THE

BOTANIST'S COMPANION

BY

PROFESSOR BALFOUR.

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OR

DIRECTIONS FOR THE USE OF THE MICROSCOPE,
AND FOR THE COLLECTION AND
PRESERVATION OF PLANTS,

WITH A

GLOSSARY OF BOTANICAL TERMS.

BY John Hutton

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EDINBURGH:
ADAM AND CHARLES BLACK.
1860.

PRINTED BY R. AND R. CLARK, EDINBURGH.

PREFACE.

THE object of the present brochure is to aid the student in the use of the Microscope, and in the prosecution of Vegetable Histology; to direct him as to the mode of collecting and drying plants, and of forming a Herbarium; to give useful hints in regard to botanical excursions; and to furnish explanations of the more important terms employed in botanical works.

It is compiled partly from the edition of the Author's Manual of Botany for 1860, and partly from the Appendix to his Class Book of Botany; and it is intended to be a pocket companion to the student in his practical researches. The Microscope has become such an essential instrument in the prosecution of Botany, that it is necessary to acquire a thorough knowledge of its use, and to understand the errors which may arise from unguarded observation. The formation of a Herbarium is also required in the study of classification, and in the diagnosis of genera and species; while the proper understanding of botanical terms and a correct nomenclature form the basis of descriptive Botany. The accurate definition of technical terms is an important part of scientific study. In mastering these terms, the student acquires, as it were, the alphabet of the science, without a thorough knowledge of which he cannot be expected to make progress.

EDINBURGH, *April* 1860.

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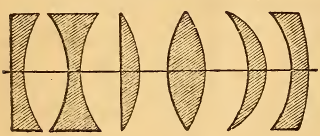
I.—On the Use of the Microscope in Botanical Researches.

The Microscope is a most important instrument in education, and it is essential for the due understanding of the structure and physiology of plants. The study of the microscopical structure of organized bodies is termed *Histology* (ἱστὸς, a web or tissue, and λόγος, discourse). Dr. Carpenter remarks:—"The universe which the microscope brings under our ken, seems as unbounded in its limit as that whose remotest depths the telescope still vainly attempts to fathom. Wonders as great are disclosed in a speck, of whose minuteness the mind can scarcely form any distinct conception, as in the most mysterious of those nebulæ, whose incalculable distance baffles our hopes of attaining a more minute knowledge of their constitution. And the general doctrines to which the labours of microscopists are manifestly tending, in regard to the laws of organization and the nature of vital action, seem fully deserving to take rank in comprehensiveness and importance with the highest principles yet attained in physical or chemical science. It is by pursuing, by the aid which the microscope alone can afford to his visual power, the history of the organic germ, from the simple and homogeneous form which seems common to every kind of living being,—either to that complex and most heterogeneous organism which is the mortal tenement of man's immortal spirit, or only to that humble Protophyte or Protozoon, which lives, and grows, and multiplies, without showing any essential advance upon its embryonic type, that the physiologist is led to the grandest conception of the unity and all-comprehensive nature of that creative design, of which the development of every individual organism, from the lowest to the highest, is a separate exemplification, at once perfect in itself, and harmonious with every other."

The microscope (μικρὸς, small, and σκοπέω, I see) is an instrument for enabling the eye to see distinctly objects which are placed at a very short distance from it, or to see minute objects that would otherwise be invisible. It has been used with great success in the examination of vegetable structure. To it we are indebted for a knowledge of the various vessels and cells which enter into the composition of the different parts of plants, of the circulation of fluids, and of ciliary movements, as well as for the facts connected with the development of the embryo. It is an instrument, however, which requires to be used cautiously; and the conclusions drawn from it ought to be carefully weighed, more especially when the observations have been made with high magnifying powers.

Lenses.—Before proceeding to notice the construction of simple and compound microscopes, it will be advantageous to notice the different kinds of lenses used, and the sources of error which require to be guarded against in their preparation. The chief forms of lenses used are, the *double-convex* (fig. 4), with two convex faces; *plano-convex* (fig. 3), with one face flat and the other convex; *double-concave* (fig. 2), with two concave faces; and *plano-concave* (fig. 1), with one flat and one concave face. Sometimes, also, a *meniscus* (fig. 5) is used, with a concave and a convex face, and a sharp edge, and a *concavo-convex* (fig. 6), with a concave and convex surface and flat edges. Convex lenses with sharp edges cause parallel rays to converge; while concave lenses with flat edges cause them to diverge. The lenses used in microscopes are chiefly convex,— the concave lenses being employed to make certain modifications in the course of the rays passing through convex lenses, whereby their performance is rendered more exact. The magnifying power of a single lens is its focal length. The principal focus is



1, 2, 3, 4, 5, 6.

Figs. 1-6. Different kinds of lenses—1. Plano-concave. 2. Double concave. 3. Plano-convex. 4. Double convex. 5. Meniscus. 6. Concavo-convex. 3, 4, 5, are sharp-edged lenses, and cause convergence. 1, 2, 6, are flat-edged, and cause divergence.

the point to which parallel rays converge after reflection or refraction. The focus of a double convex lens is at half the distance of a plano-convex, having the same curvature on one side. Ten inches is the mean focal length of the human eye. In the use of ordinary lenses, there are sources of error from the form of the lens, and the nature of the material of which it is made. When parallel rays fall on a double-convex or a plano-convex lens, they are brought into a focus at a certain distance: but it is found that no lens with a spherical surface can bring the rays of light coming from one point exactly into the focus at another point. Hence arises what is called *spherical aberration*. In this kind of aberration, the objects at the circumference of the field of the microscope are not in focus at the same time as those in the centre. Moreover, the material of which the lens is made acts differently on the different portions of each ray, and separates the white light into different colours, which have various degrees of refrangibility. This gives rise to *chromatic* (χρῶμα, colour) *aberration*. To remedy these defects, certain combinations of glasses have been adopted, so that the light traversing one lens through the centre may pass through near the margin of another. The confusion produced by these aberrations may be greatly lessened by diminishing the pencil of light; for instance, by employing a stop or diaphragm, which lessens the aperture of the lens, and cuts off the peripheral rays. In lenses of low power, such as are used in the simple dissecting microscope, these aberrations will not cause much confusion. It is only when high powers are required that these aberrations must be done away with,—the aperture being increased without interfering with definition. The invention of Wollaston's doublet with two lenses, and Holland's triplet with three, was with the view of diminishing, as far as possible, these aberrations. In this, however, they were not successful, for coloured images were still produced. Their lenses were constructed of the same kind of material; and it was afterwards found that in order that lenses might present the object uncoloured, or be what is called *achromatic* (α, privative, and χρῶμα, colour), it was necessary to use glasses of two different densities. Achromatic lenses, or such as are nearly free from aberration, are constructed by placing together glasses of different dispersive powers, and of different forms. The usual achromatic consists of a double-convex lens, made of plate or crown-glass, and a plano-concave, made of flint-glass (fig. 7), fitted accurately to it, and cemented by Canada balsam. Sometimes three lenses are used, a double concave of flint-glass, placed between

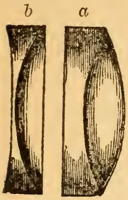


Fig. 7.

two double convex of crown-glass, and ground to certain curvatures; and in that case they cannot be cemented. The most perfect combination of lenses, for high powers, consists of eight distinct lenses:—In front, a triplet of two plano-convex lenses of crown-glass, with a plano-concave of dense flint-glass between them; next, a doublet composed of a double convex lens of crown-glass, and a double concave of flint; and at the back, another triplet of two double convex lenses of crown, with a double concave of flint between them. By this combination, an angular aperture of 170° has been obtained with an objective of $\frac{1}{12}$th of an inch focus. This is about the limit; for 10° more would bring the rays to a straight line.

Microscopes are of two kinds—Simple and Compound. By the *Simple microscope*, objects are viewed through a single lens, or through two or three lenses placed together, so as to form doublets or triplets. The glass is arranged so that it can be brought over the object, and adjusted, by means of a rack and pinion, or by some other contrivance, to its exact focal distance,—the object, when opaque, being seen by light thrown from above, and when transparent, by light transmitted from below. This instrument, when used with single lenses or doublets, is the best for ordinary botanical investigations, more especially for dissections. The combination of three lenses approaches too near the object to be easily used. A very high power may be obtained by doublets formed of plano-convex glasses, or by means of the lenses termed Coddington's or periscopic, consisting of two hemispherical lenses, cemented together by their plane faces, having a stop between them, or rather having a groove in the whole sphere filled with opaque matter. The chief objections to the simple microscope are the fatigue attendant on long-continued investigations, and the small field of view. In the simple microscope, glasses of the following focal lengths may be employed—viz., $1\frac{1}{2}$ inch, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{4}$; and, if very minute objects are to be examined, of $\frac{1}{10}$, $\frac{1}{30}$, or $\frac{1}{40}$ of an inch.

When examining minute plants, such as Diatomaceæ and Desmidieæ, during an excursion, it is useful to have a simple microscope similar to that represented in figs. 8 and 9. It consists of a Wollaston's doublet,

Fig. 7. *a*, An achromatic or aplanatic lens, consisting of a double convex lens of plate-glass, and a plano-concave of flint-glass. *b*, Section of the plano-concave lens.

fixed in a round plano-concave brass disc (fig. 8, *a*), attached to a small brass handle (fig. 8, *b*). For ordinary botanical purposes a lens magnifying 65 to 70 diameters is enough; but the lenses may be procured with a power of 150 to 220 diameters. On the plane side of this brass disc, there is a ring of silver (fig. 8, *c*), in which a thin piece of glass is fixed, also supported by a brass handle, which acts as a spring, so as to keep the two rings in contact. In the handle of the first-mentioned disc, there is a screw (fig. 9, *d*), which passes through it, and by the motion of which the

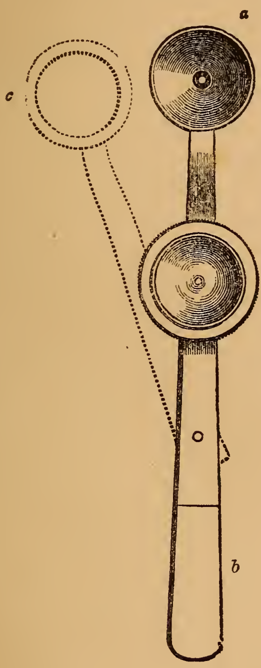


Fig. 8.

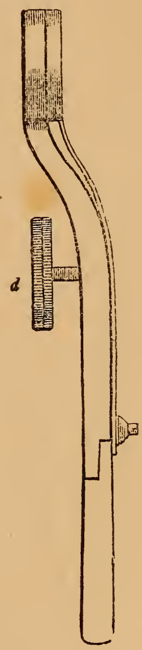


Fig. 9.

two handles can be separated or allowed to come close to each other. By this means an exact focal distance can be obtained. A drop of fluid con-

Figures 8 and 9 represent Gairdner's portable simple microscope.

In fig. 8 there is given a front view of the instrument, showing the posterior silver ring, *c*, enclosing a piece of thin glass, separated and turned aside from the disc, *a*, containing the doublet, to which the eye of the observer is applied. Fig. 9 exhibits a lateral view of the instrument, with the screw, *d*, by means of which the handles are separated or approximated, so as to bring the object into focus.

taining Diatoms, or any minute object, is placed on the outside of the thin glass in the silver ring, and it is then covered by a similar piece of thin glass, which adheres by means of the fluid. The object being brought into focus, as in fig. 9, the observer can distinguish the characters of the microscopic plant, so as to determine whether it is necessary to take specimens home for more careful examination by the compound microscope.

In the *Compound microscope* there are two sets of lenses,—the one called the *object-glass* or objective, the other the *eye-piece* or ocular. The first receives the rays from the object, and bringing them to new foci, forms an image, which the second treats as an original object, and magnifies it just as the single microscope magnified the object itself. The image is inverted, but this may be remedied by making the rays pass through another set of lenses in the tube of the microscope, called the *erector*. In the construction of the object-glasses, great care is taken to render them achromatic. Those made by the most eminent London makers consist of two or three compound lenses, which cannot be used separately, but are fixed together in a tube. In the case of high powers, the object-glasses are also provided with an adjustment for the thickness of the glass covering the object to be viewed. This adjustment makes up for the refraction caused by the passage of light through thin glass of different thickness, and is accomplished by altering the distance between the second and third pair of lenses in the object-glass. This adaptation is especially necessary in the case of a glass with a large angle of aperture. In Ross's microscope, when the mark on the cylinder coincides with the longer mark on the tube of the objective, the adjustment is perfect for an uncovered object; when the coincidence is with the short mark, the proper distance is obtained to balance the aberration produced by glass $\frac{1}{100}$ of an inch thick. The eye-piece, also, must be so formed as to be free from error. That used is called Huyghens', and consists of two plano-convex lenses with their plane sides towards the eye, and placed at a distance apart equal to half the sum of their focal lengths, with a diaphragm inserted midway between the lenses. In this eye-piece, the lens next the eye is called the eye-glass, the other the field-glass. By the Huyghenian or negative eye-piece the object is seen inverted. The Ramsden or positive eye-piece consists of two plano-convex glasses, with the convex surfaces directed towards each other; by it objects are seen erect, and it is often used as a micrometer eye-piece, that is, for measuring objects. The eye-pieces supplied with the best microscopes are usually three; and they are so constructed, that, with each of the object-glasses, they give a certain amplification of the object, the powers being in the proportion cf 1, 2, and 3, or 1, $1\frac{1}{2}$, and $2\frac{1}{2}$. In the best microscopes there is also an *achromatic condenser* or eclairage, through which the light reflected from the mirror passes. The amplification by means of an eye-piece in the compound microscope enables us to use an object-glass of a lower power than would otherwise be necessary. This kind of microscope, when well constructed, gives a flat and colourless picture of the object, with clearness of definition. The observer can use it for a length of time with less fatigue than when employing the simple microscope. Weak eye-pieces and strong object-glasses are to be recommended. The eye-piece does not add either clearness or distinctness to the object, and when it is very powerful the field of view becomes too small to take in the whole image formed by the object-glass; for the magnitude of the field of view and the strength of the illumination diminishes according to the magnifying power of the eye-piece employed. The lower powers are of use in searching for the object to be examined, which may thus be more easily found by a higher power. For the lower power a linear amplification of from 20 to 50 diameters, and for a higher power a linear amplification of from 300 to 500 diameters at most, will give a sufficiently wide range of powers. The powers are increased by a more powerful eye-piece or object-glass, or by both, or by lengthening the tube of the microscope.

In examining vegetable structures, an instrument magnifying 150 to 200 diameters is usually sufficient; but in some instances higher powers are required. Achromatic object-lenses of $1\frac{1}{4}$, $\frac{2}{3}$, and $\frac{1}{4}$ of an inch, are recommended as the most essential; and two eye-pieces should be provided, one of about $1\frac{1}{2}$ and the other of $2\frac{1}{2}$ inches in length. The instrument should have both a coarse and a fine adjustment; and it is of importance that it should be made to incline at an angle, or to stand horizontally. A moveable stage is also useful, so that the different parts of the object may be viewed without being touched by the fingers, and a spring-holder to fix the objects on the stage.

In figure 10 a compound microscope is represented. The stand, or base, consists of a strong tripod, *a*, supporting two upright pillars, *b*, *b*, between the upper parts of which an axis works. This carries the whole of the optical parts of the instrument which can be adjusted to any inclination, horizontal, vertical, or intermediate. The stage, *d*, *e*, is firmly attached to the axis, as is also the double mirror, *f*. The triangular bar, *g*, has a rack on its posterior part, which is worked by a pinion, the milled heads of which are seen at *h*, *h*. The body, *i*, screws firmly into the arm, *j*; the achromatic object-glasses are screwed into the body at *m*; the Huyghenian eye-piece slides into the other end of the body. The mirror is plane on one side, and concave on the other, and is fitted with a universal movement, so as to be inclined in any desired position. The milled heads, *h*, *h*, by being revolved, raise or lower the body, *i*, and constitute the coarse adjustment; the fine adjustment is effected by turning the milled head, *p*. The object to be examined is placed on the stage, *d*, and retained in the required position by the sliding piece, *e*. The quantity of light admitted through the instrument may be modified by the diaphragm, *r*, which consists of a plate of brass with four apertures of different diameters, made to revolve on a central pin or axis fixed to the bottom of the stage. Provision is also made for adding a polarizing apparatus. In addition to the four holes mentioned as needed to admit the requisite amount of light, the diaphragm is furnished with a fifth hole, into which a Nicol's prism may be screwed, forming the polarizer; the analyzer being screwed into the upper part of an adapter previously to its being attached to the body, *i*. The polarizer is mounted on a double tube, so as to be capable of being evolved by turning a large milled head at the bottom. A condensing

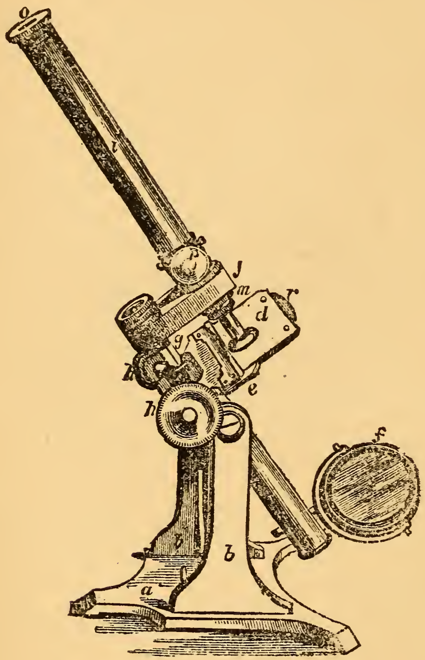


Fig. 10.

Fig. 10. Ordinary compound microscope.

lens for illuminating opaque objects may be fitted into the hole at the corner of the stage; it is so arranged that it can be used in any required position or angle. Among the objects often furnished with the microscope is a plate of selenite, which, if laid under many animal and vegetable structures while being examined by polarized light, will cause them to assume beautiful colours. Nachet has invented a binocular microscope by which the objects are seen in relief.

Very good students' instruments are made by Smith and Beck in London, and by Nachet and Oberhäuser in Paris. One of the latter as used by Dr. Bennett, is shown in fig. 11, which is taken from his lectures on Clinical Medicine. The figure is one-fourth of the real size

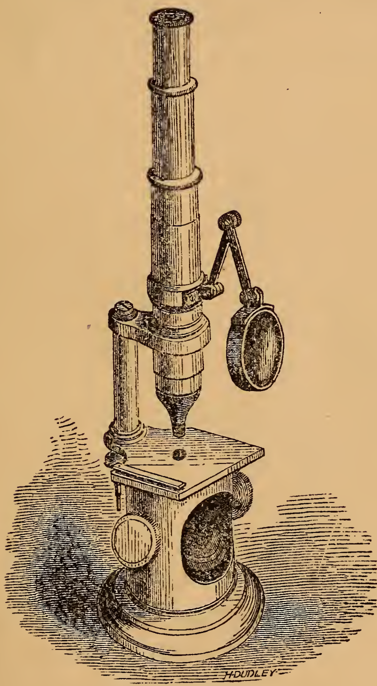


Fig. 11.

of the instrument. The body consists of a telescope tube eight inches in length, held by a split tube three inches long. It may be elevated or

Fig. 11. Oberhäuser's portable student's microscope.

depressed by the hand by a cork-screw movement, and this constitutes

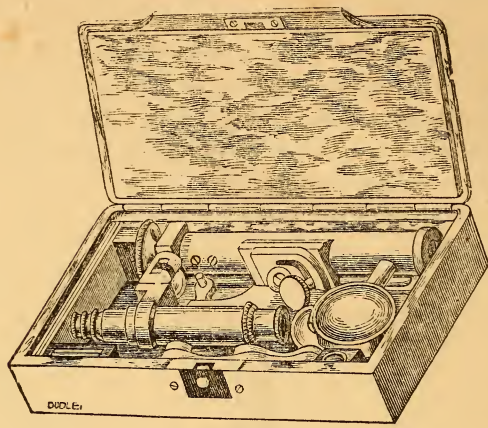


Fig. 12.

the coarse adjustment. It is attached to a cross-bar and pillar, at the

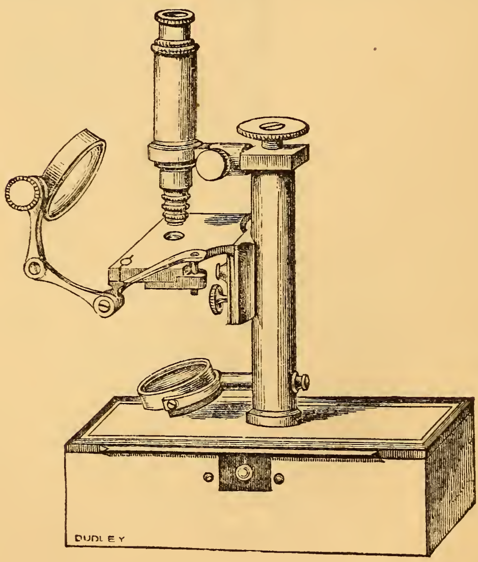


Fig. 13.

Figures 12 and 13 represent Gruby's portable compound microscope one-half its real size.

Fig. 12. The instrument in its case. Fig. 13. The instrument mounted. A full description is given by Dr. Bennett in the Edinburgh Monthly Medical Journal for December 1846.

lower portion of the latter of which there is a fine adjustment screw. The stage is three inches broad, and two and a half inches deep, with a circular diaphragm below it. The base of this portable instrument is loaded with lead so as to give it steadiness. A similar instrument is made by Nachet, in which there is a broader stage, and a broader base, as well as a means of inclining the body of the instrument. It has been preferred by botanical students in Edinburgh, and it is cheaper than Oberhäuser's. The following are the powers (linear measurement) of Nachet's student's compound achromatic microscope:—*

Objectives (Object-Glasses).	Oculars (Eye-Pieces).		
	1	2	3
1	70	90	140
2	190	250	400
5	280	360	600

As a portable compound microscope is sometimes wanted by a student, Dr. Bennett has given the accompanying figures of one recommended by Gruby of Paris. In fig. 12 the instrument is shown in its case, and in 13 it is mounted. The woodcuts are exactly one-half the real size, and give a good idea of the instrument, a detailed description of which is not required. In fig. 14, a representation is given of one of Smith and Beck's microscopes for students. A is the brass stand, supported firmly on three feet, and having two upright flat cheeks, to the top of which the stage-plate, *d*, is fixed. Into the stage-plate is screwed an upright round tube, to which is attached an open tube, *g*, in which the body of the instrument, *f h*, slides. By moving the body up and down in this tube, the coarse adjustment is effected, and when the instrument is brought near to the object on the stage-plate, *d*, a finer adjustment is made by means of the screw with the milled head, *e*, which either raises or depresses the part by which *g* is attached to the upright tube. The mirror is represented at *b*, supported on trunnions, and capable of motion upwards or downwards

* The price of the instrument, with all these powers, is 190 francs, exclusive of duty and carriage; without No. 2 ocular, and No. 5 objective, it is 150 francs.

so as to reflect the light on the object placed on the stage-plate; *c* is the diaphragm, or stop, or perforated plate attached to the stage, with the view of shutting off the extreme rays of light. The object glass or objective is placed at the lower end of the instrument, *f*, and the eye-piece or ocular, at the upper part, *h*.

In fig. 15 a diagram is given to explain the mode in which the compound microscope acts. In this figure, *o* is the object, above which is seen the triple achromatic object-glass or objective, consisting of three achromatic lenses, which are combined in one tube; *e c* is the eye-piece or ocular, consisting of two plano-convex lenses, one at *e*, being the eye-glass, and the other at *c*, the field-glass. Three rays of light are represented as proceeding from the centre of the object, and three from each end of it. These rays have a tendency to proceed so as to form an image of the object at *a*, but coming in contact with the field-glass *c*, they are made to converge and meet at *b*, where the diaphragm is placed to intercept all light except what is necessary for the formation of a perfect image. The image formed at *b* is viewed as an original object by the observer through the eye-glass *e*.

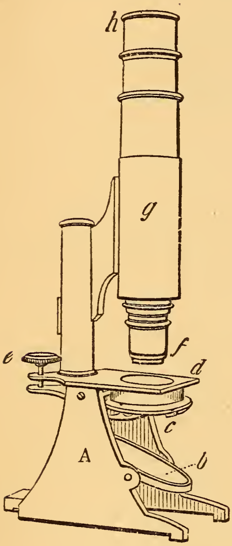


Fig. 14.

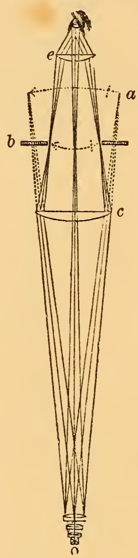


Fig. 15.

MICROMETER.—In measuring the size of microscopic objects, a *micro-*

Fig. 14. Smith and Beck's compound microscope for students. A, brass stand, supported on three feet; *b*, mirror supported on trunnions; *c*, diaphragm; *d*, stage-plate on which the object is placed; *e*, screw with milled head for fine adjustment; *g*, brass tube in which the body of the instrument is moved, so as to effect the coarse adjustment; *f*, the object-glass or objective; *h*, the eye-piece or ocular.

