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ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

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III.—*On the use of Incandescence Lamps as Accessories to the Microscope.* By C. H. Stearn, F.R.M.S.

(*Read 10th January*, 1883.)

As for the last ten years I have not followed the progress of microscopical science, I cannot but feel that in venturing now to speak on microscopical subjects, I am in a similar position to that of a colonist who, on returning to his native land, finds that the world has moved on and left him far behind. Yet it is my hope that from those fields of research in which my thoughts have of late years been straying, and in which my former microscopical pursuits have been discontinued, I may have been able to glean some information which, though not primarily connected with microscopical science, may, in its practical application, prove of some utility to microscopists.

When, in 1871, I first commenced the study of the physics of high vacua, it was with the object of investigating the law governing the arrangement of the lines in the spectra of rarefied gases; but after my meeting with Mr. J. W. Swan, in 1877, I entered with him upon an investigation, having for its object the discovery of the conditions under which thin carbon conductors could be rendered permanent when made incandescent by an electric current in the most perfect attainable vacuum. With what success that investigation was attended, my colleague has already described in his lectures and pamphlets; and I presume that there are few here present to whom its practical results in the form of incandescence lamps are not by this time familiar.

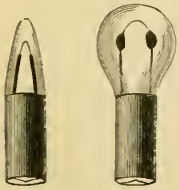
From a scientific investigation, the matter has now grown into a great commercial enterprise, and ere many months are over, there seems a probability that in many places gas will be entirely superseded by electrical illumination. When this happy time arrives, the application of the incandescence electric lamp to the purposes of microscopical illumination will certainly become universal, as it will then be not only the purest and most satisfactory light, but will be at the same time the most convenient. I hope, however, to show that microscopists need not wait for the realization of the hopes of the shareholders in electric companies, and the fears of those interested in gas companies, but may at once discard their troublesome oil or gas lamps, with many of their accessories, and proceed at once to avail themselves of the advantages of electric illumination. I am aware that Dr. Van Heurck, of Antwerp, has anticipated me in the application of our lamps to the Microscope; but, as those employed by him were of comparatively

large size,* the battery power necessary to render them incandescent would, till electricity is supplied from a central station, constitute a bar to their general use.

There can be no advantage in using a large light at a distance from the object, when a small one near to it will give as good, or better, results, and will at the same time require the expenditure of so little electrical energy, that the trouble attendant on the use of the battery is almost inappreciable; and in this way the lamp can be made a permanent attachment to the Microscope itself.

The lamps I have constructed for the purpose are shown full size in figs. 1 and 2, and *in situ* on the Microscope in fig. 3 at A B and C. The length of the incandescent filament is 1-10th of an inch, its diameter 1-166th of an inch, and its superficial area about 1-555th of a square inch. Two Bunsen or four Leclanché cells are sufficient to render them fully incandescent; but for general purposes it will be best to use an additional cell, regulating the intensity of the light by means of the adjustable resistance coil D interposed in the battery circuit and attached to the base of the Microscope.

Fig. 1. Fig. 2.



As the duration of the lamps is in an inverse ratio to the temperature at which they are maintained, it is desirable that the most intense light that the lamp will give should only be employed for a very short time when a special effect is required; such, for instance, as for purposes of micro-photography. If the lamp is at other times used no brighter than is necessary to obtain a white light, and the current turned off when observation is not going on, the lamps will last a very long time, as experience has shown that a life of more than 2000 hours of continuous and brilliant incandescence is frequently exceeded by Swan lamps. It is possible to obtain a light of $2\frac{1}{2}$ candles from the tiny surface just mentioned, with an electro-motive force of $3\frac{1}{2}$ volts, and a current of $1\frac{1}{4}$ amperes. It would, however, at a safe temperature, give a light equal to one candle.

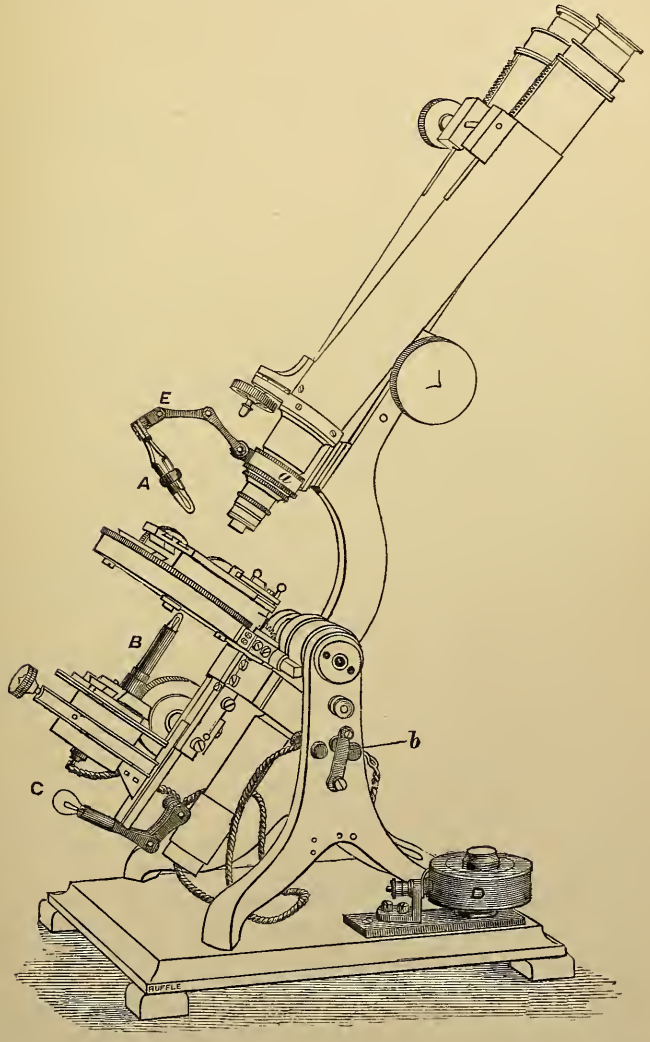
It will be found the most convenient plan to keep more than one, say three, of these lamps on the instrument, so that by merely turning a switch the position of the light may be varied.

(1) For the illumination of opaque objects the lamp A (fig. 3) is attached by a jointed arm E, to an insulated collar *a*, which screws on above the objective. The source of light can then be rotated around the object while under examination, so that delicate surface markings can be readily brought out.

* Since the above was written Dr. Van Heurck has informed me that he has used lamps requiring an electro-motive force of not more than 7 volts.

(2) On moving the switch *b* from the central position to the right, contact is made with another stud, and the current passes to a second lamp B, mounted on a platform fitting into the substage,

Fig. 3.



and capable of rotation and lateral adjustment, so that direct or oblique illumination at any angle may be obtained.

As the source of light is almost a point, and the lamp can be brought very nearly into contact with the slide, a greater degree of obliquity of the illuminating rays can thus be obtained than by almost any other method, and hence black-ground illumination is shown with great beauty, and many of the diatoms display diffraction colours with unusual splendour. The resolution of test objects becomes very much simplified, as most of them can be resolved by the lamp alone, without any accessory apparatus.

(3) For use with the polariscope, a third lamp C, of slightly larger size, is placed in the position of the usual mirror. It is put in action by moving the switch to the left, so as to make contact with the third stud. This lamp requires an additional cell so as to develope a light of about four candles.

As the sockets of the lamps are all made to a standard size, it is easy if more light be required than is given by the smaller lamp, to transpose the larger one to either of the other positions and use the full strength of the battery. If it is found desirable with the lower powers to give parallelism or convergence to the rays, a very small lens can be mounted in front of the lamp.

If a more simple mounting is desired, the forms shown in figs. 4, 5, and 6 may be adopted; and the lamp can be thus placed in any position above or below the stage.

If it is required to maintain the lamps for several hours at full incandescence, the most satisfactory battery to use would undoubtedly be a Bunsen or Grove. If, however, the switch is turned off whenever an observation is completed, a recent modification of the Leclanché answers admirably; for if exhausted through polarization it recovers itself when left for a short time, and will, when once filled, keep in good order for several months. It is best to use five of these modified Leclanché cells, controlling the strength of the current by means of the resistance, and diminishing it as the potential of the battery falls. For all ordinary work these Leclanché cells will be found to meet all the requirements of the microscopist. The Swan-Sellon, or Faure accumulator will also be found convenient, but these are at present rather expensive luxuries; and though they last for a considerable time when charged, the trouble of charging at intervals would probably counterbalance the advantages gained in other ways.

I have been able to light these lamps satisfactorily with a small dynamo, about five inches in length; and if it be possible to obtain a spring which can be wound up by hand, and will drive it for about half an hour without occupying too great a space, this may probably be a very convenient method of obtaining the current when required. When, however, we consider that to obtain the amount of electrical energy represented by the product of $3\frac{1}{2}$ volts and $1\frac{1}{4}$ amperes, we should have to expend about 4 or 5 foot-lbs. of mechanical

energy per second, the probability seems rather remote; and both for convenience and economy, the modified Leclanché cells carry off the palm at present, so far as microscopical illumination is concerned.

Fig. 4.

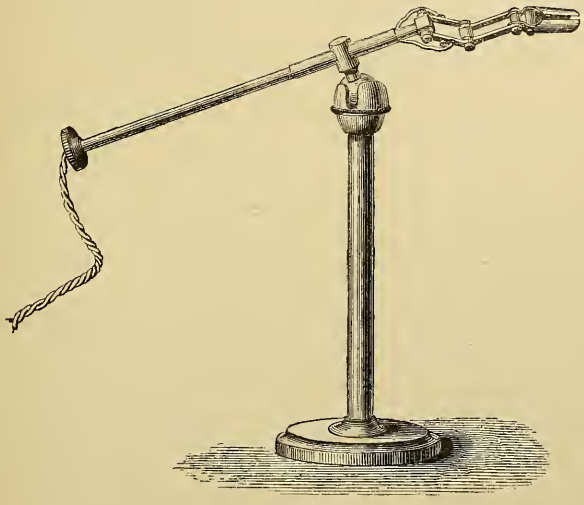


Fig. 5.

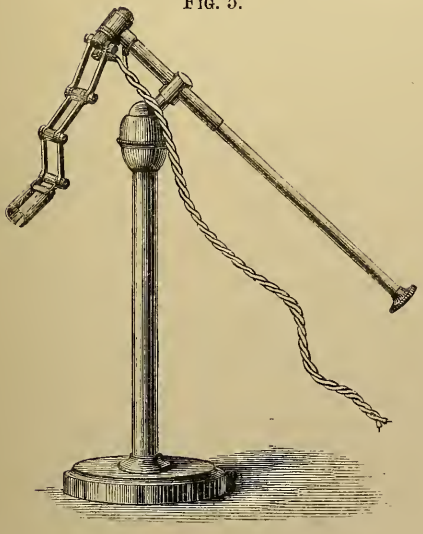
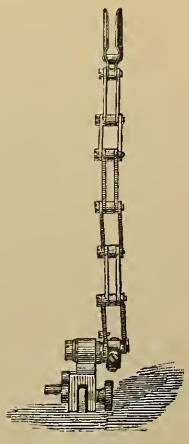


Fig. 6.



that the sections of the former were too thick, and that the closed chambers which he described must be open, as they were filled up by the immersion in balsam. Müller, however, only admits an aperture on the outer side.

