesia*, and *Luxemburgia*. It has the greatest affinity to the Cisteæ, Violaceæ, and Droseraceæ; but differs from them especially in the mode of dehiscence of its capsules, the valves of which bear the seeds on the entering margins, while the placentas are placed on the middle of the inner face of the valves in the preceding families.

[*Sauvagesia erecta* is mucilaginous and diuretic. The properties of this family, however, are little known.—Tr.]

* Family CXXVI.—Caryophylleæ, *Juss.*

The Caryophylleæ are herbaceous, rarely suffrutescent at their base. Their stems are often knotty and articulated. Their leaves simple, opposite or verticillate. Their flowers, which are generally hermaphrodite, are terminal or axillar. Their calyx is composed of four or five sepals, which are distinct or united together, and form a cylindrical or vesicular tube, merely toothed at its summit. The corolla, which is of five petals, commonly unguiculate at their base, is very rarely wanting. The number of stamina is generally equal to, or double that of the petals. In the latter case, five are alternate with the petals, and five are opposite to them, and are united beneath with the claws. They are all inserted upon a hypogynous disk which supports the ovary. The latter has from one to five cells, or is unilocular. The ovules, which are numerous, are attached to a central trophosperm. When it is many-celled, they are attached to the inner angle of each cell. The styles vary from two to five, and terminate each in a subulate stigma. The fruit is a capsule, very rarely a berry, having from one to five polyspermous cells. The capsule opens, either at its summit, by means of small teeth which separate from each other, or by complete valves. The seeds are sometimes flat and membranous, sometimes rounded. The embryo is curved, or as if rolled round the farinaceous endosperm.

Several genera, which were at first placed in this family, have been removed from it and united to some others, taken from the family of Amaranthaceæ, to form the new family of Paronychiæ, which is especially distinguished by its perigynous insertion. Such are the genera *Polycarpon*, *Lœflingia*, *Minuartia*, and *Queria*. The genera *Linum* and *Lechea*, which constituted the family of Linaceæ, have been united to the Geraniaceæ. *Frankenai* has become the type of the family of Frankeniaceæ; and *Sarothra* has been referred to the Hypericineæ.

The genera of this family may be divided into two tribes:

1. The DIANTHEÆ, which have a tubular monosepalous calyx, and petals with elongated claws. *Dianthus*, *Silene*, *Lychnis*, *Agrostemma*, *Cucubalus*, &c.

2. The ALSINEÆ, of which the calyx is spreading, and the petals without claws. *Arenaria*, *Alsine*, *Spergula*, *Cerastium*, *Mollugo*, &c.

[The Caryophylleæ are not remarkable for any important properties, being generally insipid.—TR.]

FOURTEENTH CLASS.—PERIPETALIA †.

* FAMILY CXXVII.—PARONYCHIEÆ, *Aug. St. Hil.*

HERBACEOUS or suffrutescent plants, bearing opposite leaves, often connate at their base, with or without stipules, and very small, axillar, or terminal flowers, which are naked

† Besides the families of which we here give the characters, there are several others belonging to this class. But as all these characters are not yet perfectly determined, or, as they are composed of only a very small number of genera, we have thought it better to omit them in a work like this. Of this kind are: 1. The *Escalloneæ*, allied to the Saxifrageæ; 2. The *Stackhouseæ*, which are composed of the genus *Stackhousia* alone; 3. The *Chailletticeæ*, consisting of the genera *Chailletia*, *Leucosia*, and *Iapura*; and, 4. The *Aquilarineæ*, containing the genera *Aquilaria*, *Ophispermum*, and *Gyrinops*. All these families have been proposed by Mr Brown.

or accompanied with scariose bracteas. Their calyx, which is monosepalous, often persistent, has five more or less deep divisions, and not unfrequently forms a tube at its lower part, which is often thickened by a glandular prominence. The petals, five in number, very small and squamiform, or even wanting, are inserted at the upper part of the tube of the calyx. The stamina, also five, but of which some are occasionally abortive, are alternate with the petals, and have their anthers introrse. The ovary is free, with a single cell containing a single ovule placed at the summit of a basal podosperm, sometimes very long, in which case the ovule is reversed; at other times, several ovules are attached to a very short central trophosperm. The stigma is sometimes sessile and simple, sometimes bifid and supported upon a rather short style. The fruit is a capsule, which opens by valves or slits, or remains closed. The seeds are composed of a proper integument, a cylindrical embryo applied upon one of the sides, or rolled around a farinaceous endosperm. The radicle is always directed towards the hilum.

This family, which was established by M. Auguste de St Hilaire, is composed of genera taken from the Amaranthaceæ, Portulaceæ, and Caryophylleæ, from which they differ, especially in having the insertion perigynous, whereas it is hypogynous in the other two. We have divided the genera of Paronychieæ into two tribes:

1. The SCLERANTHEÆ, which contain the genera destitute of bracteas, and of which the divisions of the calyx are not scarious on the edges, the leaves destitute of stipules and connate. Ex.: *Lœfflingia*, *Minuartia*, *Queria*, *Scleranthus*, *Mniarum*, and *Larbrea*.

2. The true PARONYCHIEÆ, the genera of which have their flowers furnished with bracteas, their calycine divisions scarious on the edges, often fleshy and canaliculate, and the leaves accompanied by stipules. Ex.: *Gymnocarpus*, *Paronychia*, *Illecebrum*, *Anychia*, *Herniaria*, *Polycarpon*, *Hagea*, &c.

[These plants are slightly astringent, but are not known to possess any remarkable properties.—TR.]

* Family CXXVIII.—Portulaceæ, *Juss.*

Herbaceous, rarely frutescent plants, with opposite, sometimes alternate, thick and fleshy leaves, destitute of stipules. The flowers are generally terminal. Their calyx is commonly formed of two sepals, more or less connected and often tubulate at the base. The corolla is composed of five petals, which are free, or slightly connected, so as to form a monopetalous corolla. The stamina are of the same number as the petals, inserted at their base, and opposite to them: more rarely they are more numerous. The ovary is free, or almost semi-inferior, with a single cell containing a variable number of ovules, arising immediately from the bottom of the cell, or attached to a central trophosperm. The style is simple, terminated by three or five filiform stigmas. The fruit is a unilocular capsule, containing three or more seeds, and opening either by three valves, or by two superimposed valves. The frequently crustaceous proper integument of the seed, covers a cylindrical embryo, which is wrapped over a farinaceous endosperm.

Several genera, which were at first united to this family, have been removed from it. Thus, the genus *Tamarix* forms the family of Tamariscineæ, which differs more especially in the absence of the endosperm; the genera *Scleranthus*, *Gymnocarpus*, and probably *Telephium*, and *Corrigiola* belong to the new family of Paronychieæ, which differs only in having the stamina alternate with the petals and not opposite, and in having the stigma simple or bifid, instead of being trifid or quinquefid. The genera which remain among the Portulaceæ are: *Portulaca*, *Talinum*, *Montia*, &c.

Family CXXIX.—Ficoideæ, *Juss.*

The Ficoideæ are generally succulent plants, like the Crassulaceæ, with alternate or opposite leaves, and axillar or terminal, often very large flowers. The calyx is monosepalous, often campanulate and persistent, its limb sometimes coloured, and four or five lobed. Corolla polypetalous, the petals sometimes indeterminate in number, sometimes united into a monopetalous corolla: more rarely the corolla is wanting. The stamina are generally pretty numerous, free and distinct. The ovary is sometimes entirely free, sometimes adherent at its base to the calyx: it has from three to five cells, each containing several ovules attached to a trophosperm, which springs from the inner angle of each cell. It is surmounted by from three to five styles, each terminated by a simple stigma. The fruit is sometimes a berry, sometimes a capsule surrounded by the calyx, with from three to five polyspermous cells. The seeds have an embryo rolled around a farinaceous endosperm.

This family is very closely allied to the Portulaceæ, from which it differs in having the petals and stamina generally numerous, more than one style, and its ovary three or five-celled, and not unilocular, as in the Portulaceæ. The principal genera of the family of Ficoideæ are: *Reaumuria*, *Mesembryanthemum*, *Nitraria*, *Tetragonia*, &c. This family, which, in its general aspect, approaches the Crassulaceæ, differs from it in having its ovary simple.

* Family CXXX.—Saxifrageæ, *Juss.*

And Cunoniaceæ, *Brown.*

The Saxifrageæ are herbaceous plants, rarely shrubs or trees, of which the leaves are alternate or opposite, simple, and sometimes compound, with or without stipules. The flowers, which are sometimes solitary, sometimes variously grouped into spikes, racemes, &c., have a monosepalous calyx, tubular beneath, where it is united to the ovary, and terminated above by three or five divisions. The corolla, which is very rarely wanting, is formed of four or five petals, sometimes united at their base. The stamina are generally double the number of the petals, sometimes indeterminate. The ovary has two, more rarely four or five cells. It is sometimes entirely free, sometimes semi-inferior or almost inferior, terminated at its summit by as many styles as there are cells. The cells usually contain several ovules, very rarely only one. The ovules are attached to a trophosperm placed along the dissepiment. The fruit, which is rarely fleshy, is generally a capsule, terminated above by two more or less elongated horns, and usually opening by two septiferous valves. The seeds have beneath their proper integument a fleshy endosperm, which contains an axile, homotrope embryo, sometimes a little bent.

This family, with which we unite the Cunoniaceæ of Mr Brown, which differ only in having the stem woody, is composed of the genera *Saxifraga*, *Heuchera*, *Tiarella*, *Cunonia*, *Weinnmannia*, &c.