Fig. 15. Diagram to show the mode in which the compound microscope acts. O, an object, with three rays of light from its centre, and three from each of its ends; *e c*, eye-piece, consisting of two plano-convex lenses—one at *e*, the eye-glass, the other at *c*, the field-glass; *b*, diaphragm; *a*, the point where an image would be formed if the rays were not made to converge by the lens *c*.

meter (μικρὸς, small, and μέτρον, a measure) is employed. The stage micrometer consists of a piece of glass, ruled with fine lines by means of a diamond point, at some known distance apart, such as the $\frac{1}{100}$th or $\frac{1}{1000}$th or $\frac{1}{2500}$th of an inch. A mode of ascertaining the magnifying power of the compound microscope is founded on the assumption, that the naked eye sees most clearly and distinctly at the distance of ten inches. If a divided scale be placed on the stage, and distinctly seen magnified through the instrument, let a rule be held at ten inches' distance from the right eye, while the observer uses, at the same time, his left eye in looking at the other scale through the microscope, and let the rule be gently moved so that it is seen to overlap or lie by the side of the magnified picture of the other scale,—a comparison as to how many of its known divisions correspond with a number of those on the magnified scale, will indicate the magnifying power. Upon a similar principle a pair of compasses may be substituted, whose points being placed on the stage are separated till they cover or mark off so many spaces as magnified by the instrument. If they cover 1 magnified space, and correspond to 2, 3, or more known spaces on the rule, then the instrument is said to magnify 2, 3, or more times linear that known space. If $\frac{1}{100}$th of an inch is found to cover 2 inches on the rule, the instrument magnifies 200 times; if 3 inches, 300 times; if 4 inches, 400 times, and so on. In this way is determined the magnifying power of any combination of lenses, and the scale which is magnified is called the object-glass micrometer. The size of objects may be measured by placing them directly on this micrometer; but it is obvious that they cannot under high powers be brought into focus at the same time as the lines of the micrometer. An instrument called the eye-piece micrometer is therefore generally used. It consists of a known scale ruled on glass, and placed in the focus of the upper glass of the eye-piece. The glass is divided by lines varying from $\frac{1}{25}$th to $\frac{1}{100}$th of an inch apart, and is placed either in the focus of the eye-lens or below the field-lens. It is observed with it how many of its divisions correspond with one division magnified by the microscope. Thus, if with an instrument which is known to magnify 250 diameters linear, it is found that 1 space of the magnified micrometer corresponds with 5 of the eye-piece micrometer, the size of the object will be $\frac{1}{5}$th of the known scale. If the scale be $\frac{1}{1000}$th part of an inch, and the object is seen to correspond to 1, or to 4, or to 5 of those spaces, then its size is the $\frac{1}{1000}$th or $\frac{4}{1000}$th, or $\frac{5}{1000}$th part of an inch. In using the eye-piece micrometer, the marked side of the glass is put undermost. With this instrument, when using a magnifying power of 500 or 600 diameters, we can estimate distances from $\frac{1}{5000}$th to $\frac{1}{7500}$th of an inch with tolerable precision. Other kinds of micrometers are also employed, such as the cobweb micrometer, where, by the motion of a delicate screw, fine wires or cobwebs are made to separate from each other. Welcker's micrometer has been of late recommended as surpassing the cobweb screw micrometer in elegance of principle and in cheapness. The exact size of objects can only be determined by actual measurement; but at the same time the size may sometimes be conveniently compared with that of any other familiar microscopic object, such as a human blood disc, or the like.

MICROSCOPIC APPARATUS.—In delineating minute structures, it is useful to have the image thrown on paper by means of a *camera-lucida*, or small prism, which can be easily attached to the microscope. In the apparatus sent along with microscopes will be found a *compressorium*, for the purpose of applying pressure to objects whilst they are under examination, troughs for holding such plants as Chara, which are to be seen in water, and various instruments for the dissection and examination both of animal and vegetable structures. In testing the power of an instrument, certain objects are used, in which peculiar markings occur, which can only be properly seen by a fine instrument. Either artificial or natural objects may be chosen as test-objects. The former have been prepared by Robert, a Konigsberg optician, and consist of glass plates, on which are ruled, with a diamond, systems of a hundred lines, which, 10 by 10, approach closer together and are finer, according to a definite standard. With most instruments only the 6th and 7th systems can be distinctly made out to be composed of separate lines. Superior instruments reach the 8th and 9th. No instrument has yet reached the 10th system, with its component lines. The best test-objects are the natural ones, as being regular and uniform in their markings, such as the scales of Podura plumbea or common Spring-tail, of Lepisma saccharina or sugar-louse, of Hipparcha janira or common meadow butterfly, Pontia brassica or cabbage butterfly, the hair of the larva of Dermestes or bacon-beetle, muscular fibrillæ, and the minute markings of the Diatomaceæ, as Pleurosigma hippocampus. Certain markings occur in these *test-objects*, which can only be seen properly by good microscopes.

In viewing objects under the microscope, they must be placed on slips or slides of glass, which should be of a uniform size, not less than three inches by one; and they should be covered with round or square pieces of very thin glass, $\frac{1}{50}$th to $\frac{1}{100}$th of an inch thick. The slides ought to be made of thin plate-glass, and the covers of very thin crown or plate-glass. In examining recent vegetable structures, it is best to moisten them with water. When the parts are dry, thin sections may be made either by means of slicing instruments, or by a sharp knife. Many dry objects are well seen when immersed in Canada balsam. To preserve objects in a moistened state, the substances used are alcohol, a mixed solution of salt and alum and corrosive sublimate, water containing a small quantity of creasote (5 grains to the ounce), and glycerine. The objects, in such instances, are placed in shallow glass cells, or they are laid on the slides and covered with thin glass, which is cemented by means of japanner's gold size, or black japan varnish. The methods of proceeding are afterwards described.

Polarization and Polarizing Apparatus.—When a ray of light is reflected or refracted in certain peculiar conditions, it acquires remarkable properties, and is said to be polarized.* Light is polarized by reflection, simple refraction, double refraction, and by absorption. Double refraction is seen in certain crystals which have the power of separating a ray of light passing through them into portions. By absorption is indicated the property possessed by certain transparent media of absorbing or stopping a part of a ray of light and transmitting the remainder. In the case of common or unpolarized light it is supposed that the vibration of luminous particles takes place in more planes than one—two of these planes being at right angles to one another, and the particles vibrating first in one plane and then in another. Polarized light, on the other hand, is produced by vibrations in one plane.

Difference between Common and Polarized Light.†

A Ray of Common Light,	*A Ray of Polarized Light,*
1. Is capable of *reflection*, at oblique angles of incidence, in every position of the reflector.	1. Is capable of *reflection*, at oblique angles of incidence, *in certain positions only* of the reflector.
2. Penetrates a plate of *tourmaline*	2. Penetrates a plate of *tourmaline*

* Derived from the supposed analogy to the poles of a magnet.

† Pereira on Polarized Light, p. 48.

(cut parallel to the axis of the crystal) in every position of the plate.	(cut parallel to the axis of the crystal) in certain positions of the plate, but in others is wholly intercepted.
3. Penetrates a *bundle of parallel glass plates*, in every position of the bundle.	3. Penetrates a *bundle of parallel glass plates*, in certain positions of the bundle, but not in others.
4. Suffers *double refraction* by Iceland spar, in every direction, except that of the axis of the crystal.	4. Does not suffer *double refraction* by Iceland spar, in every direction, except that of the axis of the crystal. In certain positions it suffers single refraction only.

A polariscope is used to ascertain whether light has undergone polarization. This consists of two parts, one for polarizing the light, called the polarizer, the other for examining the light, called the analyzer or test. In the compound microscope a prism of Iceland spar (prepared by dividing the oblique rhombic prism into two wedges and then joining the two edges by Canada balsam), is placed under the stage as a polarizer, and a similar prism is placed over the eye-piece as a test. The Canada balsam separates the two images of the doubly refracting spar to such an extent that one only is seen through the prism. Two thin plates of tourmaline may be used instead, and in that case the light is polarized by absorption. When light reflected from the mirror through the polarizer is examined by the analyzer it is found that, upon revolving either the one or the other, the light is twice completely stopped on each revolution, and the field of view darkened. To exhibit the phenomena of polarized light, interpose between the polarizer and analyzer a thin plate of some doubly refracting substance, which is called the depolarizer. This depolarizer divides the ray into two, or produces two systems of waves polarized in planes at right angles to each other. One of these systems traverses the depolarizer more slowly than the other, and thus the two intersect each other, or *interfere*, and in this case colour is usually produced.

A writer in the "North British Review," for 1856, makes the following observations on the polarizing microscope:—Certain structures in minerals and plants, and on the tissues and various parts of animals, are wholly invisible in the microscope. In the cornea and crystalline lenses of animals in composite minerals, and in simple minerals, such as amethyst, analcime, and apophyllite, in a great variety of crystals, to which the name of circular has been given, and in plants, there are beautiful organisms arising from differences in density, to which the human eye, even if assisted by the best microscopes, is absolutely blind, when viewed by common light. This light as it comes from the sun, and from artificial flame, consists of, or may be divided into, two kinds of light, as electricity may be divided into vitreous and resinous, or magnetism into north polar and south polar. Thus divided, common light is said to be polarized, and the two portions exhibit different properties when reflected from, or transmitted through bodies. If we suppose a cylindrical beam of common light to be composed of different parts, like a number of shillings arranged in a cylindrical row with the queen's heads lying in all directions—then, if one half of the shillings, separated from the other half, have all the queen's heads standing upright, and if the other half have all the queen's heads lying horizontally, we shall have an idea of polarized light. Now, the separation of common from polarized light may be effected by making light pass through several plates of glass, at an angle of about 55°; all the reflected light will be polarized like the cylinder of shillings with the queen's heads upright, and the transmitted light (when the plates are sufficiently numerous) like the cylinder with the heads lying horizontally. Light similarly reflected from a single polished surface of transparent or black bodies, not metallic, will also be polarized. Common light may be divided into two polarized pencils, by passing through certain crystals, such as Iceland spar or quartz. Each pencil is polarized oppositely, and when a rhomb of Iceland spar is cut into two parts, and these parts are combined so that one of the pencils is hindered from reaching the eye, it constitutes a Nicol's prism, now used in the polarizing microscope. In certain crystals, such as tourmaline and herapathite (the sulphate of iodoquinine), one of the pencils is absorbed, and plates of these substances, therefore, are used in microscopes as polarizers. When polarized light has passed through any transparent body, a change is made visible by looking through another polarizer placed transversely to the first polarizer, which is called the analyzer. The structure of the microscopic object is thus displayed in different colours, or in different shades of white light, the colour or the degree of light depending on the thickness of the different parts of the object. The forms thus disclosed to the eye are at once splendid and beautiful.

The polarizing microscope, simple and compound, was first constructed and used by Sir David Brewster in 1815. In the Simple Polarizing Microscope, a single lens or a doublet with a piece of tourmaline the size of the pupil, as the analyzer, is placed between it and the eye; the object is then examined by polarized light produced by reflection or otherwise. The magnifier and analyzer may be united in a lens of tourmaline. In the Compound Polarizing Microscope, the analyzing Nicol's prism is placed immediately between the object glass, and another Nicol's prism, or a small rhomb of spar, presenting one of its pencils to the object, is placed beneath the object. Along with the polarizing apparatus, there is generally sent a plate of selenite (which is a film of sulphate of lime or gypsum) of such a thickness as to polarize a blue of the second order. This plate is used to show weak polarized tints, as well as to show off the colours of polarizing structures by displaying them on a blue ground. When thus exhibited, all the negative tints (as they may be called) are diminished, and all the positive ones are increased; and the effect of the plate is to mark the true character of the phenomenon.

In proceeding to use the microscope, it is necessary to have a variety of tools and apparatus to aid in preparing objects for investigation. These may be arranged beside the observer in such a way that they shall be always within his reach.* A small tray or box, with divisions, containing a pair of needles in handles (such as are used for crotchet needles), a sharp knife or razor, a section-knife (such as that invented by Valentine, and which bears his name), scissors, and a pair of sharp or fine needle-pointed forceps, about three inches long, are among the most essential instruments required. Glass slides may be arranged also upon the same tray for common use, and the thin glasses for covers should be kept in a small box by themselves. In manipulating the object to be examined, certain re-agents are required. These are :—1. Distilled water; 2. Alcohol in the strong state, and also diluted in the proportion of about 1 part to 10 of distilled water. it is the best preserving agent; it removes colour and also air. 3. Ether, which dissolves resins, fats, and oils. 4. A solution of liquor potassæ diluted to about 1 to 20. It *swells* up, and sometimes separates membranes of cells and tubes when they exist in condensed layers. 5. A solution of iodine in Iodde of potassium diluted to the following strength,—namely, 1 grain

* The following details are partly condensed from Schacht's treatise on the microscope, and from the works of Hannover, Quekett, Jabez Hogg, and Beale.

of iodine to 3 grains of iodide of potassium, and an ounce of distilled water. 6. Chromic acid diluted in the proportion of about 1 to 30 or 40 of distilled water. The last two re-agents chiefly act by colouring the cell walls or the contents of the cells. 7. Sulphuric acid. 8. Oil, such as the finest of that obtained from coal, and known as mineral oil, is to be recommended for examining and preserving objects in. It does not become rancid, nor has it any affinity for oxygen. For the examination of pollen and spores there is nothing better. 9. One part of dry muriate of lime and 3 of water makes also an excellent solution for preserving objects which do not contain starch. 10. Glycerine is the best preserving agent for cells containing starch. 11. Canada balsam; and 12. Turpentine, are most useful re-agents and preservative materials for many dry preparations. 13. Nitric acid; used for separating cells. 14. A solution of hydrochloric acid may also be found useful in removing deposits of carbonate of lime. 15. A solution of acetic acid. 16. A solution of carbonate of potass or soda. These sixteen substances should be arranged in stoppered glass bottles, fitting into a stand or box, so as to be of easy access, and little camel's hair brushes, pipettes, and glass rods, should be arranged beside these bottles, in order to apply the fluid to the object. Lastly, the student should provide himself with a small note-book of good drawing-paper, on which he ought constantly to practise the delineation of the forms or outlines of the objects seen, and he should endeavour to colour them also when required.

Numerous other requisites and appliances will suggest themselves during the course of investigations, and especially such as will secure cleanliness of the object, and of everything used in the research. 1. One who has any regard for his instrument will never suffer it or its lenses to be handled by those unaccustomed to their use. 2. The microscope, when not in use, must be kept under cover, generally under a glass shade. It should never be exposed in a chemical laboratory. 3. Its lenses must be cleansed when necessary by a cloth which is used *only* for that purpose, or by dry elder pith. The cloth best adapted for this purpose is old and frequently washed linen. 4. A separate cloth of a coarser kind is to be used for drying and wiping the slides and covers. 5. Covers of a middle size, from concave disks, such as watch-glasses, up to the size of a wine-glass without the stem, or other bell-shaped jars, are also required to protect the objects, if it is necessary to leave them for any length of time.

The microscope is used to the best advantage in a room which receives its light from the north, or west, or both. The light which is reflected from a white and motionless cloud opposite to the sun, is the best that can be obtained. If gas-light is to be used, it ought to be corrected or modified by passing it through blue glass shades before reaching the mirror; but for exact observation, daylight is always to be preferred. When observations are made at night, a sperm-oil lamp is used, and the light is transmitted to the mirror through a plano-convex lens, called a condenser. To correct the unpleasant glare attendant on the reflected light from an ordinary mirror, Mr. Handford makes a mirror of thin concave-glass, three inches in diameter, the back rendered white by plaster of Paris. This is mounted on brass, and fitted over the frame of the ordinary silvered mirror, thus not requiring the latter to be removed. The advantage is, that the whole rays reflected from the surface of plaster of Paris are brought into one focus, together with those reflected from the surface of the glass, and thus an equal and brilliant light is produced. In viewing opaque objects, the light is thrown by the condenser directly on the object, and sometimes a metallic speculum, called a *Lieberkuhn*, is connected with the object-glass, by means of which an additional supply of light is obtained. In conducting microscopic observations, great steadiness of the instrument is required, which should accordingly be set upon a very firm and sufficiently large table, so that all the apparatus hitherto mentioned shall be within reach of the observer. It is proper also to begin the examination of objects with the lower magnifying powers, and to pass gradually from them to the use of the higher powers. By such means a far larger portion of the object is seen, and a more correct idea is obtained of the relations of the parts when considered as a whole. Object-glasses, varying from 30 to 50 diameters, are the best to begin with. The eye-glass of lowest power, that is, the longest one of the series, is also the one which ought generally to be used in the first instance, and as long as the power can be increased by object-glasses of greater magnifying power, any more powerful eye-piece should not be used, because by the use of such eye-pieces the image is rendered more obscure, while less light is obtained for its display.

Sources of Errors of Observation.—Extraneous or accidental objects may be present, and may be derived from various sources. Thus, water too long used may bring before the eye both plants and animals of the lowest forms, which otherwise would not have been present. Fresh water is absolutely necessary, and it may be even recently distilled. Particles of dust, or fibres from the cloths used in cleaning the glasses, may also add to the confusion. These consist, generally, of fibres of paper, linen, woollen, cotton, or silk fabrics, or minute hairs from the brushes used in manipulation. Air-bubbles are almost invariably a source of confusion to the microscopic observer in his first attempts; but once seen and studied, they no longer distract the attention, and the microscopist soon gets into the habit of disregarding their presence. They generally appear in the form of circles of larger or smaller diameter, with a dark black-looking rim, seen by transmitted light; while with incident or reflected light, their rim appears of a white colour. Pressure under a glass cover causes them sometimes to assume very irregular shapes, but possessing the same properties in their margin or outline in their behaviour with the light. It is also necessary to become familiar with the appearances of the lowest forms of animal and vegetable life, such, for instance, as the common forms of infusoria, the yeast, and such like plants; and the different forms of mould. It must not be forgotten also, that the various menstrua used in manipulation contain elements which properly belong to them, and which must therefore be distinguished; for example, the epithelium of the saliva, the blood corpuscles which may be in serum, and crystals which may be deposited in various fluids which are used as reagents. A peculiar motion, known as "molecular motion," is also a phenomenon which must be recognized. It is peculiar to all very small particles or molecules, when they float in a very thin fluid medium. It is best seen in the fine granules of milk when mixed with water, in the milky juices of the plants, and may be observed very distinctly in solutions of India-rubber, or caoutchouc, when dissolved in ammonia. A magnifying power of 400 or 500 diameters is the best for this observation. Another class of deceptions originates in the eye itself. These are the "muscæ volitantes," the nature of which is described as follows by Dr. W. Mackenzie in his Treatise on the Eye.

"The vision of objects on the surface or in the interior of the eye has attracted attention, chiefly in relation to a symptom, to which the name of *muscæ volitantes* has been given. Any spectrum, or visual appearance, which is apt to impose on the mind, and lead one to think that flies are moving before the eye, is called a *musca volitans* (fig. 16).

"The condition comprehends those sensations which arise from, 1. The layer of mucus and tears on the surface of the cornea; 2. Corpuscles between the external surface of the cornea and the focal centre of the eye; 3. Corpuscles between the focal centre of the eye and the sensitive layer of the retina.

"In hanging the head over the microscope, especially if one is affected with catarrh at the time, the globules, by gravitating to the centre of the cornea, not unfrequently appear to the observer so as to impede his view of the object, till by the act of nictitation he clears them away. In telescopic observations, also, the muco-lacrymal spectrum is apt to prove a source of annoyance. Thus, in looking at the sun through a tinted glass, the observer may be unable to distinguish the spots on that body, being perplexed by what seems the reflection of some part of his own eye interposed between it and the sun. This is caused by the layer of mucus and tears on the surface of the cornea.

"If one looks at the flame of a candle two or three feet distant, or at the sky, through a hole made in a blackened card with the point of a fine needle, or through a convergent lens of short focus, such as the eye-glass of a compound microscope, on steadily regarding the luminous field presented to view, four sets of spectra will be seen (fig. 16), independent of the muco-lacrymal spectrum. The most remarkable appears nearest to the eye, and consists of twisted strings of minute pearly globules, hung across the field of view (fig. 16 *a*). The second in point of remarkableness, and the farthest of the four from the eye, consists of watery-like threads, destitute of any globular appearance, and depending chiefly from the upper part of the field (fig. 16 *b*). I call the former the *pearly spectrum*, and the latter the

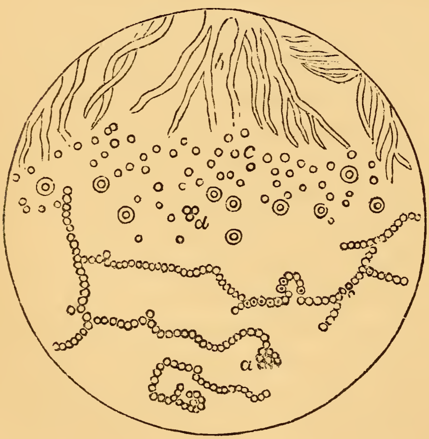


Fig. 16.

Fig. 16. Four sets of spectra, which are apt to cause errors in observations with the microscope.

watery spectrum. In two distinct planes, between those occupied by these two spectra, float two sets of globules, not aggregated into threads, but insulated. These constitute what I call the *insulo-globular spectra.* The individual globules of the set farther from the eye, being hazy and ill-defined, may be compared in appearance to small grains of sago (fig. 16 *c*). The globules of the set nearer to the eye are clear in the centre, exteriorly to which they present a sharp black ring, and still more exteriorly a lucid circumference (fig. 16 *d*). These four sets of spectra never mingle with one another, so as to change the order in which they stand before the eye; but the pearly spectrum always appears the nearest; then the sharply defined insulo-globular; then the obscurely defined globules; and farthest away the watery threads.

"Almost every eye, even the most healthy, and which has never attracted the possessor's attention by muscæ volitantes, exhibits the pearly spectrum, on being directed towards a luminous field, through a fine pin-hole, the eye-glass of a compound microscope, or a convex or concave lens of short focus. I have given it the same name of the *pearly spectrum,* from its resemblance to a string of pearls. Prevost had already called it *apparence perlée,* or simply *perles.*

"The lines of the pearly spectrum are hung across the field of vision as often transversely as vertically. On first directing the eye towards the luminous field, in one or other of the methods just mentioned, perhaps only a very few small pearly globules are perceived; but after steadily regarding it for a short time, numerous strings of them are discovered, generally twisted in different forms, and presenting a variety of knots, loops, and agglomerations. Sometimes they are so numerous as to form an extensive shower or cloud. The pearly threads are of different lengths; some of them very short, others stretching across the whole field. Not unfrequently some of them end abruptly in a sort of bulb. The globules or pearls forming the threads or rosaries, seemed joined together merely by apposition, without being contained in any tube. Sometimes, however, the globules are rather indistinct, and then the threads approach to a tubular appearance. The globules are always in single rows. They appear destitute of any nucleus. They are not all of one diameter, but are all smaller than the globules of the insulo-globular spectra. I have not satisfied myself that all the pearly threads occupy the same plane, although it is very evident that they are behind the insulo-globular spectra.

"That portion of the pearly spectrum which appears in the centre of the field of view has but little real motion, less perhaps than the watery spectrum which is seen beyond it. Both partake, of course, in the motion of the eyeball; and this gives to both a wide apparent motion. But if the field be examined towards its circumference, or if the eye be suddenly rotated upwards, other pearly spectra appear, which it is difficult or impossible for the observer to bring directly before him; and which, when he succeeds in some measure in doing so, quickly subside again out of view, partly by a real motion of their own, partly by a wide apparent motion, owing to their obliquity in respect to the axis of vision. It is these last spectra, chiefly, which produce the pearly muscæ volitantes."

There are also various optical phenomena caused by refraction, and which are necessary to be attended to. They depend, for the most part, upon a bad adjustment of the focus, or illumination of the object. The appearances are also most frequently associated with an increase of the magnifying power, and especially with the use of powerful eye-glasses. Large grains of potato-starch, pollen-grains, the thickened substance of woody tubes, and the cells of cartilage, are among the most common objects which exhibit such optical phenomena, which consist in a feeble and generally yellowish colouring of the edges of the objects when seen with particular foci.

Focal Adjustment of the Microscope.—The regulation of this adjustment is based on the fact, that the microscope can only afford a view of one surface of an object at any given time, so that nothing is distinctly seen which lies above or below such a focal plane at that time; and the more flat the field of vision, the clearer and better will be the view of objects in that plane if the adjustment is correct. The more perfect the object-glass, and the greater the angle of aperture,* the more exact is this focal plane, and the more sensitive is the instrument to any small alteration of focus. The focal adjustment is made and varied by what is called a fine adjustment screw, and which is sometimes graduated; and the accurate adjustment of the object is judged of by the sharpness of the deline-

* The angle of aperture is that made by two lines from opposite ends of the aperture of the object-glass with the point of focus of the lens. A glass with a large angle of aperture shows objects clearly. The angle varies usually from 50° to 100°. Many glasses, however, are made with a much higher angle. Ross makes glasses of 170° of angular aperture. These are useful for observing minute organisms, such as Diatoms.

ation of the image, as well as by the fineness and clearness of the outline. An experienced microscopic observer always uses the instrument with his finger and thumb grasping the fine adjustment screw, and would not be content with his observation, although it was limited to a mere peep of the object, unless he had made the fine focal adjustment for himself.

Preparation and Selection of Objects for Examination.—Opaque objects require merely to be made smooth or level on one side, and to be fixed on the other. If the object is to be viewed by transmitted light, a section or slice sufficiently thin must be procured; a common sharp knife, a razor, or Valentine's section-knife are the instruments to use. They must be moistened with water, and sometimes it is advisable to make the section under water. If the object is very delicate it may be laid between two pieces of cork, and the whole cut through. Sections should be made in various directions, so that a correct knowledge may be obtained of the relation of the component parts. Maceration in water, and tearing the parts asunder with fine needles, are the best methods for obtaining the ultimate tissues of plants. Thin glass plates to cover the object under the microscope must be invariably used. They prevent evaporation, and preserve the moisture about the object; they prevent the object-glass from being covered with vapour, and so rendered obscure, and, lastly, they produce a slight pressure, by which the elementary parts of the substance may become separated from each other, so as to lie on one plane. The thin covers are not absolutely necessary where very low powers are used. In placing the object on the stage care must be taken not to bring it in contact with the object-glass of the instrument. It is also to be remembered that, in a compound microscope, the image is inverted, and that, consequently, the object is moved in a direction contrary to that of the image.

The following list of tissues to be examined by the student of Vegetable Histology, is taken from the preparations used in the microscopical demonstrations given to the pupils of the Botanical Class in the University of Edinburgh.

Cellular Tissue.—Sea-weeds, Confervæ, Moulds and other Fungi; Lichens, Liverworts, pith of Elder, and of the Rice-paper plants (Aralia and Æschynomene), outer bark as of the Cork and of Elephantipes, succulent roots stems, and fruits, as Orange and Lemon.