Impressions on collodion do not appear to have given the results expected by the authors who employed it. On the other hand, the submersion of the valves has equally furnished facts which are wanting in concordance.

Photographs, again, give only illusory diffraction images, and the suggested examination of the valves by reflected light cannot eliminate these errors.

To show the difficulty of these investigations it is sufficient to recall the fact that the parts which are much less delicate, such as the connective, the raphe, and the nodules, still give rise to very diverse interpretations. M. Prinz thinks that these divergences originate in great part from the want of distinctness in the sections obtained by cutting diatoms contained in a medium without consistency, such as gum arabic.

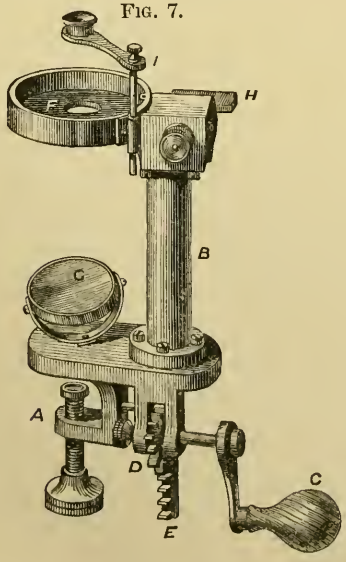
The author is about to re-examine some diatomiferous rocks with the assistance of Dr. Van Ermengem.

MICROSCOPY.

a. Instruments, Accessories, &c.

Boecker's Air-pump Microscope.—E. Boecker, of Wetzlar, manufactures the air-pump Microscope shown in Fig. 7, which enables an object to be examined in a vacuum under the Microscope, and the progressive effects attendant upon the exhaustion of the air watched, as well as serving for the more ordinary purposes of an air-pump in mounting.

Fig. 7.

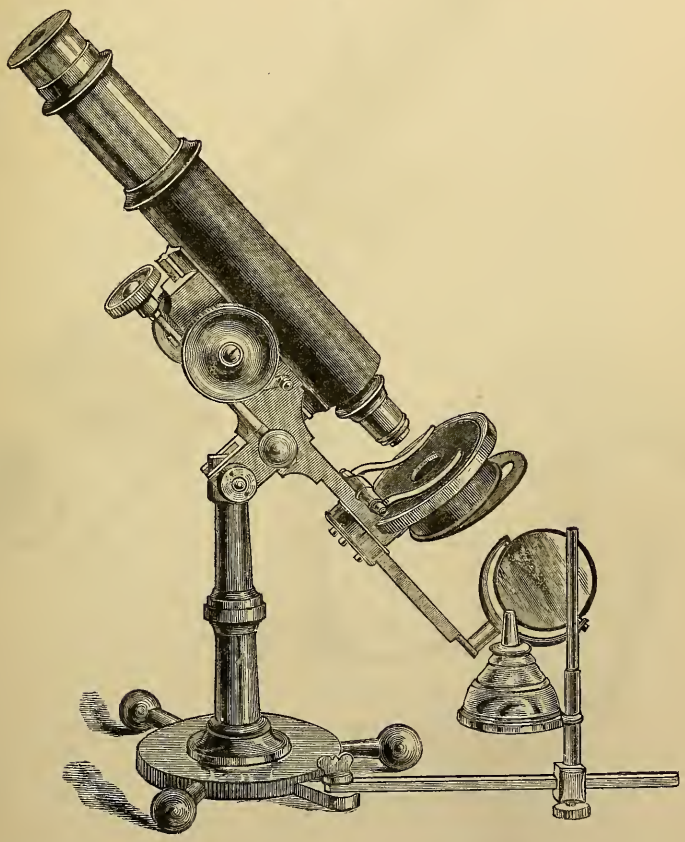


The apparatus is secured to the table by the clamp A, and the piston of the pump B is put in operation by the handle C acting on a rack and pinion D E. The chamber F ($2\frac{3}{4} \times \frac{3}{8}$ in. deep), in communication with the pump, is pierced with a central aperture which is closed by a piece of glass, allowing the light from the mirror G to reach the object placed in the chamber. The latter is made air-tight by a circular glass plate greased at its margin. H is the tap for readmitting the air. Either a simple or a compound Microscope can be attached

to the arm I, and the object observed while the chamber in which it is placed is being exhausted.*

Improved Griffith Club Microscope.† — The original "Griffith Club Microscope" was described in Vol. I. (1881) p. 293. Since that time important changes have been made by Mr. E. H. Griffith, so that very little of the original form is left, as will be seen on comparing figs. 8 and 9 with the earlier illustrations. It retains its original

Fig. 8.



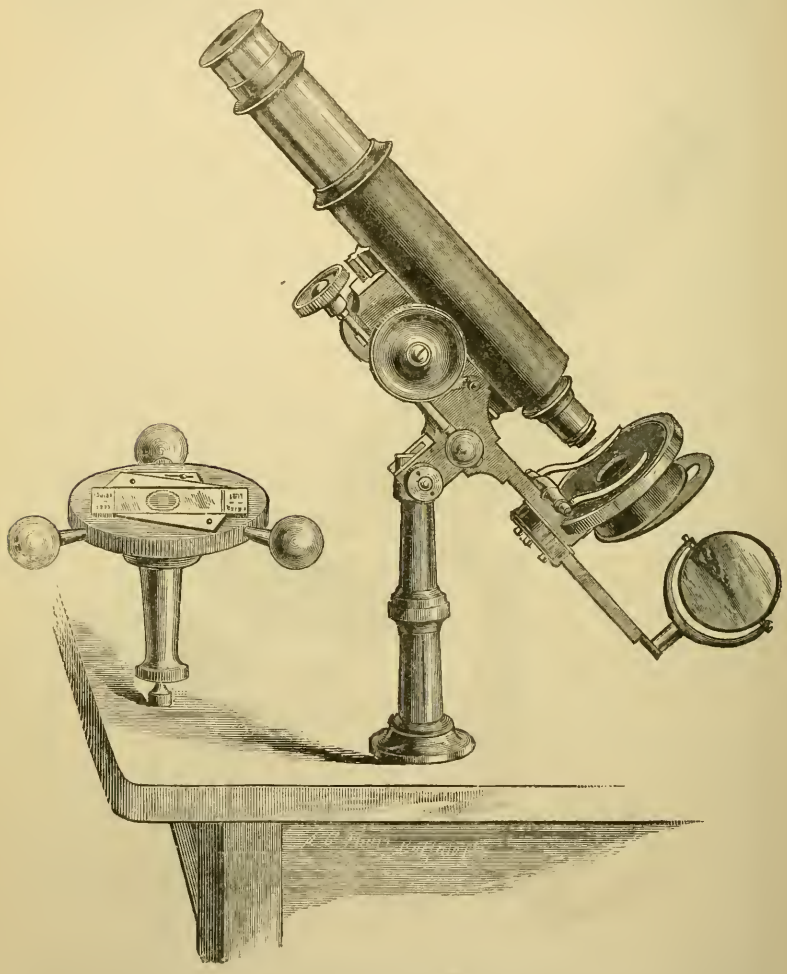
name in appreciation of the honour conferred on the inventor by the "Griffith" Clubs of Detroit and Danville, U.S.A. It is a full-sized

* Since the above was in type we observe that a nearly identical instrument is described by Dr. L. Dippel (in 'Das Mikroskop,' 2nd ed. 1882, p. 685, fig. 496) as made by Zeiss.

† Proc. Amer. Soc. Micr., 5th Annual Meeting, 1882, pp. 149–52 (3 figs.).

instrument and the main and draw tubes have the Society screw. The coarse adjustment is effected by rack and pinion on the "Jackson" principle, and has about 3 in. of motion. The fine adjustment, which appears to be both simple and efficient, is effected

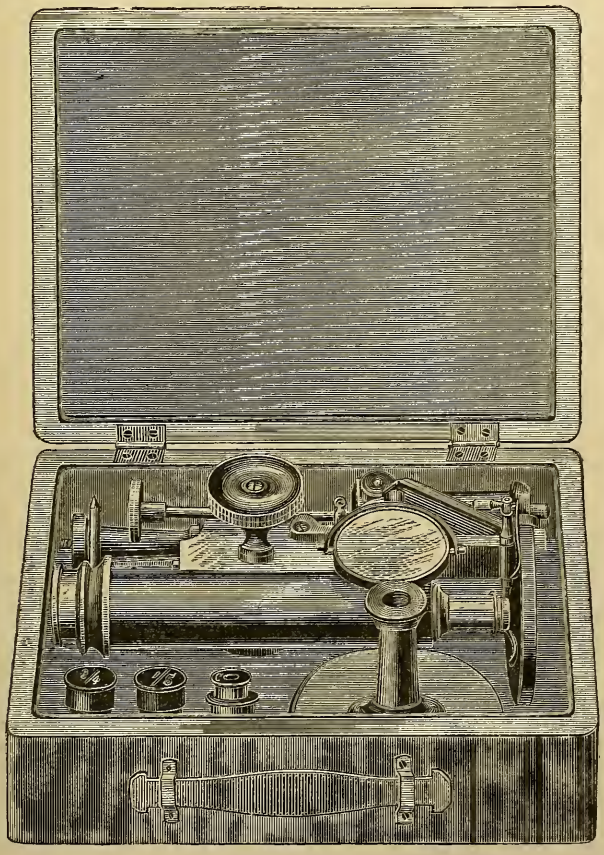
Fig. 9.



by the application of a worm-wheel and tangent-screw to the axis of the pinion of the coarse adjustment. The worm-wheel is on this axis, near the limb, and it is acted upon by the tangent-screw being sprung against it, the milled head of which is shown behind the limb in fig. 8. When the coarse adjustment is in use, a "snail"-shaped

lever on the right of the limb (handle shown beneath the large milled head) forces the tangent-screw from contact with the worm-wheel, a spring latchet locking it in position. By releasing the "snail" lever the tangent-screw is pressed into the worm-wheel, and acts upon the coarse adjustment so slowly that objectives of high power can be focussed with it. It will of course be understood that when the

Fig. 10.