[The Saxifrageæ are more or less astringent, but are not in general known to possess any remarkable properties. The roots of *Saxifraga granulata* have been employed as a diuretic. That of *Heuchera americana*, and the bark of the Weinnmanniæ, are powerfully astringent.—Tr.]

Family CXXXI.—Hamamelideæ, *Brown*.

Shrubs with alternate, simple leaves, often furnished with two caduceous stipules. The flowers are axillar, having a calyx composed of four sepals, sometimes united into a tube at their lower part, and attached to the ovary, which is semi-inferior. The corolla is composed of four elongated, linear, valvar petals, a little twisted previous to the expansion of the flowers. The stamina are four, alternate with the petals, having their anthers introrse, and two-celled, opening by a valvule, which is sometimes common to the two cells, and which occupies their inner face.

Before each petal there is often a scale of diversified form, which appears to be an abortive stamen. The ovary is semi-inferior, or entirely free, with two cells, each containing a suspended ovule. From the summit of the ovary spring two styles, each terminated by a simple stigma. The fruit, which is enveloped by the calyx, is dry, with two monospermous cells, generally opening with two septiferous valves. The seeds are composed of a homotrope embryo, covered by a fleshy endosperm.

The genus *Hamamelis*, which forms the type of this family, was placed by Jussieu at the end of the Berberideæ; but its insertion is truly perigynous. Mr Brown has proposed establishing a new family for it under the name of Hamamelideæ, to which he also refers the genera *Dicoryphe* and *Dahlia*, and approximates the genus *Fothergilla*, which, however, differs in several characters. The celebrated English naturalist thinks his family of Bruniaceæ ought to be placed near this new family. The Hamamelideæ themselves appear to us to be intimately allied to the Saxifrageæ.

Family CXXXII.—Bruniaceæ, *Brown. Ad. Brong.*

The plants which form this family are shrubs, which in habit greatly resemble the Heaths and the Phylicæ or Cape Heaths. They are all natives of the Cape of Good Hope. Their leaves are very small, stiff, entire, sometimes imbricated. The flowers are small, disposed in capitula, more rarely in panicles. The calyx is monosepalous, with five divisions, generally adherent at its base to the ovary, which is inferior or semi-inferior (free in the genus *Raspalia* alone): the five divisions are imbricated, as is the corolla, previous to expansion. The petals are five, and alternate. The five stamina alternate with the petals, and their filaments adhere laterally to the base of each of the petals, which has led some authors to consider them as opposite to the petals. The ovary is semi-inferior, or inferior, or free, with one or three cells, containing each one or two collateral suspended ovules. The style is simple or bifid, or the two styles are distinct and terminated each by a very small stigma. The fruit is dry, crowned by the calyx, corolla and stamina, which are persistent. It is indehiscent, or separates into two generally monospermous cocca, opening by a longitudinal and internal slit. The seeds are suspended, and contain a very small homotrope embryo placed near the base of a fleshy endosperm.

This small family, which was proposed by Brown in *Abel's Voyage to China*, has been adopted by M. de Candolle. M. Adolphe Brongniart has published a memoir on it, in which he has more clearly traced the characters of the family and those of the genera which compose it. The genus *Brunia*, which forms its type, was placed by Jussieu beside the genus Phylica, in the family of Rhamneæ; but it differs in several characters, such as the alternate and not opposite stamina, the ovules often geminate and suspended, not solitary and erect, &c. Mr Brown thinks that the Bruniaceæ ought to be placed near the Hygrobiaceæ and Hamamelideæ, while M. de Candolle places them near the Rhamneæ. In his monograph on this family, M. Brongniart enumerates the following genera: *Berzelia*, *Brunia*, *Raspalia*, *Staavia*, *Berardia*, *Linconia*, *Audoninia*, *Tittmannia*, and *Tamnea*.

* FAMILY CXXXIII.—CRASSULACEÆ, *De Cand.*

Sempervivеæ, *Juss.*

THIS family is composed of herbaceous plants or shrubs, the leaves, stem, and in general all the herbaceous parts of which are thick and fleshy. The leaves are alternate or opposite. The flowers, which are sometimes very finely coloured, present various modes of inflorescence. Their calyx is deeply divided into a great number of segments.

The corolla is composed of a variable, sometimes very great number of regular petals, which are distinct, or united into a monopetalous corolla. The number of stamina is the same as that of the petals, or of the lobes of the monopetalous corolla, or more rarely double their number. At the bottom of the flower are always several distinct pistils, varying from three to twelve, or even more. Each is composed of a more or less elongated ovary, having a single cell, containing several ovules attached to a sutural and internal trophosperm. The style and stigma are simple. The fruits are unilocular, polyspermous capsules, opening by their longitudinal and internal suture. Their seeds have a more or less curved embryo, in some degree enveloping a mealy endosperm.

This family, which is composed of succulent plants, is related to the Ranunculaceæ, by its polyspermous unilocular capsules opening by a single longitudinal suture. But it approaches more to the Saxifrageæ and Ficoideæ, from which it differs especially in having distinct pistils at the centre of the flower. The principal genera are: *Tillæa*, *Buliardia*, *Crassula*, *Cotyledon*, *Bryophyllum*, *Sedum*, and *Sempervivum*.

[These plants are not distinguished by any remarkable properties. They are insipid, or slightly acid, sometimes acrid.—Tr.]

Family CXXXIV.—Nopaleæ, *Vent.* Cactus, *Juss.*

This family is composed exclusively of the genus *Cactus* of Linnæus, and the divisions which have been made in it. They are perennial, often arborescent plants, of a very peculiar aspect, different from that of any other plants, excepting some *Euphorbiæ*. Their stems are either cylindrical, branched, channelled, angular, or composed of articulated pieces, which have been considered as leaves. The leaves are almost always wanting, and are substituted by spines collected into fasciculi. The flowers, which are sometimes very large, and brilliantly coloured, are generally solitary, and placed in the axilla of one of the bundles of spines. The calyx is monosepalous, adherent to the inferior ovary, sometimes scaly externally, terminated at its summit by a limb composed of a great number of unequal lobes, which are confounded with the petals. The petals are generally very numerous, and disposed in several series. The stamina, which are also very numerous, have their filaments slender and capillar. The ovary is inferior, with a single cell, containing a great number of ovules, attached to parietal trophosperms, the number of which is very variable, and commonly in relation to that of the stigmas. The style is simple, terminated by three or a greater number of rayed stigmas. The fruit is fleshy, umbilicate at its summit. Its seeds have a double integument, and contain a straight or curved embryo, destitute of endosperm.

M. de Jussieu placed in this family, along with the genus *Cactus*, the genus Ribes, of which M. de Candolle has formed his family of Grossulariæ. For the differences that exist between these two families, see the note appended to the character of the next family.

[The fruits of this family are generally mucilaginous and insipid, and some of them are eaten.—Tr.]

Family CXXXV.—Ribesiæ, *Rich.*

Grossulariæ, *De Cand.*

Bushy, sometimes spinous shrubs, having alternate leaves, without stipules. The flowers are axillar, solitary, geminate, or disposed in spikes or simple racemes. The calyx is monosepalous, tubular inferiorly where it adheres to the ovary, having its limb bell-shaped, with five spreading or reflected divisions. The corolla is formed of five petals, which are sometimes very small. The stamina, which are of the same number as the petals, and alternate with them, are inserted about the middle of the limb of the calyx. The ovary is inferior, with a single cell, containing a great number of ovules, attached in several series to two parietal trophosperms. The two styles are more or less united together, and terminate each in a simple stigma. The fruit is a globular, umbilicate, polyspermous berry, and its seeds are composed of a thick embryo, immediately covered by the proper integument.

This family is composed of the genus *Ribes*, to which might perhaps be added the genus *Gronovia*, formerly placed among the Cucurbitaceæ. It is extremely allied to the Nopaleæ, from which it differs especially in the very different habit of the plants of which it is composed, in the circumstance of the petals and stamina being always five, and not in indeterminate number, as in the Cacti, in their two trophosperms and their two styles. In another work (*Botanique Medicale*, p. 487), I have proposed dividing the numerous species of this genus into three sections or subgenera, of which the types are *Ribes Uva-crispa*, *Ribes nigrum*, and *Ribes rubrum*. I have named the first *Grossularia*, the second *Ribes*, the third *Botryocarpum*.

[The numerous varieties of Gooseberries and Currants belong to this family, of which the fruits are generally eatable, although some are insipid, and others extremely acid.—Tr.]

* Family CXXXVI.—Cucurbitaceæ, *Juss.*

Large herbaceous plants, often twining, covered with short and very stiff hairs. Their leaves are alternate, petiolate, more or less lobed. Their tendrils, which are simple or branched, arise beside the petioles. The flowers are generally unisexual and monœcious, very rarely hermaphrodite. The calyx is monosepalous : in the female flowers it presents a globular tube adherent to the inferior ovary. Its limb, which is more or less campanulate and five-lobed, is confounded and intimately united with the corolla, having only the tips of its lobes distinct. The corolla is formed of five petals, united together by means of the limb of the calyx, and thus representing a monopetalous corolla. The stamina, five in number, have their filaments monadelphous or united into three fasciculi, two formed each of two stamina, and the third of a single stamen. The anthers are unilocular, linear, bent upon themselves, in the form of the letter S placed horizontally, and with its branches very close. In the female flowers, the summit of the ovary, which is inferior, is crowned by an epigynous disk. The style is thick, short, terminated by three thick and often two-lobed stigmas. The ovary is one-celled in two genera (*Sicyos* and *Gronovia*). It contains a single pendent ovule; but, in general, it presents three triangular, very thick parietal trophosperms, in contact with each other at their sides, and thus filling the whole cavity of the ovary, and giving attachment to the ovules at their point of origin upon the walls of the ovary. The fruit is fleshy, umbilicate at its summit: it is a peponida. The seeds, when the fruit is ripe, seem scattered in the midst of a filamentous or fleshy cellular tissue. The proper integument is rather thick, and immediately covers a thick homotrope embryo, destitute of endosperm.