Nucleated Cells.—Onion, Yeast plant, Vinegar plant, ripe fruit of Strawberry, Smut, ovules or very young seeds.

Independent Cells.—Red-snow plant (Protococcus nivalis).

Thickened Cells.—Shell of Coco-nut, stone of Peach, Cherry and Nut, seed of Ivory-Palm and Date, gritty matter of Pear, scales of Cone.

Pitted or Porous Cells.—Elder, stem of Common Balsam, outer covering of seeds of Gourd and Almond.

Spiral Cells.—Leaves, stems, and aerial roots of many Orchids, as Oncidium and Pleurothallis ruscifolia, and racemiflora, leaf of Sphagnum, episperm of seeds of Collomia, Acanthodium, Calempelis scaber, Lophospermum, and Cobæa, pericarp of Salvia.

Stellate Cells. — Juncus conglomeratus and other rushes, petiole of Banana and Plantain, and of Sparganium ramosum, stems of many aquatic plants.

Ciliated Cells.—Spores of Vaucheria and some Fuci.

Filamentous Cells.—Fungi.

Pollen Cells.—Anthers of Tulip, Lily, Passion-flower, Acacia (cells united in fours), Zamia, Cycas, Tropæolum, Gloxinia, Colocasia, pollinia of Asclepias and Orchids.

Pollen Tubes.—Œnothera, Antirrhinum, Hibiscus, Linaria, Gesnera, Crocus.

Embryonic Cells.—Orchis, Listera, Hippuris, Euphrasia, Draba.

Spores or Reproductive Cells.—In Cryptogamous plants, Ferns, Mosses, Lichens, Algæ, and Fungi, Zygnema when conjugating.

Cells with Siliceous Covering.—Diatoms, cuticle of grasses, Equisetum.

Cells encrusted with Carbonate of Lime.—Chara.

Epidermal Cells.—Leaves of Hyacinth, petals of Pelargonium, Apple, and Digitalis.

Hairs.—On leaves, and in pappus of Compositæ, Cotton (twisted), articulated hairs on leaves of Goldfussia and Alstroemeria ovata, pappus of Trichinium, moniliform hairs on stamens of Tradescantia, stellate hairs of Deutzia and Aralia papyrifera, peltate hairs of Malpighia urens, glandular hairs of Nettle, Loaza, Chinese Primrose, and Dionæa.

Glandular Cells. — Sweet-Briar, Passiflora lunata, Ice-plant, Lilac, Cinchona, Rhamnus, Rottlera, Aloysia, Mentha.

Scaly Cells.—Ferns, as Polypodium sepultum, and Niphobolus, and Ceterach, Hippophäe, Begonias, Olive, Elæagnus.

Starch in Cells.—Potato, Arrow-root, cereal grains, Bean and Pea.

Raphides.—Hyacinth, Rhubarb, Arum, Onion, Squill, Balsam, Cactus, Lemna trisulca, Ficus, Aloe, Banana, petal of Ornithogalum.

Stomata.—Hyacinth, Begonia, Oleander, Lilium, Equisetum, Box, Gasteria, Marchantia, Crinum, Yucca, Billbergia.

Antheridia and Archegonia.—Prothallus of Ferns, Mosses, Fucus, Marchantia, spermatozoids in Ferns and Chara.

Conjugating Cells. — Zygnema nitidum, Tyndaridea, Cylindrocystis, Desmidieæ.

Vascular Tissue.—Young stems of Herbaceous plants.

Spiral Vessels.—Canna bicolor, Pitcher plant (Nepenthes), Banana and Plantain, Cactus, Hyacinth, Asparagus, Balsam, Strelitzia, branching spirals in Mistleto, Long-leek, and Anagallis.

Annular Vessels.—Opuntia vulgaris, Leek, Equisetum Telmateia.

Dotted Vessels.—Sugar-Cane, Nepenthes, Willow, Clematis Vitalba.

Reticulated Vessels.—Garden Balsam.

Scalariform Vessels.—Common in Ferns, Osmunda, Asplenium, Cheilanthes, Pteris.

Laticiferous Vessels.—Ficus elastica, Euphorbia, Tragopogon, Chelidonium, Lactuca, Isonandra Gutta, Dandelion.

Woody tissue.—Stems of trees, inner bark especially of plants yielding useful fibres, as Lace Bark tree, Cuba Bast, root of Elder, Cabbage.

Punctated Woody Tissue.—Stems of Coniferæ, Pinus, Abies, Araucaria, fossil stems, Cycas, Illicium, and with spirals in Yew.

PRESERVATION OF MICROSCOPE OBJECTS.—The following apparatus is required, viz., glass-slides ground at the edges, and of the requisite standard size, with circular glass covers. Preserving agents, cement, and a moveable circular disk for mounting and making cells. Among the preserving media for vegetable substances, are—A solution of chloride of calcium, glycerine, copal varnish, mineral oil, Canada balsam. Among the cements used for vegetable objects, are the following:—Brunswick black, japanner's gold size, black japan sealing-wax varnish, Robinson's liquid glue, gum mastic and caoutchouc dissolved in chloroform. Objects are put up (*i. e.*, preserved) either as dry or as wet objects. For dry objects, the oils and the Canada balsam are the preservative materials, and they are not suited for wet objects. Before mounting objects in Canada balsam they should be perfectly clean and free from moisture. They may also be soaked in turpentine, especially opaque objects, as it renders them more transparent. In mounting, the balsam should be heated to expel the air, till a fine delicate film is apparent on its surface. The solution of chloride of calcium is adapted for the preservation of wood and leaves, and for most kinds of isolated tissue. The colouring matter in the cells, however, is always more or less altered by it, while grains of starch, if present, swell up and can scarcely be recognized. The strength of the solution is one part of lime to three of water. Glycerine is used in equal parts mixed with camphor water, which prevents the tendency to mildew. The chlorophyll and the grains of starch remain unchanged, and the laminæ of the starch appear more beautiful after a few hours' immersion in the glycerine solution. Canada balsam and copal varnish are used for the preservation of dry and fossil woods. Thin sections should be made, and the hard woods which contain gum, resin, and such like matters, should be soaked in essential oil, alcohol, or ether, before mounting. If the entire structure of any exogenous wood is required to be examined, the sections must be made both in the transverse or horizontal, and in the longitudinal or vertical directions. The vertical section, made parallel to the medullary rays, or, in other words, along the course of them, shows the nature of these cellular rays, which proceed horizontally from the centre, enclosed between the layers of woody fibres, and which are known to the cabinet-maker as the silver grain of the wood. In coniferous trees, as the pine, this section shows also the beautiful punctations on the walls of the fibres. The tangential-vertical section is a slice across the ends of the medullary rays, and exhibits the form and arrangement of the cellular tissue in them. The cells of the rays are seen projecting between the fibres of the wood. These vertical sections show the form, size, and connections of the woody tubes and the spiral, reticulated, and dotted vessels. In endogenous trees horizontal and vertical sections are also required. Peat wood requires to be digested in a strong solution of carbonate of soda, and fossil woods which have been converted into carbonate of lime should be digested in hydrochloric acid.

Schleiden gives the following method of preserving minute structures for the microscope. Upon a glass slide of the common form, two narrow slips of paper are gummed, of a thickness proportioned to the object, and at a distance which is regulated by its size. Between these the object is laid in a drop of solution of chloride of calcium (one dram to half an ounce of water). A thin slip of glass, sufficient to cover the object and paper-slips, is put on; the slips are gummed, and the thin glass applied to its place, where it is retained by the gum drying. The whole may be secured by pasting a long slip of paper over all, with a hole for the object. The advantage of this method is preventing *running in.* Chloride of calcium being deliquescent, never dries up, and, if evaporation takes place, water is easily introduced at the open sides of the thin glass. The points to be attended to are—1, that the paper between the glasses be thick enough to prevent much pressure on the object, and not so thick as to allow it to float about or fall out at the side; 2, that the drop of solution be not too large, but covering the object, and yet not reaching the paper. Glycerine may be used in place of chloride of calcium in cases where the objects are very delicate, or contain chlorophyll or albumen.

Small specimens for the microscope, such as Diatoms and Desmidieæ, and many small Sea-weeds, as well as vegetable tissues, are put up in slides 3 inches long by 1 broad (fig. 17), in the centre of which there is a circular cavity formed by a layer of asphalte,* and covered by a circular piece of thin glass. The asphalte is applied by means of a hair pencil, the slide being placed on a moveable brass disc (fig. 18), which has circular marks on it corresponding to the required dimensions of the cavity. The depth of the cavity can be varied according to circumstances, by putting one or more layers of asphalte. After the thin glass cover is put on, it is luted carefully with asphalte. The cavity is filled with distilled water, weak pyroligneous acid, alcohol, diluted glycerine, a very weak solution of creazote (one drop to the ounce of distilled water), or some other fluid. When specimens are very minute, the asphalte-cell is not re-

Fig. 17.

Fig. 17. Glass slide for microscopic preparations, 3 inches long and 1 inch broad. In the centre is a ring of asphalte, forming a cell to contain fluid; the object marked by a + in the centre, is covered by a circular piece of thin glass fitted to the asphalte rim. The name of the object is often written on the glass, but perhaps it is preferable to write the name on coloured paper, and attach it to the glass by isinglass or fine bookbinder's glue.

* Prepared asphalte is much better than gold size or black japan varnish, inasmuch as it dries more rapidly, and is less liable to run. It can be procured from Smith and Beck, 6 Coleman Street, London; and from Bryson, 24 Princes Street; Kemp, Infirmary Street; and Hart, North College Street, Edinburgh.

quired; the thin glass is applied at once to the slide, a drop or two of the fluid being inserted along with the specimen. In the case of some dry preparations, as pollen-grains, and the fine-lined Diatoms, no fluid whatever is required, but precautions must be taken against the access of damp.

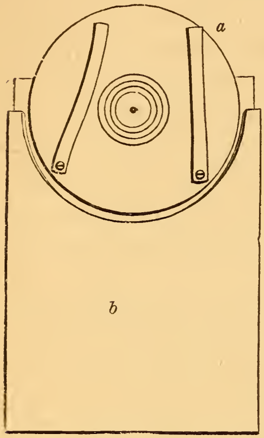


Fig. 18.

Canada balsam is useful in some instances. The specimen is put on a slide, then a minute portion of the balsam is put above it, and the thin glass above all; the slide is heated gently below by means of a spirit lamp until the balsam becomes quite fluid, and until all the air has been expelled by the weight of the glass cover. It is then set aside to dry, and ultimately a rim of asphalte is put round the margin of the glass cover. Canada balsam is well fitted for many Diatoms, and for thin sections of woods. In putting up woods, the specimen is placed in the centre of the glass, a drop of turpentine is put on it to expel the air, Canada balsam is then applied before the turpentine dries, and the same procedure is followed as above.

On preparing fossils for microscopic examination, Mr. Alexander Bryson remarks:*—

The usual mode of proceeding in making a section of fossil wood is simple, though tedious. The first process is to flatten the specimen to be operated on by grinding it on a flat *lap* made of lead charged with emery or corundum powder. It must now be rendered perfectly flat by hand on a plate of metal or glass, using much finer emery than in the first operation of grinding. The next operation is to cement the

Fig. 18. Apparatus for aiding in making the circular rim of asphalte; *b*, a piece of mahogany; *a*, a circular piece of brass, which can be moved round by the hand, and has two brass springs on its surface for holding a glass slide firm. In the centre of the brass disc are circular markings fitted for the size of asphalte cells required. These marks being seen through the slide laid above them, guide the hand in making the circular asphalte rim, the brass disc being turned round during the application.

* On an improved method of preparing siliceous and other fossils for microscopic investigation, with a description of a new pneumatic chuck. By Alex. Bryson, in Edin. N. Phil. Journal, N. S., iii., 297.

object to the glass plate. Both the plate of glass and the fossil to be cemented must be heated to a temperature rather inconvenient for the fingers to bear. By this means moisture and adherent air are driven off, especially from the object to be operated on. Canada balsam is now to be equally spread over both plate and object, and exposed again to heat, until the redundant turpentine in the balsam has been driven off by evaporation. The two surfaces are now to be connected while hot, and a slow circular motion, with pressure, given either to the plate or object, for the purpose of throwing out the superabundant balsam and globules of included air. The object should be below and the glass plate above, as we then can see when all the air is removed, by the pressure and motion indicated. It is proper to mention that too much balsam is more favourable for the expulsion of the air-bubbles than too little. When cold, the Canada balsam will be found hard and adhering, and the specimen fit for slitting. This process has hitherto been performed by using a disc of thin sheet-iron, so much employed by the tinsmith, technically called *sheet-tin*. The tin coating ought to be partially removed by heating the plate, and when hot rubbing off much of the extraneous tin by a piece of cloth. The plate has now to be planished on the polished *stake* of the tinsmith, until quite flat. If the plate is to be used in the lathe, and by the usual method, it ought to be planished so as to possess a slight convexity. This gives a certain amount of rigidity to the edge, which is useful in slitting by the hand; while by the method of mechanical slitting, about to be described, this convexity is inadmissible. The tin plate, when mounted on an appropriate chuck in the lathe, must be turned quite true, with its edge slightly rounded and made perfectly smooth by a fine-cut file. The edge of the disc is now to be charged with diamond powder. This is done by mingling the diamond powder with oil, and placing it on a piece of the hardest agate, and then turning the disc slowly round; and holding the agate with the diamond powder with a moderate pressure against the edge of the disc, it becomes thoroughly charged with a host of diamond points, becoming, as it were, a saw with invisible teeth. In pounding the diamond, some care is necessary, as also a fitting mortar. The mortar should be made of an old steel die, if accessible; if not, a mass of steel, slightly conical, the base of which ought to be 2 inches in diameter, and the upper part 1½ inch. A cylindrical hole is now to be turned out in the centre, of ¾ths of an inch diameter, and about 1 inch deep. This, when hardened, is the mortar; for safety it may be annealed to a straw colour. The pestle is merely a cylinder of steel, fitting the hollow mortar but loosely, and having a ledge or edging of an eighth of an inch projecting round it, but sufficiently raised above the upper surface of the mortar, so as not to come in contact while pounding the diamond. The point of the pestle ought only to be hardened and annealed to a straw colour, and should be of course convex, fitting the opposing and equal concavity of the mortar. The purpose of the projecting ledge is to prevent the smaller particles of diamond spurting out when the pestle is struck by the hammer.

Mr. Bryson has contrived an instrument for slitting fossils. The instrument is placed on the table of a common lathe, which is, of course, the source of motion. (Fig. 19.) It consists of a Watt's parallel motion,

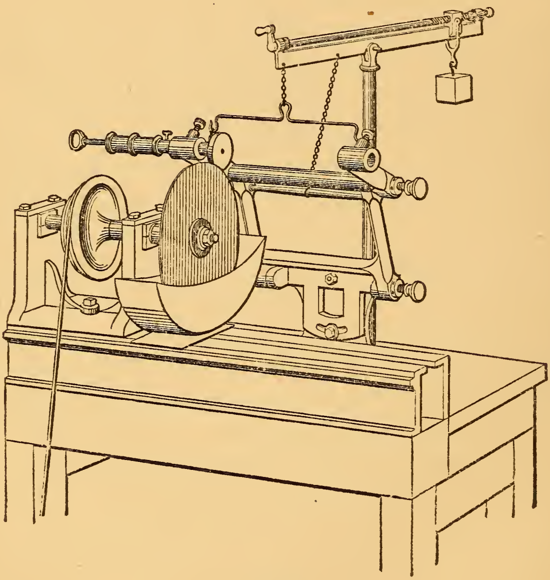


Fig. 19.

with four joints, attached to a basement fixed to the table of the lathe. This base has a motion (for adjustment only) in a horizontal plane, by which we may be enabled to place the upper joint in a parallel plane with the spindle of the lathe. This may be called the azimuthal adjustment. The adjustment, which in an astronomical instrument is called the plane

Fig. 19. Mr. Bryson's instrument for slitting fossils.

of right ascension, is given by a pivot in the top of the base, and clamped by a screw below. This motion in right ascension gives us the power of adjusting the perpendicular planes of motion, so that the object to be slit passes down from the circumference of the slitting-plate to nearly its centre, in a perfectly parallel plane. When this adjustment is made accurately, and the slitting-plate well primed and flat, a very thin and parallel slice is obtained. This jointed frame is counterpoised and supported by a lever, the centre of which is moveable in a pillar standing perpendicularly from the lathe table. Attached to the lever is a screw of three threads, by which the counterpoise weight is adjusted readily to the varying weight of the object to be slit and the necessary pressure required on the edge of the slitting-plate.

The object is fixed to the machine by a pneumatic chuck. It consists of an iron tube, which passes through an aperture on the upper joint of the guiding-frame, into which is screwed a round piece of gun-metal, slightly hollowed in the centre, but flat towards the edge. This gun-metal disc is perforated by a small hole communicating with the interior of the iron tube. This aperture permits the air between the glass plate and the chuck to be exhausted by a small air syringe at the other end. The face of this chuck is covered with a thin film of soft India-rubber not vulcanized, also perforated with a small central aperture. When the chuck is properly adjusted, and the India-rubber carefully stretched over the face of the gun-metal, one or two pulls of the syringe-piston is quite sufficient to maintain a very large object to the action of the slitting-plate. By this method no time is lost; the adhesion is made instantaneously, and as quickly broken by opening a small screw, to admit air between the glass-plate and the chuck, when the object is immediately released. Care must be taken, in stretching the India-rubber over the face of the chuck, to make it very equal in its distribution, and as thin as consistent with strength. When this material is obtained from the shops, it presents a series of slight grooves, and is rather hard for our purpose. It ought, therefore, to be slightly heated, which renders it soft and pliant, and in this state should now be stretched over the chuck, and a piece of soft copper wire tied round it, a slight groove being cut in the periphery of the chuck, to detain the wire in its place. When by use the surface of the India-rubber becomes flat, smooth, and free from the grooves which at first mar its usefulness, a specimen may be slit of many square inches, without resort being had to another exhaustion by the syringe. But when a large, hard, siliceous object has to be slit, it is well for the sake of safety to try the syringe piston, and observe if it returns forcibly to the bottom of the cylinder, which evidences the good condition of the vacuum of the chuck.

After the operation of slitting, the plate must be removed from the spindle of the lathe, and the flat lead *lap* substituted. The pneumatic chuck is now to be reversed, and the specimen placed in contact with the grinder. By giving a slightly tortuous motion to the specimen, that is, using the motion of the various joints, the object is ground perfectly flat when the length of both arms of the joints are perfectly equal. Should the leg of the first joint on the right hand side be the longer, the specimen will be ground hollow; if shorter, it will be ground convex. But if, as before stated, they are of equal length, a perfectly parallel surface will be obtained.

In operating on siliceous objects, I have found soap and water quite as speedy and efficacious as oil, which is generally used; while calcareous fossils must be slit by a solution of common soda in water. This solution of soda, if made too strong, softens the India-rubber on the face of the pneumatic chuck, and renders a new piece necessary; but if care is taken to keep the solution of moderate strength, one piece of India-rubber may last for six months. The thinner and flatter it becomes, the better hold the glass takes, until a puncture occurs in the outer portion, and a new piece is rendered necessary.

The polishing of the section is the last operation. This is performed in various ways, according to the material of which the organism is composed. If siliceous, a *lap* of tin is to be used, about the same size as the grinding *lap*. Having turned the face smooth and flat, a series of very fine notches are to be made all over the surface. This operation is accomplished by holding the edge of an old dinner-knife almost perpendicular to the surface of the *lap* while rotating; this produces a series of *criddles*, or slight asperities, which detain the polishing substance. The polishing substance used on the tin lap is technically called lapidaries' rot-stone, and is applied by slightly moistening the mass, and pressing it firmly against the polisher, care being taken to scrape off the outer surface, which often contains grit. The specimen is then to be pressed with some degree of force against the revolving tin *lap* or polisher, carefully changing the plane of action, by moving the specimen in various directions over the surface.

To polish calcareous objects, another method must be adopted as follows:—

A *lap* or disc of willow wood is to be adapted to the spindle of the lathe, three inches in thickness, and about the diameter of the other laps (10 inches), the axis of the wood being parallel to the spindle of the lathe, that is, the acting surface of the wood is the end of the fibres, or transverse section.

This polisher must be turned quite flat and smoothed by a plane, as the willow, from its softness, is peculiarly difficult to turn. It is also of consequence to remark, that both sides be turned so as that the *lap*, when dry, is quite parallel. This *lap* is most conveniently adapted to the common face chuck of a lathe with a conical screw, so that either surface may be used. This is made evident, when we state that this polisher is always used moist, and, to keep both surfaces parallel, must be entirely plunged in water before using, as both surfaces must be equally moist, otherwise the dry will be concave, and the moist surface convex. The polishing substance used with this *lap* is putty powder (oxide of tin), which ought to be well washed, to free it from grit. The calcareous fossils being finely ground, are speedily polished by this method. To polish softer substances, a piece of cloth may be spread over the wooden *lap*, and finely-levigated chalk used as a polishing medium.

In all instances slides should be labelled with the name, locality, and date, and they should be numbered and catalogued so that they may be easily referred to when put up in cases such as that shown in fig. 20, or in cabinets.*

The Diatomaceæ being either free, or attached to Algæ, etc., different modes must be resorted to for collecting them. Those which are attached require only (either at the time or after being dried) to be rinsed gently in fresh water to get rid of the sand or mud, and salt if any, and then placed in a small saucer in boiling water, with a few drops of nitric or muriatic acid. The cuticle being corroded, the Diatoms fall to the bottom, the floating Algæ are taken out with a glass rod, and the residue washed. This step is merely preparatory to that of burning or boiling the objects. If the Diatoms be free, they should, as far as possible, be gathered free

* In making sections of minute objects, such as Diatoms, they are mixed up with plaster of Paris and mucilage, and then the whole is sliced by means of a sharp razor. Small pieces of wood are sometimes put into a slit in a cork, and then the whole sliced.

from sand or mud, by skimming the surface of the pond or pool with an iron spoon; but as much mud and sand may still be mixed with them, they ought to be afterwards placed in a saucer in a little water, and exposed to

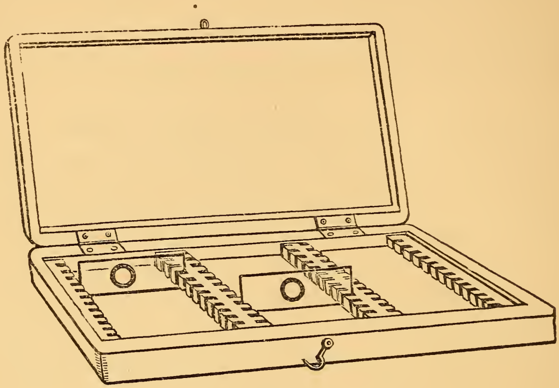


Fig. 20.

the sun for a day or two. A tumbler or hand-glass will prevent too much evaporation. Diatoms, if recently gathered and alive, will come to the surface of the sediment, or water, or both, and this affords an easy mode of separating certain species. They may now be skimmed off with a small spoon, or, what is preferable, a camel's hair pencil, and removed to clean water; and this process is to be repeated till the mud is got rid of entirely. As for preparing the specimens, they may be either burned, or boiled in

Fig. 20. A case for containing slides after being prepared. There are three divisions, each containing twelve slides, two of which are shown projecting above the lower division of the box, the lid being hollowed to receive them. Numbers corresponding to those on the slides are fastened on the partitions at the sides of the grooves which retain the slides. On the front of the box a notice of the numbers contained in it should be fastened. Corresponding numbers, with full particulars as to the preparations, ought to be inserted in a book which serves as a catalogue, in which there should be first a numeral progressive series, and then an alphabetical register for genera. Card boxes for holding 24 slides are made by Smith and Beck and others, price one shilling each. They are excellent for forming a general collection. Cabinets are also made for slides, consisting of drawers half-an-inch deep (including the bottom) divided so as to hold 30, 40, or 50 slides, all on their back; the drawers being slightly bevelled at their divisions on one side, so that the slides may be tilted up by pressing them down. Smith and Beck charge for a cabinet of Honduras mahogany, capable of holding 500 slides, four guineas; 750 slides, five pounds; 1000 slides, six guineas; and 2000 slides, eleven pounds.

nitric acid. For the isolated Diatoms,* as Navicula, Pleurosigma, Cocconeis, etc., boiling is preferable ; but for the others, as Synedra, Fragilaria, Melosira, Meridion, etc., if one wishes to have a few frustules cohering together to show their habit, then burning must be adopted, as the acid separates them joint by joint, and valve from valve. This is accomplished by arranging the specimens in the centre of a glass slide, and laying them on a thin iron-slide, and placing the whole within a little iron tray, closed in the form of a slipper, to exclude ashes. This is exposed to the fire till the slide is red hot. The slide is now allowed to cool, and the specimen is ready for being covered either with or without the intervention of balsam. The latter is called *dry* mounting, and is best accomplished by making a ring of asphalte, and following the same process as for liquid mounting, but without liquid. When nitric acid is to be used, the cleaned Diatoms are put into a large-sized test tube of German glass, with as little water as possible, and about one part of nitric acid to four of water. After being boiled for two or three minutes over a spirit-lamp, the Diatoms must be allowed to subside, and as much liquor as possible poured off with any fragments of vegetable matter floating in it. This boiling sometimes suffices, but it is always preferable to add some of the strong acid, and boil the whole again for a few minutes, so as to dissolve any vegetable or animal substances remaining. As the siliceous covering is very thin, and easily broken by a sudden change of temperature, care must be taken in washing away the acid, either to use boiling water, or to allow the Diatoms in the test-tube to cool. When a sufficient supply of *pure distilled* water can be easily got, it alone ought to be used for washing them ; but, when that is not the case, ordinary water may be employed for the first washing, but the after washings must be all made with distilled water until the acid is got rid of. After being thoroughly washed, the Diatoms are kept in a small test-tube with some distilled water. In taking the specimens from the test-tube, in order to put them on the slide, a pipette or dropping-tube is employed, having a bore of about $\frac{1}{30}$th to $\frac{1}{50}$th of an inch at its lower end.

