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THE

MICROGRAPHIC DICTIONARY:

A GUIDE TO THE EXAMINATION AND INVESTIGATION

OF THE

STRUCTURE AND NATURE

OF

MICROSCOPIC OBJECTS.

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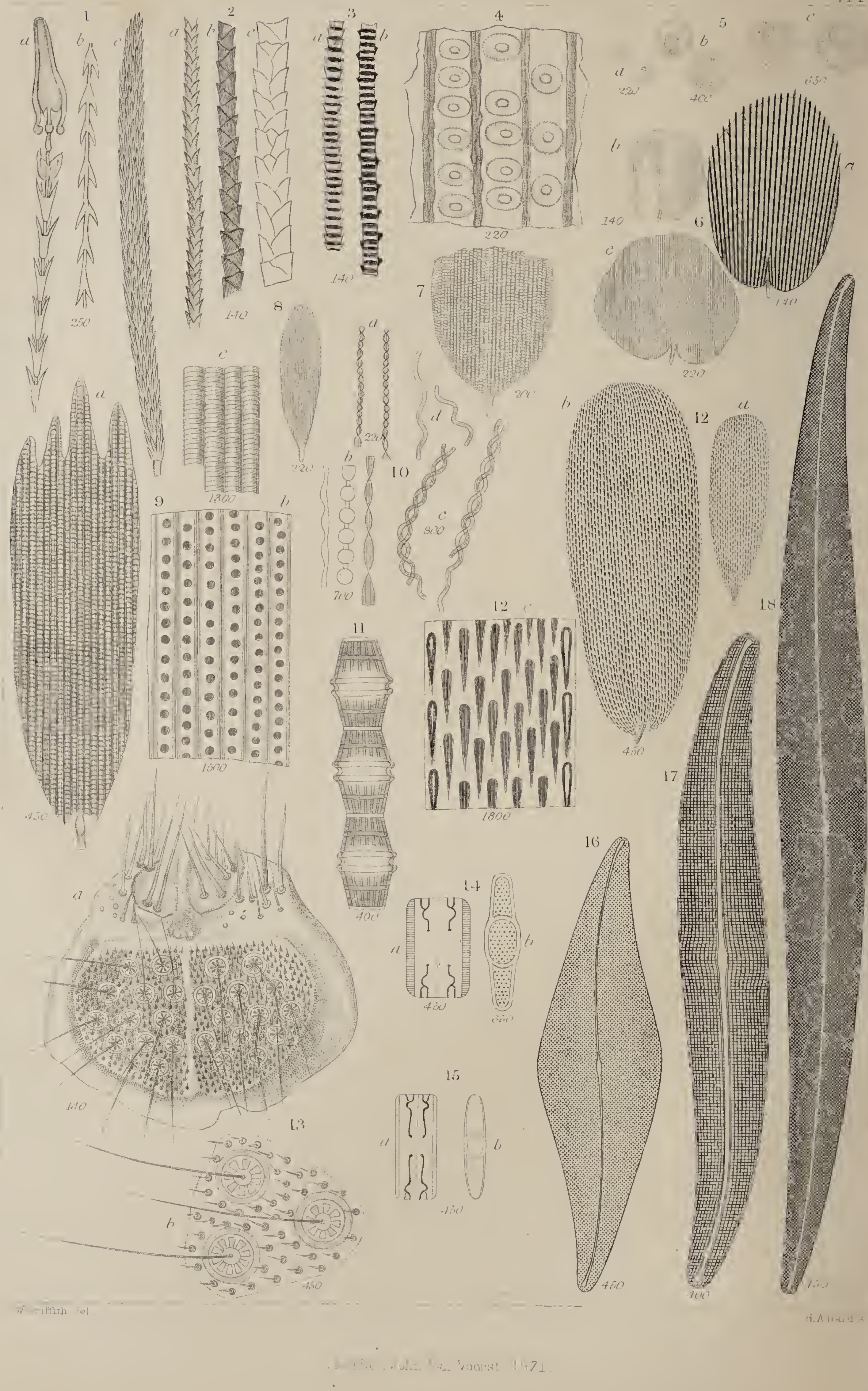
TEST OBJECTS.

Pl. I.



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INTRODUCTION.

I.—USE OF THE MICROSCOPE AND EXAMINATION OF MICROSCOPIC OBJECTS.

Before entering upon the special consideration of the Microscope, of which the Introduction treats, it may be well to make a few remarks upon the general use of the instrument in the examination of minute objects.

The Microscope will either be used as a means of affording amusement, or with a view to scientific research. In the former light, no philosophical instrument can compete with it, in regard to the great variety, the beauty, and the wonderful phenomena of structure which the minute objects it enables us to examine display, even independently of the consideration of the functions and uses of their several parts. In this light also, the investigation of the comparative structures and properties of various bodies or substances used in daily life as articles of food, dress, &c. will form subjects of intense interest to any one who may be possessed of the instrument. The mysterious phenomena of growth, reproduction, and crystallization may also be watched throughout their progress, just as we can see the effects of parts of machinery with the naked eye. But while the sense of sight is thus gratified, the mind will not be unoccupied; for every fresh appearance will impress a new fact; so that here we have both amusement and instruction combined.

It is, however, to the use of the Microscope as a means of scientific research that our remarks are most necessary; for here great care and consideration are required, and these are very apt to be neglected by those who are unaccustomed to employ this valuable instrument.

The Microscope as a means of investigation might perhaps be thus defined: the microscope is an optical instrument constructed in order to enable us to investigate the characters and properties of those objects which we are unable to study with the unassisted eye, on account of their minute size.

The use of the microscope will resolve itself into either that of proving the structure of a known object, or determining that of a new one; and in thus applying it, exactly the same precautions must be adopted, and just the same course pursued, as if the object under examination were distinctly visible to the unaided eye. The above formal definition of the true use of this valuable instrument is requisite, because it is very frequently used simply as a means of *viewing* minute objects, and judging of their nature from the simple inspection of them under the conditions in which they naturally or accidentally occur. Such a procedure, the most casual observer must be well aware, is never trusted alone in the examination of objects visible to the naked eye, being almost sure to lead to erroneous conclusions. Consider the common course pursued in the examination with the unaided sight, of a body for the first time presented to our notice! The first point is the examination of its general appearance and colour; the relative position of the eye of the observer and the object is then changed, so that an idea of its solidity may be obtained; its weight is next perhaps determined by taking it in the hand; it is presented to the light in various ways, in order to judge of its transparency, and of the optical properties of its surface. If the object be at a distance, its size is judged of by comparing its apparent size with that of adjacent bodies, whose dimensions are approximately known; and its luminousness is also taken into consideration, it being known generally that the nearer bodies of the same size are to us, the more luminous they appear. The observer then is either satisfied with the conclusions drawn from reasoning upon the results thus obtained, or he makes besides a chemical examination.

Again, care should be taken to avoid forming an opinion upon the normal or abnormal state of an organic structure, without a previous knowledge of the natural structure of organic tissues. We therefore recommend the student, before he thinks of recording his observations, to begin by testing the structure of any objects which may come in his way, or that of the TEST-OBJECTS which we have described, according to the rules laid down in the second part of this Introduction.

It may be remarked for those who have but small means at their command, and who are unable to procure a first-rate English microscope, that perhaps very many of the facts elicited by the use of this instrument have been determined by our continental neighbours with far less perfect instruments, who have made up for the imperfections of their instruments by extreme patience, care, and repeated observation; which can be done to an extent that would scarcely have been anticipated.

We have alluded to these sources of error merely for the purpose of warning future observers, and impressing upon them the importance of making themselves acquainted with the difficulties attendant upon microscopic investigations, and with the best means of overcoming them. In fact, it may be briefly stated that the object of the present work is to guide the microscopist in his researches, to give him a notion of the manner of making these researches, also some account of the characters, microscopic structure, and properties of objects in general, and to show how he may most easily arrive at satisfactory results.

But there are difficulties inherently connected with the examination of microscopic objects, which are not encountered when objects are examined with the naked eye. One of these is that, with the ordinary microscope, objects are only viewed with one eye; hence we lose the direct power of distinguishing solidity, &c., and are compelled to resort to indirect means for these purposes. This difficulty is to some extent overcome by the construction of binocular microscopes. Again, the ordinary objects around us are also usually viewed by reflected light, whilst with the microscope they are mostly viewed by transmitted light, and we are consequently much less practised in judging from the appearances of objects thus illuminated, and are therefore liable to err.

Another, but a less important difficulty in microscopic investigations, or at least manipulations, consists in the image of the objects being inverted. Erecting eyepieces, as they are called, will obviate this difficulty; but as they are expensive, and interfere with the distinctness of the images of the objects, and as the difficulty is to a great extent got over by practice, they are rarely used.

Another very serious source of error lies in the tendency to reason from analogy as to the structure or nature of a body viewed under the microscope. Any one who pursues this course has his mind prejudiced by preconceived notions, and becomes in fact no observer at all.

It need, moreover, be merely remarked that the ordinary appearance of objects to the naked eye depends in all cases upon a molecular structure, which is generally microscopic, the ordinary appearance being the optical result or expression of this structure; and since totally dissimilar microscopic structures may present similar appearances to the unaided eye, judgment as to the nature of the former founded upon the latter can be of but little value. The reader will remember that the common capability of distinguishing objects or structures by their appearance has been derived, so to speak, from practice and experience of effects; and when we bear in mind that the experience and practice in the study of the causes are attainable, the superiority of the latter must be evident.

Next to the improvement effected in the optical construction of the microscope during the last few years, must be placed that of the method of investigation. Formerly almost all microscopic bodies possessing different forms and appearances were considered distinct beings, and were named accordingly. By the present method, prolonged observation is adopted to follow the changes which the individual bodies undergo; whence it has resulted that numbers of them have been found to be simply different stages of each other. Thus a large amount of useless nomenclature and confusion is being removed from the domain of the microscopic world.

Above all, however, it must never be forgotten that microscopic investigations require more time and patience than perhaps any others, even in regard to the determination of simple points of structure and qualitative composition. In fact, notwithstanding the innumerable observations made upon the more minute objects, such as the scales of insects, the markings on the valves of the Diatomaceæ, the fibrillæ of muscular fibre, &c., such differences of opinion are still entertained that it can by no means be asserted that the structure of these bodies is positively known.

The time has passed at which the value of microscopic research could be called in question. The wonderful insight gained by its use into the structure and functions of the various organic beings belonging to the Animal and Vegetable Kingdoms, the aid it has afforded Geology, the so-called practical applications it has permitted in improving the arts, in detecting adulterations, and in defeating crime—moreover, the almost positive certainty we have obtained that it is capable of displaying all the real structure which bodies possess, save that of their ultimate molecularity, which will probably always be hidden from us—are sufficient to deprive this question of any interest.

Lastly, if it were required to prove design in the Creation, this could not be more easily effected than by the examination of the structure of the more minute organisms.

We have expressed our intention of not entering upon a description of the microscope as an optical instrument, and this because it would have been requisite to tread widely the field of general optics, which our space does not permit. We would therefore advise those who wish to become acquainted with the microscope as an optical instrument, first to study the general laws of optics, which may be done through the medium of any of the works or treatises on Natural Philosophy, as:—the article 'Optics' by Herschel in the Encycl. Metropolitana; Brewster's 'Optics;' Lloyd's 'Manual;' the 'Natural Philosophy' of the Society for the Diffusion of Useful Knowledge; Lardner's 'Natural Philosophy,' or Mrs. Somerville's 'Connexion of the Physical Sciences.' Perhaps the second work is the best for the general reader; it is a standard work, but greatly behindhand in regard to the use of the microscope. They may then proceed to the application of these laws to the various optical parts of the microscope. This may be found to some extent in:—the older work of Quekett on the Microscope, in which the various kinds of microscopes and accessory apparatus are figured, and their action described, with lists of objects of interesting appearance, &c.; Lardner's, Carpenter's, or Brewster's Treatises on the Microscope; the art. 'Microscope' in the Penny Cyclopædia, by Ross. The 'Observateur' &c. of Dujardin is an admirable work, in many respects the best ever written, although now old; the 'Micrographia' of von Mohl is greatly esteemed in Germany. But Harting's is the most complete work yet published.

We must not, however, omit a notice of the principles which should guide in the selection of a microscope and the accessory apparatus, because a large number of microscopes are at the present day sold, frequently at no mean cost, which, although well calculated to afford amusement, are utterly valueless for the purpose of scientific investigation. To those to whom money is no consideration, we may recommend with safety, as the best which can possibly be procured, such as are manufactured by Ross, Smith and Beck, or Powell, of London. These makers have a thorough knowledge of the instrument, and a reputation at stake; hence there is little occasion to test their instruments. But it may happen that a person may not wish to expend so much money as the purchase of these instruments requires, may wish to procure a foreign instrument (and these are cheaper), or may meet with one second-hand. A word or two may then be of service in guiding them in their choice; for a microscope may look very well and very handsome, yet be worth but little. It must, however, be borne in mind that there is much room for opinion in these matters; for according to what any one has been accustomed to, or according to prejudice arising from what he may have heard a supposed authority say, so will an instrument or a piece of apparatus be regarded as requisite or of importance, or not. Our statements rest upon our own experience in the long-continued use of the instrument, and as such they must be taken.

We may mention that, of the cheapest microscopes, the best are the "Prize Microscopes" of the Society of Arts. These are manufactured by Messrs. Field, of New Street, Birmingham, and sold by Mr. Wright, 36 Great Russell-street, London.

First, it may be remarked that the microscope is usually regarded as composed of the object-glass or glasses, and the stand, body, stage, eyepieces, &c.; and the object-glasses are generally sold separately, for by means of an "adapter" they can be applied to any microscope.

In regard then to the stand, body, &c.: the *stand* should be firm, and so heavy and its feet so arranged that the instrument cannot be easily overturned.

The *body*, both when the microscope has one body only, or is binocular, should be about 8 or 10 inches in length; in many of the foreign and cheap English instruments the body is short, and the eyepieces are adapted accordingly; but this adaptation is decidedly objectionable.

Whether the microscope shall be binocular or not must be a matter of opinion. In the binocular microscopes there are two bodies and two eyepieces, the rays of light just above the object-glass being divided by a refracting prism into two portions, one of which passes through each tube; in this way the stereoscopic view of objects is obtained. The binocular arrangement is an additional expense; it can be added to any microscope; but any binocular microscope can be used as a single-bodied instrument (See Binocular).

The microscope should be so constructed that the body can be inclined at any angle desired, so that the observer may examine objects while sitting. Many persons, however, prefer to use the microscope with the body placed perpendicularly; and when chemical reagents are to be applied this position is essential; but when long-continued examination of an object is required, it becomes very painful and fatiguing to keep the head in the position which the perpendicular position of the body requires. Moreover, as in a microscope with the joint or arrangement by which the body can be inclined the body can always be placed perpendicularly, the joint is decidedly advantageous. Again, it is almost essential when the camera lucida is used. A brass pin or some similar contrivance should be placed near the joint so as to check the motion of the body of the microscope when it reaches the horizontal position; no microscope should be without this.

In most microscopes a tube sliding within the body and carrying the eyepiece forms a "draw-tube." By drawing this out the magnifying power becomes enlarged without changing the eyepiece; it is very useful with the erector or erecting-glass (p. xx).

The microscope should have a coarse *rack-and-pinion* movement or *quick motion* for adjusting the focus of the lower powers or object-glasses; and when used with an object-glass of about half an inch focus, the image of the object examined whilst coming in and going out of focus, must not appear to move from one side to the other of the field when the body is raised or depressed by the coarse movement. Also when the milled head of the coarse movement is rotated, the motion should feel smooth, not irregular, uneven, or jerking. In some foreign microscopes, the effect of the coarse rack-and-pinion movement is replaced by the sliding of one tube within the other, the body consisting of two tubes working after the manner of those of a telescope. This arrangement is very objectionable, although used by some very good observers, who probably have more tact than most people, and who do not use such high powers as they ought; for when the highest powers are used it is perfectly intolerable. The objection is somewhat overcome in some microscopes by the existence of a fine movement; but we regard the rack-and-pinion coarse adjustment as essential.