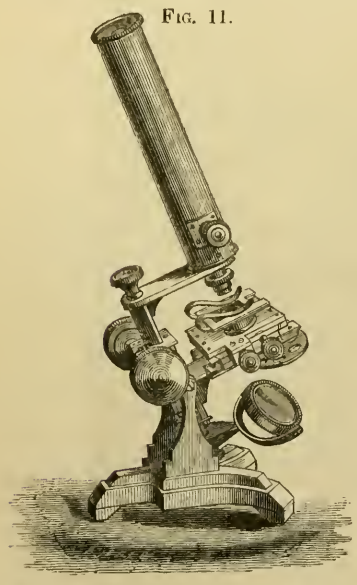


tangent-screw is sprung against the worm-wheel the coarse adjustment is no longer operative, which Mr. Griffith considers to be a protection against breakage of slides. A similar system of fine focussing was adopted in England many years ago, and is still used in some of Plössl's models. The stage clips are supported on a bar above the stage, allowing the slide to make almost a complete revolution. The

mirror-bar is adjustable in length, and the mirror can be set at any angle above or below the stage, allowing any obliquity of illumination for opaque and for transparent objects. The standard divides midway between the body and the foot, and the base may be detached, and the body set on an extra standard (fig. 9), with a screw at the end for fixing it in a tree, laboratory table, &c. The base being inverted and placed on a spindle, which is always in position in the box, becomes a turntable, provided with self-adjusting clips for holding the slide. Three rods, with silvered balls at one end, are the supports for the Microscope, and they give momentum to the turntable when in use. Two small holes in the edge of the turntable foot allow the attachment of an adjustable lamp-holder, which is furnished with a lamp for class, lecture, and exhibition use. A case about $7\frac{1}{2}$ in. long, $5\frac{1}{2}$ in. wide, and 3 in. deep, internal measure, holds the instrument when packed (fig. 10), and it may be taken down and packed for travelling or be taken from the box and set up ready for use in a few seconds, "making the Microscope not only a first-class monocular for home and office use, but also for the tourist and the naturalist." The Bausch and Lomb Optical Company are the makers.

"Midget" Microscope.—Owing to a misunderstanding the accompanying woodcut (fig. 11) of this Microscope was not given with its description at p. 852 of Vol. II. (1882), only the outline drawing to scale appearing with fig. 156 for comparison.

Fig. 11.



Microscopes for the Examination of Divided Circles.*—A somewhat novel application of Microscopes is seen in Wanschaff's apparatus for examining divided circles (fig. 12). The various parts of the base of the instrument are indicated by the letters *a*, *b*, *c*, *d*, and *e*, but these do not require notice here.

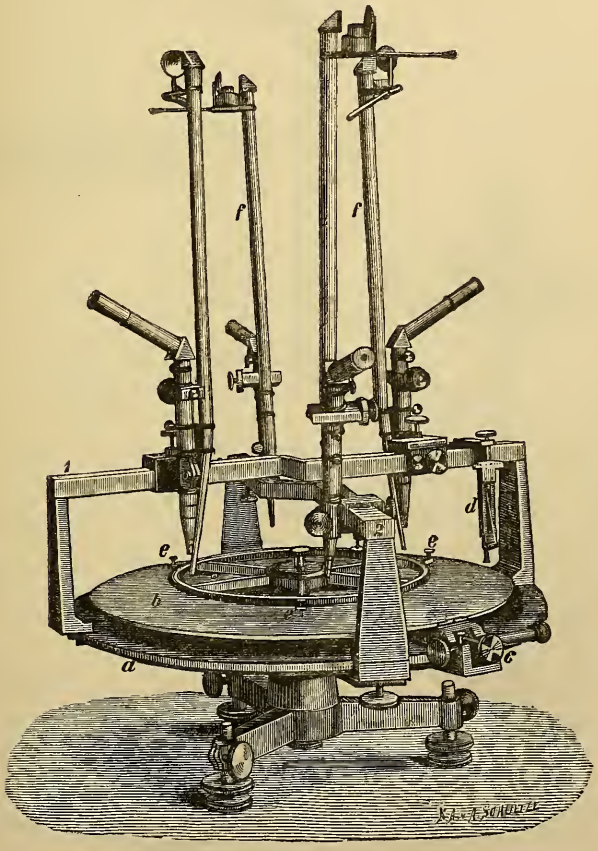
The lower fixed disk has two arms, upon which are adjusted four Microscopes intended to be directed upon the divisions of the circle under examination. The body-tube in all is, for greater convenience, bent outwards, with a prism at the angle. The power is about 60. The arm 1 is immovable, whilst 2, with its supports, can be revolved, so that the Microscopes on the two arms respectively can be placed at any desired

* Bericht über die wiss. Instrumente auf der Berliner Gewerbeausstellung im Jahre 1879 (L. Loewenberg), pp. 74-6 (1 fig.).

angle to each other. In order that they may be brought quite close together, those on the arm 1 are fixed perpendicularly to the plane of the disk, while those on 2 are inclined outward, so that the same division can be observed through two Microscopes.

The illumination of the circle is effected through four tubes *f*

Fig. 12.



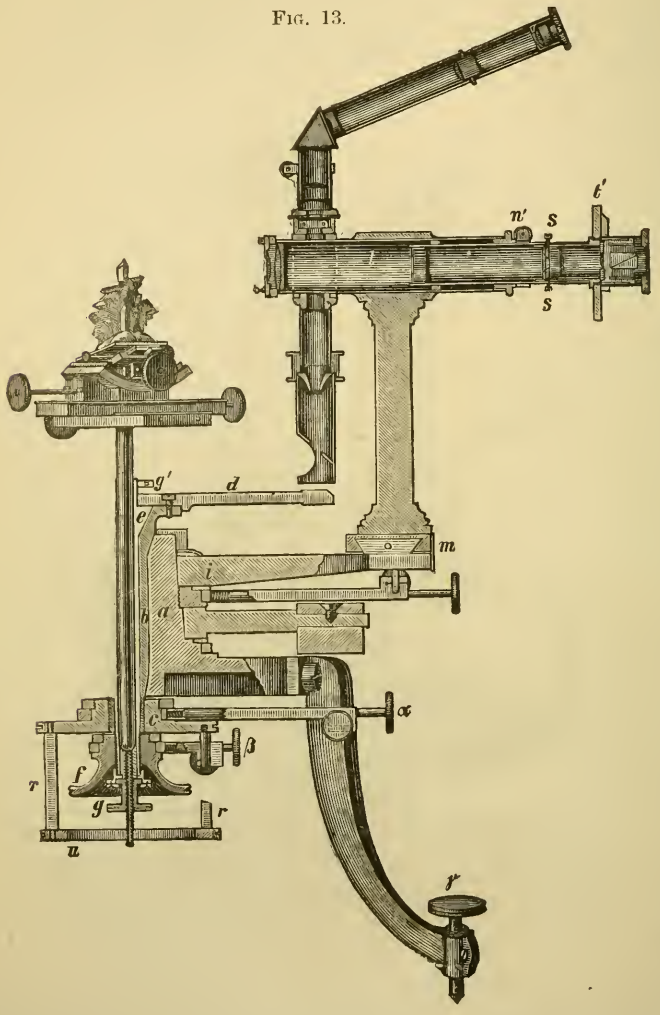
attached to the Microscopes, through which by means of concave mirrors and reflecting prisms, the light from four lamps is conducted down on the part of the circle to be examined.

Prof. W. A. Rogers, it will be remembered, uses for the same purpose the arrangement devised by Mr. Tolles, in which a prism is inserted between the lenses of the objective.* This would appear to be more convenient on the whole.

* Cf. this Journal, iii. (1880) p. 754.

In Fuess's Reflecting Goniometer* (fig. 13) two Microscopes are also arranged in a somewhat peculiar manner for reading off the

Fig. 13.



divisions on the divided circle. One passes through the telescope and the other through the collimator of the instrument, as shown in the figure.†

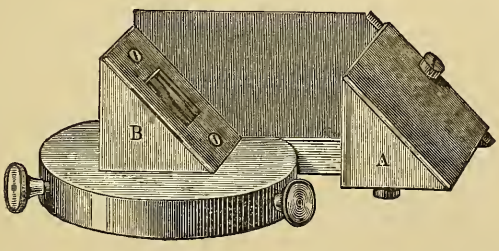
* Bericht über die wiss. Instrumente auf der Berliner Gewerbeausstellung im Jahre 1879 (L. Loewenberg), pp. 321–30 (4 figs.).

† The left (similar) half of the woodcut has been removed. The lettering refers to the parts of the instrument other than the Microscope.

Abbe's Camera Lucida.*—Dr. L. Dippel describes an addition to this apparatus† by which drawing with high powers is much facilitated. Between the prism and the mirror are interposed two movable glass plates of different tints, which can be used together or separately and serve to equalize the illumination of the field and the paper. Dr. Dippel adds, "so far as my experiments go the modified instrument surpasses all drawing instruments known to me in so high a degree that it must come into very general use."

Cameræ Lucidæ of Nobert and of Doyère and Milne-Edwards.‡—We describe and illustrate these forms more as a "contribution to the history of the camera lucida" than as offering any novelty at the present day. In the form introduced by Nobert (fig. 14)

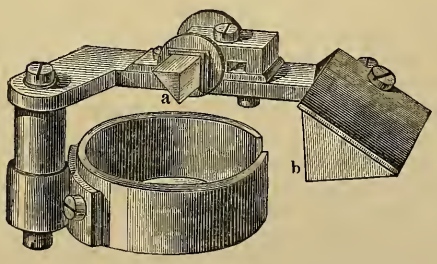
Fig. 14.



A is a rectangular prism and B a glass plate above the eye-piece, inclined at an angle of 45°, and composed of thin glass to avoid double reflection. The arrangement is, however, of little use with high eye-pieces.

The camera lucida of Doyère and Milne-Edwards (fig. 15) is

Fig. 15.



included in the catalogues of most German opticians at the present time, and has the advantage that it can be used with a high magnifying power and with the strongest eye-pieces. Dr. L. Dippel certifies that he has used it "almost exclusively for years, and can

* Bot. Centralbl., xii. (1882) pp. 211–2.

† See this Journal, ii. (1882) p. 261.

‡ Dippel, L., 'Das Mikroskop und seine Anwendung,' 1867, pp. 232–3 (2 figs.).

recommend it with perfect confidence as one of the most efficacious forms of drawing apparatus."

It consists of two rectangular prisms, of which the smaller *a* is placed over the eye-piece, while the larger *b* receives the reflection of the drawing pencil. As the prism over the eye-piece is very small, the observer can look past it at the image of the object in the Microscope, whilst the paper and the point of the pencil appear projected above it.

Grunow's Camera Lucida.*—This is a modification of the Abbe instrument, the mirror being replaced by a rectangular prism as in the Nobert and other forms.

Objectives of Large Aperture.†—Dr. J. Pelletan criticizes Dr. Carpenter's remarks on this subject at Montreal,‡ and in regard to injury to the eyesight suggested as the result of the use of a 4-10ths in. of large aperture, considers it an "accusation as well founded as to say that too large a hat will produce corns on the feet." If it is the fact that certain objectives may injure the sight it is the high powers with small angle, deficient in light, resolving badly, and requiring "efforts of vision," so to say, rather than the relatively low powers of large angle, bright, and showing at once the image of the object clearly resolved.