The principal genera of this family are: *Cucumis*, *Cucurbita*, *Pepo*, *Ecballium*, *Momordica*, *Bryonia*, *Gronovia*, &c. It has considerable affinity to the family of Onagrariæ, from which it differs in the structure of its perianth, and especially in that of its fruit. It is also very closely allied to many of the Nopaleæ and Ribesiæ. The genus *Passiflora*, which was at first placed in this family, has become the type of a distinct order under the name of Passifloreæ.

[To this family belong the Melon, Cucumber, Pumpkin, and various gourds, which are articles of food. Colocynth, a drastic purgative, is prepared from the pulp of *Cucumis Colocynthis*. The roots of *Bryonia alba* and *Momordica Elaterium* also afford drastic purgatives.—Tr.]

Family CXXXVII.—Loaseæ, *Juss.*

Herbaceous, branched plants, often covered with hispid hairs, the stinging of which burns like that of a Nettle. Their leaves are alternate or opposite, entire or variously lobed. Their flowers, which are pretty frequently yellow and large, are sometimes solitary, sometimes variously grouped. The calyx is monosepalous, tubular, free or adherent to the inferior ovary, having its limb with five divisions. The corolla is of five regular, flat or concave petals. The throat of the calyx is sometimes furnished with five appendages, or a divided border. The stamina, which are generally very numerous, are sometimes of the same number as the petals. The ovary is free or inferior, with a single cell, presenting internally three parietal trophosperms, sometimes projecting in the form of dissepiments, and bearing several ovules. The ovary is surmounted by three long, slender styles, sometimes united into one, and terminated each by a simple or penicillate stigma. The fruit is a capsule, crowned by the lobes of the calyx, or naked, opening at its summit only into three valves, which bear one of the trophosperms on the middle of their inner face, excepting in the genus *Loasea*, in which the trophosperms correspond to the sutures. The seeds, which are sometimes arillate, present a homotrope embryo in a fleshy endosperm.

This family is composed of the genera *Loasa, Mentzelia, Klaprothia,* to which M. Kunth has added *Turnera* and *Piriqueta*. It is much allied to the Onagrariæ and Nopaleæ, but differs from them in very decided characters. Thus in the Onagrariæ the ovary is multilocular, the stamina are determinate in number, &c. In the Nopaleæ the fruit is fleshy, and the seed without endosperm.

Family CXXXVIII.—Passifloreæ, *Juss.*

Herbaceous plants, or shrubs with sarmentaceous stems, furnished with extra-axillar tendrils, and alternate, simple or lobed leaves, accompanied with two stipules at their base. More rarely they are trees destitute of tendrils. Their flowers are generally large and solitary; more rarely they form a kind of raceme. They are hermaphrodite, with a monosepalous, turbinate or long and tubular calyx, with five more or less deep, sometimes coloured divisions, and a corolla of five petals, inserted at the upper part of the tube of the calyx. The stamina are five, monadelphous at their base, and forming a tube which covers the support of the ovary, and is united with it. The anthers are versatile, and two-celled. Externally of the stamina, are appendages of very diversified form, sometimes filamentous, sometimes in the form of scales or of pedicellate glands, united circularly, and forming from one to three crowns, which arise at the orifice and upon the walls of the tube of the calyx. Sometimes these appendages, and even the corolla, are entirely wanting. The ovary is free, with a long stalk and a single cell, presenting from three to five longitudinal trophosperms, which sometimes project in the form of false dissepiments, and give attachment to a great number of ovules. It is surmounted by three or four styles, terminated by as many simple stigmas. In some rare cases the stigmas are sessile. The fruit is fleshy internally, containing a very great number of seeds; more rarely it is dry, but always indehiscent. The seeds have a fleshy endosperm, in which is a homotrope and axile embryo.

According to Jussieu, the Passifloreæ, as well as the Cucurbitaceæ, have only a simple perianth; and the organ which we have above described as the corolla, is to be compared to the numerous appendages with which the mouth of the calyx is furnished. Whatever opinion may be adopted in this matter, it is very difficult to determine with accuracy the place which the Passifloreæ ought to occupy in the series of natural orders. They appear to us to be but slightly connected with the Cucurbitaceæ, among which the genus Passiflora has been placed. But they may be found to have some distant affinity to certain families of polypetalous plants, and, in particular, to the Capparideæ, and especially to the Loaseæ, in the neighbourhood of which they ought, in our opinion, to be placed.

The family of Passifloreæ is composed of the genera *Passiflora*, *Tacsonia*, *Murucuja*, *Malesherbia*, *Deidamia*, *Kolbia*, and probably *Carica*, which is also placed among the Cucurbitaceæ.

[The sweetish, fragrant, and cooling pulp of the fruits of several species is eaten. The fruit of the Papaw, *Carica Papaya*, is eaten when ripe, and in the immature state is vermifuge. According to Dr Wright this plant possesses the property of intenerating meat.—Tr.]

* Family CXXXIX.—Hygrobieæ, *Rich.*

Cercodianæ, *Juss.* Halorageæ, *Brown.*

A small family, composed generally of aquatic plants, often bearing verticillate leaves. The flowers are very small, axillar, sometimes unisexual, with a monosepalous calyx adhering to the inferior ovary, and terminated above by a limb with three or four lobes. The corolla, which is sometimes wanting, is composed of three or four petals alternate with the lobes of the calyx. The stamina are of the same or double the number of the petals, to which they are opposite in the former case. The ovary has from three to four cells, each containing a single reversed ovule. From the summit of the ovary spring three or four filiform, glandular, or downy stigmas. The fruit is a berry or a capsule, crowned by the lobes of the calyx, with several monospermous cells. The seeds are reversed, and contain a cylindrical, homotrope embryo in a fleshy endosperm.

The genera which compose this family were at first placed among the Onagrariæ and Najades. They are *Myriophyllum*, *Haloragis*, *Cercodia*, *Proserpinaca*, *Trixis*, &c. It differs especially from the Onagrariæ in having its ovary with monospermous cells, its seeds pendent, and its embryo furnished with a fleshy endosperm.

* Family CXL.—Onagrariæ, *Juss.*

Herbaceous, rarely frutescent plants, with simple, opposite, or scattered leaves, and terminal or axillar flowers. The calyx is adherent to the inferior ovary; its limb, four or five lobed. The corolla is formed of four or five petals, laterally incumbent and spirally twisted previous to expansion. It is rarely wanting. The stamina are of the same number as the petals, or double their number, sometimes fewer. The ovary is inferior, and has four or five cells, containing a considerable number of ovules, attached to their inner angle. The style is simple, and the stigma is sometimes simple, sometimes four or five-lobed. The fruit is a berry or a capsule, with four or five cells, each often containing only a small number of seeds, and opening by as many valves, bearing the dissepiments on the middle of their inner surface. The seeds have a proper integument, generally formed of two laminæ, and immediately covering a homotrope embryo destitute of endosperm.

Jussieu's family of Onagræ contained several genera which have been successively removed from it. Thus the genus *Mocanera* appears to us to belong to the family of Ternstrœmiaceæ; *Cercodia* forms the type of the family of Hygrobieæ; the genera *Cacoucia*, and *Combretum*, belong to the Combretaceæ; *Santalum* forms the type of the Santalaceæ; the genera *Mourira* and *Petaloma* appear to us to belong to the Melastomaceæ; and, lastly, the genera *Loasa* and *Mentzelia* constitute the family of Loaseæ.

The family of Onagrariæ is composed, among others, of the genera *Epilobium*, *Œnothera*, *Lopezia*, *Circæa*, *Jussiæa*, *Fuchsia*, &c. It is very nearly allied to the Myrtaceæ and Melastomaceæ, but is distinguished from the Myrtaceæ by having its leaves without dots, its stamina in determinate number, and its general aspect; and from the Melastomaceæ by the very different structure of the leaves and anthers.

[The roots of *Œnothera biennis* are eaten, but the properties of this family are little known.—Tr.]

Family CXLI.—Combretaceæ, *Brown*.

Genera Ælæagni *and* Terminaliæ *of Juss.*

Trees or shrubs, with opposite or alternate leaves, which are entire and without stipules. Flowers hermaphrodite or polygamous, variously disposed in axillar or terminal spikes. The calyx is adherent by its base to the ovary, which is inferior; its limb, which is often tubular, has four or five divisions, and is articulated to the summit of the ovary. The corolla is wanting in several genera, or is composed of four or five petals inserted between the lobes of the calyx. The number of stamina is generally double that of the divisions of the calyx, but the number is not strictly determined. The ovary has a single cell, containing from two to four ovules hanging from its summit. The style varies in length, and is terminated by a simple stigma. The fruit is always unilocular, monospermous through abortion, and indehiscent. The seed, which is pendent, is composed of an endosperm, which immediately covers the embryo.

The Combretaceæ consist of genera which were referred, some to the Elæagneæ, and others to the Onagrariæ, such as *Bucida*, *Terminalia*, *Conocarpus*, *Quisqualis*, *Combretum*, &c. This family does not at first sight appear composed of genera very intimately allied. In fact, some are furnished with petals, while others want them; some have flat cotyledons, while others have these organs convolute. But the truly distinctive character of this family consists of its unilocular ovary, containing from two to four ovules hanging from the top of the cell without podosperm. By its apetalous genera, this family is connected with the Santalaceæ, which are especially distinguished from it by the presence of an endosperm, and by their erect ovules. By its genera which are furnished with petals, it closely approaches the Onagrariæ and Myrtaceæ, between which it ought to be placed.