Mr. Jackson remarks that it is desirable that no object submitted to higher power than a quarter-inch objective of 75° aperture should ever

* By free Diatoms are meant those that are not parasitical. By isolated or solitary Diatoms are meant those not connected nor cohering together into threads or plates, or by a stipe, tube, or gelatine.

be mounted under a cover thicker than $\frac{1}{140}$th of an inch; if the aperture exceeds 120°, the best thickness for the cover is $\frac{1}{250}$th of an inch.* Glass of this thickness can easily be cut with a good writing diamond, when laid on a piece of plate glass.† To clean the covers, he recommends putting them in strong sulphuric acid for a day or two, and then washing them repeatedly with water; after that placing them, a few at a time, on a tightly stretched clean cambric handkerchief, and rubbing them very gently with another handkerchief on the finger. They should then be removed to a clean box, with forceps, and carefully kept from dust and from contact with the fingers. The covers should be sorted according to their thickness, and this is done at once by Ross's "lever of contact," which consists of a long slender index, having a projecting *touch* near the centre of motion, which is kept in contact with a plane surface by means of a spring. When a piece of glass is inserted under the touch, the index points to the thickness on a graduated arc. The thickness may also be measured in the usual way by placing a fragment in the pliers, with the edge upwards, under the microscope, armed with an inch object-glass and an eye-piece micrometer.‡

To make Cells, and to fix the thin Glass Covers.—The cells are made either round or square by thin layers of cement, according to the depth required. Perhaps the round ones are neater, but they require circular pieces of glass for covers, and by the aid of the moveable circular disc, the roundness of the mounting can be made with perfect accuracy. The cover is laid gently down, so as to float on the solution in which the object lies, and by pressing carefully on the cover, the superabundant fluid is made to pass out by the edges, and may be taken up by a sponge or blotting paper. A thin layer of Brunswick black, or liquid glue, or gold size, may be placed round the edge, which will gradually harden and completely seal up the preparation.

* I am informed by a friend, that on account of the brittleness of the glass, covers thinner than 1-140th or 1-150th of an inch are, in the hands of most manipulators, practically useless, as they break by the mere wiping or mounting, and that glass 1-150th of an inch is not too thick either for Smith and Beck's 1-5th object-glass with 100° of aperture, or Ross's 1-8th with 156° of aperture; but that when dry mounting is adopted, the object ought to be arranged on the under side of the cover, thus bringing it as near the lenses as possible.

† Quekett on the Microscope. 2d Edit. p. 265.

‡ Quarterly Journal of Microsc. Science, i. 141.

Directions by Smith and Beck for using the Compound Microscope.

Before using the microscope, see that the mirror, object-glass, and eye-piece are free from dust:—a little soft wash leather should be used in cleaning these. The instrument should be placed on a *steady* table to avoid vibration. The best position for examination by day-light is with the window to the left hand, and the back partly turned toward the window, so that the light may fall directly upon the mirror, and not upon the observer's face. At night, when a lamp is used, a shade should be placed if possible before the lamp, so as to screen the eyes from its glare. The nearer the observer can approach the window by day, and the closer the lamp can be brought towards the mirror at night (say from fifteen to twenty inches) the better; as all the light that can be obtained is required for high magnifying powers; and if too intense for some objects, can be easily modified by the mirror. When the microscope has a joint to the stand, it should generally be used with the body in an *inclined* position—at an angle of about 45°, this being much more convenient for the observer, and not so liable to injure the eye by overstraining it. The management of light, either natural or artificial, is of the greatest importance in microscopic observations. *This may be regulated by altering the position of the mirror under the stage;* the proper adjustment of which will soon be acquired by a little practice and observation. In adjusting the microscope for use, first place it in its proper position, and screw or slide on a low-powered object-glass, then look through the tube, and incline the mirror towards the light, *moving it about until a clear bright light is seen.* The object may then be placed upon the stage and the focus adjusted by the rack movement. In examining any fresh object, the lowest magnifying power should be first used, as a larger portion of it can be thus viewed at once, and a better general idea of its form, colour, etc., obtained. Afterward the higher powers may be employed, in order to reveal its minute structure.

In viewing very delicate transparent objects, as fossil infusoria, thin vegetable and animal tissues, blood and milk globules, etc., a good clear light should be used, but the mirror should be *inclined on one side more than usual, that the object may appear less brightly illuminated.* This is what is termed "oblique illumination,"—the rays of light being reflected from the mirror, through the object, in an *oblique direction*, by which many delicate markings may be observed on some objects which could not be distinguished before, and the outline also rendered more distinct.

In examining *opaque* objects, a low magnifying power should be used, and the light thrown *upon* the object by means of the "Condenser," which should be placed within two inches of it, and so arranged that a small circle of bright light may be seen upon the spot to be examined. When viewing objects in a drop of water, or examining a drop of any other liquid, a slip of thin glass should always be laid over it; otherwise the liquid will evaporate, and condensing on the object-glass, will render it dim.

WORKS ON THE MICROSCOPE.—The following works may be consulted by the student:—Quekett's Practical Treatise on the Use of the Microscope; Carpenter, The Microscope and its Revelations; Schacht, The Microscope and its Application to Vegetable Anatomy and Physiology, translated by Currey; Hannover on the Construction and Use of the Microscope, edited by Professor Goodsir; Beale, The Microscope and its Application to Clinical Medicine; Hogg on the Microscope; Ross, article "Microscope" in the Penny Cyclopædia; Bennett's Lectures on Clinical Medicine, etc.; Transactions of Microscopical Society and Microscopical Journal; Griffith and Henfrey, Micrographical Dictionary; Pritchard's Microscopic Illustrations; Robin, Du Microscope et des Injections.

ROSS' MICROSCOPES IN 1855—OBJECTIVES AND PRICES.

Object Glasses, Focal Length.	Angle of Aperture.	Magnifying Powers, with four Eye-pieces.				Prices.	
		A	B	C	D	£	s.
2 inches	12 degs.	20	30	40	60	2	0
1 inch	15 "	60	80	100	120	3	0
1 "	22 "	60	80	100	120	3	10
½ "	65 "	100	130	180	220	5	5
¼ "	85 "	220	350	500	620	5	5
¼ "	125 "	220	350	500	620	7	10
⅙ "	135 "	320	510	700	910	10	0
⅛ "	130 "	400	670	900	1200	11	0
⅛ "	150 "	400	670	900	1200	12	0
1/12 "	170 "	650	900	1250	2000	18	0

List of the Principal Microscope Makers.—Ross, Powell and Lealand, Smith and Beck, Ladd, Pillischer, Pritchard, Salmon, in London; Adie, Bryson, Hart, in Edinburgh; Field, Parkes, in Birmingham; Dancer, in Manchester; King, in Bristol; Chevalier, Nachet, Oberhäuser, Brunner, in Paris; Schiek, Pistor, in Berlin; Ploesl, in Vienna; Frauenhofer, in Munich; Amici in Modena.

II.—On Collecting and Examining Plants, and on the Formation of a Herbarium.

Instruments and Apparatus.—In examining the characters of plants with a view to classification, the chief instruments required are a lancet-pointed knife, a small pair of forceps and a lens, from $\frac{1}{4}$ to 1 inch focus. With the view of holding the object steadily, the blades of the forceps may be made so as to be fastened by a sliding button. In more minute examinations, the simple or compound microscope must be called into requisition. In selecting specimens, care should be taken to have the plants in a perfect state, or with all the characteristic parts present. The entire plant should be taken when practicable; when that is not the case, then those parts should be taken on which the generic and specific characters are founded. The roots should always be carefully washed at the time the plants are gathered. In most cases, particularly in specimens of Umbelliferæ, Leguminosæ, Compositæ, Rosæ, &c., it is of importance that both flowers and fruit should be preserved. In the case of Willows, the young shoot, with its fully developed leaves, as well as the male and female flowers, are requisite. In Rubi, specimens of the young shoots must be taken. When bulbs or tubers exist, they should be preserved, either in an entire or split condition; and when there is much mucilaginous matter in them, they may be enveloped in small pieces of paper, so as to prevent them from adhering to the drying paper. In the case of Ferns, two fronds are necessary to make a perfect specimen, showing both surfaces, along with a portion of the rhizome. Entire specimens of Gramineæ and Cyperaceæ should be collected; these, when long, may be bent into one or more folds, corresponding to the size of the paper on which they are to be fastened, the folds being temporarily retained by small slips of paper having slits in the centre. No bad specimens ought to be preserved.

In taking up the roots of plants, a small *Digger* or trowel is used, 7 or 8 inches long (fig. 21); the spud $2\frac{1}{2}$ inches long, $2\frac{1}{2}$ inches wide at the top, narrowing gradually to 2 inches at the bottom, the lower angles slightly rounded. It should be sufficiently strong to resist considerable force in digging out plants from the crevices of rocks. The iron portion, which unites the spud to the handle, should be particularly attended to in this respect. This spade is put into a leather sheath, and fastened by a strap round the waist, the spade itself being attached to the strap by a long string. A japanned tin box or *Vasculum* is required for the reception of specimens. This should be of sufficient length to receive a plant of the full size of the herbarium paper; it ought to be convex on both sides

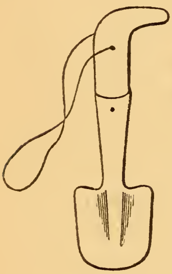


Fig. 21.

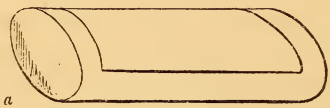


Fig. 22.

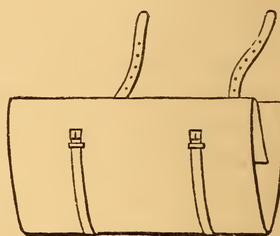


Fig. 23.

(fig. 22); and its capacity may vary according to the wish of the collector. In long excursions where productive localities are visited, it will be found that a vasculum 20 inches long, by 8 or 9 inches wide, and 5 deep, is not too large; and when it is made of thin tin, it is by no means heavy. At one end a good sized thickish handle should be placed, and it is necessary to have wires fixed at each end (*a*) so as to receive a strap for fastening the vasculum on the shoulders. The lid of the vasculum should be large, and is best secured by a wire which slips into a tin sheath, and so constructed as not to be liable to slip out when the box is held by the handle. The specimens should be put into the box in a uniform manner —the flower at one end, and the roots at the other; and care should be taken to have the former (which should be the end where the handle is) always kept on the higher position when carried on the shoulders. For

Fig. 21. Form of spade or digger.
Fig. 22. Form of Vasculum or botanical box.
Fig. 23. Form of Field-book for drying specimens of plants.

mosses and some Alpine species of plants, a small box may also be carried in the pocket. In collecting minute aquatic plants, as Desmideæ and Diatomaceæ, it is necessary to have small glass bottles, or test-tubes fitted to a small case. The corks should be numbered to facilitate notes being taken at the time, of the localities in which the specimens were collected. Many plants will not bear transport; their flowers fall off easily, and they are so delicate that their foliage becomes shrivelled. This is the case with the flower of Trientalis europæa, Rubus Chamæmorus, and Veronica saxatilis, and with some delicate Ferns. In such instances it is best to put them at once into paper. This is managed by having a small *Field-book* (fig. 23), which may be put into the pocket or suspended round the neck, secured by straps so as to give pressure, and with an oil-cloth covering which may be used in wet weather. This field-book may be made with two thin mahogany boards on the outside.

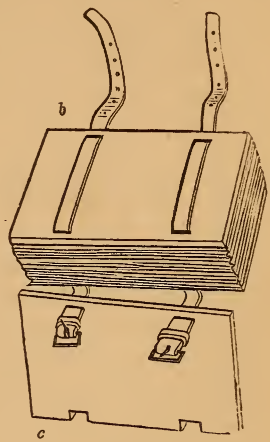


Fig. 24.

A convenient field-book used by students in Edinburgh is represented by fig. 24. It is made of two mahogany boards about nine inches long by five broad, containing from 12 to 24 parcels of paper, each parcel consisting of four sheets, the back of the parcels being covered with strips of leather or cloth. The boards may be rendered firm by being made each of two thin layers of crossed wood fastened together in the way afterwards noticed when speaking of large boards. Two narrow leather straps pass through two holes in one margin of each of the boards, and also through slits in the leather-covered backs of the parcels of the paper, *a*, so as to prevent them from falling out when the field-book is opened. In the case of one of the boards, the two straps also pass through perforations in its other margin, *b*, and under these another strap is passed for the purpose of suspending the field-book round the neck. The two small straps pass through grooves in the margin of the other board, *c*, and are thus buckled so as to apply pressure.

Fig. 24. Small field-book with thin mahogany boards outside, which are brought together by leather straps.

The *Paper for drying* should be moderately absorbent, 18 inches long by 11 broad, and arranged in parcels containing not less than four sheets. The paper which is used extensively in Scotland, is made by Cowan and Co., Princes Street, Edinburgh. In many respects, the Edinburgh botanists prefer it to Bentall's. It is of considerable thickness, absorbs moisture rapidly, but does not become too moist, and dries easily. A very thin kind of paper, called crown tea-paper, is used for holding very delicate plants, which cannot be easily transferred from one paper to another during drying. After being carefully laid out in the folds of this paper, they are placed between the sheets of drying paper, and when the paper is changed they are transferred at once in their thin cover without being disturbed. This plan is useful in the case of such plants as Myriophyllum, Callitriche autumnalis, and other aquatics, as well as Viola lutea, whose petals collapse if removed in the ordinary way, after a day's pressure.

In order that pressure may be given, *Boards* are requisite. These should be exactly the size of the drying paper. Some of them are used for outside boards, and these ought to be from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch thick. Others are inside boards, about $\frac{3}{8}$ of an inch thick. The outside boards are often made double—each double board being composed of two thin ones, the grain of the one crossing that of the other (as in the case of the field-boards already mentioned), closely glued together, and firmly secured by small screws along the edge, at intervals of three inches. They may be rounded on their outer margins. For every two reams of drying paper, not less than ten boards should be procured; two of which are for the outside, and eight for the inside. Sheets of stout pasteboard are also useful for packing up the plants as they become dry. The pressure is best applied on a botanical excursion, by means of a rope put crosswise round the boards and paper, and tightened by a rack-pin. This is much better than straps, which are apt to give way, and are with difficulty replaced during an excursion. In other circumstances, pressure is best applied by means of heavy weights. The pressure ought not to be less than 100 lbs. This is preferable to a screw-press, in which the pressure is not kept up while the plants are losing their moisture. In order to allow free ventilation, and thus to dry plants more rapidly, Mr. Twining recommends, instead of boards, frames made of crossed bars with spaces between them; the surface applied to the paper being flat,—the others being ribbed by means of prominent cross bars, so as to leave a ventilating space between the one frame and the other (figs. 25 and 26). By an apparatus consisting of eight of such inner frames, and two outer frames of a stouter nature, so as to bear pressure, the plants as well as the paper may be dried rapidly. The apparatus, with paper and plants firmly

Fig. 25.

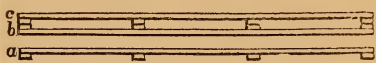


Fig. 26.

strapped, is suspended in a draft of air coming through a partially closed window, or on the branch of a tree in sunshine; and it is said that desiccation of the plants and paper is accomplished in four days. By the use of artificial heat in an open and airy place, as, for instance, by being placed before the fire, the drying may be accomplished in twenty-four or forty-eight hours. Mr. Twining, when in Switzerland, first pressed the plants tightly for twenty-four hours, and then piled them properly in the framework apparatus, which was hung up in the hot air of a drying room, and in twenty-four hours more they were ready for packing, the paper also which contained them being perfectly dry and bibulous.* Henslow recommends that, with the view of ventilating plants during drying, holes should be made in the ordinary boards at regular intervals, and that two of the inner boards should always be placed together, separated by flat cross bars which may either be fastened to the boards by liquid glue prepared from shell lac, or may be kept loose, and inserted when required. A complicated apparatus is suggested by M. Gannal, the particulars of which are given in the Botanical Gazette, ii. 55; and there also another mode of drying is described, in which plants, after having been kept in a press for a few hours, are exposed to the sun, or placed on a stove or in an oven, in an apparatus called the Coquette. This consists of two open covers made of strong

Fig. 25. Frames formed of cross bars, for pressure and ventilation.

Fig. 26. Side view of frames. One of the frames *a* seen laterally, with its cross bars forming projections; two of these frames *b* and *c* appear together, so as to allow ventilation between them.

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* See a description and drawing of this apparatus, in Botanical Gazette, ii. 59.

iron-wire network fastened into frames made of light iron rod, pressure being applied by straps or ropes, as already mentioned. The open frames allow the moisture to escape freely. Sheets of tin may be employed to separate the different layers of plants in process of drying, so as to hinder the humidity of one from reaching the other, or the inequalities of the larger from injuring the smaller and more delicate. In the case of plants with strong stems, they must either be split, or a sand-bag, of the same size as the boards, used, so as to equalize the pressure.

Process of Drying.—The plants when collected are to be placed on the drying paper. In doing this, a parcel of not less than four sheets is put on one of the outside boards; then the specimens are laid out carefully, preserving as far as possible their natural habits, and laying out the leaves and other parts. Another parcel of drying paper is then placed above these, and the same process is repeated with other specimens until twelve such parcels have been placed together. Then one of the inner boards is laid down, and other layers of paper and specimens are applied, until the whole parcel is of sufficient size to be subjected to pressure. After twelve hours' pressure, in most instances, the paper is changed, the moist paper being hung up to dry; and in transferring the specimens from the wet to the dry paper, a large pair of surgeon's forceps is used. The interval elapsing between the changing of the paper may be increased or diminished according to the nature of the plants, and the state of the weather. In the course of eight or ten days, ordinary specimens will be so dry as to require only very slight pressure, with a moderate circulation of air. Some very dry plants, as grasses, may require only one changing. Succulent plants, such as Sedum and Sempervivum, continue to grow, however much submitted to pressure and the ordinary methods of desiccation already indicated. In order to dry these plants completely and rapidly, it is necessary to kill them, by immersion in boiling water for five or ten minutes. The plants thus dealt with are then placed upon a cloth and left to drain for some time, after which they must be carefully placed between the folds of the drying paper, not forgetting to lay out properly any of the parts which the water may have disarranged. Orchideous plants are sometimes put into warm paper, and changed frequently, with the view, if possible, of preserving their colours by the rapidity of drying. Scarification has sometimes been adopted with the view of allowing the juice to flow out rapidly. Motley recommends that Orchids should be put into weak spirit for one or two nights, and then dried. In the case of some thick-headed plants, as Thistles, the capitula must either be cut, or they must be crushed between paper by temporary pressure from the foot; this treatment must also be applied to such plants as Eryngium maritimum and the Holly. Sometimes the flower or parts of the flower may be separated advantageously during drying by the insertion of small pieces of blotting paper. At the time the specimens are laid out on the drying paper, a label should be inserted with the date of collecting, the name of the station, its elevation above the sea (if it can be ascertained), and any remarks as to soil or geological structure that may be known. In the course of long excursions, it is necessary to devote every now and then some time to the proper arranging and tallying of the specimens. On this subject, Greville says, "half a day, therefore, at least, in the middle of the week, say the morning of every Wednesday till two o'clock, should be appropriated to the preservation and arrangement of your plants; and a part or the whole of every Saturday should invariably be set apart for the same purpose, in order that they may not be injured by remaining untouched on the Lord's Day." With the view of transporting dried plants securely in wet weather, it is useful to have a supply of oil cloth to cover them.

Mosses may be collected in excursions in tufts, and dried by moderate pressure at first. They can afterwards be separated, moistened, and dried with greater pressure. They ought to be gathered in fructification. In preserving minute Mosses, Dr. C. Müller takes clear talc, splits it into thin layers, and cuts it into oblong pieces of proper size. Then, with a penknife, he splits one of these pieces (from one of the narrow sides) *half-way through*, so that it may be opened to admit the object and then close by its elasticity, the unsplit end serving as a holder. A drop of water is introduced into the slit with the object. When laid aside it dries, and may be rendered fit for microscopic examination by dipping in water. Lichens sometimes require to be taken with the rocks or stones to which they are attached, and they may be merely wrapped up in paper. Sea-weeds must be washed with fresh water before being laid out. The more delicate kinds are floated out on pieces of stiff paper, and afterwards dried by moderate pressure. In preserving fungi, such as Agarics, etc., a thin slice is taken from the centre, extending from the top of the pileus to the base of the stipe. This is dried separately to show the gills or pores, etc. The inner cellular portion of the pileus and stipe is then removed and these parts are dried so as to give the form. Travellers visiting foreign countries (although not botanists) will find it an easy matter to preserve Mosses, Lichens, and Sea-weeds in a state fit for after-examination. In the case of Sea-weeds, it is necessary to avoid such specimens as are in a state of decay. Those which are taken should be spread out in the shade to dry, without washing them with fresh water, and when quite dry, packed loosely in a box. Many species are found thrown upon the beach, and the pools in the rocks at low water are often filled with excellent specimens. The stems of the larger Algæ are often covered with parasitic species, which should be dried without separation.

When the specimens (whether Phanerogamous or Cryptogamous) are fully dried, they are then selected for the herbarium, and are fastened upon fine stiff paper, fit for writing upon, 17 inches by 10½.* In large herbaria, which are constantly consulted, the best way of securing the specimens is by means of fine thin glue; the plants, after the glue is put on them, being made to adhere to the paper, by pressure between folds of drying paper. Some use gummed paper, others use thread or narrow ribbon, by means of which the specimens are sewed to the paper. Plants of certain families, as Compositæ, are more particularly exposed to the ravages of insects. Hence, all plants after being dried, should be brushed over with an alcoholic solution of corrosive sublimate.† This treatment has the inconvenience of discolouring them more or less completely, and making them assume a light brown tint; but there can be no hesitation between the alteration of their colour and the complete destruction with which they are menaced, if not submitted to the above manipulation; some recommend cyanide of potassium to destroy insects. In herbarium-presses camphor is employed to prevent the attack of insects. The specimens must be kept dry, and frequently examined, and when insects are present, they must be retouched with the solution already indicated. Dry fruits, specimens of wood and bark, large roots, lichens and minute Algæ in rocks or stones, or other specimens which cannot be preserved in a herbarium, may be either placed in drawers, in glazed cases, or in glass jars.

The size of the wooden Case for the herbarium must of course depend

* The paper used in Edinburgh is made by Cowan and Co. under the name of "M. B. Laid Medium, flat 4to," and costs two guineas a ream when cut.

† The solution commonly used consists of 30 grains of camphor, and 20 grains of common sublimate to an ounce of alcohol.

on the extent of the collection. In a private collection it is better to have numerous small Cases which are easily removed at pleasure along with the specimens. This should be particularly attended to by medical students and others who have the prospect of going abroad, and who may wish to transport their collections to foreign countries. In such instances, the Cases should be strongly made, and should be not more than four feet high, with two rows of drawers. These drawers are made open in front, and should slide freely in the Case. In the Edinburgh University Herbarium, the size of the drawers or trays is—depth (inside measurement) 4 inches, length 19 inches, and breadth 11½ inches. The size of the trays should of course correspond to that of the herbarium paper. Some collectors have peculiar fancies in regard to the size of their herbarium. Thus a valuable collection of Cryptogamic plants and grasses left by Menzies to the Edinburgh Botanic Garden has the following dimensions:—Height of the mahogany cases 30 inches, breadth in front 28½, from front to back 11; depth of the trays (inside measurement) 4½ inches, length 9½, breadth 6.

Specimens in a Moist State.—In preserving fresh specimens of fruits, and the other parts of plants, the best mode is to put them into a saturated solution of salt and water. They can thus be sent home from foreign countries in jars or barrels. In making a museum of such specimens, they are put into glass jars, the sizes of which should be regular—4, 8, 12, and 16 inches high, with a diameter varying according to the size of the specimen. The glasses may be filled with the following solution, which is nearly the same as that used by Goadby, and which seems to answer well in most instances:—

Bay salt	4 ounces.
Burnt alum	2 ounces.
Corrosive sublimate	5-10 grains.
Boiling water	2 quarts.

Dissolve and filter the solution. Alcohol is often used, but it usually makes all colours alike brown. It is useful for delicate specimens which are required for dissection. Pyroligneous acetic acid diluted with from 3 to 5 parts of water is also very generally employed. Specimens, however, in the acid are apt to become pulpy and brittle after a few years, so as not to admit of being handled; most colours are altered by it. Before being put in jars, fresh specimens should be kept for a month or more in the solution, so as to allow any colouring matter and other impurities to be separated, otherwise the preparation will become obscure and require to be re-adjusted. The mouth of the glass jars may be conveniently covered with India rubber, or in the case of glasses of small diameter, with a watch glass secured by sealing wax, or by circular glass covers cemented by a lute composed of resin 1 part, wax 2 parts, and vermilion 1 part. The glass cover on the top of the jar may be either luted or held in its place by a metallic ring (fig. 27*a*), which is fitted carefully to it, and covers a portion of the glass lid. Two grooves may be made on the inner side of the rim at the top of the jar for holding a piece of whalebone, to which the specimen may be attached by means of a thread, as seen in the figure. In the case of dry preparations, the metallic ring answers well.

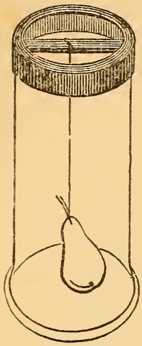

Fig. 27.

It is difficult to keep the solution of salt in the preparation jar. Dr. Christison says:—"The most effectual method, when the mouth of the jar does not exceed 2 or 2½ inches in diameter, is to have a space half an inch or more at the top of the fluid, to clean and dry the top of the jar thoroughly, to drop melted sealing-wax on the upper surface of the top, so as to form a uniform ring over it, to place over the mouth a watch-glass of such size as to cover the whole lip, and even to overhang it a little, to press this gently down with one finger, and to fuse the wax between the top of the jar and the watch glass, by moving a large spirit flame around the edge." Where the mouth of the jar is large, then a round flat piece of glass may be used, or sheet caoutchouc. The latter, after being gently heated, is stretched moderately, not strongly, by one, or still better, by two persons, while a third secures round the neck two or three folds of stout twine as a temporary ligature. A stout thin cord is then drawn steadily and tightly round three or four times above the former, taking care that the caoutchouc is not cut, and that the turns of the twine lie regularly above each other; and finally, that a secure knot is made.