A *fine movement* or *slow motion* is indispensable; for with the higher powers (one-eighth and upwards) it is impossible to adjust the focus without it. When the finger or fingers are applied to this in its use, no apparent motion of the object must take place; should this occur, the movement is worthless, unless, at all events, it is very slight, and this when tested with the high powers.

When the milled head of the fine movement is turned backward and forward, as in use, the motion should be perfectly even, and should be produced very easily, with slight pressure only of the finger or fingers; moreover no difference should be distinguishable between the two directions in which it is turned, but it should move with equal ease in both.

The *field* or luminous disk on which the objects viewed through the microscope are apparently delineated, should have its marginal line clear and black. If this line appear coloured, the eyepiece is not as it should be.

The *stage* should not be too small (say less than 3 inches in diameter). To the best instruments a moveable stage is adapted; but whether this is essential or not is considered a matter of opinion. Undoubtedly with low powers the moveable stage may be dispensed with, and is not often used; but with the higher powers its absence is felt greatly, and we should say that it is essentially necessary. In most of the English microscopes, whether provided with a moveable stage or not, there is a "sliding piece" for producing the backward and forward motion of an object, the lateral motion being effected by direct application of the fingers. If the body of the microscope is to be used in the inclined position, the sliding piece or a moveable stage becomes essential.

If the moveable stage be present, the "milled heads" should be pretty large, so as to be readily grasped, and a flat object should remain in focus whilst traversing the field by the movement of the stage. The stage should also be very thin.

The *mirror* should have one plane or flat face, and another concave. It should not be too small, and its centre should coincide with the axis of the body of the microscope. A double arm enables the mirror to be brought more considerably to either side, so as to throw more oblique light upon an object.

So long as the above conditions are fulfilled, the general form and arrangement of the stand and its parts are of little consequence. It must also be remembered that the complication and accuracy of the apparatus required will vary according to the kind of investigations pursued; thus the structure of the various tissues of animals, and that of most plants, can be satisfactorily studied with apparatus which is totally insufficient to display the structure of certain of the more minute and difficult objects. But, on the other hand, it follows that if a peculiar structure can be shown to exist in any kind of objects by a complicated apparatus, which cannot be demonstrated by a more simple or less perfect apparatus, the study of the structure of any object not previously examined must always be attended with uncertainty so long as it has not been tested by the more perfect kind of apparatus,—provided the microscopist has not acquired the art of replacing the imperfection of his apparatus by superior tact and management, which can be done to a great extent.

Object-glasses.—The goodness of the object-glasses depends mainly upon their freedom from chromatic and spherical aberration, and upon the magnitude of their angular aperture. The freedom from the former renders them good in defining power, *i.e.* in exhibiting clearly the margins of objects, whilst large angular aperture renders them capable of penetration, or of rendering markings upon the surface of objects visible or distinct. At least this is the ordinary statement made in regard to the relations of defining and penetrating power; but it is only partially true, and there are two kinds of penetrating power, as we shall show in the article "TEST-OBJECTS," where we have entered more fully upon this subject.

As in the case of the stand &c. of microscopes, so in regard to the object-glasses; the best are made in this country, and can be obtained of first-rate quality of the three makers above-mentioned. But the palm in regard to the highest powers must be given to Powell and Lealand, who alone construct a $\frac{1}{50}$ of an inch object-glass, and a $\frac{1}{16}$ with an angle of aperture of 175°. At the same time, the modern German immersion-lenses, as they are called (OBJECT-GLASSES), resolve perfectly most of the difficult valves of the Diatomaceæ; and they are cheaper than the English glasses. Some of the American object-glasses also, which are but little known in this country, must stand in the first rank in regard to excellence in defining, and especially penetrating power. When a glass of unknown value, however, presents itself, it should be tried upon the test-objects.

The defining power may be tested by the examination of the objects figured in Plate 1. figs. 1 to 4.

The outlines or margins of these objects must appear black, well defined, and perfectly free from colour, not misty and red or green; they should retain this appearance when the higher eyepieces are used, of course some allowance being made in regard to this sharpness of outline, which will appear slightly broader and less defined, but nowise interfering with the distinctness of the image of the object. The various parts of an object lying in the same plane, as a transverse section of whalebone, should also be visible at the same focus; the lines upon a micrometer used as a slide will also serve to test this point. It is not, however, of very great importance, especially with high powers; but it is a character of a superior object-glass.

If the definition of the glass be good, the field flat, and the power adequately high, it will also exhibit the structure of the objects in Plate 1. figs. 5, 6, 10, 12, and 13 clearly and distinctly; it is then of sufficiently good quality for nearly all the purposes required in the investigation of animal and vegetable structures. Some German and French glasses will do this tolerably well (although many of those sold are worthless); but they are not usually provided, especially the latter, with a correcting adjustment to compensate for the effects of the varying thicknesses of the layer of liquid and the glass cover through which objects are generally seen, so that the best working of these glasses can only be obtained by accident. Still many of them are quite fit for all ordinary investigations, so long as these are carried on in a proper manner.

The exhibition of the objects illustrated by Plate 1. figs. 6, 7, 8, 9, 10, 11, 12, and 13, requires the first kind of penetrating power, but it does not require large angular aperture. The second kind of penetration, however, requires, above all, large angular aperture, independently of any other superiority; *i. e.* a glass may be perfectly corrected as to defining power, and exhibit the above objects well, yet when the valve of a *Gyrosigma* is subjected to it the markings cannot be distinguished without particular appliances, which produce the same effect as an increase of angular aperture in the object-glass. As this property is therefore principally dependent upon the angular aperture, this should be determined by direct measurement; the method of doing which is described under the article "ANGULAR APERTURE," in which also is contained a list of the various apertures of the best glasses, so that the approximation in the case of any glass to these magnitudes will afford an indication of its quality. It must be observed that increase of angular aperture in an object-glass involves an increase in price.

The following remarks may perhaps assist in guiding the judgment in regard to the selection of an object-glass:—

1. Large angular aperture is of less importance in the case of a low than of a high power.

2. Large angular aperture is neither requisite nor advantageous in physiological and medical investigations in general.

3. Whether a glass of larger aperture will exhibit any further structure than one of less aperture has already done, can nearly always be predicted from other means.

4. Object-glasses of high power and large angular aperture require to be brought very close to the objects viewed, which is a great disadvantage, rendering them useless for general investigations.

5. In regard to objects requiring large angular aperture for exhibiting their structure, much depends upon the management of the light; so that a glass may fail in exhibiting certain parts of structure in the hands of one of but little experience, whilst in the hands of another it may show them distinctly. Hence the direct measurement of the angle is best, to determine what a glass is capable of exhibiting when properly used.

6. The markings on the Diatomaceæ were discovered by the aid of foreign glasses of small angular aperture.

7. Almost all the investigations which rendered the microscope an instrument of science have been made with foreign object-glasses of small aperture; and where these have been found faulty, the fault has arisen mainly either from judging of structure by simple inspection, or substituting analogical reasoning for observation.

8. The English object-glasses are very expensive; but they are incomparably superior to the continental in every respect—in defining power, in penetrating power, in the centering of the lenses, in the existence of an adjustment for varying thickness of glass, and in general perfection of workmanship. These advantages tell principally in the higher powers. An English glass when used with the highest eyepiece will still define better than nine tenths of the continental glasses with the lowest eyepiece.

As a complete set of English object-glasses is very costly, many persons will perhaps prefer having some English and others foreign. Under these circumstances, the higher powers should be of English and the lower of foreign manufacture.

It might be objected that the structure of many of the very minute and delicate objects examined by our continental neighbours have been erroneously described; and this would be a fact. But this has arisen from unacquaintance with certain precautions essential to the proper use of high powers; and the same errors have been committed by our own countrymen, from the same cause, even with the finest object-glasses which have been made.

The student may perhaps find himself perplexed by the conflicting statements made by different renowned observers in respect to object-glasses. The illustrious Schleiden said that only a magnifying power of about 500 diameters is useful for scientific purposes, that with our present microscopes we may see whatever we like with a power of 3000, and that only the amplification of an object to the extent of 280 or 300 diameters is produced by the object-glass, all beyond this being effected by the eyepieces with an almost total loss of light. Now these statements were perhaps formerly true; but they do not apply to the modern object-glasses. The highest English object-glasses (the one-twelfth of Ross, the one-sixteenth and one-fiftieth of Powell, and the one-twentieth of Beck) will show minute objects with a power of from 600 to 2500 diameters with the lowest eyepiece, as clearly and well defined as the ordinary glasses of 1-inch focus will show larger objects; hence enormous improvements have latterly been made in object-glasses,—the increased magnifying power being produced by the object-glasses and not by the eyepieces, by which means the visible images are rendered most distinct and trustworthy.

Diaphragm.—Most microscopes are provided with a diaphragm. It consists of a circular blackened revolving plate placed beneath the stage, and having a series of circular apertures of different sizes, each of which can be brought successively opposite to the axis of the body of the microscope. It serves to regulate the quantity of light in examining transparent objects; it also reduces the angle of the cone of the reflected rays. It is seldom, however, used, nearly the same effect being produced by the two different surfaces of the mirror.

Revolving Stage-plate.—One of the plates of which the moveable stage is composed is so constructed as to revolve in the same plane upon its axis, whereby an object may also be made to revolve in the same manner. This apparatus, however, has greater disadvantages than advantages, for it renders the stage heavy and increases its depth; and the desired effect may easily be produced by rotating the slide with the fingers; moreover it is exceedingly difficult to place the object in the centre of rotation.

Spring Clamping-piece is intended to fix the slides upon the stage. It is of little use provided the slides are of the proper length, which we have given; if they are longer, the clamp will prevent the accidental displacement of an object in changing the power, &c. It serves, however, to fix the slide in viewing objects by oblique light, when the slide projects beyond the edge of the stage, and to prevent its tilting over.

Forceps are essential for holding opaque objects, such as insects, and viewing them in different positions; to allow of which, the handle of the forceps is made capable of revolving.

The *Disk-revolver* (Beck) is a very useful apparatus. It serves to bring into view all parts of an opaque object, but that which is attached to the disk.

Dark Wells are metallic cups of various sizes, blackened inside, and serving to prevent the reflection of light upon secondary stage-objects from below. They are supported in a holder, moveable in an arm which is inserted into some part of the stand or of the microscope. Their purpose is equally well effected by a slide beneath which a piece of black velvet has been fastened by marine glue.

Achromatic Condenser.—This consists of an achromatic object-glass, or set of lenses, placed in an inverted position beneath the stage, moveable in all directions in its own plane and in the direction of its axis. It serves to condense the light reflected by the mirror to a focus upon the object, and to exclude all extraneous light. It is essential in examining minute objects with high powers; in fact, the structure of many objects cannot be made out without it. In its improved form (Gillett's condenser), a rotating diaphragm is placed behind the back glass of the combination forming the object-glass, perforated with a series of apertures of various sizes, some of them being circular, whilst others are annular—the former diminishing or increasing the cone or pencil of rays reflected from the mirror by excluding the lateral rays, the latter admitting only the lateral rays, the central ones being intercepted by the portion of the diaphragm within the ring, so that the angular inclination of the transmitted rays may be increased or diminished at will. In its most improved form it consists of two concentric revolving diaphragms, with central stops, by which the relative sizes of the apertures and stops can be varied; and its angle of aperture is 170° (Powell). In the best microscopes it is supported upon a secondary stage. The markings upon many of the Diatomaceæ can only be made out when examined by oblique light, as procured by intercepting the central rays, which effect is produced by this modified achromatic condenser. The same effect may be produced to some extent in one of the achromatic condensers of the old form, provided the compound lenses of which the object-glass in the condenser consists are separable (which should always be the case), by pasting or temporarily placing a circular disk or "stop" of black paper exactly upon the centre of the plane face of the innermost combination. The diameter of the disk should amount to about two thirds of that of the surface of the combination to which it is applied. The combinations are then fitted together as they were at first. This stop intercepts the central rays, thus diminishing the amount of light transmitted; but this difficulty is easily got over. It may be remarked that the higher object-glasses usually consist of three combinations of a doubly convex and a plano-concave lens cemented together so as to form apparently a single plano-convex lens; the outermost and smallest combination sometimes consists even of three lenses. When the achromatic condenser is used, the flat surface of the mirror should form the reflecting surface, and care should also be taken that the axis of the condenser coincides with that of the object-glass. To ensure this, a small cap of brass having a minute circular aperture in its centre should be fitted to the lower part of the tube in which the condensing lenses are situated. When the object-glass is properly adjusted with regard to the condensing lenses, the field of the microscope will appear black, excepting at a minute luminous spot. This spot must be made to occupy the centre of the field by moving the laterally adjusting screws of the condenser, or the body of the microscope; as soon as this has been effected, the brass cap must be removed. Or Ross's centering-glass may be used. This consists of a tubular eyepiece cap, in which are two plano-convex lenses, so adjusted that the image of the aperture in the object-glass, and the images of the apertures of the lenses and diaphragms of the condenser, may all be seen in focus at the same time, and their centricity or excentricity determined.

The focus of the condenser must be made to fall upon the object, which can be effected by raising or depressing the condenser until the window-bars by day, or the lamp-flame by night, are brought into focus.

The paper stop may be very advantageously replaced by a blackened metallic stop placed behind the first pair of lenses of the condenser, and screwed into the top of the condenser in the place of the ordinary diaphragm. Neither of these kinds of stop equals in convenience the improved Gillett's condenser, because with the latter the number of rays transmitted or intercepted, and the degree of their obliquity, can be varied by the simple rotation of the diaphragms. The *spot-lens* is also used for the same purpose. This consists of a very convex plano-convex lens, placed beneath the stage, the central rays being intercepted by a stop.

The central stop is generally used when objects are examined with the higher powers.

The power used in the condenser will vary greatly according to the kind of object under examination. If a considerable amount of light be required without obliquity of the rays, the condensing power should be lower than that of the object-glass. If great obliquity of the rays be required, the higher the power of the condensing lenses, and the larger their angular aperture, the better. When the achromatic condenser is suitably arranged in regard to centering, and the condensing object-glass or set of lenses is properly selected and adjusted, the structure of minute objects is displayed in a manner with which those who regard the condenser as useless must be utterly unacquainted. Webster's condenser is a good and cheap form, with central stops &c. (Collins, Great Portland Street).

Extra Eyepieces.—Always one, and sometimes two eyepieces are obtained with the microscope when purchased; but the highest eyepiece which is made should always be procured: for although high eyepieces are so far objectionable that they magnify the imperfections of the image formed by the object-glass as well as the image itself, yet they frequently render parts of structure distinct which are perhaps only just perceptible with a lower eyepiece. Kellner's orthoscopic eyepiece, in which the lower lens is doubly convex, gives a very large and flat field.

Polarizing Apparatus.—This usually consists either of two plates of tourmaline, or of two Nicol's prisms. The latter are generally used, and are preferable on account of their freedom from colour. They are composed each of two half-rhombs of calcareous spar cemented together so as to transmit only one image. The prisms should appear perfectly clear and colourless, and free from scratches and veins; and when, on holding them to a light, the uppermost is rotated so as to occupy a particular position with regard to the other, no light should be transmitted through them.

The polarizing apparatus is useful in bringing to light certain peculiarities of structure which cannot be detected in any other way. A substitute may be made of two crystals of the iodo-disulphate of quinine, dried upon and cemented to circles of thin glass. In use, one is placed beneath the object, and the other on the top of the eyepiece.