[Generally astringent and tonic. The bark of several species is used for tanning.—Tr.]

Family CXLII.—Myrtaceæ, *Juss.*

This interesting family is composed of trees or shrubs of an elegant habit, and abounding in a resinous and fragrant juice. The leaves are opposite, entire, often persistent, and marked with translucid dots. The flowers are variously disposed, either in the axillæ of the leaves, or at the summits of the twigs. Their calyx is monosepalous, adherent by its base with the inferior ovary, having its limb with five, six, or only four divisions. The corolla, which is rarely wanting, is formed of as many petals as the calyx has lobes. The stamina, which are generally very numerous, rarely in determinate number, have their filaments free, or variously united, their anthers terminal and generally rather small The ovary, which is inferior, has from two to six cells, which contain a variable number of ovules attached at their inner angle. The style is generally simple and the stigma is lobed. The fruit presents numerous modifications. It is sometimes dry, opening into as many valves as there are cells, sometimes indehiscent or fleshy. The seeds, which are generally destitute of endosperm, have an embryo the cotyledons of which are never either convolute, or rolled in a spiral form one upon the other.

Professor De Candolle has divided the Myrtaceæ into five natural tribes, as follows :

1. The Chamælaucieæ : Fruit dry, unilocular ; seeds basilar, calyx five-lobed, corolla of five petals, sometimes wanting ; stamina free or polyadelphous. The genera which form this tribe

are all natives of New Holland: *Calytrix*, *Chamælaucium*, *Pileanthus*, &c.

2. Leptospermeæ: Fruit dry, dehiscent, with several cells; seeds attached to the inner angle, destitute of arillus and endosperm; leaves opposite or alternate. Shrubs all natives of New Holland: *Beaufortia*, *Calotamnus*, *Tristania*, *Melaleuca*, *Eudesmia*, *Eucalyptus*, *Metrosyderos*, *Leptospermum*, &c.

3. Myrteæ: Fruit fleshy, generally with several cells; seeds without arillus or endosperm; stamina free; leaves opposite. Shrubs almost all natives of the tropics: *Eugenia*, *Jambosa*, *Calyptranthes*, *Caryophyllus*, *Myrtus*, *Campomanesia*, &c.

4. Barringtonieæ: Fruit dry or fleshy; always indehiscent, with several cells; stamina monadelphous at their base; leaves alternate, not dotted. Trees of the equinoctial regions of the Old and New Continents: *Dicalyx*, *Stravadium*, *Barringtonia*, *Gustavia*.

5. Lecythideæ: Fruit dry, opening by an operculum (pyxidium); stamina very numerous, monadelphous; leaves alternate, not dotted. Large trees of equinoctial America: *Lecythis*, *Couratari*, *Couroupita*, *Bertholletia*.

The Myrtaceæ form a very distinct family among the Dicotyledones with inferior ovary. It is allied to the Melastomaceæ, which differ from it in the very remarkable and constant disposition of the nerves of their leaves, and in the number and structure of their stamina; to the Onagrariæ, which differ in having their stamens determinate; to the Rosaceæ, which are distinguished by their alternate leaves and multiple styles; and to the Combretaceæ, in which the lobes of the embryo are convolute.

[These plants generally contain a pungent or fragrant volatile oil, together with tannin and gallic acid. Cloves are the flowers of *Caryophyllus aromaticus*. Pimento is obtained from a species of Myrtus. Cajeputi oil is procured from the leaves of *Melaleuca leucadendron*. The root of *Eugenia racemosa* is employed in India as an aperient. The bark of the root of the Pomegranate is astringent, and has been employed in diarrhœa, as well as a remedy for tape-worm. *Eucalyptus resinifera* yields a kind of gum; and the bark of several species is used for tanning. The fruits of the Eugeniæ are eaten, as are those of several other species of this family.—Tr.]

Family CXLIII.—Melastomaceæ, *Juss.*

The Melastomaceæ are large trees, trees of small size, shrubs or herbaceous plants, with opposite, simple leaves, generally furnished with from three to five or even eleven longitudinal nerves, from which proceed numerous other transverse, parallel, very close nerves. The flowers, which are sometimes very large, have in a manner every mode of inflorescence. The calyx is monosepalous, more or less adherent to the ovary, which is inferior, or semi-inferior: its limb is sometimes entire or toothed, or, lastly, has four or five more or less deep divisions. More rarely it forms a kind of hood or operculum. The corolla is composed of four or five petals. The stamina are double the number of the petals: their anthers present the most diversified and the most singular forms, and open at their summit by a hole or pore common to the two cells. The ovary is sometimes free, more commonly adherent to the calyx. It has from three to eight cells, each containing very numerous ovules. The summit of the ovary is often covered by an epigynous disk. The style and stigma are simple. The fruit is sometimes dry, sometimes fleshy, and has the same number of cells as the ovary. It remains indehiscent, or opens into so many septiferous valves. The seeds are frequently reniform: they contain an erect or slightly curved embryo, destitute of endosperm.

This family, which has lately been subjected to careful examination by Professor De Candolle, in the third volume of his *Prodromus*, contains a very great number of species, which have been grouped into numerous genera, such as *Melastoma*, *Rhexia*, *Miconia*, *Tristemma*, *Topobæa*, &c. It is so distinct in the disposition of the nerves of its leaves, that it cannot be confounded with any of the families which approach nearest to it, as the Onagrariæ, Myrtaceæ, and Rosaceæ.

[All that can be said of the properties of this extensive family is, that the species are generally more or less astringent, and that none of them are known to be unwholesome.—Tr.]

* Family CXLIV.—Salicariæ, *Juss.*

Herbs or shrubs with opposite or alternate leaves, bearing axillar or terminal flowers; a monosepalous, tubular or urceolate calyx, toothed at its summit; a corolla of from four to six petals, which alternate with the divisions of the calyx, and are inserted at the upper part of its tube. The corolla is wanting in some genera. The stamina are equal to the petals in number, or double, or more rarely in indefinite number. The ovary is free, simple, with several cells, each containing a considerable number of ovules. The style is simple, terminated by a usually capitate stigma. The fruit is a capsule covered by the calyx, which is persistent, and has one or more cells, containing seeds attached at their inner angle. The seeds are composed of an embryo destitute of endosperm.

Of the genera which compose this family, we may mention the following: *Lythrum*, *Cuphea*, *Ginoria*, *Lagerstrœmia*, *Ammania*. It is allied to the Onagrariæ, from which it differs in having its ovary free, and to the Rosaceæ, which have always stipules, and possess many other characters which distinguish them from the Salicariæ.

[*Lythrum Salicaria* is astringent, and has been used in diarrhœa. The henne of the east is obtained from *Lawsonia inermis*.—Tr.]

* Family CXLV.—Tamariscineæ, *Desvaux.*

Shrubs or small trees, generally with very small, squamiform and sheathing leaves, and small flowers, furnished with bracteas, and disposed in simple spikes, which are sometimes collected into a panicle. The calyx has four or five deep divisions, which are laterally imbricated: sometimes it forms a tube at its lower part. The corolla is composed of four or five persistent petals. The stamina, from five to ten, rarely four, are monadelphous at their base. The ovary is triangular, sometimes surrounded at its base by a perigynous disk. The style is simple or tripartite. The fruit is a triangular capsule, with a single cell, containing a pretty large number of seeds attached about the middle of the inner surface of the three valves which form the capsule. The embryo is erect, destitute of endosperm.

This small family is composed of the genus *Tamarix*, which M. Desvaux, Professor of Botany at Angers, proposes dividing into two genera, *Tamarix* and *Myricaria*. It was at first placed among the Portulaceæ, from which it differs in its habit, and in the embryo being destitute of endosperm. In this latter character, the family of Tamariscineæ has some affinity to the Lythrariæ.

[The ashes of *Tamarix gallica* and *africana* contain a large quantity of sulphate of soda. The bark is generally bitter and astringent.—Tr.]

* Family CXLVI.—Rosaceæ, *Juss.*

A large family composed of herbaceous plants, shrubs, or trees attaining very large dimensions. Their leaves are alternate, simple or compound, accompanied at their base by two persistent stipules, sometimes united to the petiole. The flowers present various modes of inflorescence. They have a monosepalous calyx, with four or five divisions, sometimes accompanied externally with a kind of involucre which is incorporated with the calyx, so that the latter appears to have eight or ten lobes. The corolla, which is rarely wanting, is composed of four or five regularly spreading petals. The stamina are generally very numerous and distinct. The pistil presents various modifications. Sometimes it is formed of one or several carpels, entirely free and distinct, and placed in a tubular calyx. Sometimes these carpels adhere by their outer side to the calyx; sometimes they are not only united to the calyx, but to each other; sometimes they are collected into a kind of capitulum, upon a receptacle or gynophorum. Each of these carpels is unilocular, and contains one, two, or a greater number of ovules, the position of which varies greatly. The style is always more or less lateral, and the stigma simple. The fruit is extremely diversified: sometimes it is a true drupe, sometimes a melonida or an apple; sometimes one or more akenia, or one or more dehiscent capsules; or, lastly, an aggregation of small akenia or drupes, forming a capitulum upon a gynophorum which becomes fleshy. The seeds have their embryo monotrope and destitute of endosperm.

This extensive family has been divided into tribes, some of which have been considered as distinct families.