Seeds, when sent from abroad, should be collected perfectly ripe and dry, and if possible kept in their entire seed-vessels. Small seeds may be folded in cartridge paper, and should be kept in a cool and airy place

Fig. 27. Jar for holding wet or dry preparations, the glass cover at the top being held in its place by a metallic ring.

during transport. Large seeds and oily seeds, which lose their germinating power speedily, are best transported in earth. A box about 10 inches square, with the sides $\frac{3}{4}$ of an inch thick, answers well. In this may be put alternate layers of earth and seeds, the whole being pressed firmly together. Living plants are best transported in Wardian cases, and seeds or fruits may also be scattered in the earth of the cases. Bulbs and rhizomes not in a state of vegetation, cuttings of succulent plants, as aloes and cactuses, and the pseudo-bulbs of Orchideous plants, may be put into a box or barrel with dry moss, sand, peat, or sawdust.

Hints as to the preparations to be made for alpine travelling, particularly in Switzerland, partly taken from Wills' "Wanderings on the High Alps."

A botanical trip for six weeks in Switzerland, including the expense of going and coming, need not cost more than twelve shillings a day. In a pedestrian tour the traveller must be as lightly equipped as possible; at the same time he must so provide as to have a change of dress in case of wet weather. The Botanist must send his heavy portmanteau and his drying paper, with boards, rope, and rack-pin, to different points by railway or post. During his alpine rambles, he will find that he can only carry his box, spade, field-book, alpenstock, and light waterproof. His knapsack, *while he is botanizing*, must be carried by a porter. He should, however, be prepared on an emergency to carry all his alpine baggage with him, more especially when passing from one station to another by some beaten track, where few plants are to be expected. A large party will find it convenient and economical to hire a horse for the conveyance of their knapsacks.

The articles required are as follows:—

A light waterproof knapsack, which will bear rough usage, about 14 inches long, 10 inches broad, and $3\frac{1}{2}$ inches deep, with two light straps at the top to hold a very light waterproof, and a stout leather handle by which to carry it, if necessary. The straps for the shoulders should be broad. One of the shoulder straps should end in a ring, and a hook should be fastened on the lower edge of the knapsack to receive it. By this contrivance the knapsack is easily taken off. The whole apparatus ought not to weigh above 2 lbs.

Good shoes, large, so as to allow for the swelling of the feet, the soles from $\frac{5}{8}$ to $\frac{3}{4}$ of an inch thick, studded with stout nails, not too thickly. They should be worn with gaiters, so as to keep out dust, stones, etc.

Soft woollen socks, such as those made in Shetland. Of these two or three pairs are required.

A shooting coat, a waistcoat, and trousers of flannel, or of shepherd's plaid, the two former being double-breasted. Flannel should always be worn next the skin on account of rapid changes of temperature on the glaciers and in the valleys.

A light wide-awake hat with strings or elastic band. In very hot weather the action of the sun on the forehead and temples may be diminished by a thick roll of white muslin round the hat.

A light waterproof of silk; one may be got weighing only six ounces.

The contents of the knapsack should not weigh more than 6 or 7 lbs. They should consist of two spare thin merino shirts, three or four pairs of socks, well run in heels and toes, a very thin pair of trousers or drawers for change, two pocket handkerchiefs, and a pair of light shoes; materials for mending—as needles, thread, worsted, tape, buttons, bits of cloth and flannel; also string, soap, sponge, brush and comb, razor, and tooth-brush; oiled-silk, lint, and bandages; ordinary medicine—as compound rhubarb pills, opium, and sugar of lead and opium pills, tartar emetic, lard, and sticking-plaster; a small quantity of note-paper, ink, pens, wafers; a large knife, furnished with a corkscrew, gimlet, and saw; lucifers; a pair of dark spectacles, and a dark veil, and warm gloves and muffitees. There may be also added a journal, a thermometer, compass, clinometer, whistle, and a small telescope. A flask and drinking-cup will also be of service, and a common coarse blouse, which can be procured in Switzerland for two francs. For travelling on glaciers a few screws, about $\frac{5}{8}$ of an inch long, with large double-pointed heads, are useful. Wills procured them at Chamouni. These are screwed into the sole, three or four being enough for each shoe.

For glacier work, stout ropes, thicker than a window-sash cord are required, 10 to 15 feet for each person, and an ice hatchet. An alpenstock, 6 feet in length, is of essential service. A good map is also of great value. The botanist must also have a small tin box, 10 or 12 inches in length, and about 4 deep; a small spade, in a leathern case, fastened round his waist, and a small field-book for drying plants, made of thin wooden boards, 8 or 9 inches long, and about 5 inches broad, and containing drying paper, about

1 or $1\frac{1}{2}$ inch deep. The plants gathered must be transferred to larger drying paper at different stations, and must then either be carried by a porter, or sent by conveyance of some sort.

It is by no means necessary to have guides in every part of the Alps of Switzerland. For instance, Mr. Wills says, that none are required for the Col de Balme, the Tête Noire, the Col de Vose, the Great St. Bernard, the Gemmi, and the Grimsel. In wandering, however, among the high mountains, it is always safe to take a guide. Wills suggests that the best way is to secure a good guide at starting, and keep him during the whole tour. He costs about five or six francs a day.

Directions to Collectors visiting Foreign Countries, condensed from Hooker's Kew Miscellany, Vol. IX., p. 214–219.

A Botanist visiting a foreign country should make as perfect a collection as possible of all the plants, neglecting no species and preserving specimens of every kind, more especially such as seem to be confined to certain localities. The arborescent plants, trees of every description, are to be sought for and collected in flower and in fruit; cones and larger acorns, and other kinds too large for the hortus siccus, are to be preserved apart from the foliage, and notes made of the locality, height, bulk of the trunk, etc. In proportion as mountains are ascended, the vegetation will be found to change and to become more interesting and more peculiar. Particular notice should be taken of the heights at which different plants grow, and of those plants which are found nearest to the limit of perpetual snow. Care should be taken to preserve the collections from wet and damp. They may require to be opened occasionally, and exposed to a dry air or artificial heat. Seeds should be collected, and transported in the way already noticed. Objects of interest as regards economic botany should be collected; such as articles of food, clothing, ornament, medicines, resins, dye-stuffs, samples of woods, particularly those good for carpentry and cabinet-work. Varieties and abnormal forms of species should be sought for and preserved; attention being paid to differences in habit and in the form of leaves and flowers in the same species at different periods of growth and in different conditions of growth. A comparison should be instituted between the flowers of different regions, as of the plains, swamps, and of different heights and exposures on the mountains, as well of different geological districts, as granite, limestone, etc. The times of leafing and flowering of bushes and trees, etc., should be noticed. When the vegetation seems unusually retarded or accelerated, the temperature of the surface soil and at three feet deep should be ascertained, wherever possible. The collector should, as soon as possible, make himself acquainted with the names of the more common and conspicuous plants of the district he traverses, by consulting any works which may have been written regarding it. The plants which affect waysides or the tracks of man and animals should be noticed, and the effect of clearing away forests and of burning grass land on the subsequent vegetation should be attended to. The transport of seeds by man and animals is a subject of great interest, which should not be neglected. Care should be taken to ticket the specimens, so that there may be no difficulty in determining their localities afterwards. Notes as to elevation (if above 2000 feet of the sea level), dates, name of district, and any other information, should be attached to the specimens to which they refer. A collector cannot be too careful in regard to these matters. Ascertaining the temperature of the trunks of evergreen and deciduous trees and of the soil at their roots is a subject of importance. The temperature of the soil at various depths during winter should be recorded; also the temperature of the air and water between the under surface of melting snow-beds and the subjacent dormant vegetation, with the view of determining the causes of the rapidity with which plants germinate and blossom after th disappearance of snow from alpine situations.*

* For fuller details see instructions by Sir Wm. Hooker and Dr. Hooker in Kew Miscellany Vol. ix., pp. 214-219.

GLOSSARY,

OR

EXPLANATION OF SOME OF THE MOST IMPORTANT BOTANICAL TERMS.

A, *alpha*, privative of the Greek, placed before a Greek or Latin word, indicates the absence of the organ; thus, *aphylius*, leafless, *acaulis*, stemless.

ABAXIAL or ABAXILE, not in the axis, applied to the embryo when out of the axis of the seed.

ABNORMAL, deviating from regularity or from the usual form or structure.

ABORTION, suppression of an organ, depending on non-development.

ABRUPT, ending in an abrupt manner, as the truncated leaf of the Tulip tree; *abruptly-pinnate*, ending in 2 pinnæ, in other words, pari-pinnate; *abruptly-acuminate*, a leaf with a broad extremity from which a point arises.

ABSCISSION, cutting off, applied to the separation of the segments or frustules of Diatoms.

ACAULIS or ACAULESCENT, without an evident stem.

ACCRESCENT, when parts continue to grow and increase after flowering, as the calyx of Physalis, and the styles of Anemone Pulsatilla.

ACCRETE, grown together.

ACCUMBENT, applied to the embryo of Cruciferæ, when the cotyledons have their edges applied to the folded radicle.

ACEROSE, narrow and slender, with a sharp point.

ACHENE or ACHÆNIUM, a monospermal seed-vessel which does not open, but the pericarp of which is separable from the seed.

ACHLAMYDEOUS, having no floral envelope.

ACHROMATIC, applied to lenses which prevent chromatic aberration, *i. e.*, show objects without any prismatic colours.

ACICULAR, like a needle in form.

ACICULUS, a strong bristle.

ACINACIFORM, shaped like a sabre or scimitar.

ACINUS, one of the pulpy drupels forming the fruit of the Raspberry or Bramble.

ACTINENCHYMA, cellular tissue, having a star-like or stellate form.

ACOTYLEDONOUS, having no cotyledons.

ACROCARPI, Mosses having their fructification terminating the axis.

ACROGEN and ACROGENOUS, a stem formed by the bases of fronds in ferns, increasing by its summit, and having its vascular tissue in the form of irregularly formed bundles.

ACULEUS, a prickle, a process of the bark, not of the wood, as in the Rose; *Aculeate*, furnished with prickles.

ACUMINATE, drawn out into a long point.

ACUTE, terminating gradually in a sharp point.

ADELPHOUS or ADELPHIA, in composition, means union of filaments.

ADHERENT, united, adhesion of parts that are normally separate, as when the calyx is united to the ovary.

ADNATE, when an organ is united to another throughout its whole length, as the stipules in Rose, and the filament and anther in Ranunculus.

ADPRESSED or APPRESSED, closely applied to a surface, as some hairs.

ADUNCUS, crooked or hooked.

ADVENTITIOUS, organs produced in abnormal positions, as roots arising from aërial stems.

ÆSTIVATION, the arrangement of the parts of the flower in the flower-bud.

AFFINITY, relation in all essential organs.

AGAMOUS, the same as *Cryptogamous*.

ALA, a wing, applied to the lateral petals of a papilionaceous flower, and to membranous appendages of the fruit, as in the Elm, or of the seed, as in pines.

ALBUMEN, the nutritious matter stored up with the embryo, called also *Perisperm* and *Endosperm*.

ALBURNUM, the outer young wood of a Dicotyledonous stem.

ALGOLOGY, the study of Sea-weeds.

ALSINACEOUS, a polypetalous corolla, in which there are intervals between the petals, as in Chickweed.

ALTERNATE, arranged at different heights on the same axis, as when each leaf is separated by internodes by those next to it.

ALVEOLÆ, regular cavities on a surface, as in the receptacle of the Sunflower, and in that of Nelumbium which is called *Alveolate.*

AMENTUM, a catkin or deciduous unisexual spike; plants having catkins are *Amentiferous.*

AMNIOS, the fluid or semi-fluid matter in the embryo-sac.

AMORPHOUS, without definite form.

AMPHISARCA, an indehiscent multilocular fruit with a hard exterior, and pulp round the seeds, as seen in the Baobab.

AMPHITROPAL, an ovule curved on itself, with the hilum in the middle.

AMPLEXICAUL, embracing the stem over a large part of its circumference.

AMPULLA, a hollow leaf, as in Utricularia.

ANALOGOUS, when a plant strikingly resembles one of another genus, so as to represent it.

ANASTOMOSIS, union of vessels; union of the final ramifications of the veins of a leaf.

ANATROPAL or ANATROPOUS, an inverted ovule, the hilum and micropyle being near each other, and the chalaza at the opposite end.

ANCEPS, two-edged.

ANDRŒCIUM, the male organs of the flower.

ANDROGYNOUS, male and female flowers on the same peduncle, as in some species of Carex.

ANDROPHORE, a stalk supporting the stamens, often formed by a union of the filaments.

ANER, male or stamen, in composition, *Andro* and *Androus.*

ANFRACTUOSE, wavy or sinuous, as the anthers of Cucurbitaceæ.

ANGIENCHYMA, vascular tissue in general.

ANGIOSPERMOUS, having seeds contained in a seed-vessel.

ANISOS, in composition, means unequal.

ANISOSTEMONOUS, stamens not equal in number to the floral envelopes, nor a multiple of them.

ANNOTINUS, a year old.

ANNULUS, a ring, applied to the elastic rim surrounding the sporangia of some Ferns, also to a cellular rim on the stalk of the Mushroom, being the remains of the veil.

ANTERIOR, same as *inferior*, when applied to the parts of the flower in their relation to the axis.

ANTHELA, the cymose panicle of Juncaceæ.

ANTHER, the part of the stamen containing pollen.

ANTHERIDIUM, male organ in Cryptogamic plants, frequently containing moving filaments.

ANTHEROZOA, moving filaments in an antheridium.

ANTHESIS, the opening of the flower.

ANTHOCARPOUS, applied to multiple or polygynœcial fruits, formed by the ovaries of several flowers.

ANTHODIUM, the capitulum or head of flowers of Composite plants.

ANTHOPHORE, a stalk supporting the inner floral envelopes, and separating them from the calyx.

ANTHOS, a flower, in composition, *Antho;* in Latin *Flos.*

ANTHOTAXIS, the arrangement of the flowers on the axis.

ANTICUS, placed in front of a flower, as the lip of Orchids; *Antheræ Anticæ,* anthers which open on the surface next the centre of the flower; same as *Introrse.*

ANTITROPAL, applied to an embryo whose radicle is diametrically opposite to the hilum.

APERISPERMIC, without separate albumen; same as *Exalbuminous.*

APETALOUS, without petals, in other words, monochlamydeous.

APHYLLOUS, without leaves.

APICAL or APICILAR, at the apex; often applied to parts connected with the ovary.

APICULATE, having an apiculus.

APICULUS or APICULUM, a terminal soft point springing abruptly.

APOCARPOUS, ovary and fruit composed of numerous distinct carpels.

APOPHYSIS, a swelling at the base of the theca in some Mosses.

APOTHECIUM, the rounded, shield-like fructification of Lichens.

APTEROUS, without wings.

ARACHNOID, applied to fine hairs so entangled as to resemble a cobweb.

ARCHEGONIUM, the young female cellular organ in Cryptogamic plants.

ARCUATE, curved in an arched manner like a bow.

AREOLATE, divided into distinct angular spaces, or *Areolæ.*

ARILLUS and ARILLODE, an extra covering on the seed, the former proceeding from the placenta, the latter from the exostome, as in Mace.

ARISTA, an awn, a long pointed process, as in Barley and many grasses which are called *Aristate.*

ARMITURE, the hairs, prickles, &c., covering an organ.

ARTICULATED, jointed, separating easily and cleanly at some point.

ASCENDING, applied to a procumbent stem, which rises gradually from its base; to ovules attached a little above the base of the ovary; and to hairs directed towards the upper part of their support.

ASCIDIUM, a pitcher or folded leaf, as in Nepenthes.

ASCUS, a bag, applied to the thecæ of Lichens and other Cryptogams, containing sporidia or spores.

ASPERITY, roughness, as on the leaves of Boraginaceæ.

ATRACTENCHYMA, tissue composed of spindle-shaped cells.

ATROPOUS or ATROPAL, the same as *Orthotropous.*

AURICULATE, having appendages, applied to leaves, having lobes or leaflets at their base.

AWN and AWNED, see *Arista* and *Aristate.*

AXIL, the upper angle where the leaf joins the stem.

AXILE or AXIAL, belonging to the axis.

AXILLARY, arising from the axil of a leaf.

AXIS, is applied to the central portion of the young plant, whence the plumule and radicle are given off, and the name is given in general to the central organ bearing buds; in Grasses, the common stem of a locusta.

BACCA, berry, a unilocular fruit having a soft outer covering, and seeds immersed in pulp. All such fruits are called *Baccate.*

Balausta, the fruit of the Pomegranate.
Barbate, Bearded, having tufts of hair-like pubescence.
Bark (cortex), the outer cellular and fibrous covering of the stem; separable from the wood in Dicotyledons.
Barren, not fruitful, applied to male flowers, and to the non-fructifying fronds of ferns.
Basal or **Basilar**, attached to the base of an organ.
Basidium, a cell bearing on its exterior one or more spores in some Fungi, which are hence called *Basidiosporous*.
Bast or **Bass**, the inner fibrous bark of Dicotyledonous trees.
Bedeguar, a hairy excrescence on the branches and leaves of Roses, caused by an attack of a Cynips.
Bidentate, having two tooth-like processes.
Bifarious, in two rows, one on each side of an axis.
Bifid, two-cleft, cut down to near the middle into two parts.
Biforine, a raphidian cell with an opening at each end.
Bilamellar, having two lamellæ or flat divisions, as in some stigmas.
Bilocular, having two loculaments.
Binate, applied to a leaf composed of two leaflets at the extremity of a petiole.
Bipartite, cut down to near the base into two parts.
Bipinnate, a compound leaf divided twice in a pinnate manner.
Bipinnatifid, a simple leaf, with lateral divisions extending to near the middle, and which are also similarly divided.
Bipinnatipartite, differing from bipinnatifid in the divisions extending to near the midrib.
Biplicate, doubly folded in a transverse manner.
Biporose, having two rounded openings.
Bis, twice, in composition *Bi.*
Biserrate, or duplicate-serrate, when the serratures are themselves serrate.
Biternate, a compound leaf divided into three, and each division again divided into three.
Bitten, same as *Premorse.*
Blade, the lamina or broad part of a leaf, as distinguished from the petiole or stalk.
Blanching, see *Etiolation.*
Bletting, a peculiar change in an austere fruit, by which, after being pulled, it becomes soft and edible, as in the Medlar.
Bole, the trunk of a tree.
Bothrenchyma, dotted or pitted vessels, with depressions on the inside of their walls.
Brachiate, with decussate branches.
Bract, a leaf more or less changed in form, from which a flower or flowers proceed; flowers having bracts are called *Bracteated.*
Bracteole or **Bractlet**, a small bract at the base of a separate flower in a multifloral inflorescence.
Bryology, the study of Mosses; same as *Muscology.*
Bulb, an underground bud covered with scales.
Bulbil or **Bulblet**, separable buds in the axil of leaves, as in some Lilies.
Bulbous-based, applied to hairs which are tumid at the base.
Byssoid, very slender, like a cobweb.

Caducous, falling off very early, as calyx of Poppy.
Cæspitose, growing in tufts.
Calathiform, hemispherical or concave, like a bowl or cup.
Calathium, same as *Capitulum* and *Anthodium.*
Calcar, a spur, a projecting hollow or solid process from the base of an organ, as in the flowers of Larkspur and Snapdragon; such flowers are called *Calcarate* or spurred.
Calceolate, slipper-like, applied to the hollow petals of some Orchids, also to the petals of Calceolaria.
Callosity or **Callus**, a leathery or hardened thickening on a limited portion of an organ.
Calycifloræ, a sub-class of Polypetalous Exogens, having the stamens attached to the calyx.
Calyculus or **Caliculus**, an outer calycine row of leaflets, giving rise to a double or calyculate calyx.
Calyptra, the outer covering of the sporangium of Mosses.
Calyx, the outer envelope of the flower; when there is only one envelope, it is the calyx.
Cambium, mucilaginous cells, between the bark and the young wood, or surrounding the vessels.
Campanulate, shaped like a bell, as the flower of Hare-bell.
Campulitropal or **Campylotropal**, a curved ovule with the hilum, micropyle, and chalaza near each other.
Canaliculate, channelled, having a longitudinal groove or furrow.
Cancellate, latticed, composed of veins alone.
Capillary, filiform, thread-like or hair-like.
Capitate, pin-like, having a rounded summit, as some hairs.
Capitulum, head of flowers in Compositæ.
Capreolate, having tendrils.
Caprification, the ripening of the Fig, by means of the wild fig or Caprificus.
Capsula Circumscissa, same as *Pyxis* or *Pyxidium.*
Capsule, a dry seed-vessel, opening by valves, teeth, pores, or a lid.
Carina, keel, the two partially united lower petals of papilionaceous flowers.
Carinal, applied to æstivation when the carina embraces the other parts of the flower.
Carnose, fleshy, applied to albumen having a fleshy consistence.
Carpel or **Carpidium**, the leaf forming the pistil. Several carpels may enter into the composition of one pistil.
Carpology, the study of fruits.
Carpophore, a stalk bearing the pistil, and raising it above the whorl of the stamens, as in Lychnis and Capparis.
Carpos, fruit, in composition *Carpo.*
Caruncula, a fleshy or thickened appendage of the seed.
Caryopsis or **Cariopsis**, the monospermal seed-vessel of Grasses, the pericarp being incorporated with the seed.
Cassideous, shaped like a helmet.
Catkin, same as *Amentum.*
Caudate, having a tail or feathery appendage.

CAUDEX, the stem of Palms and of Tree-ferns.
CAUDICLE, CAUDICULA, the process supporting a pollen-mass in Orchids.
CAULESCENT, having an evident stem.
CAULICLE, CAULICULUS, a stalk connecting the axis of the embryo and the cotyledons.
CAULIS, an aerial stem.
CELLULOSE, the chemical substance of which the cell-wall is composed.
CENTIMETRE, a French measure, equal to 0.3937079 British inch.
CENTRIFUGAL, applied to that kind of inflorescence in which the central flower opens first.
CENTRIPETAL, applied to that kind of inflorescence in which the flowers at the circumference or base open first.
CERAMIDIUM, an ovate conceptacle having a terminal opening, and with a tuft of spores arising from the base; seen in Algæ.
CERATIUM, a siliquæform capsule in which the lobes of the stigma are alternate with the placenta, as in Glaucium.
CEREAL, applied to Wheat, Oats, Barley, and other grains.
CERNUOUS, pendulous, nodding.
CHALAZA, the place where the nourishing vessels enter the nucleus of the ovule.
CHLAMYS, covering, applied to the floral envelope, in composition *Chlamydeous.*
CHLOROPHYLL, the green colouring matter of leaves.
CHLOROS, green, in composition *Chloro.*
CHORISIS or CHORIZATION, separation of a lamina from one part of an organ so as to form a scale or a doubling of the organ; it may be either transverse or collateral.
CHROMA, colour, in composition *Chrom.*
CHROMOGEN and CHROMULE, the colouring matter of flowers.
CHRYSOS means yellow like gold, in composition *Chryso.*
CICATRICULA, the scar left after the falling of a leaf; also applied to the hilum or base of the seed.
CILIA (Cilium), short stiff hairs fringing the margin of a leaf; also delicate vibratile hairs of zoospores.
CINENCHYMA, laticiferous tissue, formed by anastomosing vessels.
CIRCINATE, rolled up like a crozier, as the young fronds of Ferns.
CIRCUMSCISSILE, cut round in a circular manner, such as seed-vessels opening by a lid.
CIRCUMSCRIPTION, the periphery or margin of a leaf.
CIRRHUS, a tendril, or modified leaf in the form of a twining process.
CLADENCHYMA, tissue composed of branching cells.
CLADOS, a branch, in composition *Clado.*
CLATHRATUS, latticed like a grating.
CLAVATE, club-shaped, becoming gradually thicker towards the top.
CLAW, the narrow base of some petals, corresponding to the petiole of leaves.
CLEFT, divided to about the middle.
CLINANDRIUM, the part of the column of Orchids bearing the anther
CLINANTHIUM, the common receptacle of the flowers of Compositæ.
CLINE, a bed, in composition *Clin,* used in reference to parts on which the floral organs are inserted.
CLOVES, applied to young bulbs, as in the Onion.
CLYPEATE, having the shape of a buckler.
COCCIDIUM, a rounded conceptacle in Algæ without pores, and containing a tuft of spores.
COCCUS and COCCUM, applied to the portions composing the dry elastic fruit of Euphorbiaceæ.
COCHLEAR, a kind of æstivation, in which a helmet-shaped part covers all the others in the bud.
COCHLEARIFORM, shaped like a spoon.
COLEORHIZA, a sheath covering the radicles of a monocotyledonous embryo.
COLLATERAL, placed side by side, as in the case of some ovules.
COLLENCHYMA, the inter-cellular substance which unites cells.
COLLUM, neck, the part where the plumule and radicle of the embryo unite.
COLPENCHYMA, tissue composed of wavy or sinuous cells.
COLUMELLA, central column in the sporangia of Mosses; also applied to the carpophore of Umbelliferæ.
COLUMN, a part in the flower of an Orchid supporting the anthers and stigma, and formed by the union of the styles and filaments.
COMA, applied variously, to tufts of hairs, to bracts occurring beyond the inflorescence, and to the general arrangement of the leaf-bearing branches of a tree, &c.
COMMISSURE, union of the faces of the two achenes in the fruit of Umbelliferæ.
COMOSE, furnished with hairs, as the seeds of the Willow.
COMPOUND, composed of several parts, as a leaf formed by several separate leaflets, or a pistil formed by several carpels either separate or combined.
COMPRESSED, flattened laterally or lengthwise
CONCEPTACLE, a hollow sac containing a tuft or cluster of spores.
CONDUCTING TISSUE, applied to the loose cellular tissue in the interior of the canal of the style.
CONDUPLICATE, folded upon itself, applied to leaves and cotyledons.
CONE, a dry multiple fruit, formed by bracts covering naked seeds.
CONENCHYMA, conical cells, as hairs.
CONFERVOID, formed of a single row of cells, or having articulations like a Conferva.
CONFLUENT, when parts unite together in the progress of growth.
CONJUGATION, union of two cells, so as to develope a spore.
CONNATE, when parts are united even in the early state of development; applied to two leaves united by their bases.
CONNECTIVE, the part which connects the anther lobes.
CONNIVENT, when two organs, as petals, arch over so as to meet above.