Side Condenser.—This consists of a large doubly convex or plano-convex lens, or "bull's-eye," of short focus, 2 or 3 inches, mounted upon a brass arm, which slides up and down a rod placed perpendicularly in a stand. The arm should be capable of being lengthened, and the stand should be so broad and heavy that there need be no fear of its being overturned. Its use is to condense the light upon opaque objects. When used, it is placed between the object lying upon the slide under the microscope and the lamp or other source of light, which should be about 6 or 7 inches from the object, the plane surface of the lens being at right angles to the direction of the rays of light, and next the object; and the lens must be brought so close to the object that the focus falls upon the latter. Sometimes a "small condensing lens" is used to concentrate the light already transmitted through the large condenser; this is usually fixed to some part of the microscope. A doubly convex lens of much longer focus than the bull's-eye lens, about 7 or 8 inches, will be found very useful for condensing the light upon the mirror when the achromatic condenser, stops, &c. are used with the highest powers. The arm of the bull's-eye lens may be adapted to hold either or both of the lenses.

Amici's prism is sometimes useful for throwing very oblique light through a transparent object. It consists of a flattened triangular glass prism, the two narrower sides of which are convex. The third and broadest side forms the reflecting surface. The prism may be attached to a separate stand, or to the secondary stage. It is sometimes mounted on a pillar placed beneath a large brass slide, perforated in the centre. A triangular prism mounted in either of these ways forms a Reade's prism, and is used in the samer manner. Amici's prism exerts a condensing as well as reflecting action.

Lieberkühn.—Some opake objects may be well illuminated by a lieberkühn or silver cup; by which the light, first reflected by the mirror upon the concave surface of the cup, is afterwards reflected upon the object. It is not adapted for higher powers than the $\frac{1}{4}$ inch.

Wenham's Parabolic Reflector.—The discovery of the importance of excluding the central rays of light, and using a central stop for this purpose, is due to Mr. F. H. Wenham, who invented an apparatus in which this principle is taken advantage of. It consists of a brass tube fitted beneath the stage in the place of the ordinary achromatic condenser, terminated above by a hollow truncated cone, the perpendicular section of which forms a parabola, with an internal polished silver-reflecting surface. At the base of the parabola is placed a disk of thin glass, in the centre of which is cemented a dark well. In use, the central rays are stopped by the dark well, whilst the lateral rays, passing up the tube, impinge upon the parabolic surface, from which they are reflected upon the lower surface of the object. This apparatus, as modified by Mr. Shadbolt, is constructed of a solid cylinder of glass terminating above in a cone, the surface of which has the form of a parabola, and replaces the silver reflecting surface—and is the form now generally used. In objects viewed under this or any other form of black-ground illumination, the light reaching the eye is all reflected from certain suitably inclined surfaces of the object. This may be proved by placing a polarizer beneath the reflector, selecting as the object some small strongly polarizing crystals. On applying the analyzer, no colour will be seen, showing that the light has not passed through the object. Hence care must be taken in drawing conclusions from the appearances.

Brooke's Reflecting Apparatus.—The purpose of this is to illuminate objects by reflected light, so that they can be examined with the highest powers. It consists of two parts; the first is essentially the same as the apparatus proposed by Mr. Wenham. The second consists of a small, flat, circular metallic mirror (a flat lieberkühn), perforated to admit the lower end of the object-glass, upon which it slides, and so arranged that the reflecting surface is in the same plane as the lower surface of the object-glass. When in use the light is reflected by the parabolic surface upon the plane reflector, and thence upon the upper surface of the object.

A number of points in regard to the colour of objects, distinction of pigment-granules from minute air-bubbles, &c. may be decided by this apparatus. In questions of elevations or depressions of surface, the light should only be admitted on one side of the tube (for which there is a special contrivance), so that it may proceed to the object obliquely from one side only; and the conclusions must be based upon analysis of the formation and arrangement of the shadows, and not upon the general appearance, because it is well known that objects, or parts of them, usually appear larger and more prominent in proportion to the amount of light reflected by them to the eye. Hence, for instance, little depressions, which are in fact extensions of surface, by reflecting more light than the surrounding flat or nearly flat surfaces, would appear very brilliant and luminous, and thus resemble elevations.

Beck constructs an *opaque illuminator* thus:—A short screw-tube, with an aperture in one side, is fitted between the end of the body and the top of the object-glass. Within the tube is a circle of thin glass, set obliquely, so that the light entering the side aperture is reflected by the circle upon the surface of the object, and passes upwards to the eyepiece. *Tolles's illuminator* consists of a prism inserted in the side of the object-glass, between the front and middle combinations, so reflecting the light entering by a side aperture upon the object.

Camera Lucida, and steel disk or *Mirror* of Sömmering.—One of these is requisite for drawing from the microscope. The camera lucida resembles that commonly used in sketching landscapes &c., but is provided with a fitting adapting it to the eyepiece. The mirror of Sömmering is a plane mirror of polished steel, less in diameter than the pupil of the eye, supported opposite the focus of the eyepiece by a small steel arm attached to a split ring which grasps the eyepiece by its spring-action. There is one disadvantage attending the eyepiece of Sömmering, viz. that it inverts the image of objects, which the camera does not. When either of these is used, the body of the microscope must be placed horizontally, and the axis of vision be directed perpendicularly; the image of the object will then be seen upon the table, and may be traced with a pencil. In using the camera, it must be remembered that the size of the object will appear greater as the distance between the eyepiece and table is increased; hence it is best always to place the microscope in one and the same position when about to use it for drawing, so that the extent to which the objects are magnified by the same power may always be the same. The pin mentioned at page xiii is invaluable for this purpose. By placing a micrometer-slide upon the stage, and comparing the magnified image of the divisions with those on a known measure, such as a graduated rule, the magnifying power can always be checked, and any error arising from varied distance determined.

In using either the camera or the mirror of Sömmering, the eye must be kept exactly in one position, otherwise the image of the object will move. Also the field and the paper must be illuminated to nearly the same extent. One of the screens mentioned at page xxvi is very useful for excluding extraneous light.

Erecting-glass (Lister's).—This consists of a brass tube, furnished with a meniscus at the upper and a plano-convex lens at the lower end. It is screwed into the diaphragm of the body of the microscope, or that of the draw-tube. It erects the images of objects, and serves, with a low object-glass, to reduce the magnifying power at pleasure, and to facilitate dissection under the microscope.

Live-Box and Growing-Slide.—The live-box is an apparatus in which portions of liquid containing infusoria and other small animals or plants can be confined so as to prevent evaporation and allow of their being watched in a living state.

A better apparatus, however, for this purpose is my growing-slide. This consists of a piece of stout plate-glass, 5 inches long and about 2 wide. A circular aperture, of about the diameter of a test-tube, is made near one end of it. A little glass cup, formed of a portion of a test-tube cut off three fourths of an inch from the closed end, and slightly less in diameter than the aperture, is then fitted into the latter, either by pieces of cork, or by a rim consisting of a glass ring forming a neck to the cup, or in any other way. The cup should project about one-fourth above the surface of the slide; and at one portion of its margin a little groove should be ground, in which two or three threads of a lamp-wick can be placed. The cup should be covered with a circular plate of thin glass, larger than its mouth, and prevented from falling off by a disk of cork fitting the mouth, and fastened to the plate by marine glue; or the cup may be closed with a common cork, the only objection to this being that the mouth of the cup is apt to split. The manner in which the slide is used is this:—Supposing it is wished to follow the changes undergone by some minute alga or infusorium which has been detected in a drop of liquid, it is placed upon a slide and covered with thin glass; the slide is then placed upon the growing-slide in such manner that the longer dimensions of the two are in the same direction; a little ledge consisting of a strip of glass fastened by marine-glue to the growing-slide will serve to rest the slide against, and prevent its becoming displaced. Distilled water, mixed with a small proportion of the water in which the organism was living before being transferred to the slide, is next put into the cup, and a few threads of lamp-wick cotton, thoroughly moistened with distilled water, are then so placed that one end is immersed in the cup whilst the other is brought into contact with the edge of the liquid in which the object is immersed. Thus, as the water evaporates from beneath the thin glass, the threads will afford a continuous supply, and the threads will not become dry until the whole of the liquid in the cup has become absorbed by them and evaporated. In this way we obtain the requisite conditions for the continued growth of aquatic organisms. Care must be taken, however, that the thin glass presses but slightly upon the object, and that the threads come as little as possible into contact with the portions of the slide lying between the cup and the thin glass. If the thin-glass cover to the cup fit tightly, and the thread be passed through the notch in the cup, no loss will take place by the direct evaporation of the liquid in the cup. If living organisms are kept in this apparatus, they must have the influence of light. Several modifications of this have been devised (Growing-slide).

Compressor, an instrument for the regulated compression of a minute object. The same effect can be produced by a well-made live-box, or by pressure directly applied to the thin glass covering an object by the handle of a mounted needle.

Cabinet.—A box or cabinet, containing a number of drawers, will be requisite for holding the objects. Each drawer should be numbered or labelled to facilitate reference. The objects should lie flat in the drawers, so that each may be found when required without loss of time. The cabinet should be furnished with two folding doors, so as to exclude dust as much as possible. It should also be made of thoroughly seasoned wood, oak or mahogany being the best; if made of deal or cedar, the vapour of the volatile oil of the wood will insinuate itself beneath the thin glass cover and the slide in those objects which are mounted in the dry state, and, condensing upon them and the objects, will obscure and spoil them.

It may be remarked here that the names of objects should always be written upon labels pasted (not gummed) to the slides, not merely upon the slides with a diamond. The colour of the labels should be different for each kind of object; or if the labels be composed of white paper, they should have a coloured margin; thus those of the Desmidiaceæ may be green, the Diatomaceæ yellow, &c., so that the various slides, when accidentally mixed after comparative examinations, can be readily replaced in their respective drawers.

Bell-glasses.—The microscope when in use, either constant or occasional, should always be kept under a large bell-glass the base of which fits into an annular groove made in a circular flat wooden stand. In this way it is kept from dust, and the trouble and wear and tear consequent upon putting it into a box is saved. Moreover, thus protected, an object under examination can be left without fear of injury or disturbance, and be also preserved from dust.

Several smaller bell-glasses of various sizes should also be kept at hand, under which any objects which it may not be convenient to mount for a time, or the examination of which may not be completed, can be protected.

Slides.—These are ordinarily made of glass about the thickness of common window-glass; their length is usually 3 inches, and their breadth 1 inch. The old length was $2\frac{1}{2}$ inches, which I prefer; but as the aperture in the stage has been enlarged in the modern microscopes to allow of the passage of the parabolic reflector, the Amici's prism, &c., if the old size be retained, the slides will drop through the stage. Where the objects are very large, the slide must be proportionately large, and its thickness greater than usual. The slides should be made of colourless glass, so as not to interfere with the appreciation of the colour of an object. And they should be flat; otherwise the parts of the object will lie in different planes, and every motion of the slide will require new adjustment of the focus. The edges are best somewhat ground on a copper-plate with emery, to prevent injury to the fingers or scratching the stage-plate. Very delicate structures require to be examined and mounted upon thin glass. The sides may then be frequently made of wood, sheet-zinc, tin-plate, or card-board, with a circular aperture in the middle, upon which a piece of thin glass is cemented.

Covers.—Comparatively few objects can be viewed in the dry state; hence they are most frequently immersed in some kind of liquid. To prevent the evaporation and condensation of this upon the object-glass, and to reduce the thickness of the layer of liquid to a minimum, the object is usually covered with a piece of thin glass. The form of this cover is either square or circular, and the thickness from about the $\frac{1}{50}$ to the $\frac{1}{300}$ of an inch, or even less. These covers are usually kept already cut by the microscope-makers and those who sell objects. Before use, they are best allowed to remain immersed in water for some time. Care is required in wiping this thin glass. It is usually effected by holding the cover at two opposite points of the margin between the finger and the thumb of the left hand, and rubbing the surfaces with a fold of a cloth, leather, or silk handkerchief covering the same parts of the right hand. But the thinnest glass cannot be wiped in this way without being broken. This requires to be held at the edge by the finger and thumb of the left hand applied to the flat surfaces, and to be drawn slowly through the fold of the cloth in the hand. A very thin layer of mica is useful as a cover with the highest powers, as this prevents the risk of scratching the object-glass, the lower surface of which is often flush with the edge of the brass mounting.

Dipping-tubes.—These are glass tubes varying in length from about 5 inches to a foot, and in calibre from $\frac{1}{8}$ to $\frac{1}{2}$ an inch. They are cut of the proper length by a three-square file, and the ends gently fused in the flame of a spirit-lamp. One end is then coated outside with sealing-wax and spirit, or some other coloured liquid, so that the same end may always be used for the same purpose. They are of use for removing objects from water or other liquids in which they may be contained. Suppose, for instance, it is required to examine some deposit lying at the bottom of a liquid, or an object suspended: the fore finger of the hand in which the tube is held is placed upon the upper end of the tube so as to close it; the other end is then immersed in the liquid and brought into contact with, or as near as possible to the object, and the finger removed from the upper end. Hydrostatic pressure then forces the liquid, and with it the object, into the lower part of the tube, and it can be transferred to a slide. When a tube of narrow calibre is used, the liquid and object are retained within the tube by capillary attraction; they must then be removed by gently blowing at the upper end, the lower end being placed upon the slide. The use of colouring one end of the tubes is, that the idea of applying the mouth to the end of the tube which has been immersed in some offensive liquid, as fœtid water, &c., may be set aside.

These tubes should be kept in a glass of distilled water, with the coloured ends of course uppermost.

When a large tube is used, as in removing the larva of an insect, a tadpole, &c., the quantity of liquid removed is also large, and will be more than is required on the slide. The tube should then be emptied into a watch-glass, and the object placed upon the slide or in the live-box by a camel's-hair pencil.

Forceps are in constant requisition for taking hold of minute objects, dissecting, &c. Those used for medical purposes (common steel dissecting or surgical forceps) are best. There are three points to be attended to in the selection of them. They should not be too short, *i. e.* less than four inches in length at least; the spring- (separating-) action should be very feeble; and the points should be perfectly flat and smooth where they come into contact. If forceps are shorter than the above length, they are not easily held steadily; if the spring-action be strong, on holding an object, as in dissection, with the forceps, the attention being perhaps directed to the scalpel, needle-points, &c., the blades of the forceps separate, and the object escapes from their grasp. If the forceps have teeth or are grooved, perhaps after laying an object out upon a slide under water, or elsewhere, a portion of it becomes entangled in the teeth, and the whole displaced. Surgical "tenaculum-forceps" are very useful occasionally in injecting. These forceps lock by their own spring-action. Supposing, then, the injection is escaping from the orifice of some vessel which has been overlooked and no assistant is at hand, on including the open end of the vessel between the ends of these forceps, which may then be left hanging, it is firmly fixed, and the operator has both hands disengaged to tie it; in fact, these forceps are indispensable to the injector. They should be short, and not heavy; otherwise the vessel may be torn by their weight.

Surgical "dressing forceps" are also frequently of use; and long "œsophagus-forceps" with scissor handles are serviceable for removing portions of plants &c. from large jars or glass vessels.

Needles.—For separating the parts of minute objects, fine points are requisite; these are found in common needles of moderate size fixed by one end into the handle of a water-colour brush. These are easily prepared: the needle is cut in half by cutting-pliers; the blunt end is then forced into the stick, about half an inch in length being left projecting. Surgeon's "cataract-needles" ground down are elegant instruments of this kind, but they require to be shortened. For minute dissection of plants, all needles require pointing on a hone.