He also claims as conclusive evidence in favour of the necessity of objectives of the largest aperture the admission of Dr. Carpenter that the flagella of *Bacterium termo* could not have been discovered without such objectives. The ½-in. of 40° could not be of any use to a microscopist for delicate and serious observations, neither to the diatomist nor to the investigator of the histological elements who requires a large aperture to enable him to follow a fibril layer by layer so as to determine all the relations of its position and the precise point where it ends.

Abbe's Method of Testing Objectives.—The late Dr. H. E. Fripp published, in 1877,§ an account of Prof. Abbe's method of testing the optical quality of objectives, which he suggested might be usefully transferred to the pages of this Journal. Various causes have hitherto prevented this, but we are now able to print it:—

In ordinary practice, microscope objectives, if tested at all by their possessors, are simply subjected to a comparison of performance with other lenses tried upon the same "test objects." The relative excellence of the image seen through each lens may, however, depend in a great part upon fortunate illumination, and not a little upon the experience and manipulative skill of the observer; besides which any trustworthy estimate of the performance of the lens under examination involves the consideration of a suitable test object, as well as the magnifying power and aperture of the objective. The structure of the test object should be well known, and the value of its "markings,"

* Amer. Mon. Micr. Journ., iii. (1882) p. 201 (1 fig).
† Journ. de Microgr., vi. (1882) pp. 543–4.
‡ See this Journal, ii. (1882) pp. 698 and 854.
§ Proc. Bristol Naturalists' Soc., ii. (1876–9) pp. 3–11 (2 figs.).

if intended to indicate microscopical dimensions, should be accurately ascertained, care being taken that the minuteness of dimensions and general delicacy and perfection of the test object should be adapted to the power of the lens. A fairly correct estimate of the *relative* performance of lenses of moderate magnifying power may doubtless be thus made by a competent observer, but it is not possible from any comparisons of this kind to determine what may or ought to be the ultimate limit of optical performance, or whether any particular lens under examination has actually reached this limit.

Assuming the manipulation of the instrument and the illumination of the object to be as perfect as possible, and, further, that the test-object has been selected with due appreciation of the requirements of perfect optical delineation, a fair comparison can only be drawn between objectives of the same magnifying power and aperture. Which of two or more objectives gives the better image may be readily enough ascertained by such comparison, but the values thus ascertained hold good only for the particular class of objects examined. The best performance realized with a given magnifying power may possibly exceed expectation, yet still be below what might, and therefore ought to be obtained. On the other hand, extravagant expectations may induce a belief in performances which cannot be realized. The employment of the test objects most in use is, moreover, calculated to lead to an entirely one-sided estimation of the actual working power of an objective, as, for example, when "resolving power" is estimated by its *extreme limits* rather than by its general efficiency; or "defining power," by extent of amplification rather than by clearness of outline. So that an observer is tempted to affirm that he can discern through his pet lens what no eye can see or lens show. This happens chiefly with the inexperienced beginner, but not unfrequently also with the advocate of extremely high powers, in whose mind separation of detail means analysis of structure, and optically void interspaces prove the non-existence of anything which he does not see.

As much time is often lost by frequent repetition of these competitive examinations (which after all lead to no better result than that the observer finds or fancies that one lens performs in his hands more or less satisfactorily than some other lens), it seems worth while to invite attention to a mode of testing which can be readily practised by any person, with a fair certainty of being able to form a really correct estimate of the working capacity of his instrument, measuring this by a standard of strict optical requirements. The advantage of substituting some such proceeding for the comparative trial of lens against lens, so long in vogue, can scarcely be disputed. For, although the best warrant of a well-constructed lens is the fair reputation of its maker, and the choice of an objective resolves itself for the most part into the selection of the particular make of one or other of the best accredited opticians, still, when the instrument is purchased, its possessor frequently becomes haunted by the desire to pit its performance against that of some neighbour's instrument, or to match the performances traditionally accepted in our handbooks. A short and easy method of testing an objective, not by comparison with

others only, but by itself and on its own merits, affords not only the most direct and positive evidence of its qualities to those who are more concerned in proving their instruments than using them, but also yields to the genuine worker the satisfying conviction that his labour is not frustrated by faulty construction and performance of his instrument. It is, however, to be borne in mind that the microscopist, in any scrutiny of the quality of his lenses which he may attempt, has no other object in view than to acquire such insight into the optical conditions of good performance as will enable him to make the best use of his instrument, and acquire confidence in his interpretation of what he sees, as well as manipulative skill in examining microscopical objects. To the constructor and expert of optical science are left the severer investigations of optical effects and causes, the difficulties of technical construction, the invention of new lens-combinations, and the numerous methods of testing their labours by delicate and exhaustive processes which require special aptitude, and lie entirely outside the sphere of the microscopist's usual work.

The mode of testing the optical power of an objective here described, is that devised by Prof. Abbe, and explained in his 'Beiträge zur Theorie des Mikroskops.' *

The process is based on the following principle:—

In any combination of lenses of which an objective is composed, the geometrical delineations of the image of any object will be more or less complete and accurate according as the pencils of light coming from the object are more or less perfectly focussed on the conjugate focal plane of the objective. On this depend fine definition and exact distribution of light and shade. The accuracy of this focussing function will be best ascertained by analysing the course of isolated pencils directed upon different parts, or zones, of the aperture, and observing the union of the several images in the focal plane. For this purpose it is necessary to bring under view the collective action of each part of the aperture, central or peripheral, while at the same time the image, which each part singly and separately forms, must be distinguishable and capable of comparison with the other images.

1. The illumination must therefore be so regulated that each zone of the aperture shall be represented by an image formed in the upper focal plane of the objective (i. e. close behind or above its back lens), so that only one narrow track of light be allowed to pass for each zone, the tracts representing the several zones being kept as far as possible apart from each other.

Thus supposing the working surface of the front lens of an objective to be 1-4th in. in diameter, the image of the pencil of light let in should not occupy a larger space than 1-16th in. When two pencils are employed, one of these should fall so as to extend from the centre of the field to 1-16th in. outside of it, and the other should fall on the opposite side of the axis, in the outer periphery of the field, leaving thus a space of 1-16th in. clear between its own inner margin and the centre of the field, as in fig. 16, where the objective images of the pencils occupy each a quarter of the diameter of the whole field.

* Arch. f. Mikr. Anat., ix. (1873) p. 413.

If *three* pencils of light be employed, the first should fall so as to extend from the centre of the field to 1-25th in. outside of it; the second should occupy a zone on the opposite side of it, between the 1-25th and 1-12th in. (measured from the centre), and the third, the peripheral zone on the same side as the first, as in fig. 17.

This arrangement places the pencils of light in their most sensitive position, and exposes most vividly any existing defect in correction, since the course of the rays is such that the pencils meet in the focal plane of the image at the widest possible angle. As many distinct images will be perceived as there may be zones or portions of the front face of the objective put in operation by separate pencils of light. If the objective be perfect all these images should blend *with one setting of focus* into a single clear colourless picture. Such a fusion of images into one, is, however, prevented by faults of the image-forming process, which, so far as they arise from spherical aberration, do not allow this coincidence of several images from different parts of the field to take place at the same time, and so far as they arise from dispersion of colour, produce coloured fringes on the edges bordering the dark and light lines of the test object, and the edges of each separate image, as also of the corresponding coincident images in other parts of the field. It is to be borne in mind that the errors which are apparent with two or three such pencils of light, must necessarily be multiplied when the *whole area* of an objective of faulty construction is in action.

Fig. 16.

Fig. 17.

2. *The means by which such isolated pencils can be obtained.*

If a special illuminating apparatus be employed, the condenser of Professor Abbe will be found very convenient, but almost any condenser of the kind (hemispherical lens) may be arranged for this purpose.

In the lower focal plane of the illuminating lens must be fitted diaphragms (easily made of blackened cardboard) pierced with two or three openings of such a size that their images, as formed by the objective, may occupy a fourth or sixth part of the diameter of the whole aperture (i. e. of the field seen when looking down the tube of the instrument, after removing the ocular, upon the objective image). The required size of these holes, which depends, firstly on the focal length of the illuminating lens, and secondly, on the aperture of the objective, may be thus found. A test object being first sharply focussed, card diaphragms having holes of various sizes (two or three of the same size in each card) must be tried until one size is found, the image of which in the posterior focal plane of the objective shall be about a fourth to a sixth part of the diameter of the field of the objective. Holes having the dimensions thus experimentally found to give the required size of image must then be pierced in a card, in such position as will produce images situate in the field as shown by figs. 16 and 17, and the card is then fixed in its place below the condenser. If the condenser be fitted so as to revolve round the axis of the instrument and also carry with it

the ring or tube to which the card diaphragm is fixed, the pencils of light admitted through the holes, will, by simply turning the condenser round, sweep the face of the lens in as many zones as there are holes. Supposing the condenser to be carried on a rotating substage, no additional arrangement is required besides the diaphragm carrier. Thus, for example, if a Collins' condenser fitting in a rotating substage be used, all that is required is to substitute for the diaphragm which carries the stops and apertures as arranged by the maker, a diaphragm pierced with say three openings of 3-4ths in. diameter, in which circles of card may be dropped, the card being pierced with holes of different sizes according to the directions given above.

Another plan adopted by Dr. Fripp and found very convenient in practice is to mount a condensing lens (Professor Abbe's in this case) upon a short piece of tube which fits in the rotating substage. On opposite sides of this tube, and at a distance from the lower lens equal to the focal distance of the combinations, slits are cut out, through which a slip of stout cardboard can be passed across and below the lens. In the cardboard, holes of various sizes, and at various distances from each other, may be pierced according to pleasure. By simply passing the slip through the tube, the pencils of light admitted through the holes (which form images of these holes in the upper focal plane of the objective) are made to traverse the field of view, and by rotating the substage the whole face of the lens is swept and thus searched in any direction required.

When an instrument is not provided with a rotating substage it is sufficient to mount the condenser on a piece of tubing, which may slide in the setting always provided for the diaphragm on the under side of the stage. Card diaphragms for experiment may be placed upon the top of a third piece of tube (open at both ends) made to slide inside that which carries the condenser, and removable at will. By rotating this inner tube the pencils of light will be made to sweep round in the field, and thus permit each part of the central or peripheral zones to be brought into play.

3. *Test object.*

For this a prepared plate is required which shall present sharply defined black and white stripes, opaque and clear lines alternating at close intervals, and lying absolutely in the same plane, so that no deviation can occur in the course of pencils of light transmitted through it. A test plate sufficiently perfect for all practical purposes may be made by ruling groups of lines, coarse and fine, with the aid of a dividing machine on a metallic film of silver or gold of infinite thinness, and fixed by known methods on glass. Cover-glasses of various thicknesses, from 0·24 mm. to 0·09 mm. (accurately measured), are ruled on one surface thus coated with a film of metal, the groups of lines varying from 1-250th to 1-1250th in.; the ruled side is then cemented with balsam on a polished glass slip, several such prepared glasses being cemented side by side on the same slip, presenting the appearance shown in fig. 18 (natural size), fig. 19 being one of the circles enlarged.