1. Chrysobalaneæ, Brown: Ovary single, free, containing two erect ovules; style filiform, arising nearly from the base of the ovary; flowers more or less irregular; fruit drupaceous. Ex.: *Chrysobalanus*, *Parinarium*, *Moquilea*, &c.

2. Drupaceæ, De Cand.: Ovary single, free, containing two collateral ovules; style filiform, terminal; flowers regular; fruit drupaceous. Ex.: *Prunus*, *Amygdalus*, *Cerasus*, &c.

3. Spiræaceæ, Rich.: Several ovaries, which are free or slightly attached to each other by their inner side, containing two or four collateral ovules; style terminal: capsules distinct, unilocular; or a single polyspermous capsule. Ex.: *Spiræa*, *Kerria*.

4. Fragariaceæ, Rich.: Calyx spreading, often furnished with an external calyculus; several monospermous, indehiscent carpels, sometimes collected upon a fleshy gynophorum; style more or less lateral. Ex.: *Potentilla*, *Fragaria*, *Geum*, *Rubus*, *Dryas*, *Comarum*, &c.

5. SANGUISORBEÆ, Juss.: Flowers usually polygamous and sometimes destitute of corolla; one or two carpels, sometimes adherent to the calyx, terminated by a style and a styliform or penicillate stigma. Ex.: *Poterium, Cliffortia, Alchemilla,* &c.

6. ROSEÆ, Juss.: Calyx tubular, urceolate, containing a variable number of monospermous carpels attached to the inner wall of the calyx, which becomes fleshy and covers them. Ex.: *Rosa.*

7. POMACEÆ, Rich.: Several unilocular carpels, each containing two ascending ovules, rarely a great number attached to the inner side, united together and with the calyx, and forming a fleshy fruit, known by the name of Melonida or apple. Ex.: *Malus, Pyrus, Cratægus, Sorbus, Cydonia,* &c.

[The Rosaceæ are generally astringent. The fruits of several Chrysobalaneæ, which are chiefly tropical, are eaten. Those of the Drupaceæ, such as the Cherry, Peach, Nectarine, Plum, &c., are well known as articles of the dessert. The leaves and kernels of this tribe yield prussic acid, and some of them are, for this reason, dangerous. The leaves of the Sloe and the Bird-cherry have been employed as a substitute for tea. The root of Spiræa Ulmaria, which is highly astringent, has been used as a tonic, and for dyeing black. The fruits of many Fragariaceæ, as the Strawberry, Rasp, and Brambles, are in common use. The root of *Rubus villosus* affords an astringent decoction. *Brayera anthelminthicum* is an effectual remedy for tape-worm. *Agrimonia* and *Poterium* are astringent. The fruit of *Rosa canina,* and the petals of *Rosa gallica,* are astringent, and have been employed in chronic diarrhœa and cases of debility. The fruits of most of the Pomaceæ, as the Apple, the Pear, the Quince, the Medlar, are in common use.—TR.]

FAMILY CXLVII.—HOMALINEÆ, *Brown.*

THE Homalineæ are shrubs or small trees, all natives of warm countries. Their leaves are alternate, petiolate, simple, furnished with caducous stipules. Their flowers are hermaphrodite, disposed in spikes, racemes, or panicles. Their calyx is monosepalous, having the tube short, conical, and adherent to the ovary, the limb divided into from ten to thirty lobes, of which the outer are larger and valvar, and the inner smaller and petalliform. The corolla is wanting. At the inner face, and most commonly towards the base of the inner sepals, are situated glandular and sessile appendages. The number of stamina varies: it is sometimes equal to that of the outer lobes of the calyx, and the stamina are opposite to them; at other times the stamina are more numerous and collected into bundles. The ovary is generally semi-inferior, with a single cell containing a great number of ovules attached to three or five parietal trophosperms. The styles, which are of the same number as the trophosperms, terminate each in a simple stigma. The fruit is sometimes dry, sometimes fleshy. The seeds have their embryo placed in a fleshy endosperm.

This family, which is as yet little known, was proposed by Brown, and has been adopted by M. de Candolle, who refers to it the following genera: *Homalium*, *Napimoga*, *Pineda*, *Blackwellia*, *Astranthus*, *Nisa*, *Myriantheia*, *Asteropeia*, and *Aristotelia*. In the structure of its fruit, this family approaches the Flacourtianeæ and Samydeæ, and by its insertion comes near the Rosaceæ.

Family CXLVIII.—Samydeæ, *Vent.*

Exotic shrubs, growing in the warmest regions of the globe, and bearing alternate, distichous, simple, persistent leaves, commonly marked with translucid dots, and furnished with two stipules at their base. The flowers are axillar, solitary, or grouped. They have a calyx formed of five, more rarely of three or seven sepals, united together at their base, and sometimes forming a more or less elongated tube. The limb has more or less deep divisions, coloured on their inner surface. The corolla is always wanting. The stamina are of the same number as the divisions of the calyx, or double, triple, or quadruple, and are inserted at their base. They are monadelphous, and some of them are occasionally sterile, and reduced to their filament, which becomes flat and downy. The ovary is free, with a single cell, containing a great number of ovules inserted on three or five parietal trophosperms. The style is simple, terminated by a capitulate or lobed stigma. The fruit is a unilocular capsule, opening by three or five valves, which bear upon the middle of their inner surface the seeds, enveloped in a more or less abundant coloured pulp. The seeds have a fleshy endosperm, in which is a very small heterotrope embryo, in other words, having its radicle opposite to the hilum or point of attachment of the seed.

This family is composed of the genera *Samyda*, *Anauringa*, and *Casearia*. In the structure of its fruit it approaches the Violets and Flacourtianeæ; but its insertion, which is evidently perigynous, places it near the Rosaceæ, several genera of which are equally apetalous. Besides the three genera mentioned above, there ought to be referred to this family the genus *Piparea* of Aublet, which has hitherto been placed among the Violaceæ.

* Family CXLIX.—Leguminosæ, *Juss.*

A very natural family, in which are contained herbaceous plants, shrubs, or small trees, and trees often of colossal dimensions. Their leaves are alternate, compound or decompound, sometimes simple. Rarely the leaflets are abortive, and there only remains the petiole, which widens and forms a kind of simple leaf. At the base of each leaf are two persistent stipules. The flowers present a very diversified inflorescence. They are generally hermaphrodite. Their calyx is sometimes tubular, with five unequal teeth, sometimes with five more or less deep and unequal divisions. At the outside of the calyx, there are one or more bracteas, or sometimes a calyciform involucre. The corolla, which is sometimes wanting, is composed of five generally unequal petals, of which one, named the *standard*, is larger and superior; two named *wings* are lateral; and two inferior, and more or less coherent or united, forming the *keel*. Sometimes the corolla is formed of five equal petals. The stamina are generally ten in number, sometimes more numerous. Their filaments are usually diadelphous, rarely monadelphous, or entirely free, perigynous or hypogynous. The ovary is more or less stipitate at its base. It is generally elongated, inequilateral, with a single cell, containing one or more ovules attached to the inner suture. The style is somewhat lateral, often bent or curved, and terminated by a simple stigma. The fruit is always a legume. The seeds are generally destitute of endosperm.

This extensive family is composed of very numerous genera, which may be divided into three natural tribes:

1. Papilionaceæ: Corolla formed of five unequal petals, constituting the irregular corolla named papilionaceous; ten stamina generally diadelphous. Ex.: *Phaseolus*, *Faba*, *Lathyrus*, *Robinia*, *Glycine*, *Astragalus*, *Phaca*, &c.

2. Cassieæ: Corolla generally formed of five regular petals; the ten stamina usually free. Ex.: *Cassia*, *Bauhinia*, *Geoffræa*, &c.

3. Mimoseæ: Containing the apetalous genera, furnished with a calyciform involucre; stamina very numerous and free. Ex.: *Mimosa*, *Acacia*, *Inga*, &c.

The family of Leguminosæ is very nearly allied to the Rosaceæ, and, although at first sight it appears very easy to distinguish them, there are genera which form a kind of transition from the one family to the other.

[The Papilionaceæ are possessed of very diversified properties. The seeds of many species are used as food, such as the Bean, the Pea, &c., while those of others are purgative, emetic, or poisonous. Of the latter kind are those of the Laburnum. The pulp of the Tamarind, *Ceratonia siliqua*, *Mimosa fagifolia*, and *Cassia fistula*, is more or less purgative. Senna consists of the leaves of several species of Cassia. Catechu is obtained from *Acacia Catechu*. Gum Arabic is yielded by *Acacia senegalensis* and other species; gum tragacanth by *Astragalus creticus* and *verus*. *Myroxylon balsamiferum* affords the balsam of Tolu; *Copaifera officinalis*, copaiba balsam. Indigo is obtained from several species of Indigofera; logwood is the wood of *Hæmatoxylon campechianum*; Sanders-wood that of *Pterocarpus santalinus*. The Tonkay-bean is the seed of *Coumarouma odorata*, which owes its fragrance to a peculiar principle found also in the flowers of *Melilotus officinalis*.—Tr.]

Family CL.—Terebinthaceæ, *Juss.*

Trees or shrubs, often lactescent or resinous, having alternate, generally compound leaves, destitute of stipules, and small hermaphrodite or unisexual flowers, usually disposed in racemes. Each of the flowers has a calyx of from three to five sepals, sometimes connected at their base, and united to the ovary, which is inferior, and a corolla, which is sometimes wanting, but is usually composed of a number of petals equal to the lobes of the calyx, and regular. The stamina are generally of the same number as the petals, more rarely double or quadruple: in the former case they alternate with the petals. The pistil is composed of from three to five carpels, sometimes distinct, sometimes more or less united, and surrounded at their base by a perigynous, annular disk. Sometimes some of the carpels are abortive, and there remains only one, from which spring several styles. Each carpel has a single cell, containing sometimes an ovule, supported upon the top of a filiform podosperm, which arises from the bottom of the cell, sometimes a reversed ovule, sometimes two reversed or collateral ovules.