A stout sable-hair or fine bristle, inserted into a slender wooden handle, is frequently of use in isolating minute bodies, as Diatomaceæ, which would be broken by any other instrument. It is used thus: suppose we have a number of Naviculæ, or the like, in a bottle, mixed with other bodies, and we wish to isolate one for preservation. A small quantity of the deposit is taken up with a dipping-tube, and allowed to escape upon a slide in such manner as to form a narrow stripe upon it. This is then examined with the lowest power with which the object can be distinguished, and one near the margin of the liquid stripe is selected, and may easily be removed with the mounted bristle (under the microscope) beyond the margin of the liquid. The remainder of the liquid is then wiped away with a cloth, a little distilled water added to the small quantity of liquid left containing the object, and the latter moved with the bristle into the middle of the slide. The liquid is then driven off by heat, and the object is left on the slide ready for mounting. Or, when the matter is dried upon the slide, any one of the minute objects being lightly touched with the dry bristle will adhere to it; and by gently pressing or rotating the bristle upon the middle of a new slide, the object will readily be transferred to the latter. The Diatomaceæ may be easily isolated in this way.

Knives.—Ordinary dissecting knives or scalpels. The handles should be sufficiently large to allow of being firmly held.

A particular and most useful kind of knife for producing thin sections of soft bodies is that known as "Valentin's knife." It consists of two or sometimes three blades with their flat surfaces parallel, set in a handle. The blades can be fixed at any distance apart, according to the thickness of the section required. It is drawn across and through the substance, from heel to point; the section remains between the blades, and is then removed, either with forceps, or the blades of the knife are opened under water, and the section floated upon a slide immersed in the liquid. In the latter case, the action of the water upon the tissue must not be overlooked. Valentin's knife is absolutely indispensable in the examination of animal bodies. Some sections, especially of plants, are best made with a razor.

Black and white disk.—A disk 3 or 4 inches in diameter, made of seasoned wood, and upon one face of which a piece of white paper or card-board has been fastened by paste or glue. One half of the paper or card-board is coloured black, the other is left white. This is very useful in dissecting or separating minute portions of tissues; if these are white, they become much more easily distinguished than usual when placed (on a slide) over the black part of the disk; if they are dark, over the white portion.

Leaded cork.—Some structures require to be dissected under water, as, *e. g.*, those of insects &c. These should be fixed with pins upon a piece of cork, beneath which a plate of lead, corresponding in size, has been fastened. In many cases it is advantageous to dissect these tissues under the simple microscope. An aperture may then be made in the lead and cork, and the tissue or structure stretched across the aperture, so that the light may pass through it; or it may be illuminated as an opaque object by the aid of the bull's-eye.

A trough, composed of five pieces of glass cemented together with marine glue, four for the sides and one for the bottom, will serve to hold the water and the loaded cork.

Evaporating Dish or Saucer.—It is advisable to keep one of these, with a flat bottom, always at hand filled with distilled water, in which slides and covers that have been used may be immersed. The remains of objects which have been examined are thus easily separated from the glasses, and there is but little trouble in wiping the latter clean. If held under a gentle current of water, all remains of tissues or test-liquids may be washed away from the dish—the glasses, from their gravity, remaining at the bottom.

Test-box.—A wooden box, holding from six to a dozen or more test-bottles, is indispensably requisite. The box must be divided into partitions corresponding to the size of the bottles, and the latter must be wedged between these partitions so that the stopper can be removed without fear of disturbing the bottles. The box should be covered with a lid furnished with hinges, so that no room may be required to place the lid when the box is opened. The bottles will vary in size according to option, but they should be of at least 1-ounce capacity. Each should have a stopper so prolonged as nearly to reach the bottom of the bottle, its form being either conical or fusiform. The advantages of this form of stopper are, that a mere trace or several ordinary drops of the reagent may be applied to the object as required. If a very minute quantity be desired, the lower part of the stopper is allowed to touch the inside of the neck of the bottle when it is withdrawn; and if a larger quantity be required, this proceeding may be avoided. Each bottle should be labelled, and a label should also be placed upon the upper end of the side or partition of the box near to the bottle, so that the nature of the contents of each bottle may be ascertained without removing it from the box. The general advantages of this apparatus are, that the quantity of reagent required can be obtained to the greatest nicety, and it can be added to the exact spot required with one hand only, so that the other can be employed to hold the slide and object &c. Mr. Ferguson, of Giltspur Street, supplies these at a small cost, after our pattern.

Reagents or test-liquids.—Some of these should be kept in the test-bottles; but larger quantities should also be kept in other stoppered bottles. We give a list here of those test-reagents which are most frequently required; the method of preparing each, the strength, &c. will be found under the respective heads.

1. Sulphuric acid. 2. Nitric acid. 3. Acetic acid. 4. Caustic potash. 5. Chloride of calcium. 6. Aqueous solution of iodine. 7. Oil of turpentine. 8. Glycerine. 9. Acid nitrate of mercury (Millon's test-liquid). 10. Distilled water.

Ether or the cheaper benzole, and alcohol, should also be kept at hand. Chromic acid

MICROGRAPHIC DICTIONARY.

ABERRATION.—The deviation of the rays of light from the true focus of a lens or curved mirror, in consequence of which they do not unite at a single point, but form an indistinct or coloured image of an object. It arises from two causes: the form of the lens or mirror, when it is called spherical aberration; and the different refrangibility of the rays of light, when it is called chromatic aberration. See OPTICS.

ABROTHAL'LUS, Notaris and Tulasne.—A genus of Coccocarpeæ (Gymnocarpous Lichens), remarkable for their parasitic habit and the absence of a thallus, so that they are generally destitute of the only characters by which the Lichens, as a class, can be distinguished from the Fungi, namely the presence of gonidia containing chlorophyll; but, according to Lindsay, a sorediiferous degeneration of the apothecia sometimes occurs, when green cell-contents are produced. The genus exhibits three forms of reproductive organs, namely: *asci* with *spores*, contained in *apothecia*; *spermatia* produced in *spermogonia* like those of other Lichens; and besides these, *pycnidia* containing *stylospores*, resembling those of Coniomycetous Fungi. Tulasne describes numerous species, which Lindsay reduces to two, viz.

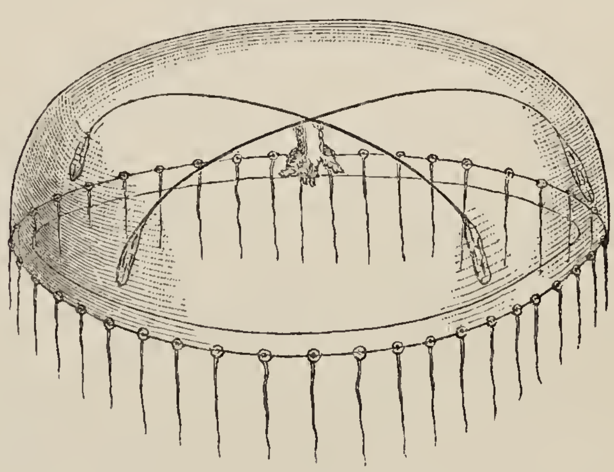
1. *A. Smithii* (including *A. Smithii*, *Welwitzschii* and *microspermus* of Tulasne). Occurring upon furfuraceous thalli of various species of *Parmelia*, and on *Sticta fuliginosa*, in the form of scattered or rarely confluent, *prominent*, *pulviniform* black spots (apothecia), ultimately falling out and leaving little pits. Spermogonia not found; pycnidia abundant, forming minute black spots.

2. *A. oxysporus*. Occurring on furfuraceous states of *Parmelia saxatilis*, mostly associated with *A. Smithii*, on *P. conspersa* and *Cetraria glauca*, in the form of *flattened* or *discoid* brownish-black spots, generally crowded. Spermogonia rare, pycnidia not found.

BIBLIOGRAPHY. Lindsay, *Qu. Micr. Journ.* v. p. 27, and *Brit. Lich.* 311; Tulasne, *Ann. d. Sc. Nat.* 3 sér. Bot. xvii. p. 112, 1852; De Notaris, *Mem. R. Acad. Sc. Turin*, ser. 2. x. p. 351, 1849; Berkeley, *Intr. Cryp. Bot.* 405.

ACALE'PHÆ (Medusæ).—A class in the Animal Kingdom, commonly known as Sea-nettles, on account of their producing urtication when touched; or Jelly-fishes, or Sea-blubbers, from their gelatinous consistence.

Fig. 1.



Thaumantias hemisphærica, magnified 2 diameters.

They are transparent, floating and free, discoid or spheroid, often shaped like an umbrella; and vary in size from a mere speck to a yard in diameter. The margin of the disk is furnished with filiform tentacles, cirri, &c. Their organs are arranged in a radiate manner around a longitudinal axis, occupied by a central peduncle or stalk, at the bottom of which is the mouth. The disposition of the parts is generally quaternary.

The body is usually composed of a transparent gelatinous substance, closely resembling the vitreous humour of the eye in the Vertebrata.

The *cutaneous surface* of the body is covered with a very delicate epidermis (Pl. 40. fig. 2). Cilia exist on various parts of the body, especially the arms, tentacles, cirri, &c.; upon which also peculiar stinging organs and organs of adhesion occur. In those species which are notorious for their urticating powers, these organs are also situated in aggregations beneath the epidermis of the body. The stinging organs usually form oval capsules, in which a spirally coiled filament is enclosed (Pl. 40. fig. 3 *a*, *b*); this flies out on the slightest touch, with the capsule to which it is attached, from the irritated part of the skin (Pl. 40. fig. 3 *c*). In some Acalephæ, these stinging organs are replaced by oval capsules from which a rigid bristle projects (Pl. 40. fig. 4). These do not produce urtication, but enable the animal to adhere to other bodies. Near the surface of the body and between the cells composing its substance, pigment-cells frequently occur, some of which are isolated, others aggregated into groups. The paler and more delicate colours are said to arise in some instances from pigment uniformly dissolved in the substance of the body; it is most probable, however, that they arise from iridescence.

A distinct *muscular system* is present, in the form of long, thin, reticular muscular fibres and bundles, almost everywhere pervading the contractile substance of the body.

The floating and locomotion of these animals is often aided by larger or smaller cavities filled with air.

The *nervous system* consists of a ring following the margin of the disk, with ganglionic expansions at intervals, giving off branches to the tentacles and the radial canals. In the Medusæ there are ganglia at the bases of the tentacles.

The *organs of sense* consist of tubercular or spathulate bodies situated near the margin of the body or at the base of the tentacles, and connected with adjoining ganglia. These were regarded as organs of vision; and consist essentially of a membranous capsule containing a clear liquid with crystals of carbonate of lime, and sometimes a red or black pigment (Pl. 40. fig. 5 *g*). But as many of them contain no pigment, these have been considered to be of auditory function, and the crystalline bodies otolithes. Some of them are protected by an overhanging fold of membrane; hence the distinction of naked- and covered-eyed *Medusæ*.

The *digestive cavity*, which is situated in the middle of the body, is lined with ciliated epithelium and furnished with distinct walls, which are directly continuous with the general parenchyma of the body, so that there is no abdominal cavity. The mouth is either single and central, or multiple. In the former case, it is situated at the end of the peduncle, in the middle of the under side, and leads into a stomach, which is frequently furnished with cæcal appendages. When several oral apertures are present, either several œsophageal canals conduct the nutriment through the arms, in which the oral apertures are placed, to a central stomach, or each separate mouth is connected with a distinct tubular stomach. A distinct hepatic organ has not yet been found.

Gastrovascular system. A number of vessels or vessel-like canals run from the stomach or central cavity throughout the body, the principal branches forming rays from the centre to the margin, communicating finally with a circular vessel traversing its circumference (Pl. 40. fig. 5 *d*). These are also lined with cilia, and contain both the food and water. But there is no regular circulation.

A *blood-vessel system* has been described, consisting of a set of closed vessels with very delicate walls, accompanying and enclosing the former vessels, and containing a coloured liquid with coloured globules, representing the blood. But its existence is doubtful.

The Acalephæ are propagated by the formation of ova, and according to the plan of alternation of generations. They are either hermaphrodite or unisexual.

The reproductive organs of the two sexes are often so similar in colour, external form, and arrangement, that they might easily be mistaken for each other, without examination of their contents. They form either utricular or strap-shaped stripes, placed at various parts of the body, often near the rays of the gastrovascular system. In the former case, the spermatic fluid and the ova are evacuated through distinct excretory ducts; in the latter, the spermatozoa and ova escaping from the strap-shaped testis or ovary, pass directly outwards, or into capacious cavities opening externally by wide orifices. The ova are round, and surrounded by a single very delicate capsule; and the germinal vesicle with its simple germinal spot is visible through the whitish, violet or yellow yolks. The spermatozoa move rapidly in, and are unaffected by water; they are sometimes linear, at others one end is rounded, the other prolonged into a capillary appendage (Pl. 40. fig. 5*).

The developmental metamorphosis of the Acalephæ (*Medusæ*) is very remarkable. When the ordinary process of segmentation of the entire yolk is completed, the ova become converted into ovate infusoria-like embryos (Pl. 40. fig. 6), which revolve upon their longitudinal axis by means of ciliated epidermis, and swim about like species of *Leucophrys* or *Bursaria*. After a time, they become fixed at the anterior extremity to some body; arms then shoot out from the unattached extremity, between which the mouth of the polype-like animal (Hydratuba state) is developed (Pl. 40. figs. 7 & 8). At this stage of development the larvæ multiply by the formation of gemmæ (Pl. 40. fig. 9 *a*), and offsets or stolons (Pl. 40. fig. 9 *b*); and ultimately each undergoes transverse division, which takes place as follows:—the larvæ grow in length, and the body becomes constricted into several segments (Pl. 40. fig. 10), from each of which eight bipartite processes shoot out in a whorl (Strobila-state). The segments of the body then separate from each other seriatim, from before backwards, swim about with eight rays (Pl. 40. fig. 11), and at last become gradually developed into perfect Medusæ. Many of the Medusæ are phosphorescent, and render the sea luminous.

Gegenbaur divided a *Thaumantias* into a hundred pieces, and found that each piece, provided it contained a portion of the margin of the umbrella, grew into a perfect small *Medusa*.

Some of the organisms, until recently considered species of Acalephæ, are the free reproductive buds of Polypi (Campanulariadæ and Tubulariadæ).

BIBL. Eschscholtz, *System der Acalephen*, Berlin, 1829; Will, *Horæ Tergestinæ, &c.*, 1844; Ehrenberg, *Abhandl. der Berl. Akad.* 1835; Art. *Acalephæ*, Todd's *Cycl.* (R. Jones); Siebold, *Lehr. d. Vergl. Anat.*; Huxley, *Phil. Trans.* 1849; Leuckart, Siebold and Kölliker's *Zeitschrift für Wiss. Zool.* Bd. 3, 1851; Lesson, *Suites à Buffon* (*Zoophytes Acalèphes*); Wagner, *Icones Zootomicæ*; Gegenbaur, *Vergl. Anat.* 1870; Gosse, *Marine Zool.*; Forbes, *Monogr. of Nak.-eyed Medusæ* (Ray Soc.); Kölliker, *Icon. Histol.* 1865; Kowalewsky, *Ann. Nat. Hist.* 1867, p. 228.

ACANTHA'CEÆ.—The seeds of many genera of this family are clothed with hairs composed of hygroscopic cells, containing unrollable spiral fibres or detached rings. Among these are *Acanthodium spicatum*, Delile, *Blepharis*, and *Ruellia formosa*. Other species and genera have the hygroscopic cells destitute of internal fibre, as *Ruellia littoralis*, *Phaylopsis glutinosa*, *Barleria noctiflora*, *Lepidagathis*, &c. Further particulars respecting the hygroscopic cells will be found under CELL-MEMBRANE and SPIRAL STRUCTURES. See also ACANTHODIUM and RUELLIA, and for a similar phenomenon in other families, COLLOMIA, COBÆA, SALVIA.

BIBL. Kippist, *On the existence of Spiral Cells in the seeds of Acanthaceæ*, *Linnean Transactions*, vol. xix. p. 65.

ACANTHOCYSTIS, Carter.—A genus of Rhizopoda, apparently referable to the Actinophryina.