A perfectly corrected objective, tested with the test object, and by

the mode of illumination above described, ought to show over the middle of the field a clearly defined image of the groups of lines under examination *without any alteration of focus*, and the coloured

Fig. 18.

borders of the separate partial images should not show any other tints than a very narrow edging of pure green, rose, or violet of the secondary colours of a spectrum. Spherical aberration is revealed, when, with the best focussing, the clear lines appear as if immersed in the middle of a broader foggy streak, or when two images, more or less overlapping each other, merge on altering the focus, into one image, somewhat broader and more misty.

Fig. 19.

A short and ready method of testing approximately any objective is recommended by Professor Abbe, as it is applicable to all instruments without requiring any apparatus except the test object already described. This may be briefly explained as follows :—

First, focus the test plate with central illuminating rays, then withdraw the eye-piece, and turn aside the mirror so as to give the utmost obliquity of illumination, which the objective under trial will admit of. This will be best determined by looking down the tube of the Microscope whilst moving the mirror, and observing when the elliptic image of light reflected from it, reaches the peripheral edge of the field. As soon as this is done, replace the eye-piece, and examine afresh the object plate *without altering the focus*. If the objective be perfectly corrected, the groups of lines will be seen with as sharply defined edges as before, and the colours of the edges must, as before, appear only as those of the secondary spectrum in narrow and pure outline. Defective correction is revealed when this sharp definition fails, and the lines appear misty and overspread with colour, or when *an alteration of focus* is necessary to get better definition, and colours confuse the images.

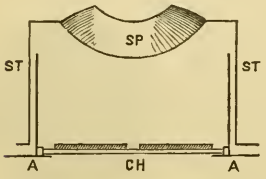
A test image of this kind at once lays bare in all particulars the whole state of correction of the Microscope; it being of course assumed that the observer knows how to observe and what to look for.

With the aid which theory offers to the diagnosis of the various

aberrations, a comparison of the coloured borders of the separate partial images, and an examination of their lateral separation and their differences of level, as well in the middle as in the peripheral zones of the entire field, suffices for an accurate definition of the nature and amount of the several errors of correction, each of them appearing in its own primary form. Therewith we also see that which arises from aberration, properly so called (faults of focussing function), clearly separated from such imperfections or anomalies as spring from mere differences of amplification between unequally converged and unequally refracted rays; and moreover we eliminate completely all influence of the ocular on the quality of the image.

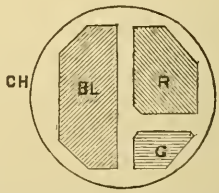
Hardy's Chromatoscope.—Mr. J. D. Hardy describes a method of illumination by an instrument (figs. 20 and 21) which he calls the "Chromatoscope":—"Its chief purpose is that of illuminating and defining objects which are non-polarizable, in a similar manner to that in which the polariscope defines polarizable objects. It can also be

Fig. 20.



Sp. Spot lens in its tube *St.* *Ch.* Chromatoscope glass plate resting on the inner flange of the tube *A*.

Fig. 21.



The letters indicate the disposition of the blue, red, and green stained glass.

applied to many polarizable objects. This quality, combined with the transmission of a greater amount of light than is obtainable by the polariscope, renders objects thus seen much more effective.

It is constructed as follows:—Into the tube of the spot lens (fig. 20) a short tube is made to move freely and easily. This inner tube has a double flange, the outer one (which is milled) for rotating, and the inner one for carrying a glass plate. This plate (fig. 21) is made of flat, clear glass, and upon it are cemented by a very small quantity of balsam, three pieces of coloured (stained) glass, blue, red, and green, in the proportion of about 8, 5, and 3, as shown in the figure. The light from the lamp is allowed to pass to some extent through the interspaces, and is by comparison a strong yellow, thus giving four principal colours. Secondary colours are formed by a combination of the rays in passing through the spot lens. The stained glass should be as rich in colour and as good in quality as possible, and a better effect is obtained by three pieces of stained glass than by a number of small pieces.

The application of the chromatoscope is almost unlimited, as it can be used with all objectives up to the 1-8th. Transparent objects,

particularly crystals which will not polarize, diatoms, infusoria, palates of molluscs, &c., can not only be seen to greater advantage, but their parts can be more easily studied. As its cost is merely nominal, it can be applied to every instrument, large or small, and when its merits and its utility by practice are known, I am confident that it will be considered a valuable accessory to the Microscope."

Gundlach's Substage Refractor.—E. Gundlach publishes directions (with a table) for using this apparatus for the determination of the aperture of objectives from 1·13 N.A. to 1·51 N.A. (97° to 180° in crown glass).

The refractor (described Vol. II. (1882) pp. 692 and 860) consists of a small cube of glass, having one blackened and several polished surfaces.

To use it, screw on the objective, and in place of the eye-piece, put a diaphragm having an opening about 1-4th in. in diameter. Then to the front surface of the objective, with a very small drop of Canada balsam, make the refractor adhere by that surface which is opposite the blackened one, in such a position that the two polished side surfaces will stand vertical when the body is brought into a horizontal position. Let the balsam harden a little; place the body in a horizontal position, and turn the mirror to one side to get it out of the way.

Then place two lights—flat-wicked oil lamps are best—at some distance from the Microscope, say six or eight feet, one on each side of the optical axis, and at first pretty near this axis. By looking through the diaphragm at the eye-piece end, towards the objective, the two lights will appear there as two small light-spots, presuming the angle of the objective to be large enough. If they do not appear, and also will not, or at least one of them, when the lights are brought very near together, then the angle of the objective is smaller than 96° or 97° in crown glass, according to the index of refraction of the crown glass used in the refractor; and the angle cannot be determined with it. If they appear, move both lights slowly away from the axis and find carefully the place for each where its image in the objective will just disappear. Determine the angle described by the light-rays entering the refractor at each side from each lamp, either by measuring directly, or by measuring the distance of the lamps from each other and from the refractor, reducing the distance of the lamps by the thickness of the glass cube, and finding from these three measurements, as the sides of a triangle, the desired angle by calculation.

Compare the angle thus found with those given in column A of the table, and find the one which is nearest to the determined angle. The corresponding angle of column B is the crown-glass angle of the objective, and the corresponding number of column C is its numerical aperture. The balsam may be removed easily and safely with a little benzine.

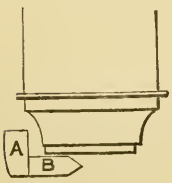
Tolles' Frontal-prism Illuminator.—Fig. 22 shows an arrangement devised by Mr. R. B. Tolles to be applied to the front of a 1-in. objective for illuminating opaque objects.

The segment of a plano-convex lens A has a curvature of 0·4 in. radius, and for convenience of mounting, the segment is somewhat longer than is optically necessary. To it is cemented an equilateral prism from which the greater portions of the basal angles have been cut off so as to leave only a small part of the original form of the prism at the apex B. The dimensions of the prism are:—

Total length	0·30 in.
Upper reflecting face	·11 „
Surface of emergence	·075 „
Thickness	·1 „
Breadth	·2 „

The lens condenses the rays upon the upper internal face of the prism, whence they are totally reflected and pass with slight refraction through the lower prism-face in the direction of an object placed under the centre of the front lens of the objective.

Fig. 22.



Mr. Tolles states that by this arrangement the effective aperture of the object is not reduced, as the apex of the prism is placed just outside the cone of rays which the objective transmits from the object.

Such a device seems hardly needed for so low a power as 1 in., but it would be interesting to know if the plan can be successfully used with higher powers.

Warm and Moist Stages.—Dr. R. L. Maddox describes several forms of these stages which he has devised.

A slab of ebonite $3\frac{1}{2} \times 2\frac{1}{4} \times \frac{3}{8}$ in. has a central hole 5-8ths in. in diameter, slightly countersunk on the under side (fig. 23), into

Fig. 23.

which is cemented a circle of stout cover-glass. On the upper side a deep groove is cut at about 1-12th in. from the aperture, 1-8th in. wide, and 3-16ths in. deep; another deep groove concentric with the former being turned out 1-12th in. from it, about 3-16ths in. wide and 5-16ths in. deep. Two holes are drilled through one end of the slab, $\frac{1}{2}$ in. apart, ending in the outer groove. At the opposite end of the slab either a deep well is sunk to hold a small circular thermometer, or a hole is drilled through the end of the slab reaching nearly to the outer groove, to hold a clinical thermometer. The opposite holes have two small brass tubes $1\frac{1}{2}$ in. long screwed into them and cemented air-tight. Three screws, furnished with rather wide thin screw nuts, are screwed into the base-plate, one between the

two drilled holes and 6-8ths in. from the edge of the base-plate, the two others at 6-8ths in. from the opposite end and 5-16ths from the sides; the screws project through the top of the plate about 3-16ths of an inch. This completes the base-plate.

The top-plate consists of a stiff thin plate of brass, $2\frac{3}{4}$ in. long by $2\frac{1}{4}$ in. wide, with a central aperture of $\frac{1}{2}$ in. countersunk or bevelled on one side, which forms the upper surface; three holes are drilled to permit the three screws to pass through, and if the circular thermometer be preferred a portion of the edge is cut away, half-moon shape, to permit of easy reading of the small thermometer. To the non-bevelled surface is cemented a thin circle 5-8ths in. wide; a plain ring of brass, which will drop easily into the middle of the inner groove flush with its upper surface, is soldered on to the under surface of the top-plate. This completes the top-plate, which should be platinum blacked.

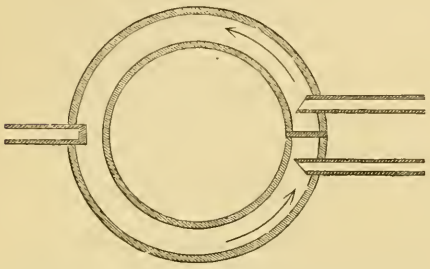
In use the top-plate is turned over, under surface up. On the thin cover is put the droplet, with the objects for study, and, if required, a very thin, small circle of mica or thin cover-glass is placed carefully upon it, which will adhere by capillary attraction. An indiarubber flat band, with an aperture that will just pass over the brass ring without undue stretching, is put on, the width of the band or a little sheet of pure indiarubber extending to the side edges of the top-plate. If the observation is likely to be carried on for any time, a little olive-oil or glycerine, or even water, is placed in the narrow groove, into which the ring fits easily. To the two tubes in the base-plate are attached two narrow indiarubber tubes about 8 in. long, into the opposite ends of which are fixed two glass tubes, drawn out at the free ends into almost capillary orifices. The cover ready prepared is now put on the base-plate, the brass ring dipping into the fluid in the inner groove forming an air-tight trap, the nuts are screwed on to the three screws and pressure made on the top-plate, so as to render, by means of the wide flat band of indiarubber, the whole water-tight. A piece of thick grey or drab cloth, with a central aperture 3-4ths in. or 1 in. in diameter punched out of the centre, is placed on the stage of the Microscope, and on it is arranged the warm stage. A vessel containing hot water is supported on a tripod at one side or in front of the Microscope; one of the tubes is put into it, reaching to the bottom; the end of the other tube is placed in the mouth and the water sucked through, and is then turned down into a vessel to receive the water that passes round the outer groove, the rate of discharge being in relation to the length of the lower limb of the siphon and the entering orifice for the flow of hot water, as in Professor E. H. Bartley's plan.* To ensure the water flowing round the groove, it is best to place a partition in the outer groove between the two drilled holes for the brass tubes. The water in the vessel may be maintained at any required heat up to the boiling-point by means of a lamp or gas flame, but if kept steadily at 160° Fahr. the thermometer indicates a temperature of about 92° Fahr. Should plenty of moisture be

* See this Journal, i. (1881) p. 672.

required, a narrow strip of blotting-paper can be damped and placed round the central hole, making it adhere to the sides.