The fruits are dry or drupaceous, generally containing a single seed. The seed contains an embryo destitute of endosperm.

This family has been carefully examined by our excellent friend Professor Kunth. It may be divided into seven natural tribes:

1. ANACARDIEÆ or CASSUVIEÆ, containing the genera *Anacardium*, *Mangifera*, *Pistacia*, &c.

2. SUMACHINEÆ, to which belong the genera *Rhus*, *Mauria*, *Davana*, &c.

3. SPONDIACEÆ, which comprehend the genera *Spondias* and *Poupartia*.

4. BURSERACEÆ, containing the genera *Scica*, *Boswellia*, *Bursera*, *Canarium*, &c.

5. AMYRIDEÆ. Ex.: *Amyris*.

6. CONNARACEÆ. Ex.: *Connarus*, *Omphalobium*, *Cnestis*, &c.

7. JUGLANDEÆ. Ex.: *Juglans*, *Carya*, &c.

This family is very closely related to the Leguminosæ, from which it is distinguished more especially by the absence of stipules. It is also allied to the Rhamneæ, which differ from it in having the ovary always inferior, and the stamina opposite to the petals.

[The Anacardieæ and Sumachineæ abound in a resinous juice, which is often poisonous; but the fruit of several species, as well as of the Spondiaceæ, is eatable. The Burseraceæ, Connaraceæ, and Amyrideæ, are equally resiniferous. The Walnut is the fruit of a species of Juglans. Several fruits belonging to the same genus are eaten in America.—TR.]

* FAMILY CLI.—RHAMNEÆ, *Brown*.

Part of the Rhamni *of Jussieu.*

TREES or shrubs with simple, alternate, very rarely opposite leaves, furnished with two very small caducous, or persistent and spinous stipules. The flowers are small, hermaphrodite or unisexual, axillar, solitary, or collected into sertules, fasciculi, &c., sometimes forming racemes or terminal sertules. The calyx is monosepalous, more or less tubular at its lower part, where it adheres to the ovary, which is inferior, having its limb dilated, with four or five valvar lobes. The corolla is composed of four or five very small, unguiculate petals, often involute and concave. The stamina, which are of the same number as the petals, are placed opposite to them, and are often embraced by them. The ovary is sometimes free, sometimes semi-inferior, or completely adherent, with two, three or four cells, containing each a single erect ovule. From the summit of the ovary generally proceed as many styles as it has cells. The base of the tube of the calyx, when the ovary is free, or the summit of the ovary when it is inferior, presents a glandular disk varying in thickness. The fruit is fleshy and indehiscent, or dry and opening into three cocca. The seed is erect, and contains in a fleshy, sometimes very thin endosperm, a homotrope embryo, having the cotyledons very broad and thin.

The family of Rhamneæ, such as it was proposed by the celebrated author of the *Genera Plantarum*, was divided into four sections. Mr Brown first proposed forming a distinct family of the first two sections, under the name of *Celastrineæ*. This family is distinguished by its calyx, the lobes of which are imbricated and not valvar; its stamina, which are alternate and not opposite to the petals; its ovary, which is always free, and of which the cells contain one or two lateral and superimposed ovules; and by its fruit, which is always dry, and opens by means of septiferous valves.

Mr Brown has further proposed forming a particular family, having the genus *Brunia* for its type. This division of the family has been adopted by M. de Candolle in the second volume of his *Prodromus*, and M. Brongniart the younger, in his *Dissertation sur la Famille des Rhamnées*. Of the genera of this family, we may here mention *Rhamnus*, *Paliurus*, *Ceanothus*, and *Colletia*.

[The berries of several species are drastic purgatives.—Tr.]

FAMILY CLII.—CELASTRINEÆ, *Brown. Ad. Brong.*

Part of the Rhamni *of Jussieu.*

THIS family is composed of shrubs or trees with alternate or sometimes opposite leaves, and axillar flowers disposed in cymes. The calyx, which is slightly tubular at its base, has a limb with four or five spreading divisions, which are imbricated previous to expansion. The corolla is composed of four or five flat, slightly fleshy petals, destitute of claws, and inserted beneath the disk. The stamina alternate with the petals, and are inserted either upon the edge of the disk, or upon its upper surface. The disk is perigynal and parietal, surrounding the ovary. The ovary is free, with three or four cells, containing each one or more ovules attached by a filiform podosperm to the inner angle of each cell, and ascending. The fruit, which is sometimes a dry drupe, is more commonly a capsule with three or four cells opening into three or four valves, each bearing a dissepiment upon the middle of its inner surface. The seeds, which are sometimes covered by a fleshy arillus, contain a fleshy endosperm in which is an axile and homotrope embryo.

In speaking of the Rhamneæ, we pointed out the principal differences which exist between that family and that of the Celastrineæ. M. de Candolle, in his *Prodromus*, divides the latter family into three tribes; *Staphyleaceæ,' Euonymeæ*, and *Aquifoliaceæ*. M. Adolphe Brongniart adopts the first opinion of the celebrated Professor of Geneva, who, in his *Theorie Elementaire*, considered the Aquifoliaceæ as a distinct family. In fact, this group is distinguished from the true Celastrineæ by its frequently monopetalous corolla, its hypogynous insertion, the entire absence of disk, and by the cells of its ovary always containing a single pendent ovule, and its fleshy fruit containing from two to six bony nucules.

* FAMILY CLIII.—AQUIFOLIACEÆ, *De Cand.*

Ilicineæ, *Ad Brong.*

SHRUBS with alternate or opposite, persistent, coriaceous, glabrous leaves, which are toothed, the teeth being sometimes spinous. The flowers are solitary, or variously grouped in the axillæ of the leaves. Each of them has a calyx with from four to six small and imbricated petals, and a corolla of an equal number of alternate petals, united at their base, and forming a monopetalous corolla, with deep and hypogynous divisions. The stamina, which are alternate with the lobes of the corolla, are inserted at its base. There is no appearance of a disk. The ovary is free, thick, truncate, with from two to six cells, each containing a single ovule suspended from the summit of the cell, and supported by a cup-shaped podosperm. The stigma is generally sessile and lobed. The fruit is always fleshy, containing from two to six indehiscent, woody or fibrous, and monospermous nucules. The embryo is small, homotrope, and placed towards the base of a fleshy endosperm.

This family, as we have demonstrated when speaking of the Celastrineæ, is very distinct from the true Rhamneæ and Celastrineæ, with which it had been united. These differences are, in fact, so great, that M. de Jussieu, and more recently Professor De Candolle, thought the Aquifoliaceæ should be placed among the Monopetalæ, near the Sapotaceæ, and especially the Ebenaceæ, from which it differs only in characters of little importance. But M. de Candolle has since renounced this opinion, as in the second volume of his *Prodromus* he makes the Aquifoliaceæ merely a tribe of the Celastrineæ. The first, however, seems to us the more correct opinion. Among the genera which compose the family of Aquifoliaceæ, we find the following: *Ilex*, *Cassine*, *Myginda*, &c.

[Prinos verticillatus is astringent and tonic.—TR.]

FIFTEENTH CLASS.—DICLINIA.

* FAMILY CLIV.—EUPHORBIACEÆ, *Juss.*

THE Euphorbiaceæ are herbaceous plants, shrubs, or very large trees, which occur in all regions of the globe. Most of them contain a milky acrid juice. The leaves are usually alternate, sometimes opposite, accompanied with stipules, which are sometimes wanting. The flowers are unisexual, generally small, and are very diversified in their mode of inflorescence. The calyx is monosepalous, with three, four, five or six deep divisions, furnished internally with scaly and glandular appendages. The corolla is wanting in most genera, or is composed of petals sometimes distinct, sometimes united into a monopetalous corolla. It appears to be formed of abortive and sterile stamina. In the male flowers, there is a considerable number of stamina. More rarely the number is limited, or each stamen may be considered as a flower (as is admitted to be the case in the genus *Euphorbia*). The stamina are free or monadelphous. The female flowers are composed of a free, sessile, or stipitate ovary, sometimes accompanied by a hypogynous disk. The ovary has usually three cells, each containing one or two suspended ovules. From the summit of the ovary arise three stigmas which are generally sessile and elongated. The fruit is dry or slightly fleshy, and is composed of as many cocca, containing one or two seeds, as the fruit has cells. The cocca, which are internally bony, open elastically at their inner angle into two valves. They rest by their inner angle upon a central columella, which often continues after their dispersion. The seeds, which are externally crustaceous, and present a small fleshy caruncle, in the vicinity of their point of attachment, have a fleshy endosperm, in which is contained an axile and homotrope embryo.

We are indebted to M. Adrien de Jussieu for an excellent monograph of the genera of this family, of which he describes 186, containing about 1040 species. Of these genera it is sufficient to mention here the following: *Euphorbia*, *Mercurialis*, *Ricinus*, *Croton*, *Jatropha*, *Hura*, *Buxus*, and *Acalypha*.

[The plants of this family contain a milky juice which is acrid, or poisonous. They abound in caoutchouc. Castor oil is obtained from the seeds of *Ricinus communis*. The roots of several species are emetic, of others purgative. *Croton Tiglium* affords an oil, which is a drastic purgative. In general, the family is characterized by acrid, narcotic, and poisonous qualities, residing in a volatile principle, which may be dissipated by heat.—Tr.]