Char. Rounded, green, with moveable radiating spines and pseudopodia. Body flexible, covered with minute fusiform curved spicula; spines straight, hollow, bifid, discoid at base.

A. turfacea (Pl. 42. fig. 9). Found in heath-bog water; diam. of body $\frac{1}{411}''$.

BIBL. Carter, *Ann. Nat. Hist.* 1863, xii. p. 263.

ACANTHO'DIUM (Flowering Plants, fam. *Acanthaceæ*).—Kippist first described the curious hairs upon the seed of *Acanthodium spicatum*, Delile (Pl. 21. fig. 24). The entire surface of the seed is clothed with hairs of whitish colour, appressed and closely adherent in the dry state, being apparently glued together at their extremities. When placed in water, the hairs are set free and spread out on all sides; they are then seen to consist of clusters of from five to twenty spiral cells firmly coherent below, but free above and separating from the cluster at different heights, expanding in all directions like plumes, and forming a very beautiful microscopic object. The free portions of the cells elongate so as to separate the coils of one, two, or occasionally three internal spiral fibres, which are sometimes branched and not unfrequently broken up into rings; at the lower part of the cells the turns of the spiral are connected by perpendicular processes so as to convert the spiral into a reticulated structure. See SPIRAL STRUCTURES.

BIBL. *Linnean Transactions*, xix. 65.

ACANTHOME'TRA, Müll. A genus of ACANTHOMETRINA.

ACANTHOME'TRINA.—A family of Radiolarian Rhizopoda.

Char. Body spherical, capsular; traversed by numerous elongate, mostly angular and hollow siliceous spines, which meet in the centre. Between the spines, pseudopodia radiate from the body, as in *Actinophrys* (Pl. 42. fig. 10). Marine.

The body contains yellow globules, and is sometimes covered with small spicules; and it is enveloped by a softer cortical sarcodic mass.

The Acanthometrina, with the Polycystina, have been rearranged by Häckel, in his splendidly illustrated monograph, into 68 genera and 150 species.

They are found recent on the surface and at the bottom of the sea, in the Mediterranean, the Adriatic, and the North Sea.

They form beautiful microscopic objects. See RADIOLARIA.

BIBL. Müller, *Ber. d. Berl. Akad.* 1855, p. 248; id., *Abh. d. Berl. Ak.* 1858, p. 1; Häckel, *Die Radiolarien*, 1862; Claparède and Lachmann, *Etudes s. l. Infus. &c.* 1858, p. 59.

ACA'REA.—A family of Arachnida, belonging to the (3rd) Order *Acarina* (see ARACHNIDA).

These animals are commonly called mites; and every one is familiar with them as occurring in cheese, sugar, flour, &c. Some also occur upon the skin of man and animals, producing the itch and the mange.

The parts of the mouth and the legs, upon which the characters are usually founded, may be best made out by crushing the animals upon a slide with a thin glass cover, and washing away the exuding substance with water, as directed in the Article PREPARATION; sometimes hot solution of potash is requisite, with the subsequent addition of acetic acid and further washing. When afterwards dried, and immersed in Canada balsam, the various parts become beautifully distinct, and may be permanently preserved.

Acarus (*Tyroglyphus*). Body with a transverse furrow between the 2nd and 3rd pairs of legs; legs nearly equal, all perfect, and terminated by a membranous sucker or claws, or both; palpi adherent to the labium (lip).

Trichodactylus. Rostrum (beak) short, with minute bristles; 4th pair of legs longer than the rest, without claws, and terminated by a very long bristle, the rest with 2 claws. (Parasitic.)

Psoroptes. Body soft, depressed, spiny beneath and at the base of the legs; posterior pair of legs small and rudimentary, the rest with a claw and sucker; body terminated by two bristly projections. (Parasitic.)

Sarcoptes. Body soft, transversely wrinkled, and with dorsal papillæ; anterior 2 pairs of legs with suckers, posterior terminated by a long bristle and without suckers. (Parasitic.)

Demodex. Body elongate; cephalothorax distinct from the ringed abdomen; legs terminated by 4 or 5 very minute claws.

ACARI'NA.—An order of ARACHNIDA.

AC'ARUS, Linn.—A genus of Arachnida, of the Order Acarina, and family Acarea (see ARACHNIDA and ACAREA).

The palpi adherent to the labium, the perfect legs, and the transverse furrow distinguish the genus.

Ac. domesticus (Pl. 2. fig. 1), the common Cheese-mite. Body oval, soft, whitish, turgid and furnished with long feathery hairs (*b*). The transverse furrow (*c*) occurs at about the anterior fourth of the body, and another is seen between the head and the part corresponding to the thorax. The head is susceptible of elevation and depression. In its natural state it appears conical (*d*), and is furnished with two large mandibles; these consist of a soft retractile basal joint (*e*), and a second, dilated, non-retractile joint (*f*) resembling the fixed claw of a lobster, and a moveable piece (*f**) working against the latter. The last two pieces are toothed where in contact with each other. These mandibles can be advanced separately or together, and be separated or approximated. When in a state of repose, they form as it were a roof above the labium. The labium (*g*) is quadrilateral, elongated, notched at the end, thin anteriorly and in the middle, and consolidated laterally with the palpi, which are 4 or 5-jointed (*hh*). The legs are reddish, inserted in two separate groups, but not very far distant as in *Sarcoptes*. The anterior pair of legs are remarkable for their size in the male, which is smaller and more active than the female; the third pair are the shortest and smallest; the third joint or femur is larger and longer than those next it; the sixth joint is long and thin; the seventh joint is furnished with a cordiform membranous caruncle, and a single simple claw or hook; rostrum and legs reddish.

This species is viviparous and oviparous, and the eggs very numerous.

These mites are very abundant upon old cheese, the powder of which entirely consists of them, with their eggs and excrement.

Ac. longior. Body oblongo-ovate. Found upon Gruyère and Dutch cheese (Pl. 2. fig. 2).

Ac. bicaudatus. Abdomen furnished with two pediform tubercles, beneath the base of each of which is a stigma. Found upon the feathers of an ostrich.

Ac. farinæ. Found in bad flour. DeGeer, *Mém.* vii. p. 97. pl. 15. fig. 15. (*Ac. feculæ*, found by myriads in potatoes. Guérin-Méneville, *Ann. Nat. Hist.* 1867, xix. p. 71.)

Ac. destructor. Resembles *Ac. domesticus*, but legs not reddish, rostrum brown, front end of body broadest; hairs long and dark. It feeds upon the contents of entomological cabinets, especially butterflies. Schrank, *Enum. Ins. Austriæ*, sp. 1057; Lyonet, *Mém. Mus.* xviii. p. 284. pl. 12. fig. 10–12.

There is another *Acarus* which well deserves the name of *destructor*, from its destructive effects upon dried insects; it differs from the *Ac. domesticus* only in having a more strongly marked furrow, in the legs being shorter, and the two foremost pairs being somewhat more widely separated at their origin; the sixth joint is particularly short.

Ac. lactis. Found upon preserved cream. Fabricius, *Spec. Ins.* ii. 490.

Ac. Dysenteriæ. Nyander, *Amœnit. Acad.* v. p. 97; Linn. Gmel. p. 2929. Found in the dejections of dysentery; also in old casks.

Ac. passerinus. Found upon young birds. DeGeer, vol. vii. 139. *Ac. chelopus*, Herm. *Mém. Aptérol.* p. 82. pl. 3. fig. 7.

Ac. passularum. With two very long buccal bristles; it lives upon dried figs, and other saccharine fruits. Hering, *Nova Acta Nat. Curios.* xviii. p. 618, pl. 45. f. 14, 15.

Ac. plumiger, Koch, *Deutschl. Crust., &c.* fasc. 5. pl. 15, is said to have feathery hairs; but this is probably the case in all the Acari, and certainly in many of them (Pl. 2. fig. 1*b*).

Some doubtful species have been formed into new genera, which may find place here.

a. Glyciphagus (Hering). Body soft, not divided into two parts by a transverse line or furrow; legs perfect, with acetabula.

A. (*Gl.*) *prunorum.* Found on dried plums. Hering, *Nova Acta Nat. Curios.* xviii. p. 619. pl. 45. f. 16, 17.

A. (*Gl.*) *hippopodos.* Body as broad as long, very acute anteriorly, entirely covered with short hairs; a minute projection at the end of the abdomen. Found upon the crusts of ulcers on horses' feet. Hering, *Nov. Act. Nat. Curios.* xviii. 607. An undescribed Acarus has also been mentioned as occurring upon the feet of sheep affected with the canker. Grognier, *Zool. vétér.* p. 233.

A. (*Gl.*) *hericius.* Found on weeping ulcers of elms. Robin, *Journ. d. l'Anat.* 1868, p. 603.

A. (*Gl.*) *cursor.* Found in the feathers of the owl and in the cavities of the bones of skeletons. The hairs are jointed. Gervais, *Ann. Sc. Nat.* 2 sér. xv. p. 18. pl. 2. f. 5 *a*.

A. (*Gl.*) (*Sarcoptes*) *palumbinus.* On the pigeon. Koch, *l. c.* fasc. 5. pl. 12; Robertson, *Qu. Micr. Jn.* 1866, p. 201.

Some other species have been insufficiently examined.

Ac. avicularum, DeGeer, *Mém.* vii. 106. pl. 6. fig. 9. Louse of the grouse. Lyonet, *Mém. Mus.* xviii. 281. pl. 15. f. 16.

Ac. marilæ, Gervais, *Dict. Sc. Nat. Suppl.* i. 45.

Ac. favorum. Found in old honeycombs. Herm. *Mém. Aptérol.* p. 86.

Ac. fungi, Herm. *l. c.*

b. Myobia (Heyden). Body elongate, many-lobed; legs perfect, the posterior ones largest. The type of this genus is

A. pediculus musculinus, Schranck, p. 501. pl. 1. f. 5. *Sarcoptes musculinus*, Koch, *Deutsch. Crust. &c.* fasc. 5. pl. 13.

c. Hypopus. See Hypopus.

Bibl. Dugès, *Ann. d. Sc. Nat.* 2 sér. ii. p. 40; Koch, *Deutschl. Crust.*; Walckenaer, *Aptères*, 3 (Gervais); Fumouze and Robin, *Journ. d. l'Anat.* 1867, 505, 561; Boisduval, *L'Entomologie horticole*, p. 76.

ACAULON, C. Müller.—A genus of Phascaceæ (Acrocarpous Mosses), taken as a section of *Phascum* by Wilson. *A. muticum* is common on moist banks.

Bibl. Müller, *Synops. Musc.* i. p. 21; Wilson, *Bryol. Brit.* p. 29.

ACEPHALOCYSTS.—A term used to denote certain simple sacs filled with a transparent liquid, found in the bodies of animals, and usually known as Hydatids by pathologists. They were formerly regarded as distinct parasitic animals; but recent observations show that they often consist of the cysts or larval forms of cestoid Entozoa. The cysts in many cases contain at first only an amorphous substance or a liquid. At a later period their real nature is determined by the presence of the included Echinococcus—head and hooks. The sacs or vesicles are described as oval or somewhat spherical; developing smaller cysts between the laminæ of the parent, which are discharged from its inner or outer surface. They vary in size from a pin's to a child's head. The walls of the sacs vary in thickness and transparence. They present no appearance of either head or body. In the larger cysts the walls are distinctly laminated. They exhibit no fibrous structure, but appear composed of a homogeneous substance closely resembling albumen in properties. Regarding these bodies as animals, two species have been distinguished:—

A. endogena (*socialis* vel *prolifera*), the pill-box hydatid of Hunter. This is met with in the liver, kidney, ovary, testis, and cavity of the abdomen. When developed in the substance of an organ, it is always enveloped by areolar tissue. The secondary cysts are detached from the inner surface of the parent.

A. exogena: in this, the progeny is developed from the outer surface. It is said to be found in the ox and other domestic animals.

In the examination of cysts supposed to be hydatids, careful search should be made for the hooks of *Echinococcus* or *Cysticercus*, which can frequently be found when no further remains of the body are distinguishable. These hooks are figured in Pl. 16. fig. 1*b*. See Entozoa and Echinococcus.

ACERVULINA, Schultze.—Under this name Schultze, in 1854, grouped as a genus some of the adherent varieties of *Planorbulina variabilis*, D'Orb., that have an irregular growth, with *heaped* chambers. They are found in warm seas, attached to algæ and other bodies. The word "acervuline" is applied to any such wildly aggregated growth in Foraminifera.

Bibl. Schultze, *Organism. Polythal.* 67; Carpenter, *Introd. Foram.* 209.

ACETIC ACID. — This is the well-known acid of vinegar.

It occurs in the juice of the flesh of animals; sometimes in the stomach in indigestion; also in the human blood after the use of alcoholic liquids, and in that of animals whose food has been soaked in spirit. It is also a common product of the decomposition of vegetable substances, both by fermentation and in distillation, as well as a component of the natural plants, mostly combined with lime or potash; it is also a rare constituent of some mineral waters.

The only salt of this acid requiring mention is the *acetate of copper* (neutral), which is made by dissolving common verdigris in excess of dilute acetic acid, filtering and crystallizing upon the slides. The crystals, when mounted in Canada balsam, exhibit well the phenomena of dichroism. Pl. 31. fig. 2.

Acetic acid is one of the most common and valuable micro-chemical reagents. It is particularly useful on account of its action upon animal cells in general, rendering the cell-walls transparent and the nuclei more distinct. The ordinary strong acid (sp. gr. 1044) should be used.

ACHARAD'RIA, Wright.—A genus of Hydroida (Polypi).

A. larynx resembles in habit *Tubularia larynx*. Marine; on stones.

Bibl. Str. Wright, *Qu. Mic. Journ.* 1865, iii. p. 50; Hincks, *Brit. Hydr. Zoophyt.* p. 133.

ACHE'TA.—A genus of Orthopterous insects, one species of which, *A. domestica*, the house-cricket, is familiar to every one. The general structure of this insect agrees so closely with that of *Blatta orientalis*, the common cockroach or black beetle, which is described at some length, that it requires no special notice here. (See Blatta.) Some parts of the internal structure of the cricket are very beautiful, as the tongue (Pl. 26. fig. 23), the gizzard (Pl. 27. fig. 1), and the ear in the fore legs (Pl. 27. fig. 7*b*). These, as also the curious mechanism by which the chirping noise of the male is produced, are described under Insects.

ACH'LYA, Nees (*Saprolegnia*, Kützing).—Remarkable microscopic plants, sometimes referred to the Algæ, but more properly belonging to Fungi. Cienkowski has recently confirmed the idea formerly entertained, that *Achlya* is an aquatic form of the Mucorinous Fungus called Sporendonema *Muscæ* (*Empusa Muscæ*, Cohn), the common fly-fungus. Cohn and Al. Braun deny the identity, while Berkeley thinks *Achlya* may be an aquatic form of *Botrytis Bassiana*. They are found growing parasitically upon the bodies of dead flies lying in water, also upon fish, frogs, &c., and in some cases upon decaying plants. To the naked eye they appear like colourless minutely filamentous tufts adherent to such objects, forming a kind of gelatinous cloud more or less enveloping them. When placed beneath the microscope, the tufts are seen to consist of long, colourless, tubular filaments, spreading out in all directions, with or without lateral branches; these erect filaments arise from a kind of mycelium of ramified filaments lying upon the object upon which the plant grows. The erect filaments are devoid of septa, narrowed upwards, and vary in thickness, being usually of smallest diameter in those cases where they are closely crowded; the ordinary thickness varies from 1-1000 to 1-350 of an inch. The tubes contain a colourless, slightly granular protoplasm, which is denser on the walls; and these sometimes exhibit an irregular spiral arrangement of the granules; the granules are seen to move slowly in anastomosing currents running in various directions, exhibiting, that is, the well-known phenomenon of the circulation of cell-contents, such as is met with in the hairs of *Tradescantia*, &c. The walls of the tubes are coloured blue by iodine and sulphuric acid, therefore consist of cellulose; the contents are nitrogenous, taking a bright yellowish brown with iodine; no trace of starch or of chlorophyll can be detected in the cell-contents in this stage, whence these plants are regarded by some authors as Fungi; but, as mentioned hereafter, Pringsheim states that their ripe spores do contain starch.