Another form (fig. 24) consists of a hollow ring of brass, $1\frac{3}{4}$ in. external diameter, the tube of the ring being about 1-4th in. outside diameter. A saw-cut is made almost through the ring, and into it is soldered a partition plate. On each side, about 1-4th in. from the partition, two holes are drilled into the tube, and into each is soldered a fine brass tube; at the opposite side of the ring is soldered another tube, closed at the end that is fixed in the ring. Into this, when in use, is placed the end of a small clinical thermometer. Indiarubber tubes are attached to the two brass tubes, as in the former, terminating in glass tubes with small orifices.

Fig. 24.



Two flat plates of thin ebonite are also required, with central apertures of the same diameter as in the previous forms, the bottom one having its aperture closed with a stout cover circle, and the upper one with a thin cover circle cemented to the inner surface.

To use the ring-stage, place a narrow ring of damp blotting-paper on the upper surface of the bottom plate, then a flat ring of india-rubber; upon this carefully put the brass ring (which has its upper and under surface slightly flattened on the lathe), and on the top, place a similar indiarubber band; then, having put the material to be examined on the under surface of the thin cover, either protected with mica or otherwise, turn it over upon the indiarubber ring on the brass ring, and bind the two ebonite plates together by two stout indiarubber bands. This is then used in the same way as the former, the temperature obtained being very similar; the thermometer is placed at any part of the upper plate, but preferably on the part over or between the two brass tubes.

The brass portion of this form may be put to another use. To a thin ebonite plate with a central aperture (fig. 25) is cemented and

Fig. 25.

pinned a circular ebonite block of the same thickness as the ebonite stage of the first form. In the block is turned a central aperture wider at the base than at the top, which is slightly countersunk, and

into it is cemented a small cover circle; round the central aperture is turned concentrically a deep groove to form an air-space, and into which a moistening thread can be placed if required. A brass cap with milled edge and central aperture has cemented to the inside, over the aperture, a thin circle cover, and on this the object is to be placed. Over the outside of the circular ebonite block is slipped a thin, narrow indiarubber ring; the brass cap must fit correctly over the ebonite block, the ring of the cap closing upon the indiarubber ring, making the whole air-tight, and bringing the free surface of the droplet of liquid to touch the surface of the small glass circle, in a similar way to the ordinary live-box. The brass ring warm stage is now placed over the circular block of ebonite. In this way it is found, if care be taken, that the circular thermometer placed on the thin cover indicates 90° Fahr. without the water boiling, and if protected from cooling by cloth above and below, the temperature can be equably maintained.

Another plan is to employ two thin ebonite plates 3 by 1½ in., pierced with apertures about 5-8ths in. bevelled on one side; each is closed with a thin cover circle, one is used as the base-plate, the other as an ordinary slide. The object is put on the cover; upon this is gently placed a very thin cover-glass about 7-16ths in. in diameter; one or two small indiarubber bands are placed flat on the lower plate, the upper one is reversed over them, and the two are bound together by two indiarubber rings. An air-tight space is thus easily made, and if it be desired to add moisture, a thin circle of damp blotting-paper can be placed within the rings, or if between them, the edge of the ring of paper may project and be moistened as required; but the pressure from the bands must not be too great. If increased temperature be required, the whole can be put on the brass ring stage without trouble.

Dr. Maddox does not claim that there is much novelty in these different forms, but he believes they differ somewhat from any described, and may prove useful in the study of minute organisms, which has so largely developed within the last few years.

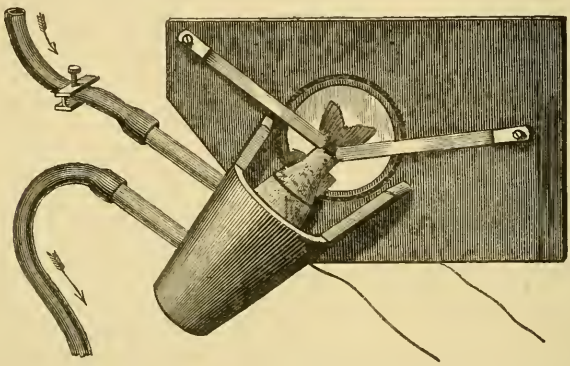
Dibdin's Hot Stage.*—Mr. W. J. Dibdin also describes a form of "Hot Stage" in which simplicity is probably carried to its furthest limit. It consists only of a square white glass bottle resting on the stage (which must be inclined 45°). In its cork is a thermometer and two siphon tubes, one serving as a waste-pipe and the other communicating (by a piece of indiarubber tubing) with another siphon-tube in the cork of a flask, which is kept heated on a tripod over a spirit-lamp, and also has a thermometer. A constant stream of water is thus kept flowing through the bottle on the upper side of which the object is placed. Mr. Dibdin used the apparatus for observing the bursting-point of starch cells.

Caton's Fish-trough. — This (fig. 26) consists of an oblong or slightly conical box of ebonite, closed at one end and large enough to hold the body of a minnow or stickleback very loosely. This box is attached to a plate of ebonite, which can be placed on the stage of the

* Journ. Post. Micr. Soc., i. (1882) pp. 177–8 (1 fig.).

Microscope. The tail of the fish covers an aperture in the plate closed with a piece of glass, and it is held securely in its place by a ligature; the caudal fin, which rests on the glass, is further secured by a couple of springs. The box itself, which incloses the head and

Fig. 26.



gills of the fish, contains water which is constantly renewed by means of two tubes, the upper of which, guarded by a screw-clamp, communicates with a vessel at a higher level, the lower conveying the water away as fast as it is supplied. The stage must be inclined at an angle of about 40°. "The excellency of this method" (according to Prof. J. Burdon-Sanderson *) "lies in the fact that the animal can be kept under observation, without the use of any narcotizing drug, for a long time in a perfectly natural condition."

Dayton's Modification of the Wenham Half-disk Illuminator.† Dr. R. Dayton, being convinced that the improved resolution of the markings upon diatoms, when the V-shaped diaphragm was used, consisted not so much in its cutting off the less oblique pencils of light reflected from the mirror, but in the total exclusion of the diffused rays emanating from the source of illumination, describes a modification by which the benefits arising from the use of the Wenham half-disk are combined with those of the Woodward prism and V diaphragm in a single apparatus.

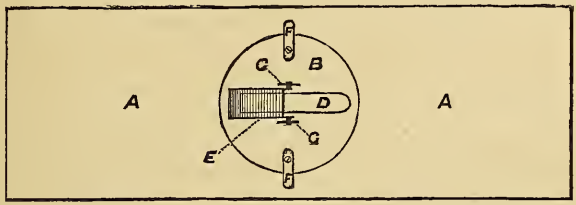
A brass slide, 3 in. by 1 in., A A (fig. 27, under-view; fig. 28, vertical section), has a circular bevelled opening, in which a correspondingly bevelled brass disk B fits from above. Two latchets F F are attached to the under surface of the disk, and allow it to rotate freely in its bed without slipping out of the slide. In the disk B is an opening exactly fitting the illuminator D. Dr. Dayton proposes to cut away a portion of the lenticular edge of the latter, leaving a

* 'Handbook for the Physiological Laboratory,' 1873, p. 229 (1 fig.). In the fig. the shape of the box differs slightly from that in our text.

† Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 161–3 (3 figs.).

plane face H (fig. 27) on one side, through which parallel rays making an angle of 68° with the optic axis may be transmitted without condensation, as in Woodward's prism. A swinging shutter-diaphragm E, of blackened brass, forming a shell-like quadrant exterior to the illuminator, is suspended on pivots G G (fig. 27) on either side of the

Fig. 27.



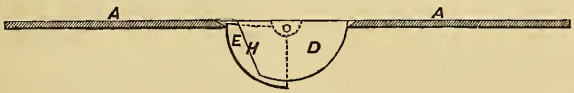


Fig. 28.

illuminator, so that it can be swung to shut off light from the plane or lenticular edge. The rotation of the disk B allows either edge of the glass disk D to be presented to the source of illumination. A slit-diaphragm cut through a very thin brass disk is placed on the upper surface of B, and completes the device.

No plan of mounting the semi-disk, or prism, or hemisphere, can, we think, be considered advantageous in which they are not left entirely free of the rectangular mechanical motions of the object-stage. As regards the use of a slit-diaphragm in connection with the swinging shutter, we possess a device, made seven years ago by Tolles, in which the slit is cut through the swinging shutter, which we think will be found the more convenient arrangement.

Adams, J. M.—The Microscope among Infinities.
[Speculations on the limits of perception.]
The Microscope, II. (1882) pp. 164–5.

" " How to turn over Small Objects.
["A simple and convenient way of turning over small objects, as corpuscles, epithelium, diatoms, &c., in a liquid, is to half fill a live-box and revolve the stage or hold the instrument so that it can be swayed out of level or from one side to another. In this way all sides can be easily and readily seen."]
The Microscope, II. (1882) p. 165.

Blackburn, W.—The Theory of Aperture in the Microscope: a popular exposition. *North. Microscopist*, II. (1882) pp. 325–34 (11 figs.).

Blackham, G.—Presidential Addresses at the Elmira Meeting of the American Society of Microscopists.
[The Evolution of the Modern Microscope, &c. Cf. Vol. II. (1882) p. 698. Appendix of leading facts in the lives of R. B. Tolles, E. Gundlach, W. H. Bulloch, and the Bausch and Lomb Optical Co.]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 4–5, 5–8, 25–47.

Boecker, E.—See Dippel, L., *infra*.

Bradbury, W.—The Achromatic Object-glass, XIII., XIV.
Engl. Mech., XXXVI. (1882) pp. 351–2, 421–2.

Bradford, Microscopical Society for. *Micr. News*, III. (1883) p. 24.

Brittain, T.—The Beginnings of Microscopic Study in Manchester [from 183 –82.]
Field Natural., I. (1882) pp. 14?–50.

Carpenter, W. B.—On Angular Aperture in relation to Biological Investigation.
[Title only of paper read in the Microscopical Section of the Amer. Assoc. Adv. Sci. Same as II. (1882) p. 698.]
Amer. Natural., XVI. (1882) p. 1050.