* Family CLV.—Urticeæ, *Kunth.*

Urticeæ, *Juss. and* Celtideæ, *Rich.*

Herbaceous plants, shrubs, or large trees, sometimes lactescent, with alternate leaves, generally furnished with stipules. Flowers unisexual, very rarely hermaphrodite, solitary, or variously grouped, and forming catkins or collected in a fleshy involucre, which is flat, spreading, or pyriform and closed. In the male flowers, there are a calyx formed of four or five sepals, which are distinct or united, and forming a tube, and four or five stamina, which are alternate, or very rarely opposite to the sepals. The female flowers have a calyx formed of from two to four sepals, or merely a scale, in the axilla of which they are placed. The ovary is free, with a single cell, containing a single pendent ovule, and surmounted, either by two long sessile stigmas, or by a single stigma, sometimes supported upon a style of variable length. The fruit is always composed of a crustaceous akenium, enveloped by the calyx, which sometimes becomes fleshy: at other times the involucre, which contains the female flowers, enlarges, as is remarked in the genera *Ficus*, *Dorstenia*, &c. The seed, besides its proper integument, is composed of a generally curved embryo, often contained within a more or less thin endosperm.

Following the example of our learned friend Professor Kunth, we have united to the Urticeæ the genera *Ulmus* and *Celtis*, which were formerly placed among the Amentaceæ, and of which the family of Celtideæ had been formed. This group, in fact, differs in no essential character from the other Urticeæ. The family thus defined, may be divided into three tribes :

1. Celtideæ, Rich. : Flowers hermaphrodite ; embryo without endosperm. Ex. : *Ulmus*, *Celtis*.

2. Urticeæ : Flowers unisexual ; fruits distinct ; embryo enclosed in a thin endosperm. Ex. : *Urtica*, *Parietaria*, *Humulus*, *Cannabis*, *Morus*.

3. Artocarpeæ, De Cand. : Flowers unisexual ; fruits collected in a flat or pyriform fleshy involucre ; embryo furnished with an endosperm. Ex. : *Dorstenia*, *Ficus*, &c.

[The bark of the Elms is bitter and astringent. The uses of hemp are well known. Its leaves are narcotic. The Urticæ are remarkable for their stinging propensities. The Common Hop contains a bitter and narcotic principle, which is used in the manufacture of ale and porter. The Artocarpeæ are extremely heterogeneous as to their properties, the bread-fruit, the mulberry, and the fig, being the products of certain species, while others yield the most deadly poisons. Caoutchouc is also yielded by several species.—Tr.]

Family CLVI.—Monimiæ, *Juss.*

Atherospermeæ, *Brown*.

Trees or shrubs, with opposite leaves, destitute of stipules and unisexual flowers. The flowers present a globular or calyciform involucre, the divisions of which are disposed in two series. In the former case, the involucre has only some small teeth at its summit; and, in the male flowers, bursts and opens into four deep and pretty regular lobes, the whole upper surface of which is covered with stamina, having short filaments, and each forming a male flower. In the second case *(Ruizia)*, the stamina line only the lower and tubular part of the involucre; the filaments are longer; and, towards their lower part, bear on each side a pedicellate tubercle, similar to that which is observed in the same place in the Laurineæ. The female flowers are composed of an involucre precisely similar to that of the male flowers. In the genera *Monimia* and *Ruizia*, there are at the bottom of this involucre, eight or ten erect pistils, perfectly distinct from each other, and intermixed with hairs. In *Ambora*, these pistils are very numerous, entirely immersed in the substance of the walls of the involucre, the only part that is free and visible being their summit, which is a small conical mammilla, and forms the real stigma. Each of these pistils is unilocular, and contains a single ovule suspended from its summit. In the genera *Ambora* and *Monimia*, the involucre is persistent; it even enlarges greatly, and becomes fleshy in the first of these genera. The fruits, which in *Ambora* are contained in the substance of the walls of the involucre, are so many small unilocular one-seeded drupes. The seed is composed of a rather thin proper integument, covering a very thick fleshy endosperm, in the upper part of which is placed an embryo which has the same direction as the seed.

This family, which was established by M. de Jussieu, has been divided into two distinct families by Mr Brown. We are of opinion, however, that these two families merely form two tribes of the same natural group.

1. Amboreæ: Anthers opening by a longitudinal groove; seeds reversed. *Ambora, Monimia, Ruizia.*

2. Atherospermeæ: Anthers opening from the base to the summit by means of a valve; seeds erect. *Pavonia, Atherosperma, Citrosma.*

The Monimiæ are much allied to the Urticeæ, with which several of their genera were formerly united; but they differ from them especially in having their seeds furnished with a very large endosperm, and in having their ovule pendent and not erect. The same character also separates them from the Laurineæ, which they approach in the structure of their stamina in the tribe of Atherospermeæ.

* Family CLVII.—Salicineæ, *Rich.*

This family is composed of the genera *Salix* and *Populus*, and contains large trees with alternate, simple leaves, furnished with caducous stipules. The flowers are unisexual, and disposed in cylindrical or egg-shaped catkins. The male flowers are composed of from two to twenty stamina, placed in the axilla of a scale, or upon its upper surface. The female flowers consist of a fusiform pistil, terminated by two bipartite stigmas, situated in the axilla of a scale, and sometimes accompanied at their base by a cup-shaped calyx. The ovary has one or two cells containing a considerable number of erect ovules, attached to the bottom of the cell and the base of two parietal trophosperms. The fruit is a small, elongated capsule, with one or two cells, containing several seeds surrounded by long silky hairs, and opening by two valves. The embryo is erect, homotrope, destitute of endosperm.

The Salicineæ, a dismemberment of the Amentaceæ, form a group which is very distinct in the form of their fruit.

[The bark is generally astringent and tonic. It is employed in tanning, and that of some species, especially of *Salix Helix*, has of late acquired great celebrity as a substitute for Peruvian bark in fevers.—Tr.]

* Family CLVIII.—Myriceæ, *Rich.*

Casuarineæ, *Mirbel.*

If we except the genus Casuarina, which, in its general aspect, resembles a gigantic *Equisetum*, the Myriceæ are trees or shrubs with alternate or sparse leaves, with or without stipules. Their flowers are always unisexual, and most commonly diœcious. The male flowers, disposed in catkins, are composed of one or more stamina, often collected upon a branched androphorum, and placed in the axilla of a bractea. The female flowers, which are also in catkins, are solitary and sessile in the axilla of a bractea longer than themselves. Each flower is composed of a lenticular ovary, containing a single erect ovule. The style is very short, and surmounted by two long subulate, glandular stigmas. Externally of the ovary are two, three or a greater number of hypogynous, persistent scales, which are sometimes united to the fruit. The fruit is a kind of small monospermous, indehiscent nut, sometimes membranous and winged upon its margins. The seed which it contains is erect; its integument immediately covers a large embryo having a direction entirely the reverse of that of the seed.

This family, which is formed of genera that were formerly placed in the discordant group of Amentaceæ, is allied to the Celtideæ and Betulineæ, but differs from the former in its flowers being in catkins, and always unisexual, and its erect ovule, and from the latter in its unilocular ovary, and its embryo destitute of endosperm.

[Generally aromatic and resinous. Wax is obtained from the berries of *Myrica cerifera*.—Tr.]

* CLIX.—Betulineæ, *Rich.*

Trees with simple, alternate leaves, accompanied at their base by two stipules. Flowers unisexual, disposed in scaly catkins. In the male catkins, each scale, which is sometimes formed of several scales united, bears two or three flowers which are naked, or have a calyx with three or four deep divisions. The number of stamina is very variable in each flower. The female catkins are egg-shaped or cylindrical, and scaly. At the inner base of each scale are from one to three naked, sessile flowers, presenting a free, compressed ovary, with two cells, containing each a single ovule attached towards the upper part of the dissepiment, and surmounted by two elongated, cylindrical and glandular stigmas. The fruit is a scaly cone, the woody or merely cartilaginous scales bear at their base one or two small unilocular akenia, which are monospermous through abortion and membranous on the edges. The seed is composed of a large embryo without endosperm, having the radicle superior.

The two genera *Alnus* and *Betula* constitute this family, which differs from the Salicineæ in having its ovary furnished with two monospermous cells, its indehiscent fruits, and its seeds, destitute of the long hairs which cover those of the Salicineæ. The Myriceæ are also closely allied to the Betulineæ, but their ovary is always unilocular, and their ovule erect.

[The bark is usually astringent; that of *Betula alba* and others is used for tanning. The juice of the same plant is sweetish, flows in considerable abundance from a cut in the bark, and is said to have formerly been employed in making a kind of wine.—Tr.]

* Family CLX.—Cupuliferæ, *Rich.*

Part of the Amentaceæ *of Jussieu.*

Trees with alternate, simple leaves, furnished with caducous stipules at their base. The flowers are always unisexual, and almost always monœcious. The male flowers form cylindrical, scaly catkins. Each flower presents a simple, trilobate, or calyciform scale, on the upper face of which are attached from six to a great number of stamina, without any appearance of pistil. The female flowers are generally axillar, sometimes solitary, sometimes grouped into capitula or catkins. In all cases, each of them is covered, in part or in whole, by a scaly cupula, and presents an inferior ovary, having its limb not very prominent, and forming a small irregularly toothed rim. From the summit of the ovary rises a short style, which is terminated by two or three subulate or flat stigmas. This ovary has two, three or a greater number of cells, each containing one or two suspended ovules. The fruit is always an acorn, generally unilocular, often monospermous by abortion, always accompanied by a cupule, which sometimes covers the fruit entirely like a pericarp, as in the Chestnut and Beech. The seed is composed of a very large embryo, destitute of endosperm.