Kützing describes a number of species of this genus, under the name of *Saprolegnia*, while a recent observer, Pringsheim, regards them all as forms produced by varying external conditions. A. de Bary separates *Achlya prolifera*, Nees, from *Saprolegnia ferax*, Kützing, referring to the former the *Saprolegnia ferax* of Carus and the *Saprolegnia capitulifera* of Alex. Braun, to the latter the *Achlya prolifera* of Carus, and, doubtfully, the *S. molluscorum* of Nees and Gruithuisen. The distinction between these is said to lie in the details of the formation and emission of the active gonidia or zoospores, but we cannot make out satisfactory differences.

The following details respecting the formation of the active gonidia and the resting spores, are given at length on account of their well illustrating modifications of free-cell formation. In about thirty-six hours after the appearance of a specimen on any body, the apices of the erect filaments exhibit remarkable changes. The granular protoplasm, which at first is equally diffused throughout the tube, only densest where it lies on the wall, increases in quantity and "travels up" into the end of the tube, becoming accumulated there, giving it a brownish colour and at the same time causing its distension, so that the upper part of the tube acquires a clavate form, rounded off above. A sharp line of demarcation is soon formed by the division of the primordial utricle, followed by the production of a septum, which shuts off this clavate joint as the sporange; and a little projecting pouch or beak is developed at the summit, or sometimes a little below this on one side. The contents, becoming still more condensed, again apply themselves as a thick investment on the wall, leaving a lighter space in the middle of the cavity. Inequalities, or nodular protuberances, are soon observable in this layer, and it speedily becomes broken up into numerous little isolated portions, the individualization of these commencing at the summit of the sporange and becoming completed gradually from above downwards. The end-cell is now a clavate sporange filled with numerous polyhedral or globular new "primordial cells," in the development of which from the contents of the general parent-cell no trace of nuclei or "special parent-cells" can be detected; their size is about 1-2700 of an inch, and they have clearly defined outlines, but are still connected together by a gelatinous substance, in which they are completely imbedded. These secondary cells then become retracted from the walls, and accumulate in a dense, rather confused-looking mass in the centre of the sporange; endosmose of water through the now bare cellulose wall of the sporange seems to exert a pressure upon them, and also on the wall itself, which finally bursts at the process or beak mentioned above, and the secondary cells nearest the opening are shot out with some force, the rest following, but gradually more quietly. There is no independent motion of the contents, or jerking of the secondary cells, before this emission of the latter; on the contrary, while in the sporange, they adhere so closely that their shape is scarçely distinguishable, and it is only when the greater portion have escaped, that it is perceived that the pressure had caused them to assume a spindle-shape. As the emission of the secondary cells goes on, those escaping first are only removed so far as to make room for their successors, and the whole remain adherent together as a globular mass or "capitulum" seated on the apex of the sporange; they reassume, more or less completely, the spherical form, by degrees, after they have escaped from the sporange; those which can expand freely become globular, those pressed upon by their fellows become polyhedral. At the time of emission, these secondary cells exhibit a double line at the circumference, which seems to indicate the thickness of the primordial utricle. Soon after the expulsion another delicate line is detected external to these; and this indicates a newly produced envelope, which becomes thicker with age, and after a certain time can be coloured blue by sulphuric acid and iodine, which demonstrates its composition of cellulose. Application of a strong acid is necessary for this purpose.

The globular head of secondary cells remains for two or three hours attached upon the summit of the empty, colourless sporange. Then these minute cells emit their contents by a lateral orifice, giving origin, each of them, to a zoospore or active gonidium. Neither the motion nor the appearance of the cilia follows the expulsion immediately, but takes place after the gonidia have increased somewhat in size and acquired an ovate form. The duration of the motion lasts from a few seconds to a few minutes, after which the gonidium sinks to rest and begins to germinate. The gonidia possess no cellulose membrane while in motion, but acquire one when they come to rest and germinate. The cilia are two in number, and arise from the point which first emerged from the parent vesicle, and which at all periods exhibited a lighter tint, indicating a vacuole in the protoplasmic mass. If the expulsion of the gonidia is prevented, as occurs sometimes when the plant is kept under the pressure of a glass slide, in too little water, in microscopic investigation of it, the gonidia germinate within their cell-membranes, which, instead of discharging active zoospores, emit germinating prolongations, just like those issuing from the single germinating gonidia. These spread out here in all directions from the globular *capitulum*, still seated on the end of the sporange.

During the formation of these sporanges and the gonidia, after the septum has been completed, the tube sends out lateral branches from just below it, which sometimes equal the sporange in length by the time the latter discharges its contents; then this branch becomes developed as a sporange, either at its summit or in its whole length, or, when the branch is very short, the portion of the main tube below the first septum becomes a sporange. Sporanges of a third rank may succeed to those of the second rank, and so on, until the plant has exhausted the supply of food at its service. In another form the active gonidia are produced at once in the sporanges, without the intervention of secondary cells, and then they begin to move even before leaving the parent sac.

Achlya prolifera also produces, though more rarely, globular or spindle-shaped sporanges, either terminal or borne on special, short, lateral branches, in which are developed resting spores, characterized by a larger size, double cell-membrane, and by the absence of the cilia and consequent motion. The mode of their development is similar to that of the active gonidia, but they are much fewer in number, sometimes as many as twenty, sometimes only four, three, two, or even one being present in a sporange. When a number occur in a spindle-shaped sporange, they are ranged in two rows, alternately, so that each is partially interposed between its two opposite neighbours. Their diameter varies from 1-1250 to 1-750 of an inch, the colour brownish, displaying numerous oil-drops in the granular contents when mature. The sporanges producing them display a number of round orifices when the spores are ripe; but the spores appear to escape by the decay of the walls. These resting spores may remain unchanged in water for a long time when no suitable *nidus* exists, and then will quickly germinate if a dead insect or similar object is thrown in.

The resting spores are from 1 to 20, while the active gonidia are from 5 to 150, the number depending in each case on the size of the sporange, not upon the size of the spores or gonidia, which is tolerably regular. Pringsheim states that starch occurs in the contents of the resting spores of *S. ferax*.

A third form of reproductive organ is described by Cienkowski, which in the earlier stages resembles a sporange of resting spores; but the spores each produce a long tubular neck, which bores through the wall of the sporange and discharges its contents as minute swarming bodies into the water; these have not been seen to germinate.

These flask-shaped bodies resemble the formations seen by Carter in Spirogyra, and we have seen them in other Algæ. Al. Braun at first described them as a species of Chytridium, but subsequently has expressed an inclination to regard them as *antheridial* spores of *Achlya*.

In addition to the above, Al. Braun has described curled tubular processes, resembling the horns of *Vaucheria*, associated with the sporanges in which resting spores are formed, and he is inclined to regard them as *antheridia* exercising a fecundating office, like the horns of *Vaucheria*. Similar bodies have been recorded in other *Saprolegniæ*, especially in *Achlya cornuta*. (See Saprolegniæ.)

Bibl. A description of the supposed species will be found in Kützing's *Species Algarum*, p. 159. For further information on the development, see Al. Braun's *Rejuven. in Nature* (*Ray Society*, 1853, pp. 188, 268); Pringsheim, *Nova Acta*, xxiii. pt. 1. p. 397–460, 1851; Anton de Bary, *Botanische Zeitung*, x. p. 473, 1852; Unger, *Linnæa*, 1843, p. 129 (translated in *Ann. des Sc. Nat.* 3me sér. tome ii. p. 5. pl. 1. 1844); Meyen, *Pflanz. physiologie*, iii. 457; Nägeli, *Zeitschrift für Wis. Botanik*, heft 1. p. 102, heft 3, 4, p. 28 (*Ray Society's Reports*, 1845, p. 278, 1849, p. 101); Thuret, *Ann. des Sc. Nat.* 3me sér. t. xiv. p. 20, p. xxii, 1851; Ch. Robin, *Hist. des Végétaux Parasites*, 2nd edit. 1853, p. 372; Varley, *Trans. Microsc. Society*, iii.; Cienkowski, *Bot. Zeit.* xiii. p. 801; Al. Braun, *Ueb. Chytridium*, *Abhandl. Berlin. Akad.* 1855; *Verjüng. in der Natur*, p. 318 (*Ray Society*, vol. 1853, p. 298). A list of all the writers who had treated of *Achlya* before 1843, is subjoined to Unger's Essay in the *Linnæa*; Pringsheim, *Jahrbücher*, Bd. 1. heft 2, bd. 2. heft 2; Archer, *Qu. Mic. Journ.* 1867, p. 126.

ACHNANTHES, Bory.—A genus of Diatomaceæ (Cohort Achnantheæ).

Char. Frustules compressed; either single, in pairs, or united into a straight filament; geniculate in front view, without septa; attached by a stipes fixed to one angle; uppermost valve with a longitudinal median line, lowermost with a longitudinal line, and a median nodule or stauros.

The individual frustule, when single, or the lowermost when they are united, is furnished with a stipes or stalk, arising from one end of the lower margin. Side view of frustules elliptical, oblong or linear, sometimes slightly constricted in the middle; markings of upper and lower valves different, the upper (Pl. 12. fig. 2) exhibiting transverse rows of dots (appearing like striæ under a low power) interrupted by a longitudinal line, the lower (Pl. 12. fig. 3) being also furnished with transverse rows of dots, interrupted by a stauros, as also by a longitudinal line which in some has a nodule at each end. The valves being much compressed, the transverse rows of dots appear also in the front view. The hoops exhibit faint longitudinal and sometimes transverse striæ.

Achnanthes resembles *Striatella* in its stalked flag-like filaments, but may be known from it by the absence of internal siliceous plates or vittæ.

Four British species:—

Freshwater; markings faint (minute)	*A. exilis**.
Marine or brackish water; markings distinct.	
Stipes longer than frustules	*A. longipes*†.
Stipes shorter than frustules.	
Ends of valves acute	*A. brevipes*.
Ends of valves obtuse	*A. subsessilis*.

* Pl. 12. fig. 4. † Pl. 12. fig. 1.

Kützing enumerates 15 species of *Achnanthes*.

Bibl. Ralfs, *Ann. Nat. Hist.* xiii. 489; Kützing, *Bacill.* p. 75, & *Sp. Alg.* p. 54; Smith, *Brit. Diat.* ii. 25.

ACHNANTHIDIUM, Kütz. A genus of Diatomaceæ (Cohort Achnantheæ).

Char. Those of *Achnanthes*, mostly single, and without the stipes.

Five British species; freshwater:—

Filament of numerous frustules ...	*A. lanceolatum*.
Frustules few, valves constricted in middle	*A. coarctatum*.
Frustules few, often straight, valves constricted near the end............	*A. microcephalum**.
Frustules few, valves obtuse, unconstricted	*A. lineare*.
Frustules few, median line sigmoid	*A. flexellum* †.

* Pl. 12. fig. 5. † Pl. 12. fig. 6.

Frustules very small and markings very faint.

Bibl. Smith, *Brit. Diat.* ii. 30; Kützing, *Bacill.* 75, & *Sp. Alg.* 53.

ACHORION, Link and Remak.—The generic name applied to one of the vegetables occurring in *Favus*, and characteristic of that disease of the skin (also called *Porrigo* or *Tinea favosa*). The structure of the plant, *Achorion Schœnleinii*, bears much resemblance to that of the genus *Torula*; but it occurs in definitely bounded patches having a special arrangement of the microscopic elements of which it is constituted.

Ch. Robin gives a very full history of this plant; but it will suffice to abstract the principal points touching on the microscopic structure, previously to presenting some remarks tending to alter the opinion commonly entertained as to the nature of the so-called *Achorion.* The plant is found upon the human skin, either in the hair-follicles or in depressions of the surface. With regard to the former situation, it appears to be a secondary seat, as it were, since only the "spores" or moniliform filaments composed of rows of "spores" occur therein, adhering firmly to the hair and forming a kind of sheath around it. When it occurs upon the ordinary surface of the skin, it forms a little mass, like a little cup, the *favus*, which is at first developed beneath the epidermis, and laid bare afterwards by desquamation. The *favus* is somewhat hemispherical in general form, and varies from 1-25 to 3-5 of an inch in diameter, its depth or thickness being from 1-25 to 1-6 or 1-5 of an inch. The upper free side is concave, the lower convex, the colour is pale sulphur-yellow, sometimes a little browned by the presence of foreign bodies. The cup-like depression existing at first becomes filled up with advancing growth, and when the *favi* have acquired a considerable size, concentric lines are perceived upon the upper surface. The circumference of the free upper surface adheres to the epidermis, and the mass is generally traversed by one or two hairs, passing completely through it from below. When a vertical section is made of a favus dissected out of its seat, it is found to be composed of the following elements. The periphery consists of a granular crust, about 1-150 of an inch in diameter, the *stroma*, apparently a hardened exudation from the surrounding parts; this is lined by the *mycelium* passing in from it, composed of flexuous, branched, inarticulate filaments, uniform in thickness (at most 1-8000 of an inch). Next the mycelium, proceeding inwards, come the '*sporophores*,' consisting of tubes analogous to those of the *mycelium*, less flexuous, the fertile being more or less straight, terminating in strings of spores. The *spores* are round or oval, the smallest 1-8000 to 1-6000 inch, the largest 1-5000 to 1-4000 inch in diameter, the oval are as much as 1-3500 to 1-2500 in length; the spherical sometimes 1-3500 in diameter. Their membrane is well defined; water and acetic acid do not affect them.

Much has been written by medical authors regarding these bodies; but we shall not enter into this part of the subject here, further than to state that the presence of this vegetable structure seems to be essential and causative in the disease of the skin to which we have alluded. Remak was unable to make any of the spores germinate in or on animal substances; some however emitted prolongations when placed upon an apple, but the surface then decayed and turned brown within the week, and became covered with mildew (*Penicillium glaucum*). One of the entire corpuscles kept upon the arm for several days, fell off without leaving any mark, but a fortnight after a *favus* began to be developed. Gruby states that he inoculated various parts of the body with it, and even caused it to grow upon wood(?). Bennett ultimately confirmed the statements of Gruby as to the inoculation. Other authors are mentioned at the end of this article.

Unfortunately, most authors who have written on the parasitic fungi which occur in morbid conditions of the human frame, or are productive of disease, have not been well acquainted with either Fungi or Algæ. Numberless names have been assigned to them; and in consequence, while many of these organisms have been considered Algæ, they have been regarded by others as Fungi. It is, however, probable that all of them are mere conditions of the most universally diffused species of *Penicillium*, *Aspergillus*, *Mucor*, or *Cladosporium*—genera which are capable of propagation by cells thrown off from the threads, other than the normal fruit. It is quite impossible that, as supposed by Ardsten, such a genus as *Puccinia* could be produced on animal tissues.

Bibl. Ch. Robin, *Végétaux parasites*, Paris, 1853 (with plates, 2nd edit.); Bennett, *Vegetable nature of Tinea favosa* (*Porr. lupinosa* of Bateman), *&c.*, *Monthly Journ. of Medical Sciences,* 1850 (figs.), and *Trans. Roy. Soc. Edinb.* 1842, xv. pp. 227–294; Gruby, *Mém. s. la Teigne, &c.*, *Compt. Rend.* 1841, xiii. p. 72; *Sur les Mycodermes, &c.*, *ibid.*, 309; *Ueber Tinea favosa, Müller's Archiv,* 1842, p. 22; Hannover, *Müller's Archiv,* 1842, p. 281–295, pl. 15. figs. 7–9; Müller and Retzius, *Müller's Archiv,* 1842, p. 192, pl. 8 and 9; Lebert, *Physiol. Pathol.* ii. p. 477, Paris, 1845; Remak, *Diagnost. und Pathogen. Unters.* Berlin, 1845, p. 193–215; Bazin, *Rech. sur les Teignes,* Paris, 1853, 8vo (Plates).