" " Remarks made at the dinner of the New York Microscopical Society.
[Personal recollections of the first development of the achromatic Microscope in London.]
Amer. Mon. Micr. Journ., III. (1882) pp. 203–5, 219–20.

Crisp, F.—Notes sur l'Ouverture, la vision microscopique et la valeur des objectifs à immersion à grand angle. (Notes on Aperture, Microscopical Vision, and the value of wide-angled Immersion Objectives.)—*contd.*
[Transl. of paper, *ante*, I. (1881) pp. 303–60.]
Journ. de Microgr., VI. (1882) pp. 473–5.

Crumbaugh, J. W.—The History of the Microscope and its Accessories, IV.
The Microscope, II. (1882) p. 145–9.

Cuvillier, A.—Ein Mikrometer-Kaliber. (Micrometer-Callipers.)
[Allows of exact measurements to 0·01 mm. or 0·0004 in.]
Centr.-Ztg. f. Opt. u. Mech., III. (1882) p. 260 (1 fig.), from *Scientific American*, 9th Sept. 1882.

Davies, A. E.—Microscopical.
[Commendation of Tolles' Amplifier, and suggestion that instead of being screwed into the draw-tube it should be fitted in a box and made to slip in and out like the prism in the Wenham binocular.]
Engl. Mech., XXXVI. (1882) p. 276.

Davis, G. E.—Dr. Carpenter in America.
[Criticism of remarks on the aperture of objectives at the meeting of the Amer. Assoc. Adv. Sci. at Montreal. Vol. II. (1882) pp. 698 & 854.]
Micr. News, III. (1882) pp. 15–18.

" " Preparing drawings for the *Microscopical News*.
[Deals with the value of Photo-zincography for illustrating microscopical literature, with directions for drawing.]
Micr. News, III. (1882) pp. 19–21 (1 fig.).

Dayton, R.—Modification of the Wenham Half-disk Illuminator with an improved Mounting. [*Supra*, p. 132.]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 161–3 (3 figs.).

Deecke, T.—Brief Description of Large Microscope and Apparatus for Photographing large Sections. [*Post.*]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 277–9.

Dibdin, W. J.—Hot Stage. [*Supra*, p. 131.]
Journ. Post. Micr. Soc., I. (1882) pp. 177–8 (1 fig.).

Dippel, L.—Das Mikroskop und seine Anwendung. (The Microscope and its use.) 2nd ed. Part 1. Handbuch der Allgemeinen Mikroskopie. (Handbook of General Microscopy.) Sec. 2, pp. 337–736 (figs. 190–506). 8vo, Braunschweig, 1882.

" " Ein neuer beweglicher Objecttisch. (A new movable stage.)
[Devised by E. Boecker of Wetzlar. Does not appear to be specially novel.]
Bot. Centralbl., XII. (1882) pp. 385–6.

Fell, G. E.—The Microscope and Medicine.
[Remarks on the value of the Microscope in medical research.]
The Microscope, II. (1882) pp. 149–56.

Fleming, J.—Microscopical Studies.
[Lecture to Mutual Improvement Society.]
St. Matthias' (Sulford) Parish Magazine, VIII. (1882) pp. 10–11.

Frasse & Co.'s Mikrometer-Dickmesser. (Micrometrical-measurer of thickness).
[Measures to 1-1000th in.]
Centr.-Ztg. f. Opt. u. Mech., III. (1882) p. 274 (1 fig.).

Giltay, E.—Ueber die Abbe'sche Camera Lucida und eine im allgemeinen an Cameras anzubringende Verbesserung. (On the Abbe Camera Lucida and an improvement applicable to Cameras in general.) [*Post.*]
Bot. Centralbl., XII. (1882) pp. 419–22.

Griffith, E. H.—The improved Griffith Club Microscope. [*Supra*, p. 113.]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, pp. 149–52 (3 figs.).
Cincinn. Med. News, XI. (1882) pp. 762–4 (2 figs.).

Grunow's (J.) New Camera Lucida. [*Supra*, p. 120.]
Amer. Mon. Micr. Journ., III. (1882) p. 201 (1 fig.).

Gundlach, E.—On Light and Illumination.
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 79–90, 255–61.

Hasert, B.—Kombination von Okularlinsen welche die Achromatisirung eines einfachen Kronglas-Objektives direkt bewirken. (Combination of ocular-lenses which effect the achromatising of a single crown-glass objective.)
[Title (only) of German Patent No. 20729, 4th April, 1882.]
Centr.-Ztg. f. Opt. u. Mech., III. (1882) p. 288.

Hilgendorf, F. — Apparat für mikroskopische geometrische Zeichnungen. (Apparatus for microscopical geometrical drawings.) [*Post.*]
Zeitschr. f. Instrumentenk., II. (1882) pp. 459–60 (1 fig.).

Hitchcock, R.—Remarks on the Illumination of Insect Preparations mounted without pressure. [*Post.*]
Amer. Mon. Micr. Journ., III. (1882) p. 219.

„ „ The Podura-scale.
[Remarks on the different appearances with objectives of different makers.]
Amer. Mon. Micr. Journ., III. (1882) pp. 224–5.

„ „ Commendation of Spencer's 1-15th in. "Professional" objectives. Also of Tolles' 1-6th in. on *Amphipleura pellucida*.
Amer. Mon. Micr. Journ., III. (1882) p. 238.

„ „ Note on the aperture discussion at Manchester.
Amer. Mon. Micr. Journ., III. (1882) p. 238.

Hitchcock's (R.) Journal.
[Anonymous criticism of note on p. 177 of Vol. III.]
The Microscope, II. (1882) p. 166.

Houghton, W.—The Microscope and some of the wonders it reveals. 4th ed. iv. and 128 pp. (47 figs.). 8vo, London, n. d.

"Jumbo" and "Midget" Microscopes.
["'Among the curiosities recently exhibited by a London Society was the Microscope of half a century ago, weighing 125 pounds, and the 'Midget,' a modern invention, weighing only a few ounces,' so says a newspaper."]
The Microscope, II. (1882) p. 172.

Kent, W. K.—Live Cage for dry objects.
["It consists of a wooden slide, with a cover-glass set near one end, and a spring-clamp near the middle. In other half slides of different thickness cover-glasses were inserted (*sic*), and these, when placed under the spring-clamp, which held them firmly in place, made convenient cells."]
The Microscope, II. (1882) p. 172.

Kruess, H.—Die wissenschaftlichen Instrumente auf der Bayrischen Landes-Industrie-, Gewerbe-, und Kunst-Ausstellung in Nürnberg 1882. (The Scientific Instruments at the Bavarian Rural-Industrial, Trade, and Art Exhibition in Nürnberg 1882.)
[Brief reference to a Microscope made by the Nürnberg Industrial School.]
Centr.-Ztg. f. Opt. u. Mech., III. (1882) pp. 255–9.

McCalla, A.—Circular (from the President) to the Members of the American Society of Microscopists.
[Exhortation to co-operation with the officers of the Society to advance the cause of microscopical research and scientific progress.]
14th October, 1882.

MENDENHALL, T. C.—On the Fasoldt Stage Micrometer.
[Records results of measurements—500 or 600.]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 201-8 (2 pls.).

MERCER, A. C.—Stereoscopic effects obtained by the high-power binocular arrangement of Powell and Lealand.
[Vol. II. (1882) p. 271.]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 127–30.

'Microscopical News, and Northern Microscopist'—Note "to our readers" [on the change in title and as to future arrangements.]
Micr. News, III. (1883) pp. 1–2.

MOORE, A. Y.—Camera Lucida.
[Vol. II. (1882) p. 865.]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, p. 283.

NOBERT, F. A.—Die höchste Leistung des heutigen Mikroskops und seine Prüfung durch künstliche und natürliche Objecte. (The best performance of the present Microscopes and their testing by artificial and natural objects.) [*Post.*]
M. T. Naturwiss. Ver. Neu-Vorpommern, XIII. (1882) pp. 92–105.

PEASE'S (J. L.) new Method of Attaching Objectives.
[A Nose-piece—"its operation resembles that of the self-centering chucks used by mechanics; the objective is held firmly as in a vice, and its centering is perfect. Changing objectives is accomplished with great rapidity and ease."]
Amer. Mon. Micr. Journ., III. (1882) pp. 237.

PELLETAN, J.—Criticism of Dr. Carpenter's remarks on objectives of small and large aperture at the Montreal meeting of the Amer. Assoc. Adv. Sci. [*Supra*, p. 120.] *Journ. de Microgr.*, VI. (1882) pp. 543–4.

PHIN, J.—How to use the Microscope. 5th ed. 264 pp. 12mo, New York, 1882.

Postal Microscopical Society.—Rules and Names and Addresses of Members.
Supplt. to Vol. I. of *Journ. Post. Micr. Soc.* (1882) 17 pp.

"Prismatique."—Object-glass working, III.
Engl. Mech., XXXVI. (1883) p. 397.

Pritchard, Andrew, Death of. *Sci.-Gossip*, 1883, p. 16.

Projection-Microscopes.
[Note *à propos* of Dr. H. Schröder's article II. (1882) p. 673. "The perfecting of such Microscopes would be a desideratum."]
Journ. of Sci., IV. (1882) p. 753.

ROBINSON, W., junr.—Micro-photography.
[Reply to "Density," II. (1882) p. 863.—"The distance between the visual and actinic foci is the same no matter how much the conjugate focus may vary."] *Engl. Mech.*, XXXVI. (1882) p. 324.

ROGERS, W. A.—A study of the problem of fine rulings with reference to the limit of naked-eye visibility and microscopic resolution.
[Title (only) of paper read in the Microscopical Section of the Amer. Assoc. Adv. Sci.]
Amer. Natural., XVI. (1882) p. 1050. (Cf. Brief note, also pp. 1042–3.)

„ „ On the conditions of success in the construction and the comparison of standards of length.
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 231–51 (1 fig.).

S., W. J.—[Note on the desirability of a universal gauge for eye-pieces and substage fittings.] *Sci.-Gossip*, 1882, p. 276.

SCHROEDER, H.—[Note recording the discovery of optical glass, by the use of which the secondary spectrum is removed, leaving only "an extremely small tertiary spectrum which under ordinary conditions is scarcely visible."]
Centr.-Ztg. f. Opt. u. Mech., III. (1882) p. 261.

SCOTT, E. T.—Microscope Noses and Screws.
["Don't believe that one screw that is turned to fit one body, and is properly adjusted, will really be so for another body."]
Engl. Mech., XXXVI. (1882) p. 362.

Scovill Manufacturing Co.'s apparatus for photographing microscopical objects, Note on. *Amer. Mon. Micr. Journ.*, III. (1882) pp. 218–9.