This family, which is composed of genera formerly placed in the family of Amentaceæ, comprehends the genera *Quercus, Corylus, Carpinus, Castanea,* and *Fagus.* It has some affinity to the Coniferæ and Betulineæ; but the former are sufficiently distinguished by their general aspect, the structure of their female flowers, and the endosperm of their embryo, and the latter by their female flowers being disposed in cones, their simple ovary, &c. The other families which have also been formed of the Amentaceæ, such as the Salicineæ and Myriceæ, are more particularly distinguished from the Cupuliferæ by having the ovary free.

[Generally astringent, stomachic, and tonic. The bark of *Quercus Robur* is used for tanning in this country, and of *Q. tinctoria* in America. The seeds abound in fixed oil, and are used as food. Galls, which are employed in making ink, are excrescences of a species of Oak. Cork is the bark of another species, *Q. Suber.*—Tr.]

* Family CLXI.—Coniferæ, *J. Rich.*

This family is composed of trees resembling the Pine and Fir. Their leaves, which are coriaceous and stiff, are persistent in all the species, excepting the Larch and Gingo. They are sometimes linear, subulate, aggregated in bundles of from two to five, and accompanied at the base by a small scariose sheath; or they are in the form of imbricated or lanceolate scales, &c. The flowers are always unisexual, and generally disposed in cones or catkins. The male flowers consist essentially each of a stamen, sometimes naked sometimes accompanied by a scale in the axilla, or on the lower surface of which it is placed. Not unfrequently several stamina are united together by their filaments, and their anthers, which are unilocular, remain distinct, or unite together. The inflorescence of the female flowers is very variable, although they generally form cones or scaly catkins. Thus they are sometimes solitary, terminal or axillar, or they are collected in a fleshy or dry involucre. Each of these flowers has a monosepalous calyx, adherent to the ovary, which is in part or entirely inferior. Its limb, which is sometimes tubular, is entire, or has two divaricate lobes, glandular at their inner surface, and which have been generally considered as two stigmas. The ovary is one-celled, and contains a single ovule. At its summit it commonly presents a small cicatrix, which is the true stigma. Sometimes the female flowers are erect in the axilla of the scales, or in the involucre in which they are placed; sometimes they are reversed and united two and two, by one of their sides, to the inner surface, and towards the base of the scales which form the cone. The fruit is generally a scaly cone or a galbule, of which the scales are sometimes fleshy, unite and represent a kind of berry as in the Junipers. Each particular fruit, that is, each fecundated pistil, has a pericarp which is frequently crustaceous, sometimes furnished with a membranous, marginal wing. The proper tegument of the seed is adherent to the pericarp, and covers a kernel composed of a fleshy endosperm, containing an axile and cylindrical embryo, of which the radicle is united to the endosperm, and its cotyledonary extremity divided into two, three, four, and even as many as ten cotyledons.

The family of Coniferæ, on which my father published so beautiful a work (*Commentatio Botanica de Coniferis*, Fol. Paris, 1826), may be divided into three orders:

1. Taxineæ: Female flowers distinct from each other, attached to a scale, or in a cupula; fruit simple. Ex.: *Podocarpus*, *Dacrydium*, *Taxus*, *Salisburia*, *Phyllocladus*, *Ephedra*.

2. Cupressineæ: Female flowers erect, collected several together in the axilla of scales which are not numerous, forming a galbule, which is sometimes fleshy. Ex.: *Juniperus*, *Thuya*, *Callitrix*, *Cupressus*, *Taxodium*.

3. Abietineæ. To this order belong all the genera in which the female flowers are reversed, and which have for their fruit a true scaly cone. Ex.: *Pinus*, *Abies*, *Cunninghamia*, *Araucaria*, &c.

[The Coniferæ are among the most important natural families, in an economical point of view, their long branchless stems affording excellent materials for carpenter work, and their resinous products being highly useful for numerous purposes. Some species, as *Dammara australis* and *Pinus Lambertiana*, are said to attain a height of 200 feet or more. Oil of turpentine, resin, and pitch are obtained from *Pinus sylvestris*, *Abies pectinata*, and other species. Spruce-beer is made from an extract of the branches of *Abies canadensis*. The bark of the Larch is said to equal that of the Oak for tanning. *Juniperus Sabina* is stimulant and diuretic. The berries of *Juniperus communis*, which are also diuretic, are employed in the manufacture of gin. The berries of the Yew are said to be poisonous, and its leaves are dangerous to cattle.—Tr.]

Family CLXII.—Cycadeæ, *Rich.*

The Cycadeæ, which are composed of only two genera, *Cycas* and *Zamia*, are extra-European plants, having the habit of Palms. Their leaves, which are collected at the top of the stipe, are pinnate and rolled up in the form of a crosier previous to their development, as in the Ferns. The flowers are always diœcious. The male flowers form catkins or cones, which are sometimes very large, and which are composed of spathulate scales, covered at their lower surface by very numerous stamina, which must be considered as so many male flowers. The inflorescence of the female flowers is different in the two genera *Cycas* and *Zamia*. In the former, a long, acute, spathulate spadix, toothed on the edges, bears at each tooth a female flower, immersed in a small cavity. *Zamia* has its female flowers also in a cone, and its scales, which are thick and peltate, bear each at their lower surface two reversed female flowers. These flowers are composed of a globular calyx, perforated by a very small aperture at its summit, and applied upon the ovary, which is in part adherent at its base. The ovary is unilocular and contains a single ovule; it is terminated at its summit by a nipple-like stigma. The fruit is a kind of nut formed by the calyx, which sometimes is slightly fleshy. The pericarp is generally thin, crustaceous and indehiscent, and adheres to the proper integument of the seed. The kernel is composed of a fleshy endosperm, containing an embryo with two unequal cotyledons, sometimes adhering together, and with the radicle united to the endosperm.

However superficially one may compare the structure of the male flowers, and especially of the female flowers, of the Cycadeæ with that of the Coniferæ, he will be struck with the very great similarity that exists between the two families, and cannot fail to adopt the opinion of my father, who places them beside each other. In fact, in both, the male flowers consist each of a monospermous perianth, and a semi-inferior ovary, with a single cell and a single ovule. The fruit and the seed have the same organization. It is true that the habit or general aspect is entirely different in the two families, the Cycadeæ resembling the Palms, and the internal structure of the stem being that of the Monocotyledones. But ought we to sacrifice to this character the important resemblances which exist in the organization of the flowers of the Cycadeæ and Coniferæ, and place among the Monocotyledones a family, the embryo of which has evidently two cotyledons? Admitting the supposition, beside what monocotyledonous family could we place the Cycadeæ? They have no affinity to any of these families, and would necessarily remain by themselves; whereas, if we give the preference to the structure of the embryo and that of the flowers, and place the Cycadeæ among the Dicotyledones, no doubt remains as to the position which they ought to occupy, it being decidedly beside the Coniferæ.

[A kind of Sago is prepared from the central parenchyma of *Cycas circinalis*.—Tr.]

HOROLOGIUM FLORÆ,

OR A TABLE OF THE HOURS AT WHICH CERTAIN PLANTS EXPAND AND SHUT, AT UPSAL, IN THE 60TH DEGREE OF NORTH LAT.

Hours at which the Flowers open.	NAMES OF PLANTS.	Hours at which the Flowers close.	
A. M.		A. M.	P. M.
3 to 4	Tragopogon pratense . . .	9 to 10	...
4 to 5	Leontodon tuberosum . . .	...	3
4 to 5	Picris hieracioides . . .	...	...
4 to 5	Cichorium Intybus . . .	10	...
4 to 5	Crepis tectorum	10 to 12	...
4 to 6	Picridium tingitanum . . .	10	...
5	Sonchus oleraceus . . .	11 to 12	...
5	Papaver nudicaule . . .	...	7
5	Hemerocallis fulva . . .	...	7 to 8
5 to 6	Leontodon taraxacum . . .	8 to 12	...
5 to 6	Crepis alpina	11	...
5 to 6	Rhagadiolus edulis . . .	10	1
6	Hypochæris maculata . . .	...	4 to 5
6	Hieracium umbellatum . .	...	5
6 to 7	Hieracium murorum . . .	...	2
6 to 7	Hieracium Pilosella . . .	...	3 to 4
6 to 7	Crepis rubra	...	1 to 2
6 to 7	Sonchus arvensis	10 to 12	...
6 to 8	Alyssum utriculatum . . .	...	4
7	Leontodon	...	3
7	Sonchus lapponicus . . .	12	...
7	Lactuca sativa	10	...
7	Calendula pluvialis . . .	...	3 to 4
7	Nymphæa alba	...	5
7	Anthericum ramosum . . .	...	3 to 4
7 to 8	Mesembryanthemum barbatum .	...	2
7 to 8	Mesembryanthemum linguiforme	...	3
8	Hieracium auricula . . .	...	2
8	Anagallis arvensis . . .	...	...
8	Dianthus prolifer . . .	...	1
9	Hieracium chondrilloides . .	...	1
9	Calendula arvensis . . .	12	8
9 to 10	Arenaria	...	2 to 3
9 to 10	Mesembryanthemum crystallinum	...	2 to 4
10 to 11	Mesembryanthemum nodiflorum	...	3
		...	...
P. M.		...	...
5	Nyctago hortensis . . .	...	...
6	Geranium triste	...	...
9 to 10	Silene noctiflora	...	...
9 to 10	Cactus grandiflorus . . .	...	12

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FINIS.

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