CONTORTED, when the parts in a bud are imbricated and regularly twisted in one direction
CONVOLUTE or CONVOLUTIVE, when a leaf in the bud is rolled upon itself.
CORALLINE, like Coral, as the root of Corallorhiza.
CORCULUM, a name for the embryo.
CORD, the process which attaches the seed to the placenta.
CORDATE, heart-shaped, a plane body with the division or broad part of the heart next the stalk or stem.
CORDIFORM, a solid body having the shape of a heart
CORIACEOUS, having a leathery consistence.
CORM, thickened underground stem, as in the Colchicum and Arum.
CORMOGENÆ, having a corm or stem.
CORNU, a horn; *Corneous*, having the consistence of horn; *Bicornis* or *Bicornute*, having two horns.
COROLLA, the inner envelope of the flower.
COROLLIFLORÆ, Gamopetalous Exogens, with hypogynous stamens.
CORONA, a corolline appendage, as the crown of the Daffodil.
CORRUGATED, wrinkled or shrivelled.
CORTEX, the bark; *Cortical*, belonging to the bark; *Corticated*, having a bark.
CORTINA, the remains of the veil which continue attached to the edges of the pileus in Agarics.
CORYMB, a raceme in which the lower stalks are longest, and all the flowers come nearly to a level above; *Corymbiferous* or *Corymbose*, bearing a corymb, or in the form of a corymb.
COSTA, a rib, applied to the prominent bundles of vessels in the leaves; *Costate*, provided with ribs.
COTYLEDON, the temporary leaf or lobe of the embryo.
CRAMPONS, a name given to adventitious roots which serve as fulcra or supports, as in the Ivy.
CREMOCARP, the fruit of Umbelliferæ, composed of two separable achenes or mericarps.
CRENATE, having superficial rounded marginal divisions
CRENATURES, divisions of the margin of a crenate leaf.
CREST, an appendage to fruits or seeds, having the form of a crest.
CRISP, having an undulated margin.
CROWN OF THE ROOT, the short stem which is at the upper part of the root of perennial herbs.
CRUCIFORM and CRUCIATE, arranged like the parts of a cross, as flowers of Cruciferæ.
CRUSTACEOUS, hard, thin, and brittle; applied to those Lichens which are hard and expanded like a crust.
CRYTOGAMOUS, organs of reproduction obscure.
CRYPTOS, inconspicuous or concealed, in composition *Crypto.*
CUCULLATE, formed like a hood.
CULM, stem or stalk of grasses.
CUNEIFORM or CUNEATE, shaped like a wedge standing upon its point.
CUPULA, the cup of the acorn, formed by aggregated bracts.
CURVEMBRYEÆ, with the embryo curved.
CUSPIS, a long point large at the base, and gradually attenuated; *Cuspidate*, prolonged into a cuspis, abruptly acuminate.
CUTICLE, the thin layer that covers the epidermis.
CYATHIFORM, like a wine-glass; concave, in the form of a reversed cone.
CYCLOGENS, applied to Dicotyledons with concentric woody circles.
CYCLOSIS, movement of the latex in laticiferous vessels.
CYLINDRENCHYMA, tissue composed of cylindrical cells
CYMBIFORM, shaped like a boat.
CYME, a kind of definite inflorescence, in which the flowers are in racemes, corymbs, or umbels, the successive central flowers expanding first; *Cymose*, inflorescence in the form of a cyme.
CYPSELA, monospermal fruit of Compositæ.
CYSTIDIA, sacs containing spores; a kind of fructification in Fungi.
CYTOBLAST, the nucleus of a cell.
CYTOBLASTEMA, mucilaginous formative matter of cells, called also *Protoplasm.*
CYTOGENESIS, cell-development.
CYTOS, a cell, in composition *Cyto.*

DÆDALENCHYMA, entangled cells.
DECA, ten, in Greek words, same as the Latin *Decem;* as *decandrous*, having ten stamens; *decagynous*, having ten styles.
DECIDUOUS, falling off after performing its functions for a limited time, as calyx of Ranunculus.
DECIDUOUS TREES, which lose their leaves annually.
DECIMETRE, the tenth part of a metre or ten centimetres.
DECLINATE or DECLINING, directed downwards from its base, applied to stamens of Amaryllis.
DECOMPOUND, a leaf cut into numerous compound divisions.
DECORTICATED, deprived of bark.
DECUMBENT, lying flat along the ground, and rising from it at the apex.
DECURRENT, leaves which are attached along the side of a stem below their point of insertion. Such stems are often called *Winged.*
DECUSSATE, opposite leaves crossing each other in pairs at right angles.
DEDUPLICATION, same as *Chorisis.*
DEFINITE, applied to inflorescence when it ends in a single flower, and the expansion of the flower is centrifugal; also when the number of the parts of an organ is limited, as when the stamens are under twenty.
DEFLEXED, bent downwards in a continuous curve.
DEFOLIATION, the fall of the leaves.
DEGENERATION, when an organ is changed from its usual appearance and becomes less highly developed, as when scales take the place of leaves.
DEHISCENCE, mode of opening of an organ, as of the seed-vessel and anther.
DELTOID, like the Greek Δ in form, properly applied solely to describe the transverse section of solids.
DENTATE, toothed, having short triangular divisions of the margin. The term is also applied

to the superficial divisions of a gamosepalous calyx and a gamopetalous corolla.
DENTICULATE, finely-toothed, having small tooth-like projections along the margin.
DEPRESSED, flattening of a solid organ from above downwards.
DETERMINATE, applied to definite or cymose inflorescence.
DEXTRORSE, directed towards the right.
DIACHÆNIUM, same as *Cremocarp*, fruit composed of two achenes.
DIACHYMA, the parenchyma of the leaf.
DIADELPHOUS, stamens in two bundles, united by their filaments.
DIALYCARPOUS, pistil or fruit composed of distinct (separate) carpels.
DIALYPETALOUS, corolla composed of separate petals.
DIALYSEPALOUS or DIALYPHYLLOUS, calyx composed of separate sepals.
DICHLAMYDEOUS, having calyx and corolla.
DICHOTOMOUS, stem dividing by twos.
DICLINOUS, unisexual flowers, either monœcious or diœcious.
DICOTYLEDONOUS, embryo having two cotyledons.
DICTYOGENOUS, applied to monocotyledons having netted veins.
DIDYMOUS, twice, union of two similar organs.
DIDYNAMOUS, two long and two short stamens.
DIGITATE, compound leaf composed of several leaflets attached to one point.
DIGYNOUS, having two styles.
DILAMINATION, same as *Deduplication* and *Chorisis.*
DIMEROUS, composed of two pieces.
DIMIDIATE, split into two on one side, as the calyptra of some Mosses.
DIMORPHOUS, when similar parts of a plant assume different forms.
DIŒCIOUS, staminiferous and pistilliferous flowers on separate plants.
DIPLECOLOBEÆ, cotyledons twice folded transversely.
DIPLOOS, double, in composition *Diplo.*
DIPLOPERISTOMI, Mosses with a double peristome.
DIPLOSTEMONOUS, stamens double the number of the petals or sepals.
DIPTEROUS, having two wings.
DIS, twice in composition, *Di*, same as Latin *Bis* or *Bi*; as *disepalous,* having two sepals, *dispermous,* two seeded.
DISCIFORM and DISCOID, in the form of a disc or flattened sphere; *discoid pith,* divided into cavities by discs.
DISCOID, also applied to the flosculous or tubular flowers of Compositæ.
DISCS, the peculiar rounded and dotted markings on coniferous wood.
DISK, a part intervening between the stamens and the pistil in the form of scales, a ring, etc.
DISPERMOUS, having two seeds.
DISSECTED, cut into a number of narrow divisions.
DISSEPIMENT, a division in the ovary; *true,* when formed by edges of the carpels; *false,* when formed otherwise.
DISSILIENT, applied to fruit which bursts in an elastic manner.
DISTICHOUS, in two rows, on opposite sides of a stem.
DISTRACTILE, separating two parts to a distance from each other.
DITHECAL, having two loculaments.
DIVARICATING, branches coming off from the stem at a very wide or obtuse angle.
DODECA, twelve; in Latin *Duodecim.*
DODECAGYNOUS, having twelve pistils.
DODECANDROUS, having twelve stamens.
DOLABRIFORM, shaped like an axe.
DORSAL, applied to the suture of the carpel which is farthest from the axis.
DORSIFEROUS, Ferns bearing fructification on the back of their fronds.
DORSUM, the back, the part of the carpel which is farthest from the axis.
DOUBLE FLOWER, when the organs of reproduction are converted into petals.
DRUPE, a fleshy fruit like the Cherry, having a stony endocarp. *Drupels,* small drupes aggregated to form a fruit, as in the Raspberry.
DUMOSE, having a low shrubby aspect.
DURAMEN, heart-wood of Dicotyledonous trees.
DYNAMIS, power, in composition means superiority in length; as *didynamous,* two stamens longer than two others.

E or Ex, in composition corresponds to *alpha,* privative; as *ebracteated,* without bracts; *exaristate,* without awns; *edentate,* without teeth; *ecostate,* without ribs.
ELATERS, spiral fibres in the spore-cases of Hepaticæ.
ELLIPTICAL, having the form of an ellipse.
EMARGINATE, with a superficial portion taken out of the end.
EMBRYO, the young plant contained in the seed.
EMBRYO-BUDS, nodules in the bark of the Beech and other trees.
EMBRYOGENY, the development of the embryo in the ovule.
EMBRYOLOGY, the study of the formation of the embryo.
EMBRYO-SAC or EMBRYONARY-SAC, the cellular bag in which the embryo is formed.
EMBRYOTEGA, a process raised from the spermoderm by the embryo of some seeds during germination, as in the Bean.
ENDECA, in Greek, eleven; in Latin, *undecim.*
ENDECAGYNOUS, having eleven pistils.
ENDECANDROUS, having eleven stamens.
ENDOCARP, the inner layer of the pericarp next the seed.
ENDOCHROME, the colouring matter of cellular plants.
ENDOGEN, an inside grower, having an endogenous stem.
ENDON, within or inwards, in Composition *Endo.*
ENDOPHLŒUM, the inner bark or liber.
ENDOPLEURA, the inner covering of the seed.
ENDORHIZAL, numerous rootlets, arising from a common radicle, and passing through sheaths, as in endogenous germination.
ENDOSMOSE, movement of fluids inwards, through a membrane.
ENDOSPERM, albumen formed within the embryo-sac.

ENDOSPOROUS, Fungi having their spores contained in a case.
ENDOSTOME, the inner foramen of the ovule.
ENDOTHECIUM, the inner coat of the anther.
ENERVIS, without veins.
ENNEA, nine; in Latin *Novem.*
ENNEAGYNOUS, having nine pistils.
ENNEANDROUS, having nine stamens.
ENSIFORM, in the form of a sword, as the leaves of Iris.
ENTIRE (*integer*), without marginal divisions; (*integerrimus*), without either lobes or marginal divisions.
ENVELOPES, FLORAL, the calyx and corolla.
EPI, upon, in composition, means on the outside or above, as *epicarp*, the outer covering of the fruit; *epigynous*, above the ovary.
EPICALYX, outer calyx, formed either of sepals or bracts, as in Mallow and Potentilla.
EPICARP, the outer covering of the fruit.
EPICHILIUM, the label or terminal portion of the strangulated or articulated lip (labellum) of Orchids.
EPICOROLLINE, inserted upon the corolla.
EPIDERMIS, the cellular layer covering the external surface of plants.
EPIGEAL, above ground, applied to cotyledons.
EPIGONE, the cellular layer which covers the young sporangium in Mosses and Hepaticæ.
EPIGYNOUS, above the ovary by adhesion to it.
EPIPETALOUS, inserted upon the petals.
EPIPHRAGM, the membrane closing the orifice of the thecæ of some Mosses.
EPIPHYLLOUS, growing upon a leaf.
EPIPHYTE, attached to another plant, and growing suspended in the air.
EPIRRHEOLOGY, the influence of external agents on living plants.
EPISPERM, the external covering of the seed.
EPISPORE, the outer covering of some spores.
EQUITANT, applied to leaves folded longitudinally, and overlapping each other without any involution.
ERECT, applied to an ovule which rises from the base of the ovary; also applied to innate anthers.
EROSE, irregularly toothed, as if gnawed.
ERUMPENT, prominent, as if bursting through the epidermis, as seen in some tetraspores.
ETÆRIO, the aggregate drupes forming the fruit of Rubus.
ETIOLATION, blanching, losing colour in the dark.
EXALBUMINOUS, without a separate store of albumen or perisperm.
EXANNULATE, without a ring, applied to some Ferns.
EXCENTRIC, removed from the centre or axis; applied to a lateral embryo.
EXCIPULUS, a receptacle containing fructification in Lichens.
EXCURRENT, running out beyond the edge or point.
EXINTINE, one of the inner coverings of the pollen-grain.
EXO, in composition, on the outside.
EXOGEN, outside grower, same as Dicotyledon.
EXORHIZAL, radicle proceeding directly from the axis, and afterwards branching, as in Exogens.
EXOSMOSE, the passing outwards of a fluid through a membrane.
EXOSPOROUS, Fungi having naked spores.
EXOSTOME, the outer opening of the foramen of the ovule.
EXOTHECIUM, the outer coat of the anther.
EXSERTED, extending beyond an organ, as stamens beyond the corolla.
EXSTIPULATE, without stipules.
EXTINE, the outer covering of the pollen-grain.
EXTRA-AXILLARY, removed from the axil of the leaf, as in the case of some buds.
EXTRORSE, applied to anthers which dehisce on the side farthest removed from the pistil.
EXUTIVE, applied by Miers to seeds wanting the usual integumentary covering, as in Olacaceæ.

FALCATE or FALCIFORM, bent like a sickle.
FARINACEOUS, mealy, containing much starch.
FASCIATION, union of branches of stems, so as to present a flattened riband-like form.
FASCICLE, a shortened umbellate cyme, as in some species of Dianthus.
FASTIGIATE, having a pyramidal form, from the branches being parallel and erect, as Lombardy Poplar.
FAVELLA, a kind of conceptacle in Algæ.
FAVELLIDIA, spherical masses of spores usually contained in sacs called capsules.
FEATHER-VEINED, a leaf having the veins passing from the midrib at a more or less acute angle, and extending to the margin.
FENESTRATE, applied to a replum or leaf with openings in it, compared to windows.
FERTILE, applied to pistillate flowers; and to the fruit-bearing frond of Ferns.
FIBRO-CELLULAR tissue, composed of spiral cells.
FIBROUS, composed of numerous fibres, as some roots.
FIBRO-VASCULAR tissue, composed of vessels containing spiral and other fibres.
FID, in composition, cleft, cut down to about the middle.
FILAMENT, stalk supporting the anther.
FILAMENTOUS, a string of cells placed end to end.
FILIFORM, like a thread.
FIMBRIATED, fringed at the margin.
FISSIPAROUS, dividing spontaneously into two parts, by means of a septum.
FISSURE, a straight slit in an organ for the discharge of its contents.
FISTULOUS, hollow, like the stem of Grasses.
FLABELLIFORM, fan-shaped, as the leaves of some Palms.
FLAGELLUM, a runner, a weak, creeping stem bearing rooting buds at different points, as in the Strawberry.
FLEXUOSE or FLEXUOUS, having alternate curvations in opposite directions; bent in a zig-zag manner.
FLOCCI, woolly filaments with sporules in Fungi and Algæ.
FLOCCOSE, covered with wool-like tufts.
FLORAL ENVELOPES, the calyx and corolla.
FLOSCULOUS, the tubular florets of Compositæ.
FOLIATION, the development of leaves.
FOLIOLA, same as *Phylla* and *Sepala.*
FOLLICLE, a fruit formed by a single carpel, de-

hiscing by one suture, which is usually the ventral.
FOOT, French, equal to 1.07892 foot British.
FORAMEN, the opening in the coverings of the ovule.
FOVEATE or FOVEOLATE, having pits or depressions called foveæ or foveolæ.
FOVILLA, minute granular matter in the pollen-grain.
FROND, the leaf-like organ of Ferns bearing the fructification; also applied to the thallus of many Cryptogamics.
FRONDOSE, applied to Cryptogams with foliaceous or leaf-like expansions.
FRUSTULES, the parts or fragments into which Diatomaceæ separate.
FRUTEX, a shrub; *Fruticose*, shrubby.
FUGACIOUS, evanescent, falling off early, as the petals of Cistus.
FULVOUS, tawny-yellow.
FUNICULUS, the umbilical cord connecting the hilum of the ovule to the placenta.
FURCATE, divided into two branches, like a two-pronged fork.
FURFURACEOUS, scurfy or scaly.
FUSIFORM, shaped like a spindle.

GALBULUS, the polygynœcial succulent fruit of Juniper.
GALEA, applied to a sepal or petal shaped like a helmet; the part is called *Galeate.*
GAMO, in composition, means union of parts.
GAMOPETALOUS, same as *Monopetalous*, petals united.
GAMOPHYLLOUS and GAMOSEPALOUS, same as *Monophyllous* and *Monosepalous*, sepals united.
GEMINATE, twin organs combined in pairs, same as *Binate.*
GEMMA, a leaf-bud; *Gemmation*, the development of leaf-buds.
GEMMIFEROUS, bearing buds.
GEMMIPAROUS, reproduction by buds.
GEMMULE, same as *Plumule*, the first bud of the embryo.
GENICULATE, bent like a knee.
GERMEN, a name for the ovary.
GERMINAL VESICLE, a cell contained in the embryo sac, from which the embryo is developed.
GERMINATION, the sprouting of the young plant.
GIBBOSITY, a swelling at the base of an organ, such as the calyx or corolla.
GIBBOUS, swollen at the base, or having a distinct swelling at some part of the surface.
GLABROUS, smooth, without hairs.
GLAND, an organ of secretion consisting of cells, and generally occurring on the epidermis of plants.
GLANDULAR HAIRS, hairs tipped with a gland, as in Drosera and Chinese Primrose.
GLANS, nut, applied to the Acorn and Hazel-nut, which are enclosed in bracts.
GLAUCOUS, covered with a pale-green bloom.
GLOBULE, male organ of Chara.
GLOCHIDIATE, barbed, applied to hairs with two reflexed points at their summit.
GLOMERULUS, a rounded, cymose inflorescence, as in Urtica.
GLOSSOLOGY, explanation of technical terms.
GLUMACEOUS, of the nature of glumes.
GLUME, a bract covering the organs of reproduction in the spikelets of Grasses, which are hence called *Glumiferous.*
GLUMELLE and GLUMELLULE, a name applied to the palea or pale of a Grass.
GONIDIA, green germinating cells in the thallus of Lichens.
GONUS or GONUM, in composition, means either kneed or angled; in the former case the *o* is short, in the latter long, *Polygonum*, many-kneed; *Tetragonum*, four-angled.
GRAIN, caryopsis, the fruit of Cereal Grasses.
GRAINS of pollen, minute cells composing the pollen.
GRANULES, minute bodies and varying greatly in size, having a distinct external shadowed ring or margin, the external edge of which is abrupt.
GRANULATED, composed of granules.
GRUMOUS, collected into granular masses.
GYMNOGEN, a plant with naked seeds, *i. e.*, seeds not in a true ovary.
GYMNOS, naked, in composition *Gymno.*
GYMNOSPERMOUS, plants with naked seeds, *i. e.*, seeds not in a true ovary, as Conifers.
GYMNOSPORE, a naked spore; *Gymnosporous*, having naked spores.
GYMNOSTOMI, naked-mouthed, Mosses without a peristome.
GYNANDROUS, stamen and pistil united in a common column, as in Orchids.
GYNE, female, and GYN, GYNOUS, and GYNO, in composition, refer to the pistil or the ovary.
GYNIZUS, the position of the stigma on the column of Orchids.
GYNOBASE, a central axis to the base of which the carpels are attached.
GYNŒCIUM, the female organs of the flower.
GYNOPHORE, a stalk supporting the ovary.
GYNOSTEMIUM, column in Orchids bearing the organs of reproduction.
GYRATE, same as *Circinate.*
GYRATION, same as *Rotation* in cells.

HABIT of a plant, its general external appearance.
HALOPHYTES, plants of salt-marshes, containing salts of soda in their composition.
HASTATE, halbert-shaped, applied to a leaf with two portions at the base projecting more or less completely at right angles to the blade.
HAULM, dead stems of herbs, as of the potato.
HAUSTORIUM, the sucker at the extremity of the parasitic root of Dodder.
HEART-WOOD, same as *Duramen.*
HELICOIDAL, having a coiled appearance like the shell of a snail, applied to inflorescence.
HELMET, the upper petaloid sepal of Aconitum.
HEMI, half; same as Latin *Semi.*
HEMICARP, one of the achenes forming the cremocarp of Umbelliferæ.
HEPTA, seven; same as Latin *Septem.*
HEPTAGYNOUS, having seven styles.
HEPTANDROUS, having seven stamens.
HERB, a plant with an annual stem, opposed to a woody plant.
HERBACEOUS, green succulent plants which die down to the ground in winter; annual shoots; green-coloured cellular parts.

HERMAPHRODITE, stamens and pistil in the same flower.
HESPERIDIUM, the fruit of the Orange, and other Aurantiaceæ.
HETEROCEPHALOUS, Composite plants having male and female capitula on the same plant.
HETEROCYSTS, peculiar cells forming large germs in Nostochineæ.
HETERODROMOUS, running in different directions.
HETEROGAMOUS, Composite plants having hermaphrodite and unisexual flowers on the same head.
HETEROPHYLLOUS, presenting two different forms of leaves.
HETERORHIZAL, rootlets proceeding from various points of a spore during germination.
HETEROS, dissimilar or diverse, in composition *Hetero.*
HETEROTROPAL, ovule with the hilum in the middle, and the foramen and chalaza at opposite ends.
HEXA, six; same as Latin *Sex.*
HEXAGYNOUS, having six styles.
HEXANDROUS, having six stamens.
HILUM, the base of the seed to which the placenta is attached either directly or by means of a cord. The term is also applied to the mark at one end of some grains of starch.
HIRSUTE, covered with long stiff hairs.
HISPID, covered with long very harsh hairs.
HISTOLOGY, the study of microscopic tissues.
HOLOSERICEOUS, covered with minute silky hairs, discovered better by the touch than by sight.
HOMODROMOUS, running in the same direction.
HOMOGAMOUS, Composite plants having the flowers of the capitula all hermaphrodite.
HOMOGENEOUS, having a uniform structure or substance.
HOMOS and HOMOIOS, similar, in composition *Homo.*
HOMOTROPAL, when the slightly curved embryo has the same general direction as the seed.
HOROLOGICAL, flowers opening and closing at certain hours.
HUMIFUSE, spreading along the ground.
HYALINE, transparent or colourless, applied by Barry to the part where the cell-nucleus appears.
HYBRID, a plant resulting from the fecundation of one species by another.
HYMENIUM, the part which bears the fructification in Agarics.
HYPANTHODIUM, the receptacle of Dorstenia, bearing many flowers.
HYPHASMA, a web-like thallus of Agarics.
HYPO, under or below, in composition *Hyp.*
HYPOCARPOGEAN, plants producing their fruit below ground.
HYPOCHILIUM, the lower part of the labellum of Orchids.
HYPOCRATERIFORM, shaped like a salver, as the corolla of Primula.
HYPOGEAL or HYPOGEOUS, under the surface of the soil, applied to cotyledons.
HYPOGYNOUS, inserted below the ovary or pistil.
HYPOTHALLUS, the mycelium of certain Entophytic Fungi as Uredines.
HYPSOMETRICAL, measurement of altitude.
HYSTERANTHOUS, when leaves expand after the flowers have opened.

ICOSANDRIA, having twenty stamens or more inserted on the calyx; *Icosandrous,* having twenty stamens.
ICOSI, twenty; in composition *Icos.* Same as Latin *Viginti.*
IMBRICATE or IMBRICATED, parts overlying each other like tiles on a house. *Imbricated æstivation,* the parts of the flower-bud alternately overlapping each other and arranged in a spiral manner.
IMPARI-PINNATE, unequally-pinnate, pinnate leaf ending in an odd leaflet.
INARCHING, a mode of grafting by bending two growing plants towards each other, and causing a branch of the one to unite to the other.
INARTICULATE, without joints or interruption to continuity.
INCH, French, is equal to 1.06578 inch British.
INCISED, cut down deeply.
INCLUDED, applied to the stamens when enclosed within the corolla, and not pushed out beyond its tube.
INCUMBENT, cotyledons with the radicle on their back.
INDEFINITE, applied to inflorescence with centripetal expansion; also to stamens above twenty, and to ovules and seeds when very numerous.
INDEHISCENT, not opening; having no regular line of suture.
INDETERMINATE, applied to indefinite inflorescence.
INDIGENOUS, an aboriginal native in a country.
INDUPLICATE or INDUPLICATIVE, edges of the sepals or petals turned slightly inwards in æstivation.
INDUSIUM, epidermal covering of the fructification in some Ferns.
INDUTIVE, applied by Miers to seeds having the usual integumentary covering.
INERMIS, unarmed, without prickles or thorns.
INFERIOR, applied to the ovary when it seems to be situated below the calyx; and to the part of a flower farthest from the axis.
INFLORESCENCE, the mode in which the flowers are arranged on the axis.
INFUNDIBULIFORM, in shape like a funnel; as seen in some gamopetalous corollas.
INNATE, applied to anthers when attached to the top of the filament.
INNOVATIONS, buds in Mosses.
INTERCELLULAR SPACE, same as *Lacuna.*
INTERFOLIAR, between two opposite leaves.
INTERNODE, the portion of the stem between two nodes or leaf-buds.
INTERPETIOLAR, between the petioles of opposite leaves; as the stipules of Cinchona.
INTERRUPTEDLY-PINNATE, a pinnate leaf in which pairs of small pinnæ occur between the larger pairs.
INTEXTINE, one of the inner coverings of the pollen-grain.
INTINE, the inner covering of the pollen-grain.
INTRORSE, applied to anthers which open on the side next the pistil.
INVOLUCEL, bracts surrounding the partial umbel of Umbelliferæ.