ACHROMATISM. — A term properly signifying freedom from chromatic aberration; but commonly used to denote freedom from both spherical and chromatic aberration.

ACICULARIA, D'Archiac.—One of the *Foraminifera imperforata,* related to *Dactylopora,* and consisting of numerous chambers arranged in close order side by side without intercommunication, and forming minute aciculate cylinders, or narrow tapering plates. Known fossil only in some Tertiary beds of France.

Bibl. Carpenter, *Introd. Foram.* 137.

ACINERIA, Duj.—A genus of Infusoria, of the family Trichodinia.

Char. Body oblong or lanceolate, depressed, the fore part somewhat obliquely recurved like the blade of a sabre; a row of cilia, directed forwards, arising from one side.

Differs from *Trachelius,* Duj., in the arrangement of the cilia and in the anterior curvature; devoid of a mouth, like *Trachelius,* which especially distinguishes the present genus from *Pelecida.* 2 species:

1. *A. incurvata* (Pl. 23. fig. 1); marine, colourless; length 1-590 inch.

2. *A. acuta* (Pl. 23. fig. 2), found in fresh water; length 1-580 inch.

Dujardin figures in the latter species cilia upon both margins, those on one side being directed forwards, and those on the other backwards.

Claparède and Lachm. refer these to *Amphileptus.*

Bibl. Dujardin, *Infus.* p. 402; Clap. and Lachm. *Infus.* &c., p. 356.

ACINETA, Ehr.—A genus of Rhizopoda, belonging to the family *Acinetina.*

Claparède and Lachmann enumerate 8 species.

A. mystacina (Pl. 42. fig. 11). Yellowish brown, rounded, tentacles in two bundles; 1-120 to 1-800. On *Lemna minor.*

A. patula (Pl. 42. fig. 12). Body as if resting on a cup-shaped carapace, variable in form; contains brown granules. On marine Algæ. Norway. Length $\frac{1}{100}''$.

A. tuberosa (Pl. 23. fig. 4). Colourless or yellowish brown, triangular when expanded; tentacles arising from the distal angles only. Salt or brackish waters; 1-100 to 1-410.

A. Lyngbyi, ferrum-equinum and *cylindrica,* are referred by Cl. and Lachm. to *Podophrya.*

A. Notonectæ. On the hairs of the legs of *N. glauca.*

Bibl. Pineau, *Ann d. Sc. Nat.* 3 sér. Zool. iii. and ix.; Ehr. *Inf.*; Duj. *Inf.*; Claparède and Lachmann, *Etudes, &c.*; *Ann. N. H.* 1857, xix.; Stein, *Infus.*

ACINETINA, Ehr.—A family of Radiolarian Rhizopoda.

Char. Those of the Actinophryina, but with usually capitate and suctorial tentacles; the body being more or less enclosed in a carapace, which is generally prolonged to form a stalk.

The structure and relations of these animals are still very unsettled. The researches of Pineau and Stein tended to render the existence of the species doubtful, by showing that they were stages of development of *Epistylis, Vaginicola, Vorticella,* &c.; but this has since been found to be incorrect. The remarkable suctorial character of the tentacles has not been proved to occur in all the genera and species. Many, however, have been seen to take food voraciously, which is thus effected: when an Infusorium touches the button-like end of the tentacle, it usually remains adherent to it; the end becomes still more dilated so as to constitute a sucking disk, and the ray becomes thicker and shorter; the other rays at the same time making grasping movements, and endeavouring to attach their extremities to the captured prey. A current of chyme-particles is then soon seen running from the captured infusorium into the body of the *Acineta.* The chyme-particles form at first a slender row, but afterwards collect in a drop. The body of the *Acineta* then becomes opaque, from the collection of the drops.

The colourless or coloured ova described by Ehrenberg are partly chyme-particles, partly oil-drop-like globules which make their appearance in the *Acinetæ* after animal food. The ciliated swarm-germs to which they give origin have been traced directly into *Acinetæ.* Fission has been observed in *Acineta mystacina,* not in the others. The genera may be thus divided:

*Tentacles not borne upon a proboscis.
 Tentacles unbranched.
  Stalks simple.
   No shell { A peduncle .... 1. *Podophrya.*
   No shell { No peduncle { free .. 2. *Sphærophrya.*
   No shell { No peduncle { fixed. 3. *Trichophrya.*
   A shell { Peduncle present 4. *Acineta.*
   A shell { Peduncle absent . 5. *Solenophrya.*
  Stalks branched .... 6. *Dendrosoma.*
 Tentacles branched .... 7. *Dendromycetes.*
**Tentacles borne on a long proboscis .... 8. *Ophryodendrion.*

Here belong, perhaps, the genera *Corethria, Ephelota,* and *Zootcira* (Wright); and Alder's animalcules.

ACMOSPORIUM, Corda. See Botrytis.

ACOMIA, Duj.—A genus of Infusoria, of the family Enchelia.

Char. Body oblong-ovate or irregular, colourless or granular, turbid, composed of a glutinous homogeneous substance containing irregular granules, and ciliated only or principally at one end. Dujardin describes eight species, to which Perty adds one.

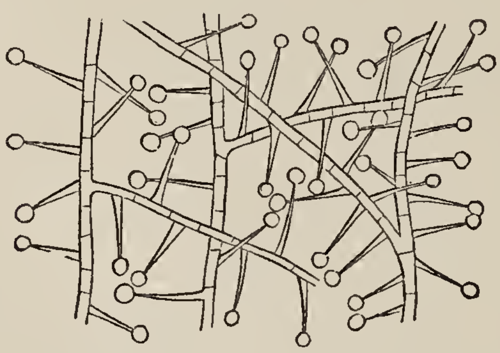
Some are marine, the others inhabiting decomposing infusions. All are minute and colourless.

A. vitrea (Pl. 23. fig. 3), aquatic (freshwater); length 1-868.

Bibl. Duj. *Infus.* p. 382; Perty, *Zur Kenntniss, &c.* p. 149.

ACREMONIUM, Link.—A genus of Hyphomycetous Fungi, belonging to the division Mucedines; distinguished by its jointed threads bearing numerous patent branchlets, each of which is terminated by

Fig. 2.



Acremonium fuscum (magnified).

a single globose spore. Perhaps only states of some other genus. British species:

1. *A. verticillatum*, Link. On dead wood, trunks of trees.

2. *A. alternatum*, Link. On decaying leaves.

3. *A. fuscum*, Schmidt (fig. 1). On dead wood and sticks.

4. *A. ranigenum*, B. and Br. On dead frogs. Distinguished by the threads being matted together below into a distinct stem.

Bibl. *English Flora*, v. pt. 2. p. 347; Greville, *Scott. Cryptogam. Flora*, t. 124. figs. 1 and 2; Berk. and Br. *Ann. Nat. Hist.* 1871, June.

ACROCARPI.—An artificial division of Mosses (see Mosses).

ACROPERUS.—A genus of Entomostraca, of the family Lynceidæ (Baird).

Char. Shell somewhat harp-shaped, the anterior inferior margin projecting and obtusely angular, inferior antennæ long; beak blunt, very slightly curved downwards; shell striated with longitudinal ribs directed obliquely downwards and forwards; colourless. 2 species:—

1. *A. harpæ* (Pl. 14. fig. 1); each branch of inferior antennæ with 3 long setæ from the extremity of the last joint only.

2. *A. nanus* (Pl. 14. fig. 2), much smaller than the last; anterior branch of inferior antennæ with 4 setæ, one arising from the second, and three from the end of the last joint.

This genus is scarcely distinct from *Camptocercus.*

Bibl. Baird, *Ann. Nat. Hist.* xi. 91; and *Nat. Hist. Brit. Entomos.* 129.

ACROSPERMUM, Tode.—A genus of Sphæronemei (Coniomycetous Fungi), consisting of minute, somewhat cartilaginous perithecia, a few lines high, discharging long, wavy, erect, simple, microscopic spores from a terminal pore or ostiole. British species:—

1. *A. compressum*, Tode. On dry stalks of herbaceous plants.

2. *A. graminum*, Libert. On dead grasses.

A. cornutum, which is not uncommon on the gills of blackened Agarics, is merely the winter resting-state of *Agaricus tuberosus.*

Bibl. *English Flora*, v. pt. 2. p. 221; *Grev. Sc. Crypt. Flora*, t. 182.

ACROSPORIUM, Nees. — A generic name, formerly applied to certain species of *Oidium* (see Oidium).

ACROSTALAGMUS, Corda.—A genus of Mucorini (Physomycetous Fungi), distinguished by its whorled branched septate threads, each branch terminated by a globose vesicle, which is pierced by the tip of the branchlet, from which numerous spores are given off within the vesicle.

Fig. 3.

Acrostalagmus cinnabarinus (highly magnified).

Verticillium lateritium is a form of this beautiful mould with minute naked spores.

The accompanying figure represents *Acrostalagmus cinnabarinus*, Corda. It grows in large patches on rotten potatoes. Hoffmann regards it as a mere form of *Trichothecium roseum*, which is rather a *Dactylium.*

Bibl. Berkeley, *Cryptog. Botany*, p. 294; see also Trichothecium and Verticillium.

ACROSTICHEÆ.—A subfamily of Polypodæous Ferns, with naked sori.

Illustrative genera.

1. *Acrostichum.* Sori seated on all the veins, venules, and parenchyma; veins very much branched, and anastomosing in more or less regular meshes.

2. *Campium.* Sori on all the veins, venules, and the parenchyma; veins very much branched, and anastomosing in more or less regular meshes, with free venules.

3. *Polybotrya.* Sori on all the veins, venules, and the parenchyma; veins pinnate, scarcely anastomosing.

ACROSTICHUM, L.—A genus of Acrosticheæ (Polypodæous Ferns), with naked sori seated on all parts of the leaf. Now broken up into several genera, such as *Platycerium* &c. See Hairs.

ACTINIA. A genus of Anthozoa (Polypes; Zoophytes).

Char. Body conical or cylindrical, adhering by a broad discoidal base; mouth simple, superior, surrounded by one or more uninterrupted series of conical, undivided, tubular tentacula, which are entirely retractile; marine.

Johnston describes 20 British species. They are commonly known as sea-anemones, and are found on the sea-coast adhering to rocks and stones. *A. mesembryanthemum* ($1-1\frac{1}{2}''$ diam.), with numerous azure-blue tubercles surrounding the margin of its oral disk, is very common on the British coast.

The body is formed of a thick coat, the inner layer of which consists of longitudinal and transverse muscular fibres. The tentacles are covered with stinging threads and capsules, as in the Acalephæ, often forming beautiful objects. The space between the stomach and the skin is divided into cellular spaces by radiate partitions; the ovaries and the spermatic convoluted tubes being attached to these partitions.

The fibro-areolar tissue, of which the parenchyma of the body consists, is composed of numerous fibres, cells, and intermediate stages, of extreme delicacy (Pl. 33. fig. 1), and somewhat resembling the fibroplastic tissue met with abnormally in the human body. Dispersed throughout it are numerous spindle-shaped, flexible, organic spicula (Pl. 33. figs. 1 *a* and 2), many of them curiously marked by interrupted transverse markings (fig. 2).

In reproductive power they almost equal the Hydræ; when cut across, new tentacles form in a few weeks on the lower half, and each piece becomes a new animal. They are usually propagated by ova, which pass from the ovaries into the stomach, where they are developed. Many of the species exhibit the most splendid iridescent colours.

Bibl. Johnston, *Hist. of British Zoophytes*, 1847; Tugwell, *Man. of Common English Sea-Anemones*; Gosse, *Mar. Zool.* 1, and "*Devonshire Coast*;" Bronn, *Die Klass. &c. d. Thierreichs*; Gegenbaur, *Vergl. Anat.*

ACTINISCUS, Ehrenberg.—A doubtful genus of Diatomaceæ, provided with siliceous shells bearing radiating spines. (Cohort Actinisceæ.)

Char. Individuals microscopic, solid, radiate, resembling a star; marine.

These organisms, which are found both recent and fossil, are ill understood at present. They are especially remarkable for their valves being frequently found perforated. Species:—

1. *A. Tetrasterias*, Ehr. (Pl. 43. fig. 1). Stellate, with 4 free rays; diam. 1-1000″. Virginia.

2. *A. Pentasterias*, Ehr. (Pl. 43. fig. 2). Rays 5; diam. 1-1200″. Recent on the shore of Norway; fossil in the chalk-marl of Greece.

3. *A. quinarius*, Ehr. (Pl. 43. fig. 3). Stellate, rays 5, free; diam. 1-3000″. Ægina.

4. *A. Sirius*, Ehr. (Pl. 41. fig. 45). Rays 6, acute, winged at the base; diam. 1-1200″. Shore of Norway, recent.

5. *A. Discus*, Ehr. (Pl. 43. fig. 4). Disk-shaped, centre smooth, 8 marginal rays not exserted; diam. 1-1200″. Oran.

6. *A. Rota*, Ehr. (Pl. 43. fig. 5). Disk-shaped, centre smooth, 10 marginal rays exserted; diam. 1-1900″. Oran.

7. *A. Lancearius*, Ehr. (Pl. 43. fig. 6). Stellate, with 8 marginal lanceolate rays, and some central shorter on one side; diam. 1-240″. Antarctic Ocean.

Bibl. Ehrenberg, *Leb. Kreidethierchen*, 1840, p. 69; *Monatsbericht*, 1844, p. 76, &c.; Kützing, *Kieselschal. Bacillarien*, 1844, p. 139; *Species Algarum*, 1849, p. 141.

ACTINOCLADIUM, Ehr.—A genus of Mucedines (Hyphomycetous Fungi). No British species yet recorded.

ACTINOCOCCUS, Kützing.—A genus

of exotic Algæ (marine), referred to *Rivularia* by Suhr (Kütz. *Tab. Phyc.* 31. fig. 2).

ACTINOCYCLUS.—A genus of Diatomaceæ (Cohort Coscinodisceæ).

Char. Frustules solitary, free or adherent to other bodies; disk-shaped; valves circular, exhibiting apparently cellular markings, with rays or bands radiating from the centre, which is free from the cellular appearance; no internal septa; marine.

The cellular appearance arises from the existence of depressions upon the surface. The radiant bands arise from undulations of the surface, which are best seen in the front view (Pl. 18. fig. 43 *b*).

Only 1 British species, *A. undulatus* (Pl. 18. fig. 43 *a*); rays 6, diam. 1-250 to 1-1100′′.

Kützing enumerates 34 species; some are found fossil.

Smith admits *A. duodenarius* (rays 12), *A. sedenarius* (rays 16), and *A. octodenarius* (rays 18) as British—species referred by Ehrenberg and Kützing to the genus *Actinoptychus.* These are found in the Medway.

Bibl. Ehrenberg, *Leb. Kreidethierchen*, 1840, p. 57; *Monatsbericht*, 1844, and *Mikrog.*; Kützing, *Kieselschaligen Bacillar.* 1844; *Species Algarum*, 1849; Roper, *Micr. Journ.* ii.; Smith, *Brit. Diat.* i. 25, and ii. 86.

ACTINODISCUS, Grev. A genus of Diatomaceæ.

Char. Frustules free, disk-shaped; valves granular, with a central nucleus, and numerous (15) linear smooth rays extending from it to the margin.

A. Barbadensis (Pl. 44. fig. 22). Diam. 1-250′′. In the Barbadoes deposit.

Bibl. Greville, *Micr. Trans.* 1863, 69.