Involucre, bracts surrounding the general umbel in Umbelliferæ, the heads of flowers in Compositæ, and in general any verticillate bracts surrounding numerous flowers. It is also used in the same sense as the Indusium of Ferns.
Involute or Involutive, edges of leaves rolled inwards spirally on each side, in æstivation.
Irregular, a flower in which the parts of any of the verticils differ in size.
Isocheimal or Isocheimonal, lines passing through places which have the same mean winter temperature.
Isomeric, applied chemically to substances which, though differing in qualities, have the same elements in the same proportions.
Isomerous, when the organs of a flower are composed each of an equal number of parts.
Isos, equal, in composition *Iso.*
Isostemonous, when stamens and floral envelopes have the same number of parts or multiples.
Isotheral, lines passing through places which have the same mean summer temperature.
Isothermal, lines passing through places which have the same mean annual temperature.

Juga, a name given to the ribs on the fruit of Umbelliferæ.
Jugum, a pair of leaflets; *jugate*, applied to the pairs of leaflets in compound leaves; *unijugate*, one pair; *bijugate*, two pairs, and so on.

Keel, same as *Carina.*
Knotted, when a cylindrical stem is swollen at intervals into knobs.

Label, the terminal division of the lip of the flower in Orchids.
Labellum, lip, one of the divisions of the inner whorl of the flower of Orchids. This part is in reality superior, but becomes inferior by the twisting of the ovary.
Labiate, lipped, applied to irregular gamopetalous flowers, with an upper and under portion separated more or less by a hiatus or gap.
Laciniated, irregularly cut into narrow segments.
Lacinula, the small inflexed point of the petals of Umbelliferæ.
Lactescent, yielding milky juice.
Lacuna, a large space in the midst of a group of cells.
Lævigatus, having a smooth polished appearance.
Lævis, even.
Lamellæ, gills of an Agaric, also applied to flat divisions of the stigma.
Lamina, the blade of the leaf, the broad part of a petal or sepal.
Lanceolate, narrowly elliptical, tapering to each end.
Lanuginous, woolly, covered with long flexuous interlaced hairs.
Lateral, arising from the side of the axis, not terminal.
Latex, granular fluid contained in laticiferous vessels.
Laticiferous, vessels containing latex, which anastomose.
Latiseptæ, Cruciferous plants having a broad replum in their silicula.
Legume, a pod composed of one carpel, opening usually by ventral and dorsal suture, as in Pea.
Lenticel, a small process on the bark of the Willow and other plants, whence adventitious roots proceed.
Lenticular, in the form of a doubly-convex lens.
Lepidote, covered with scales or scurf; *Lepis*, a scale.
Lianas or Lianes, twining woody plants.
Liber, the fibrous inner bark or endophlœum.
Lieberkuhn, a metallic mirror attached to the objective of a microscope for the purpose of throwing down light on opaque objects.
Lignine, woody matter which thickens the cell-walls.
Ligulate, strap-shaped florets, as in Dandelion.
Ligule, a process arising from the petiole of grasses where it joins the blade.
Ligulifloræ, Composite plants having ligulate florets.
Limb, the blade of the leaf; the broad part of a petal or sepal; when sepals or petals are united, the combined broad parts are denominated collectively the limb.
Line, the 12th part of an inch; *Line*, French, is equal to 0.088815 inch British.
Linear, very narrow leaves, in which the length exceeds greatly the breadth.
Lirella, sessile linear apothecium of Lichens.
Lobe, large division of a leaf or any other organ; applied often to the divisions of the anther.
Loculicidal, fruit dehiscing through the back of the carpels.
Loculus or Loculament, a cavity in an ovary, which is called *unilocular* when it has one cavity, *bilocular* with two, and so on. The terms are also applied to the anther.
Locusta, a spikelet of grasses formed of one or several flowers.
Lodicule, a scale at the base of the ovary of Grasses.
Lomentum and Lomentaceous, applied to a legume or pod with transverse partitions, each division containing one seed.
Lunate, crescent-shaped.
Lyrate, a pinnatifid leaf with a large terminal lobe, and smaller ones as we approach the petiole.

Macropodous, applied to the thickened radicle of a monocotyledonous embryo.
Macros, large, in composition *Macro.*
Malpighiaceous Hairs, peltate hairs, such as are seen in Malpighiaceæ.
Manicate, applied to scales surrounding a stalk like a frill, and easily removed.
Marcescent, withering, but not falling off until the part bearing it is perfected.
Marginate, applied to calyx, same as *Obsolete.*
Masked, same as *Personate.*
Math, a term sometimes used for crop; an agricultural term.

MATTULLA, the fibrous matter covering the petioles of Palms.
MEDULLA, the cellular pith.
MEDULLARY RAYS or PLATES, cellular prolongations uniting the pith and the bark.
MEDULLARY SHEATH, sheath containing spiral vessels surrounding the pith in Exogens.
MEIOSTEMONOUS or MIOSTEMONOUS, the stamens less in number than the parts of the corolla.
MEMBRANACEOUS or MEMBRANOUS, having the consistence, aspect, and structure of a membrane.
MENISCUS, a lens having a concave and a convex face, with a sharp edge.
MERENCHYMA, tissue composed of rounded cells.
MERICARP, carpel forming one-half of the fruit of Umbelliferæ.
MERITHAL, a term used in place of internode; applied by Gaudichaud to the different parts of the leaf.
MESOCARP, middle covering of the fruit.
MESOCHILIUM, middle portion of the labellum of Orchids.
MESOPHLŒUM, middle layer of the bark.
MESOPHYLLUM, the parenchyma of the leaf.
MESOS, the middle, in composition *Meso.*
MESOSPERM, applied to a covering of the seed derived from the secundine.
METRE, equal to 39.37079 inches British.
MICROMETER, instrument for measuring microscopic objects.
MICROPYLE, the opening or foramen of the seed.
MICROS, small, in composition *Micro.*
MILLIMETRE, equal to 0.03937079 English inch, or 25.39954 millimetres equal to an English inch.
MITRIFORM, shaped like a mitre, as the calyptræ of some Mosses.
MOLECULE, an exceedingly minute body in which we cannot discover any determinate external circle nor internal centre.
MONADELPHOUS, stamens united into one bundle by union of their filaments.
MONANDROUS, having one stamen.
MONEMBRYONY, having a single embryo.
MONILIFORM, beaded, cells united, with interruptions, so as to resemble a string of beads.
MONOCARPIC, producing flowers and fruit once during life, and then dying.
MONOCHLAMYDEOUS, flower having a single envelope, which is the calyx.
MONOCLINOUS, stamens and pistils in the same flower.
MONOCOTYLEDONOUS, having one cotyledon in the embryo.
MONŒCIOUS, stamens and pistils in different flowers on the same plant.
MONOGYNŒCIAL, applied to simple fruits, formed by the pistil of one flower.
MONOGYNOUS, having one pistil or carpel; also applied to plants having one style.
MONOPETALOUS, same as *Gamopetalous.*
MONOPHYLLOUS, same as *Gamophyllous.*
MONOS, one, in composition *Mono* and *Mon*, as *Monandrous*, one stamen; sometimes applied to the union of parts into one, as *Monopetalous*, meaning combined petals; same as Latin *Unus.*
MONOSEPALOUS, same as *Gamosepalous.*
MONOSPERMOUS or MONOSPERMAL, having a single seed.
MONOTHECAL, having a single loculament.
MONSTROSITY, an abnormal development, applied more especially to double flowers.
MORPHOLOGY, the study of the forms which the different organs assume, and the laws that regulate their metamorphoses.
MUCRO, a stiff point abruptly terminating an organ; *Mucronate*, having a mucro.
MUCUS, definite, peculiar matter forming a covering of certain sea-weeds.
MULTICOSTATE, many-ribbed.
MULTIFID, applied to a simple leaf divided laterally to about the middle into numerous portions; when the divisions extend deeper it is *Multipartite.*
MULTILOCULAR, having many loculaments.
MULTIPLE, applied to anthocarpous or polygynœcial fruits formed by the union of several flowers.
MURICATE, covered with firm, short points or excrescences.
MURIFORM, like bricks in a wall; applied to cells.
MUSCOLOGY, the study of Mosses.
MUTICUS, without any pointed process or awn.
MYCELIUM, the cellular spawn of Fungi.

NAKED, applied to seeds not contained in a true ovary; also to flowers without any floral envelopes.
NAPIFORM, shaped like a turnip.
NATURALISED, originally introduced by artificial means, but become apparently wild.
NAVICULAR, hollowed like a boat.
NECTARIFEROUS, having a honey-like secretion; applied to petals having depressions or furrows at their base, which contain a sweet secretion.
NECTARY, any abnormal part of a flower. It ought to be restricted to organs secreting a honey-like matter, as in Crown Imperial.
NERVATION or NEURATION, same as *Venation.*
NETTED, applied to reticulated venation, also covered with raised lines disposed like the threads of a net.
NITIDUS, having a smooth and polished surface.
NODE, the part of the stem from which a leaf-bud proceeds.
NODOSE, having swollen nodes or articulations.
NODULOSE, applied to roots with thickened knots at intervals.
NOSOLOGY, vegetable, the study of the diseases of plants.
NOTORHIZEÆ, radicle on the back of the cotyledons, as in some Cruciferæ.
NUCLEUS, the body which gives origin to new cells; also applied to the central cellular portion of the ovule and seed.
NUCULANIUM, applied to the fruit of the Medlar having nucules; some also apply this term to the Grape.
NUCULE, hard carpel in the Medlar, also one of the parts of fructification in Characeæ.
NUCUMENTACEOUS, Cruciferæ having a dry monospermal fruit.
NUT, properly applied to the glans, but also applied to any hard nut-like fruit, as in Carex and Rumex.

OB, in composition, means reversed or contrariwise.
OBCOMPRESSED, flattened in front and behind, not laterally.
OBCORDATE, inversely heart-shaped, with the divisions of the heart at the opposite end from the stalk.
OBLONG, about $\frac{3}{4}$ as long as broad; elliptical, obtuse at each end.
OBOVATE, reversely ovate, the broad part of the egg being uppermost.
OBSOLETE, imperfectly developed or abortive; applied to the calyx when it is in the form of a rim.
OBTUSE, not pointed, with a rounded or blunt termination.
OBVOLUTE, margins of one leaf alternately overlapping those of the leaf opposite to it.
OCHREA, boot, applied to the sheathing stipule of Polygonaceæ.
OCTANDROUS, having eight stamens.
OCTO, eight, in composition *Oct.*
OCTOGYNOUS, having eight styles.
ŒCIUM and ŒCIOUS, in composition, have reference to the position of the reproductive organs, as *Andrœcium*, the staminal organs; *Diœcious*, stamen and pistil in different flowers.
OFFICINAL, sold in the shops.
OFFSET, same as *Propagulum.*
OLERACEOUS, used as an esculent potherb.
OLIGANDROUS, stamens under twenty.
OLIGOS, few or in small number, in composition *Oligo* and *Olig.*
OMPHALODE, the central point of the hilum where the nourishing vessels enter.
OOPHORIDIUM, organ in Lycopodiaceæ containing large spores.
OPAQUE, dull, not shining.
OPERCULUM, lid, applied to the separable part of the theca of Mosses; also applied to the lid of certain seed-vessels; *Operculate,* opening by a lid.
OPPOSITE, applied to leaves placed on opposite sides of a stem at the same level.
ORBICULAR, rounded leaf with petiole attached to the centre of it.
ORGANOGENY, the development of organs.
ORGANOGRAPHY, the description of the organs of plants.
ORTHOPLOCEÆ, Cruciferæ having conduplicate cotyledons.
ORTHOS, straight, in composition *Ortho,* same as Latin *Rectus.*
ORTHOTROPAL and ORTHOTROPOUS, ovule with foramen opposite to the hilum; embryo with radicle next the hilum.
OSMOSE, the force with which fluids pass through membranes in experiments on exosmose and endosmose.
OVAL, elliptical, blunt at each end.
OVARY, the part of the pistil which contains the ovules.
OVATE, shaped like an egg, applied to a leaf with the broader end of the egg next the petiole or axis; *Ovate-lanceolate,* a lanceolate leaf, which is somewhat ovate.
OVENCHYMA, tissue composed of oval cells.
OVULE, the young seed contained in the ovary.
PAGINA, applied to the surface of the leaf, or any flat surface.
PALÆONTOLOGY, the study of Fossils.
PALÆOPHYTOLOGY, the study of Fossil plants.
PALATE, the projecting portion of the under lip of personate flowers.
PALEA or PALE, the part of the flower of Grasses within the glume; also applied to the small scaly laminæ which occur in the receptacle of some Compositæ.
PALEACEOUS, chaffy, covered with small erect membranous scales.
PALMATE and PALMATIFID, applied to a leaf with radiating venation, divided into lobes to about the middle.
PALMATIPARTITE, applied to a leaf with radiating venation, cut nearly to the base in a palmate manner.
PANDURIFORM, shaped like a fiddle, applied to an oblong leaf, with a sinus on each side about the middle.
PANICLE, inflorescence of Grasses, consisting of spikelets on long peduncles coming off in a racemose manner.
PANICULATE, forming a panicle.
PAPILIONACEOUS, corolla composed of vexillum, two alæ, and carina, as in the Pea.
PAPILLATED and PAPILLOSE, covered with small nipple-like prominences.
PAPPUS, the hairs at the summit of the ovary in Compositæ. They consist of the altered calycine limb. *Pappose,* provided with pappus.
PARAPHYSES, filaments, sometimes articulated, occurring in the fructification of Mosses, and other Cryptogams; also applied by some authors to abortive petals or stamens.
PARASITE, attached to another plant, and deriving nourishment from it.
PARENCHYMA, cellular tissue.
PARIETAL, applied to placentas on the wall of the ovary.
PARI-PINNATE, a compound pinnate leaf, ending in two leaflets.
PARTHENOGENESIS, production of perfect seed with embryo, without the application of pollen.
PARTITE or PARTED, cut down to near the base, the divisions being called *Partitions.*
PATELLA, rounded sessile apothecium of Lichens.
PATENT, spreading widely.
PATHOLOGY, vegetable, same as *Nosology.*
PATULOUS, spreading less than when patent.
PECTINATE, divided laterally into narrow segments, like the teeth of a comb.
PEDATE and PEDATIFID, a palmate leaf of three lobes, the lateral lobes bearing other equally large lobes on the edges next the middle lobe.
PEDICEL, the stalk supporting a single flower; such a flower is *Pedicellate.*
PEDUNCLE, the general flower-stalk or floral axis. Sometimes it bears one flower, at other times it bears several sessile or pedicellate flowers.
PELAGIC, growing in many distant parts of the ocean.
PELLICLE, the outer cuticular covering of plants.
PELORIA, a name given to a teratological phenomenon, which consists in a flower, which is usually irregular, becoming regular; for instance, when Linaria, in place of one spur, produces five.

PELTATE, shield-like, fixed to the stalk by a point within the margin; *peltate hairs*, attached by their middle.
PENDULOUS, applied to ovules which are hung from the upper part of the ovary.
PENICILLATE, pencilled, applied to a tufted stigma resembling a camel's hair pencil, as in the Nettle.
PENNI-NERVED and PENNI-VEINED, the veins disposed like the parts of a feather, running from the midrib of the leaf to the margin.
PENTA, PENTE, five, same as *Quinque* in Latin.
PENTAGYNOUS, having five styles.
PENTAMEROUS, composed of five parts; a pentamerous flower has its different whorls in five, or multiples of that number.
PENTANDROUS, having five stamens.
PEPO and PEPONIDA, the fruit of the Melon, Cucumber, and other Cucurbitaceæ.
PER, when placed before an adjective, sometimes gives it the value of a superlative, as *perpusillus*, very weak; at other times it means through, as *perfoliate*, through the leaf.
PERCURRENT, running through from top to bottom.
PERENNIAL, living, or rather flowering, for several years.
PERFOLIATE, a leaf with the lobes at the base, united on the side of the stem opposite the blade, so that the stalk appears to pass through the leaf.
PERI, around; in Latin *Circa*.
PERIANTH, a general name for the floral envelope; applied in cases where there is only a calyx, or where the calyx and corolla are alike.
PERICARP, the covering of the fruit.
PERICHÆTIAL, applied to the leaves surrounding the fruit stalk or seta of Mosses.
PERICLADIUM, the large sheathing petiole of Umbelliferæ.
PERICLINIUM and PERIPHORANTHIUM, the involucre of Compositæ.
PERIDERM, a name applied to the outer layer of bark.
PERIDIUM, the envelope of the fructification in Gasteromycetous Fungi.
PERIGONE, same as Perianth. Some restrict the term to cases in which the flower is female or pistilliferous. It has also been applied to the involucre of Jungermannieæ.
PERIGYNIUM, applied to the covering of the pistil in the genus Carex.
PERIGYNOUS, applied to corolla and stamens when attached to the calyx.
PERIPHERICAL, applied to an embryo curved so as to surround the albumen, following the inner part of the covering of the seed.
PERISPERM, the albumen or nourishing matter stored up with the embryo in the seed.
PERISPORE, the outer covering of a spore.
PERISTOME, the opening of the sporangium of Mosses after the removal of the calyptra and operculum.
PERITHECIUM, a conceptacle in Cryptogams, containing spores, and having an opening at one end.
PERSISTENT, not falling off, remaining attached to the axis until the part which bears it is matured.
PERSONATE, a gamopetalous irregular corolla having the lower lip pushed upwards, so as to close the hiatus between the two lips.
PERTUSE, having slits or holes.
PERULÆ, the scales of the leaf bud.
PETALOID, like a petal.
PETALS, the leaves forming the corolline whorl.
PETIOLATE, having a stalk or petiole.
PETIOLE, a leaf-stalk; *Petiolule*, the stalk of a leaflet in a compound leaf.
PHANEROGAMOUS, having conspicuous flowers.
PHANEROS and PHÆNOS, conspicuous, in composition *Phanero* and *Phœno*.
PHÆNOGAMOUS, same as *Phanerogamous*.
PHLŒUM, a name applied in composition to the bark.
PHORANTHIUM, applied to the receptacle of Compositæ.
PHORUS, PHORUM, and PHORE, in words derived from the Greek, are used as terminations, meaning, that which bears; equivalent to the Latin *Ferus* and *Fer*.
PHRAGMA, transverse division or false dissepiment in fruits.
PHYCOLOGY, the study of Algæ or Sea-Weeds.
PHYLLARIES, the leaflets forming the involucre of Composite flowers.
PHYLLODIUM, leaf-stalk enlarged so as to have the appearance of a leaf.
PHYLLOID, like a leaf.
PHYLLOLOBEÆ, cotyledons green and leafy.
PHYLLOPTOSIS, the fall of the leaf.
PHYLLOTAXIS, the arrangement of the leaves on the axis.
PHYLLUM, leaf, in composition *Phyllo* and *Phyllous*; in Latin *Folium*.
PHYSIOGNOMY, general appearance, without reference to botanical characters.
PHYSIOLOGY, Vegetable, the study of the functions of plants.
PHYTOGENESIS, the development of the plant.
PHYTOGRAPHY, the description of plants.
PHYTOLOGY, the study of plants.
PHYTON, a name given by Gaudichaud to the simple individual plant, as represented by a leaf. In words derived from the Greek, *Phyton* and *Phyto* mean plant.
PHYTOZOA, moving filaments in the antheridia of Cryptogams.
PILEORHIZA, a covering of the root, as in Lemna.
PILEUS, the cap-like portion of the Mushroom, bearing the hymenium on its under side.
PILOSE, provided with hairs; applied to pappus composed of simple hairs.
PINENCHYMA, tissue composed of tabular cells.
PINNA, the leaflet of a pinnate leaf.
PINNATE, a compound leaf having leaflets arranged on each side of a central rib.
PINNATIFID, a simple leaf cut into lateral segments to about the middle.
PINNATIPARTITE, a simple leaf cut into lateral segments, the divisions extending nearly to the central rib.
PINNULE, the small pinnæ of a bipinnate or tripinnate leaf.
PISTIL, the female organ of the flower, composed of one or more carpels; each carpel being composed of ovary, style, and stigma.

PISTILLATE and PISTILLIFEROUS, applied to a female flower or a female plant.
PISTILLIDIUM, the female organ in Cryptogams.
PLACENTA, the cellular part of the carpel bearing the ovule.
PLACENTARY, a placenta bearing numerous ovules.
PLACENTATION, the formation and arrangement of the placenta.
PLATYS, large or broad; in composition *Platy;* in Latin *Latus* and *Late.*
PLEION, several, in composition *Pleio;* in Latin *Pluri.*
PLEIOTRACHEÆ, spiral vessels with several fibres united.
PLENUS, when applied to the flower, means double.
PLEURENCHYMA, woody tissue.
PLEUROCARPI, Mosses with the fructification proceeding laterally from the axils of the leaves.
PLEURORHIZEÆ, Cruciferous plants having the radicle of the embryo applied to the edges of the cotyledons, which are called *Accumbent.*
PLICATE and PLICATIVE, plaited or folded like a fan.
PLUMOSE, feathery, applied to hairs having two longitudinal rows of minute cellular processes.
PLUMULE, the first-bud of the embryo, usually enclosed by the cotyledons.
PLURI, in Latin words means several.
PLURILOCULAR, having many loculaments.
PODETIUM, a stalk bearing the fructification in some Lichens.
PODOCARP, a stalk supporting the fruit.
PODOGYNIUM, a stalk supporting an ovary.
PODOSPERM, the cord attaching the seed to the placenta.
POGON, beard; in Latin *Barba.*
POLLARD-TREES, cut down so as to leave only the lower part of the trunk, which gives off numerous buds and branches.
POLLEN, the powdery matter contained in the anther.
POLLEN-TUBE, the tube emitted by the pollen-grain after it is applied to the stigma.
POLLINIA, masses of pollen found in Orchids and Asclepiads.
POLYADELPHOUS, stamens united by their filaments so as to form more than two bundles.
POLYANDROUS, stamens above twenty.
POLYCARPIC, plants which flower and fruit many times in the course of their life.
POLYCOTYLEDONOUS, an embryo having many cotyledons, as in Firs.
POLYEMBRYONY, having more than one embryo.
POLYGAMOUS, plants bearing hermaphrodite as well as male and female flowers.
POLYGYNŒCIAL, applied to multiple fruits formed by the united pistils of many flowers.
POLYGYNOUS, having many pistils or styles.
POLYMORPHOUS, assuming many shapes.
POLYPETALOUS, a corolla composed of separate petals.
POLYPHYLLOUS, a calyx or involucre composed of separate leaflets.
POLYS, many, in composition *Poly;* in Latin *Multus.*
POLYSEPALOUS, a calyx composed of separate sepals.
POLYSPERMAL, containing many seeds.
POME, a fruit like the Apple and Pear.
PORES of the leaf, same as *Stomata.*
POROUS vessels, same as Pitted or Dotted vessels.
PORRECT, extended forwards.
POSTERIOR, applied to the part of the flower placed next the axis; same as *Superior.*
POSTICUS, same as *Extrorse;* applied to anthers.
POUCH, the short pod or silicle of some Cruciferæ.
POUS, PODOS, a foot or stalk, in composition *Podo;* in Latin *Pes, Pedis.*
PRÆFLORATION, same as *Æstivation.*
PRÆFOLIATION, same as *Vernation.*
PREMORSE, bitten, applied to a root terminating abruptly, as if bitten off.
PRICKLES, hardened epidermal appendages, of a nature similar to hairs.
PRIMINE, the outer coat of the ovule.
PRIMORDIAL, the first true leaves given off by the young plant; also the first fruit produced on a raceme or spike.
PRIMORDIAL UTRICLE, the lining membrane of cells in their early state.
PRISMENCHYMA, tissue composed of prismatical cells.
PROCESS, any prominence or projecting part, or small lobe.
PROCUMBENT, lying on the ground.
PRO-EMBRYO, cellular body in ovary, from which the embryo and its suspensor are formed. Sometimes *Pro-embryo* is used for *Prothallus.*
PROLIFEROUS, bearing abnormal buds.
PRONE, prostrate, lying flat on the earth.
PROPAGULUM, an off-shoot, or germinating bud attached by a thickish stalk to the parent plant.
PROSENCHYMA, fusiform tissue forming wood.
PROTHALLIUM or PROTHALLUS, names given to the first part produced by the spore of an acrogen in germinating.
PROTOPLASM, the matter which seems to be concerned in the early formation of nuclei and cells.
PRUINOSE, covered with a coarse granular secretion, as if dusted.
PSEUDO, false; in Latin, *Spurius.*
PSEUDO-BULB, the peculiar aerial stem of many epiphytic Orchids.
PSEUDO-SPERMOUS, applied to plants bearing single-seeded seed-vessels, such as Achenes, resembling seeds.
PTERIDOGRAPHIA, a treatise on Ferns.
PTEROCARPUS, winged fruit.
PUBESCENCE, short and soft hairs covering a surface, which is hence called *Pubescent.*
PULVERULENT, covered with fine powdery matter.
PULVINATE, shaped like a cushion or pillow.
PULVINUS, cellular swelling at the point where the leaf-stalk joins the axis.
PUNCTATED, applied to the peculiar dotted woody fibres of Coniferæ.
PUTAMEN, the hard endocarp of some fruits.
PYCNIDE, a papillæform or wart-like minute cellular reproductive body in the thallus of Lichens.
PYRENÆ, stony coverings of the seeds in the Medlar.

PYRIDIUM, same as *Pome.*
PYRIFORM, pear-shaped.
PYXIS and PYXIDIUM, a capsule opening by a lid.

QUADRI, in composition means four times.
QUADRIFARIOUS, in four rows.
QUADRIFID, four-cleft, cut down into four parts to about the middle.
QUADRIJUGATE, having four pairs of leaflets.
QUADRILOCULAR, having four loculaments.
QUADRIPARTITE, divided deeply into four parts.
QUARTINE, the fourth coat of the ovule, which often is changed into albumen.
QUATERNATE, leaves coming off in fours from one point.
QUINARY, composed of five parts, or of a multiple of five.
QUINATE, five leaves coming off from one point.
QUINCUNX, when the leaves in the bud are five, of which two are exterior, two interior, and the fifth covers the interior with one margin, and has its other margin covered by the exterior. *Quincuncial,* arranged in a quincunx.
QUINQUE, in compound words means five.
QUINQUEFID, five-cleft, cut into five parts as far as the middle.
QUINQUELOCULAR, having five loculaments.
QUINQUEPARTITE, divided deeply into five parts.
QUINTINE, the fifth coat of the ovule, otherwise called the embryo-sac.

RACE, a permanent variety.
RACEME, cluster, inflorescence in which there is a primary axis bearing stalked flowers.
RACEMOSE, flowering in racemes.
RACHIS, the axis of inflorescence; also applied to the stalk of the frond in Ferns, and to the common stalk bearing the alternate spikelets in some Grasses.
RADIANT, applied to flowers which form a ray-like appearance, as seen in Umbelliferæ and in Viburnum, &c.
RADIATE, disposed like the spokes of a wheel; also applied to the florets of the ray or circumference of the capitula of Compositæ.
RADICAL, belonging to the root, applied to leaves close to the ground, clustered at the base of a flower stalk.
RADICLE, the young root of the embryo.
RADIUS, the ray or outer part of the heads of Composite flowers.
RAMAL, belonging to the branches.
RAMENTA, the scales or chaff of Ferns.
RAMOSE and RAMOUS, branched.
RAPHE, the line which connects the hilum and the chalaza in anatropal ovules.
RAPHIDES, crystals found in cells, which are hence called *Raphidian.*
RECEPTACLE, the flattened end of the peduncle or rachis, bearing numerous flowers in a head; applied also generally to the extremity of the peduncle or pedicel.
RECLINATE, curved downwards from the horizontal, bent back up.
RECTEMBRYEÆ, the embryo straight in the axis of the seed.
RECTINERVIS and RECTIVENIUS, straight and parallel-veined.
RECTISERIAL, leaves disposed in a rectilinear series.
RECURVED, bent backwards.
REDUPLICATE, edges of the sepals or petals turned outwards in æstivation.
REGMA, seed-vessel composed of elastic cocci, as in Euphorbia.
REGULAR, applied to an organ, the parts of which are of similar form and size.
RELIQUIÆ, remains of withered leaves attached to the plant.
RENIFORM, in shape like a kidney.
REPAND, having a slightly undulated or sinuous margin.
REPLUM, a longitudinal division in a pod formed by the placenta, as in Cruciferæ.
RESUPINATE, inverted by a twisting of the stalk.
RETICULATED, netted, applied to leaves having a network of anastomosing veins.
RETIFORM, like network.
RETINACULUM, the glandular viscid portion at the extremity of the caudicle in some pollinia.
RETINERVIS and RETIVENIUS, having reticulated veins.
RETRORSE, turned backwards.
RETUSE, when the extremity is broad, blunt, and slightly depressed.
REVOLUTE and REVOLUTIVE, leaf with its edges rolled backwards in vernation.
RHIZA, in words derived from the Greek, means root.
RHIZOME, a stem creeping horizontally, more or less covered by the soil, giving off buds above, and roots below.
RHIZOTAXIS, the arrangement of the roots.
RHOMBOID, quadrangular form, not square, with equal sides.
RICTUS, the throat or chink in personate flowers.
RINGENT, a Labiate flower, in which the upper lip is much arched.
ROSACEOUS, applied to corollas having separate sessile petals like the Rose.
ROSETTE, leaves disposed in close circles forming a cluster.
ROSTELLUM, a prolongation of the upper edge of the stigma in some Orchids.
ROSTRATE, beaked, having a long sharp point.
ROTATE, a regular gamopetalous corolla with a short tube, the limb spreading out more or less at right angles.
ROTATION or GYRATION, a peculiar circulation of the cell sap, seen in Hydrocharidaceæ, &c.
ROOT-STOCK, same as *Rhizome.*
RUDIMENTARY, an organ in an abortive state arrested in its development.
RUGOSE, wrinkled.
RUMINATE, applied to mottled albumen.
RUNCINATE, a pinnatifid leaf with a triangular termination, and sharp divisions pointing downwards, as in Dandelion.

SACCATE, forming a sack or bag, seen in some petals.
SAGITTATE, like an arrow, a leaf having two prolonged sharp-pointed lobes projecting downwards beyond the insertion of the petiole.
SAMARA, a winged dry fruit, as in the Elm.
SARCOCARP and SARCODERM, the mesocarp of the fruit having become succulent.

Sarcolobeæ, cotyledons thick and fleshy, as in Bean and Pea.
Sarmentum, sometimes meaning the same as *Flagellum*, or runner, at other times applied to a twining stem which supports itself by means of others.
Scabrous, rough, covered with very stiff short hairs; *Scabriusculus*, somewhat rough.
Scalariform, vessels having bars like a ladder, seen in Ferns.
Scandent, climbing by means of supports, as on a wall or rock.
Scape, a naked flower-stalk, bearing one or more flowers arising from a short axis, and usually with radical leaves at its base.
Scarious, having the consistence of a dry scale, membranous, dry, and shrivelled.
Scion, the young twig used as a graft.
Sclerogen, the thickening matter of woody cells.
Scobiform, in the form of filings, or like fine sawdust.
Scobina, the flexuose rachis of some Grasses.
Scorpioidal, like the tail of a scorpion, a peculiar twisted cymose inflorescence, as in Boraginaceæ.
Scrobiculate, pitted, having small depressions.
Scutellum, a sort of apothecium in Lichens.
Secund, turned to one side.
Secundine, the second coat of the ovule within the primine.
Segregate, separated from each other.
Semi, half, same as the Greek *Hemi*.
Semiflosculous, same as *Ligulate*.
Seminal, applied to the cotyledons, or seed-leaves.
Sepal, one of the leaflets forming the calyx.
Septate, divided by septa or partitions.
Septem, seven, in Greek *Hepta*.
Septenate, organs approaching in sevens; a compound leaf with seven leaflets coming off from one point.
Septicidal, dehiscence of a seed-vessel through the septa or edges of the carpels.
Septifragal, dehiscence of a seed-vessel through the back of the loculaments, the valves also separating from the septa.
Septulate, having spurious transverse dissepiments.
Septum, a division in an ovary formed by the sides of the carpels.
Sericeous, silky, covered with fine, close-pressed hairs.
Serrate or Serrated, having sharp processes arranged like the teeth of a saw. *Biserrate*, when these are alternately large and small, or where the teeth are themselves serrated.
Serratures, pointed marginal divisions arranged like the teeth of a saw.
Serrulate, with very fine serratures.
Sesqui, in composition, means one and a half.
Sessile, without a stalk, as a leaf without a petiole.
Seta, a bristle or sharp hair; also applied to the gland-tipped hairs of Rosaceæ and Hieracia; and to the stalk bearing the theca in Mosses.
Setaceous and Setiform, in the form of bristles.
Setigerous, bearing setæ.
Setose, covered with setæ.
Sex, in Latin six, same as Greek *Hexa*.
Silicula or Silicle, a short pod with a double placenta and replum, as in some Cruciferæ.
Siliculosæ, bearing a silicle.
Siliqua, a long pod similar in structure to the silicula.
Siliquæform, fruit like a siliqua in form.
Siliquosæ, bearing a siliqua.
Simple, not branching, not divided into separate parts; *Simple fruits* are those formed by one flower.
Sinistrorse, directed towards the left.
Sinuated, the margin having numerous large obtuse indentations.
Sinuous, with a wavy or flexuous margin.
Slashed, divided by deep and very acute incisions.
Soboles, a creeping under-ground stem.
Social Plants, such as grow naturally in groups or masses.
Soredia, powdery cells on the surface of the thallus of some Lichens.
Sorosis, a compound or polygynœcial succulent fruit, such as Breadfruit and Mulberry.
Sorus, a cluster of sporangia in Ferns; applied also to fructification in Alaria, containing pyriform stipitate spores.
Spadix, a succulent spike bearing male and female flowers, as in Arum.
Spathaceous, having the aspect and membranous consistence of a spathe.
Spathe, large membranous bract covering numerous flowers.
Spathellæ, another name for the glumellæ of Grasses.
Spathulate, shaped like a spathula, applied to a leaf having a linear form, enlarging suddenly into a rounded extremity.
Spawn, same as *Mycelium*.
Specific Character, the essential character of a species.
Spermatia, motionless spermatozoids in the spermogones of Lichens and Fungi.
Spermatozoids, moving filaments contained in the antheridia of Cryptogams; called also phytozoa and antherozoids.
Spermoderm, the general covering of the seed. Sometimes applied to the episperm or outer covering.
Spermogone, a microscopic conceptacle in Lichens, containing reproductive bodies called Spermatia; also a conceptacle containing fructification in Fungi.
Sphærenchyma, tissue composed of spherical cells.
Spike, inflorescence consisting of numerous flowers sessile on an axis.
Spikelet, small cluster of flowers in Grasses.
Spine or Thorn, an abortive branch with a hard sharp point.
Spinescent or Spinose, bearing spines.
Spiral Vessels or Spiroidea, having a spiral fibre coiled up inside a tube.
Spirillum, same as *Spermatozoid*.
Spirolobeæ, Cruciferæ having the cotyledons folded transversely, the radicle being dorsal.
Spongiole or Spongelet, the cellular extremity of a young root.
Sporangium, a case containing spores.

SPORE, a cellular germinating body in Cryptogamic plants.
SPORIDIUM, a cellular germinating body in Cryptogamics containing two or more cells in its interior.
SPOROCARP, the involucre or ovoid-sac containing the organs of reproduction in Marsileaceæ.
SPOROPHORE, a stalk supporting a spore.
SPOROZOID, a moving spore furnished with cilia or vibratile processes.
SPUR, same as *Calcar*.
SQUAMA, a scale; also applied to bracts on the receptacle of Compositæ, to bracts in the inflorescence of Amentiferæ, and to the lodiculæ of Grasses.
SQUAMOSE, covered with scales.
SQUARROSE, covered with processes spreading at right angles or in a greater degree.
STACHYS and STACHYA, in Greek words signify a spike.
STAMEN, the male organ of the flower, formed by a stalk or filament and the anther containing pollen.
STAMINATE and STAMINIFEROUS, applied to a male flower, or to plants bearing male flowers.
STAMINODIUM, an abortive stamen.
STANDARD, same as *Vexillum*.
STELLATE or STELLIFORM, arranged like a star.
STERIGMATA, cells bearing naked spores; also cellular filaments bearing spermatia and stylospores, in the Spermogones and Pycnides of Lichens.
STERILE, male flowers not bearing fruit.
STICHIDIA, pod-like receptacles containing spores.
STICHOUS, at the termination of words means a row, as *distichous*, in two rows.
STIGMA, the upper cellular secreting portion of the pistil, uncovered with epidermis; *Stigmatic*, belonging to the stigma.
STIMULUS, a sting, applied to stinging hairs with an irritating secretion at the base.
STIPE, the stem of Palms and of Tree-ferns; also applied to the stalk of Fern-fronds, and to the stalk bearing the pileus in Agarics.
STIPEL, a small leaflet at the base of the pinnæ or pinnules of compound leaves.
STIPITATE, supported on a stalk.
STIPULARY, applied to organs occupying the place of stipules, such as tendrils.
STIPULATE, furnished with stipules.
STIPULE, leaflet at the base of other leaves, having a lateral position, and more or less changed either in form or texture.
STOLON, a sucker, at first aerial, and then turning downwards and rooting.
STOLONIFEROUS, having creeping runners which root at the joints.
STOOL, a plant from which layers are propagated, by bending down the branches so as to root in the soil.
STOMATES and STOMATA, openings in the epidermis of plants, especially in the leaves.
STRANGULATED, contracted and expanded irregularly.
STRAP-SHAPED, same as *Ligulate;* linear, or about six times as long as broad.
STRIA, a narrow line or mark.
STRIATED, marked by streaks or striæ.
STRIGOSE, covered with rough, strong, adpressed hairs.
STROBILUS, a cone, applied to the fruit of Firs as well as to that of the Hop.
STROPHIOLE, a sort of aril or swelling on the surface of a seed.
STRUMA, a cellular swelling at the point where a leaflet joins the midrib; also a swelling below the sporangium of Mosses.
STUPOSE, having a tuft of hairs.
STYLE, the stalk interposed between the ovary and the stigma.
STYLOPOD, an epigynous disk seen at the base of the styles of Umbelliferæ.
STYLOSPORE, a spore-like body borne on a sterigma or cellular stalk, in the Pycnides of Lichens.
SUBEROUS, having a corky texture.
SUBICULUM, same as *Hypothallus*.
SUBTERRANEAN, under ground, same as *Hypogeal*.
SUBULATE, shaped like a cobbler's awl.
SUCCISUS, abrupt, as it were cut off, same as *Premorse*.
SUFFRUTICOSE, having the characters of an undershrub.
SULCATE, furrowed or grooved.
SUPERIOR, applied to the ovary when free or not adherent to the calyx; to the calyx when it is adherent to the ovary; to the part of a flower placed next the axis.
SUPERVOLUTE or SUPERVOLUTIVE, a leaf rolled upon itself in vernation.
SURCULUS, a sucker, a shoot thrown off underground, and only rooting at its base.
SUSPENDED, applied to an ovule which hangs from a point a little below the apex of the ovary.
SUSPENSOR, the cord which suspends the embryo, and is attached to the radicle in the young state.
SUTURAL, applied to that kind of dehiscence which takes place at the sutures of the fruit.
SUTURE, the part where separate organs unite, or where the edges of a folded organ adhere; the *ventral suture* of the ovary is that next the centre of the flower; the *dorsal suture* corresponds to the midrib.
SYCONUS, a multiple or polygynœcial succulent hollow fruit, as in the Fig.
SYMMETRY, applied to the flower, has reference to the parts being of the same number, or multiples of each other.
SYN, in composition means united.
SYNANTHEROUS, anthers united.
SYNANTHOS, flowers united together.
SYNCARPOUS, carpels united so as to form one ovary or pistil.
SYNGENESIOUS, same as *Synantherous*.
SYNOCHREATE, stipules uniting together on the opposite side of the axis from the leaf.

TAPHRENCHYMA, pitted vessels, same as *Bothrenchyma*.
TAP-ROOT, root descending deeply in a tapering undivided manner.
TAXONOMY, principles of the classification of plants.
TEGMEN, the second covering of the seed, called also *Endopleura*.
TEGMENTA, scales protecting buds.

Teratology, study of monstrosities and morphological changes.
Tercine, the third coat of the ovule, forming the covering of the central nucleus.
Terete, nearly cylindrical, somewhat tapering into a very elongated cone, the transverse section nearly circular.
Ternary, parts arranged in threes.
Ternate, compound leaves composed of three leaflets.
Testa, the outer covering of the seed; some apply it to the coverings taken collectively.
Testiculate, root having two oblong tubercules.
Tetra, in Greek words four; in Latin *Quater* or *Quadri.*
Tetradynamous, four long stamens and two short, as in Cruciferæ.
Tetragonous or Tetragonal, having four angles, the faces being convex.
Tetragynous, having four carpels or four styles.
Tetramerous, composed of four parts; a flower is tetramerous when its envelopes are in fours, or multiples of that number.
Tetrandrous, having four stamens.
Tetrapterous, having four wings.
Tetraquetrous, having four angles, the faces being concave.
Tetraspore, a germinating body in Algæ composed of four spore-like cells; but also applied to those of three cells.
Tetrathecal, having four loculaments.
Thalamifloral, parts of the floral envelope inserted separately into the receptacle of thalamus.
Thalamus, the receptacle of the flower, or the part of the peduncle into which the floral organs are inserted.
Thallogens or Thallophytes, plants producing a thallus.
Thallus, cellular expansion in Lichens and other Cryptogams, bearing the fructification.
Theca, sporangium or spore-case containing spores.
Thecaphore, a stalk supporting the ovary.
Thecasporous, applied to Fungi which have the spores in thecæ.
Throat, the orifice of a gamopetalous flower.
Thyrsus, a sort of panicle, in form like a bunch of grapes, the inflorescence being mixed.
Tigellus, the young embryonic axis.
Toise, is equal to 1.94904 metres or 6.39459 English feet.
Tomentose, covered with cottony, entangled pubescence called *tomentum.*
Torulose, presenting successive rounded swellings, as in the moniliform pods of some Cruciferæ.
Torus, another name for thalamus; sometimes applied to a much developed thalamus, as in Nelumbium.
Tracheæ, a name for spiral vessels.
Trachenchyma, tissue composed of spiral vessels.
Transpiration, the exhalation of fluids by leaves, &c.
Treis, three; Tris, thrice, in composition *Tri.*
Triadelphous, stamens united in three bundles by their filaments.
Triandrous, having three stamens.
Triangular, having three angles, the faces being flat.
Trichotomous, divided successively into three branches.
Tricoccous, formed by three elastic monospermal carpels.
Tricostate, three-ribbed, ribs from the base.
Tricuspidate, having three long points or cuspides.
Tridentate, having three teeth.
Trifarious, in three rows, looking in three directions.
Trifid, three-cleft, a leaf divided into three segments which reach to the middle.
Trifoliate or Trifoliolate, same as *Ternate.* When the three leaves come off at one point the leaf is *ternately-trifoliolate;* when there is a terminal stalked leaflet and two lateral ones, it is *pinnately-trifoliolate.*
Trigonous, having three angles, the faces being convex.
Trigynous, having three carpels or three styles.
Trijugate, having three pairs of leaflets.
Trilocular, having three loculaments.
Trimerous, composed of three parts; *a trimerous flower* has its envelopes in three or multiples of three.
Trinervis, having three ribs springing together from the base.
Triœcious, a species producing hermaphrodite, staminate, and pistillate flowers on three separate individuals.
Tripartite, deeply divided into three.
Tripinnate, a compound leaf three times divided in a pinnate manner.
Tripinnatifid, a pinnatifid leaf with the segments twice divided in a pinnatifid manner.
Triplicostate, three ribs proceeding from above the base of the leaf.
Triquetrous, having three angles, the faces being concave.
Tristichous, in three rows.
Triternate, three times divided in a ternate manner.
Trophosperm, a name for the placenta.
Truncate, terminating abruptly, as if cut off at the end.
Tryma, drupaceous fruit like the Walnut.
Tuber, a thickened underground stem as the potato.
Tubercule, the swollen root of some terrestrial Orchids.
Tuberous, applied to roots in the form of tubercules.
Tubular, applied to the regular florets of the Compositæ.
Tubular-bell-shaped, applied to a campanulate corolla, which is somewhat tubular in its form.
Tunicated, applied to a bulb covered by thin external scales, as the Onion.
Turbinate, in the form of a top.
Turio, a young shoot covered with scales sent up from an underground stem, as in Asparagus.
Type, the perfect representation or idea of anything.
Typical, applied to a specimen which has eminently the characteristics of the species, or to a species or genus characteristic of an order.

UMBEL, inflorescence in which numerous stalked flowers arise from one point.
UMBELLULE, a small umbel, seen in the compound umbellate flowers of many Umbelliferæ.
UMBILICATE, fixed to a stalk by a point in the centre.
UMBILICUS, the hilum or base of a seed.
UMBO, a conical protuberance on a surface.
UMBONATE, round, with a projecting point in the centre, like the boss of an ancient shield.
UMBRACULIFEROUS, in the form of an expanded umbrella.
UNCINATE, provided with an *uncus* or hooked process.
UNDECIM, eleven, in Greek *Endeca.*
UNGUIS, claw, the narrowed part of a petal; such a petal is called *Unguiculate.*
UNI, in composition one, same as Greek *Mono.*
UNICELLULAR, composed of a single cell, as some Algæ.
UNILATERAL, arranged on one side, or turned to one side.
UNILOCULAR, having a single *loculus* or cavity.
UNISEXUAL, of a single sex, applied to plants having separate male and female flowers.
URCEOLATE, urn-shaped, applied to a gamopetalous globular corolla, with a narrow opening.
USTULATE, blackened.
UTRICLE, a name for a thin-walled cell, or for a bladder-like covering.
UTRICULUS, applied to a kind of fruit like the achene, but with an inflated covering; also to the persistent confluent perigone of Carex; in Algæ applied to a loose cellular envelope containing spores.

VAGINA, sheath, lower sheathing portion of some leaves.
VALLECULA, an interval between the ribs on the fruit of Umbelliferæ.
VALVATE, opening by valves, like the parts of certain seed-vessels, which separate at the edges of the carpels.
VALVATE ÆSTIVATION and VERNATION, when leaves in the flower-bud and leaf-bud are applied to each other by their margins only.
VALVES, the portions which separate in some dehiscent capsules. A name also given to the parts of the flower of grasses.
VASCULAR TISSUE, composed of spiral vessels and their modifications.
VASIFORM TISSUE, same as *Dotted vessels.*
VEINS, bundles of vessels in leaves.
VELUM, veil, the cellular covering of the gills of an Agaric, in its early state.
VELUTINOUS, having a velvety appearance.
VENATION, the arrangement of the veins.
VENTRAL, applied to the part of the carpel which is next the axis.
VENTRICOSE, swelling unequally on one side.
VERMICULAR, shaped like a worm.
VERNATION, the arrangement of the leaves in the bud.
VERRUCOSE, covered with wart-like excrescences.
VERSATILE, applied to an anther which is attached by one point of its back to the filament, and hence is very easily turned about.
VERTICIL, a whorl, parts arranged opposite to each other at the same level, or, in other words, in a circle round an axis. The parts are said to be *Verticillate.*
VERTICILLASTER, a false whorl, formed of two nearly sessile cymes placed in the axils of opposite leaves, as in Dead-nettle.
VESICLE, another name for a cell or utricle.
VESSELS, tubes with closed extremities.
VEXILLARY, applied to æstivation when the vexillum is folded over the other parts of the flower.
VEXILLUM, standard, the upper or posterior petal of a papilionaceous flower.
VIGINTI, twenty; same as Greek *Icosi.*
VILLOUS, covered with long soft hairs, and having a woolly appearance.
VIRGATE, long and straight like a wand.
VISCOUS, clammy, like bird-lime.
VITELLUS, the embryo-sac when persistent in the seed.
VITTÆ, cells or clavate tubes containing oil in the pericarp of Umbelliferæ.
VIVIPAROUS, plants producing leaf-buds in place of fruit.
VOLUBILE, twining, a stem or tendril twining round other plants.
VOLVA, wrapper, the organ which encloses the parts of fructification in some Fungi in their young state.

WHORLED, same as *Verticillate.*
WINGS, the two lateral petals of a papilionaceous flower, or the broad flat edge of any organ.

XANTHOPHYLL, yellow colouring matter in plants.
XANTHOS, yellow, in composition *Xantho.*
XYLOCARPOUS, fruit which becomes hard and woody.

ZOOSPORE, a moving spore provided with cilia; called also *Zoosperm* and *Sporozoid.*
ZOOTHECA, a cell containing a spermatozoid.

ABBREVIATIONS AND SYMBOLS.

THE names of Authors are abridged in Botanical works by giving the first letter or syllable, &c.—Thus, L. stands for Linnæus; DC. for De Candolle; Br. for Brown; Lam. and Lmk. for Lamarck; Hook. for Hooker; Hook. fil. for Hooker junior; Lindl. for Lindley; Arn. for Arnott; H. and B. for Humboldt and Bonpland; H. B. and K. for Humboldt, Bonpland, and Kunth; W. and A. for Wight and Arnott; Benth. for Bentham; Berk. for Berkeley; Bab. for Babington, &c.

The symbol ∞ or 00 means an indefinite number; in the case of stamens, it means above 20.

⊙ means Monocarpic, flowering and fruiting once during life; duration uncertain.

○ ① or A. means a Monocarpic annual plant; flowering and fruiting within the year and then dying.

♂ ⊙⊙ ⊙ ② or B. means a biennial plant; flowering and fruiting in the second year.

♃ △ or P. means a perennial plant; Rhizocarpic.

♄ means a woody plant. ♄ means an undershrub.

♄ ♄ or Sh. means a Shrub; ♄ means a Tree under 25 feet; T. or ♄ a Tree above 25 feet.

⌣ means a Climber;) turning to the left; (turning to the right.

O = Cotyledons accumbent, radicle lateral; Pleurorhizeæ.

O ‖ Cotyledons incumbent, radicle dorsal; Notorhizeæ.

O≫ Cotyledons conduplicate, radicle dorsal; Orthoploceæ.

O ‖ ‖ Cotyledons plicate or folded, radicle dorsal; Spirolobeæ.

O ‖ ‖ ‖ Cotyledons biplicate or twice folded, radicle dorsal; Diplecolobeæ.

☿ Hermaphrodite flower, having both stamens and pistil.

♂ Male, staminiferous, staminate, or sterile flower.

♀ Female, pistilliferous, pistillate, or fertile flower.

♂ ♀ Unisexual species, having separate male and female flowers.

♂ — ♀ Monœcious species, having male and female flowers on the same plant.

♂ : ♀ Diœcious species, having male and female flowers on different plants.

☿ ♂ ♀ Polygamous species, having hermaphrodite and unisexual flowers on the same or different plants.

! Indicates certainty as to a genus or species described by the author quoted.

? Indicates doubt as to the genus or species.

O Indicates absence of a part.

v. v. sp. or *v. v.* Vidi vivam spontaneam, indicates that the author has seen a living native specimen of the plant described by him.

v. v. c. Vidi vivam cultam, indicates that he has seen a living cultivated specimen.

v. s. sp. or *v. s.* Vidi siccam spontaneam, indicates that he has seen a dried native specimen.

v. s. c. Vidi siccam cultam, indicates that he has seen a dried cultivated specimen.

v. in *h.* Seen in Herbarium.