ACTINOGONIUM, Ehr.—A genus of Diatomaceæ.

Char. Prismatic, frustules not forming a filament, subspherical, with 7 or more angles.

A. septenarium (Pl. 43. fig. 8). With 7 angles. Found fossil in Barbadoes earth, with Polycystina.

Not British.

Bibl. Ehr. *Monatsber. d. Berl. Akad.* 1847; *Ann. Nat. Hist.* vol. xx. p. 127.

ACTINONEMA, Fries. See Asteroma.

ACTINOPHRYINA, Duj.—A family of Radiolarian Rhizopoda.

Char. Body usually rounded, contained in a shell or shell-less, giving off radiate non-agglutinating pseudopodia, either from the entire surface, or from parts only; spicules and spines absent.

The genera may be divided thus:—

Shell absent.
  Pseudopodia arising from all parts of the surface .... *Actinophrys.*
    (*Acanthocystis.*)
  Pseudopodia arising from a zone near the circumference .... *Trichodiscus.*
  Pseudopodia arising from one side ... *Plagiophrys.*
Shell present.
  Free.
    Incrusted with foreign matter ...... *Pleurophrys.*
    Not incrusted, oblong.
      Orifice lateral .... *Trinema.*
      Orifice terminal .... *Euglypha.*
  Attached to foreign bodies .... *Urnula.*

Bibl. That of the genera.

ACTINOPHRYS, Ehr.—A genus of Actinophryina.

The species of *Actinophrys* are found in both fresh and salt water. The body exhibits contractile vesicles, mostly near the margin; but sometimes more diffused, and giving it a cellular appearance. Conjugation has been repeatedly observed; but authors are not agreed upon its import. The movement of the pseudopodia is very slow; granules may be seen continually moving in them, as in the Gromida and Foraminifera; but the circulation is much slower, and requires great attention and a high power to render it visible.

A. sol, E. (Pl. 23. fig. 7 *b*). Spherical, colourless, whitish tentacles radiating from all parts of the body; 1 or 2 contractile vesicles strongly projecting on the surface; parenchyma not reticular; diam. 1-430 to 1-1200′′; aquatic.

A. Eichornii, E. (Pl. 23. fig. 7 *a*). As *A. sol*, but parenchyma presenting a more or less regular cellular appearance; diam. 1-100′′.

A. marina, D. As *A. sol*, but marine, rather smaller, and movements of tentacles more rapid.

A. brevicirrhis, P. Greenish, not reticular; pseudopodia very short and very numerous.

A. pennipes, Cl. & L. Not reticular; pseudopodia few, slender, and very long; no projecting vesicle.

A. viridis, E. (Pl. 23. fig. 6). Spherical; greenish; rays shorter than the body; diam. 1-280 to 1-620′′; aquatic. Perhaps *A. sol* coloured by chlorophyll.

A. digitata, D. Colourless, depressed, tentacles flexible, thickened at base, and when contracted forming finger-like prolongations; diam. 1-770; aquatic.

A. granata, D. Spherical; opaque in

centre; rays taper, shorter than body; aquatic.

A. paradoxa, Carter. With numerous capitate and longer simple tentacles; aquatic. Bombay.

A. oculata, St.=*A. sol?* *A. discus*, D.= *Trichodiscus sol*, E. (Pl. 25. fig. 8). *A. pedicellata*, D. = *Podophrya fixa*, E. *A. stella*, Perty=the eggs of one of the Rotatoria.

The manner in which these animals feed is curious. Any part of the surface of the body may be converted into a temporary stomach. When an infusorium or a minute alga comes into contact with one of the tentacles, it generally becomes adherent. The tentacle with the prey then slowly shortens, and the surrounding tentacles apply themselves upon it, bending their points around the captive, so that it gradually becomes enclosed on all sides. In this way the prey is gradually brought to the surface of the body. The spot at the surface of the body upon which the captured organism is lying slowly retracts, and forms at first a shallow depression, which gradually becomes deeper and deeper, in which the organism is finally lodged. As the depression becomes still deeper, its edges coalesce, and thus a cavity closed on all sides is formed, in which it remains for a certain time and becomes digested. If there be any indigestible residue, a passage for its exit is formed, and it is expelled by further contractions of the substance of the body, and in the same or a different direction from that at which it entered, the canal and the aperture entirely disappearing.

Bibl. Kölliker, *Zeitschr. f. Wissensch. Zoologie*, Bd. i. (*Qt. Micr. Journ.* i.); Stein, *Archiv. f. Naturgeschichte*, 1849; Brightwell, *Fauna Infusoria of Norfolk*; Pritchard, *Infusoria*; Claparède and Lachmann, *Etudes*, *&c.*; Perty, *Z. Kenntniss &c.*, p. 159; Carter, *Ann. Nat. Hist.* 1864.

ACTINOPTYCHUS, Ehr.—A genus of Diatomaceæ. (Cohort Coscinodisceæ.)

Char. Frustules solitary, free, disk-shaped, with rays and internal radiating septa; valves apparently cellular (areolar), except opposite the rays.

The presence of true internal septa is doubtful; hence it becomes a question whether this genus should not be consolidated with *Actinocyclus*.

Kützing enumerates 16 species, distinguished principally by the number of septa and rays: *A. ternarius*, septa 3; *A. quaternarius*, septa 4; *A. senarius*, rays 6 (Pl. 18. fig. 45), &c. *A. hexapterus*, with 6 thick, solid conical rays, is one of the calcareous corpuscles of an echinoderm; the margin of the disk thick, undulate, and toothed within. Many of the species are fossil.

Bibl. Ehrenberg, *Infus. Abh. d. Berl. Akad.* 1838, and *Berl. Bericht.* 1844; Kützing, *Bacill.* 134; *Sp. Alg.* 130; Greville, *Micr. Trans.* 1866, p. 5.

ACTINOSPHÆRA, Perty.—A doubtful genus of Rhizopoda.

Char. Body minute, spherical, surrounded with irregular, rather rigid processes. Movement that of swimming on various axes.

Processes stout and taper. Body colourless, containing greyish-green (food-) spots.

Bibl. Perty, *Zur Kenntniss &c.*, p. 189.

ACTINOSPHÆRIUM=*Actinophrys*, in part.

ACTINOTHYRIUM, Kunze.—A genus of Sphæronemei (Coniomycetous Fungi), forming minute round, flat, black spots, with a central boss of close, radiating, fibrous structure. British species:—

Fig. 4.

Actinothyrium graminis (highly magnified).

A. graminis, Kunze. On leaves and stalks of Grasses in spring (fig. 4). The innate, radiately fibrous, shield-like perithecium finally dissolves at the apex. The stylospores, which are spindle-shaped, are formed beneath the disk, attached by their bases; Fries conjectures that they are transformed asci.

It is probably a state of some *Sphæria* or allied genus.

Bibl. Greville, *Scott. Crypt. Flora*, t. 218.

ACTINURUS.—A genus of Rotatoria, of the family Philodinæa, Ehr.

Char. Eye-spots two, frontal (red); tail-like foot with 2 lateral horny processes and 3 terminal toes. (*Rotifer* with 5 points to the foot.)

Agrees with *Rotifer* in general structure; teeth 2 in each jaw (Pl. 34. fig. 2).

1 species, *A. Neptunius* (Pl. 34. fig. 1). Colourless, body attenuated; length 1-18 to 1-36″. Very common, aquatic.

ADELOSINA, D'Orb.—At first regarded as a generic form, but now recognized as only the young condition of some of the Milioline Imperforate Foraminifera. *Spiroloculina*, *Quinqueloculina*, and *Triloculina*, subgenera of *Miliola*, commence their growth, after the fashion of their congeners also, with a relatively large, subglobose "primordial chamber;" and the succeeding growth produces a curved flask-like chamber, closely enwrapping one side of the former. Until the successive lateral overlappings by new chambers build up the nearly oval outline of the adult *Miliola*, the young shell is one-sided, and may be termed "Adelosina." Found in all seas, and common among Tertiary and Cretaceous fossils at many places.

BIBL. Williamson and Carpenter, *Brit. Foram.*; D'Orbigny, *For. fossiles d. Vienne*, 301.

ADIANTEÆ.—A subfamily of Polypodioideæ (Polypodiæous Ferns).

Illustrative Genera.

Sori on the notches of the fronds.

1. *Lonchitis.* Veins anastomosing; sori linear, semilunate; indusium marginal, semilunar, free within.

2. *Hypolepis.* Veins pinnate; sori subglobose, on the inferior border of the sinuses of the laciniæ or teeth of the frond; indusium marginal, semilunar, free within.

Sori on the margin of the fronds.

3. *Lomaria.* Veins pinnate, forked; fertile fronds narrower; sorus linear, continuous; indusium linear, continuous, free within.

4. *Pteris.* Veins pinnate; sorus continuous; indusium marginal, linear, free within.

5. *Amphiblestra.* Primary veins strong; venules much branched, anastomosing in unequal hexagonal spots; sorus linear, continuous; indusium marginal, linear, free within.

6. *Litobrochia.* Veins anastomosing in hexagonal spots; sorus linear, continuous; indusium marginal, linear, free within.

7. *Allosorus.* Veins pinnate; sori at first roundish and distinct, very soon confluent, and then linear and continuous, covered by the reflexed margin; indusium marginal, linear, continuous, free within.

8. *Cassebeera.* Veins pinnate; sori two under each notched tooth of the leaf; indusium marginal, roundish, covering the pair of sori.

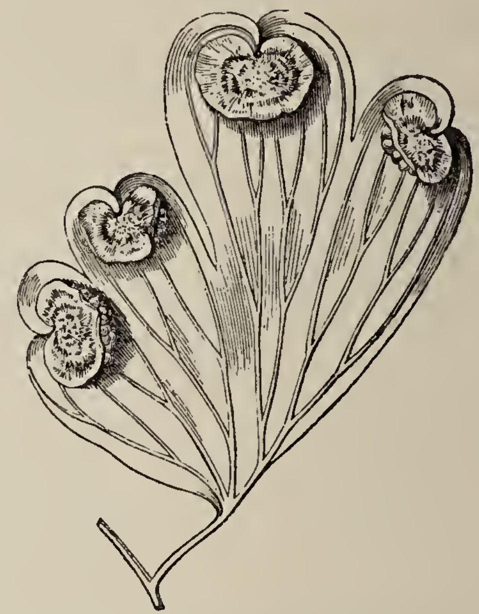
9. *Adiantum.* Veins fan-pinnate; sori linear, indusium linear or semilunar, free within.

10. *Hewardia.* Veins reticulated; sori linear; indusium linear or semilunar, free within.

11. *Cheilanthes.* Veins pinnate; sori subglobose, minute, covered by the reflexed apex of a tooth and the indusium; indusium marginal, scarious, narrow, free within.

ADIANTUM, Linn.—A genus of Adianteæ (Polypodiæous Ferns), with one elegant indigenous, and many exotic species.

Fig. 5.



Adiantum (pinnule with sori covered by indusia); 5 diam.

ADULTERATIONS.—A very important use to which the microscope is applicable, consists in the detection of various adulterations of articles of food, drugs, and products of the arts and manufactures.

The first point in a question of adulteration is, to determine, by microscopic and micro-chemical analysis, the structure and composition of the pure substance; and if the Table given at the end of the Introduction be kept in view in this proceeding, but few points will probably be overlooked. On then comparing these results with those obtained by a similar mode of proceeding in regard to a suspected substance, there will in general be found little difficulty in determining whether it is pure or not. If impurities or adulterating ingredients are present, the next point will be to determine their nature. To do this with certainty, would require that the structure and composition of every kind of substance, either natural or artificial, should be known, which would imply an amount of knowledge possessed by no one. But the question is simplified in practice, because substances used in adulteration must be cheap, and either grown or manufactured in quantities at home, or imported from abroad. Hence they are generally common, and it is pretty well known of what they will probably con-

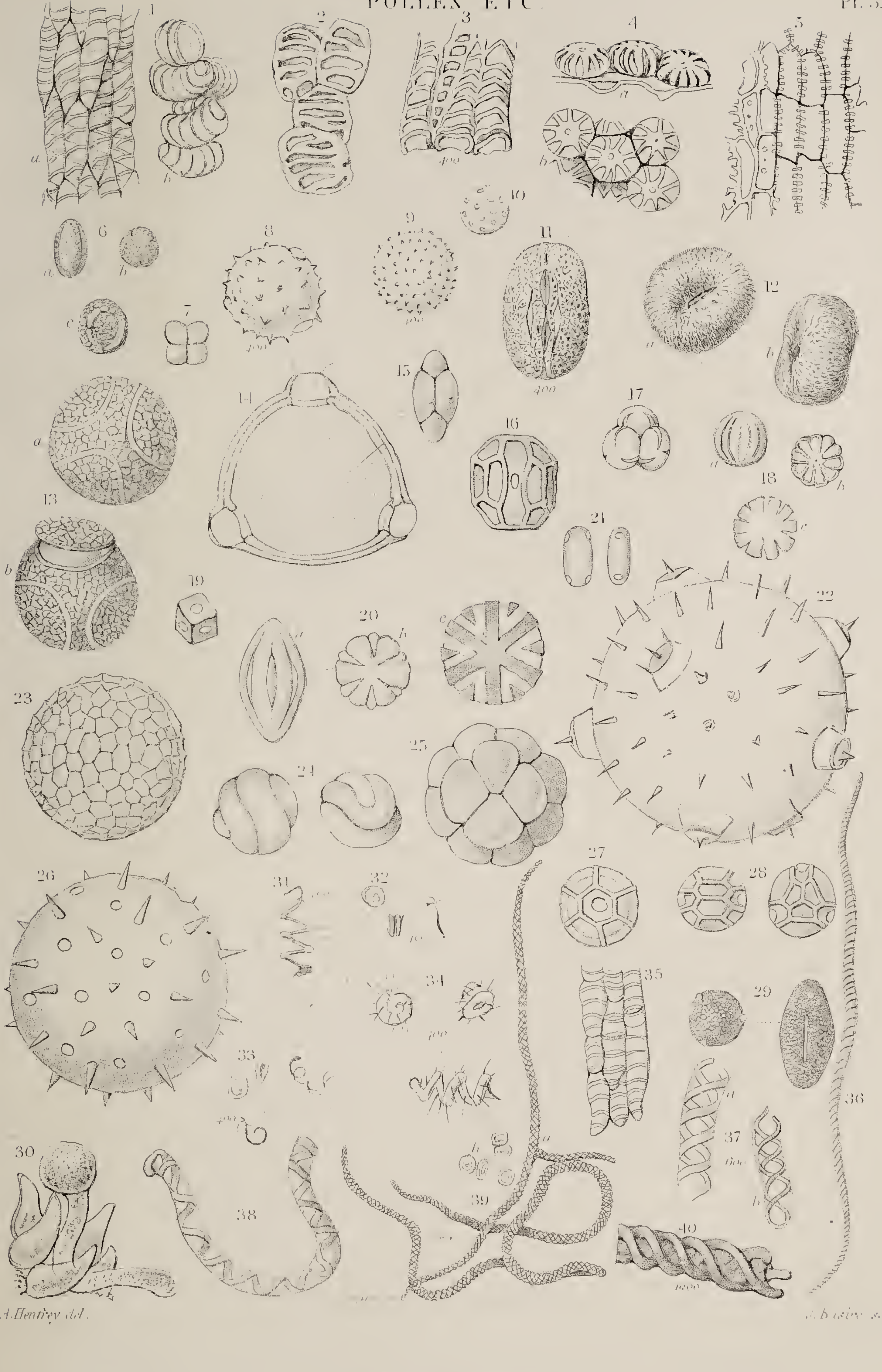
G. Jarman sc.

London. Van Voorst. 1871.

A. Henfrey, del. J. Basire, sc.

London, Van Voorst, 1871

POLLEN ETC.



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