Smith, H. L.—Memoir of C. H. Spencer.
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 49–74 (Portrait).
Spencer, C. A., Memoir of. See Smith, H. L.
Stearn's (C. H.) Incandescent Electric Light applied to microscopical illumination. [*Supra*, p. 29.] *Engl. Mech.*, XXXVI. (1883) p. 403.
Stowell, C. H. and L. R.—Criticism of the prices asked for some second-hand apparatus. *The Microscope*, II. (1882) p. 176.
Stowell's (C. H. and L. R.) election as honorary members of the Aurora Microscopical Club. *The Microscope*, II. (1882) p. 166.
Suffolk, W. T.—Standard sizes for eye-pieces.
[Calling attention to the recommendations of the Committee, II. (1882) p. 595.] *Sci.-Gossip*, 1883, p. 17.
Sundell, A. F.—Aenderungen in der Brennweite eines achromatischen Objectivs durch Temperatur-variationen. (Changes in the focal length of an achromatic objective through variations of temperature.)
[Experiments on Telescopic Objectives. Description of Apparatus. Differences of 28·1° C. and 31·9° C. produced changes of 1·72 mm. and 2·05 mm.]
Zeitschr. f. Instrumentenk., III. (1882) pp. 410–1, from *Astronom. Nachr.*, No. 2450.
Taylor, G. C.—An Improved Lamp for use with the Microscope.
[Vol. II. (1882) p. 866.]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 14 and 273.
Thoulet, —.—Heating Apparatus for the Microscope. [*Post.*]
Amer. Natural., XVII. (1883) p. 76, from *Bull. Soc. Mineral. France.*
Tuttle, Prof. A. H.'s, Address delivered before the new Section of Histology and Microscopy of the Amer. Assoc. Adv. Sci. at Montreal.
[In justification of the formation of the Section.]
Amer. Mon. Micr. Journ., III. (1882) pp. 205–10, 218.
Walmsley, W. H.—Micro-photography with dry-plates and lamp-light and its application to making lantern positives. [*Post.*]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 179–82, 273–5.
Ward, R. H.—Report of Committee on Eye-pieces. [Vol. II. (1882) p. 853.]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, p. 16.
„ „ Report of National Committee on Micrometry.
[A ruling upon a platino-iridium bar has been tested by the Coast Survey, and will soon be in the hands of the Committee.]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, p. 16.
Watson's Lithological Microscope.
[Described, Vol. II. (1879) p. 470.]
Amer. Mon. Micr. Journ., III. (1882) pp. 226–7 (1 fig.).

β. Collecting, Mounting and Examining Objects, &c.

Carbonic Acid as a Narcotic for Marine Animals.*—Dr. H. Fol recommends carbonic acid as the best narcotic for marine animals so as to preserve their form and habit. The ordinary narcotics, if in small doses, do not render the animals immovable, whilst in large they act as poisons. The same applies to the solutions of ether, chloroform, &c.

If the sea-water in which a Medusa is swimming is saturated with carbonic acid the animal soon becomes completely immovable and insensible, retaining at the same time its natural appearance. If it is left in an hermetically closed vessel it will remain hours and even days unchanged, but immediately becomes lively again when it is placed in pure sea-water. Starfishes remained immovable four days, and

* Zool. Anzeig., v. (1882) pp. 698–9. Bull. Soc. Belg. Micr., ix. (1882) pp. 35–36.

after half an hour in fresh sea-water were as active and healthy as if nothing had happened. The experiment fails, however, for fishes and Mollusca, and Crustacea only endure it for a short time.

In addition to the value of this method for photography, it will prove useful for distributing living marine animals and for physiological purposes.

Corallin as a Microscopical Reagent.*—I. Szyszylowicz distinguishes the various descriptions of mucilage occurring in the vegetable kingdom as follows:—1. Mucilage, i. e. substances which swell in water, are nearly allied chemically to cellulose, are coloured blue by iodine and sulphuric acid or zinc chloride, and which yield oxalic acid when boiled with nitric acid; examples, salep, *Symphytum*, &c. 2. Gums, which also swell in water, dissolving at the same time, are not coloured blue by iodine even on addition of sulphuric acid and zinc chloride, and which yield mucic acid when boiled with nitric acid; examples, *Tilia*, *Osmunda*, &c. 3. Mixtures of mucilage and gum, which the author calls gum-mucilage; and which combine the properties of the two first kinds; these are the most common in the vegetable kingdom; examples, *Linum*, *Plantago*, *Althæa*, &c. At present we have no microscopical reagent for gum, mucilage, or gum-mucilage, except the property of swelling, and the stronger refringence than the surrounding substances; but these are not always sufficient.

Corallin (sometimes called rosolic acid) is obtained by the action of sulphuric acid on phenol in the presence of oxalic acid, and is strictly a pigment composed of aurin and rosolic acid. The author employs it only dissolved in sodium carbonate, when it is of a purple-red colour not changed by exposure to light. The reagent acts differently on the mucilage derived from starch, as in the tubers of Orchideæ, and on that derived from cellulose, as in the root of *Symphytum*.

The colour imparted to starch-mucilage by corallin is remarkably durable; even long-continued boiling in alcohol does not cause any change, which is the more characteristic from the cell-walls and the protoplasm remaining perfectly clear. Cellulose-mucilage is also coloured by corallin, but the colour is destroyed by cold, and still more by hot alcohol. The pigment has no effect whatever on gum. Gum-mucilage is more or less coloured, the shade and permanence of the colour depending on the proportion of the two ingredients. The reagent enables one to detect the smallest quantity of mucilage, and its power of swelling, which has not been the case before. It is of especial value in the examination of the callus in sieve-tubes. In similar cases Russow uses anilin-blue to distinguish the callus-plate; but the author maintains that corallin produces a better result when the callus is beginning to swell or is already dissolved.

The preservation of preparations coloured by corallin is not always possible. The author has preserved very beautiful preparations from starch-mucilage in Canada balsam, but others, and especially those with gum-mucilage, have not been so successful, the

* Osobne odbicie z Rozpran Akad. Umiej w Krakowie, x. (1882). See Bot. Centralbl., xii. (1882) p. 138.

colour being attacked, as might be expected, by the preserving material.

Preparing Bacillus tuberculosis.*—Prof. J. Brun proposes the following "ameliorations" to Koch and Ehrlich's processes.

1st. Not to coagulate the albumen by heat, avoiding desiccation at more than 80° C. At 100° or 120° C. the bacteria are contracted.

2nd. To render the organic matter transparent by acetic acid:—Concentrated nitric acid 5 parts,† glacial acetic acid 10 parts, water 55 parts.

3rd. To neutralize the nitric acid which, remaining to a greater or less extent in the organic layer, at length decolorizes the bacteria and renders them invisible. For this purpose is to be used a concentrated aqueous solution of aniline which neutralizes all the acid not removed by repeated washings.

4th. To avoid Canada balsam, the index of which (1·53) is too high, and to take a neutral liquid having the same index as the albuminoid substances (1·37):—Very white gelatine 14 parts, salicylic acid ·25, distilled water 88.‡ This has an index of 1·356 for the yellow rays. Castor-oil can also be used, though its index is 1·46.

It is better to leave the field uncoloured than to colour it an orange-brown with vesuvine or other colouring matter, because the blue of the bacteria is rendered fainter by the complementary orange tint.

Staining Bacteria.§—Professor C. Weigert adopts two distinct principles in the staining of bacteria for microscopical examination, according as they occur on the one hand in clear liquids or dried masses, or, on the other, in tissues of which, after hardening, sections can be made. For most *Micrococci* all nucleus-staining substances are suitable, viz. (red) all the modifications of carmine, also purpurin, fuchsin, and Magdala-red; (brown) Bismarck-brown, vesuvin; (violet-brown) carmine, the preparations being washed, after staining, in alcohol, to which some chloride of iron has been added; (green) methyl-green; (blue and violet) hæmatoxylin, iodine-violet, methyl-violet, dahlia, gentian-violet.

For staining *Bacilli* and the rare *Megacocci*, anilin colours are alone recommended; carmine and hæmatoxylin produce no effect; of the anilin colours only those which stain nuclei, viz. the basic compounds (e.g. Bismarck-brown, methyl-violet, methyl-green, safranin, fuchsin, magdala, &c.) are applicable; gentian-violet appears to be especially suitable; the objection to methyl-violet and fuchsin is that in decolorizing in order to leave only the nucleus stained, the

* Bull. Soc. Belge Micr., viii. (1882) pp. clxix.-lxxvii. Journ. de Microgr., vi. (1882) pp. 500-3.

† In Bull. Soc. Belge Micr. this is given as 15 parts.

‡ In Journ. de Micr. this formula is not given, but in place of it the following, which in Bull. Soc. Belge Micr. is said not to preserve so well the colour of the bacteria:—Glycerine 10, commercial glucose 40, camphorated alcohol 10, water 140. The index is 1·37.

§ Arch. pathol. Anat. (Virchow), lxxxiv. (1881) pp. 275-94.

colour is apt to go altogether. Some of these colours are unsuited to certain bacteria, e. g. Bismarck-brown does not stain the bacillus of *lepra* at all, and that of splenic fever but badly. In order to stain the bacteria, the sections are placed in a 1 per cent. watery solution of the dye; in a few moments they are deeply coloured, and may then be "differentiated" (the term applied by Professor Weigert to the process of removal of the colour from the body of the cell), by means of alcohol, in which they may be allowed to lie more than an hour; if oil of cloves is used, they may be left in it half an hour and upwards; then if there is not time to examine them, they may be put into water for as much as a day without losing their colour. The use of absolute alcohol for the washing is specially recommended; for gentian-violet, which strongly resists the washing-out process, treatment with oil of cloves, and then with alcohol, transferring back to the oil, is the quickest way. Gentian-violet is particularly useful when it is uncertain what form of bacterium is present, but the colour is removed from the nuclei when placed in glycerine.

Double-staining is very useful for colouring the nuclei and the bacteria differently; of all combinations picrocarmine was found to be the best; it is used as made in the following way, in preference to commercial specimens of this reagent, which Professor Weigert finds are seldom entirely satisfactory:—

Over 2 grammes of carmine are poured 4 grammes common ammonia, and the whole left 24 hours in a place protected against evaporation; 200 grammes of a concentrated picric acid solution are then poured in; the mixture is left 24 hours until all soluble matters are dissolved. Very small quantities of acetic acid are then added until a slight precipitate comes down even after stirring; a rather copious precipitate is usually thrown down in the course of the next 24 hours; it should be removed by filtration.

A picrocarmine which does not stain readily may be improved by addition of acetic acid. After staining, the sections should be washed in pure water or water containing only a trace of acid.

In applying double-staining to bacteria contained in the tissues, the sections should first be treated with gentian violet and alcohol, placed for a moment in water to remove the alcohol and then placed in the picrocarmine and kept there for half an hour or an hour; the superfluous picrocarmine is washed away with water, and the specimen well washed with alcohol and mounted in Canada balsam, after passing through oil of cloves. This method may be applied to *Micrococci*, care being taken not to stain them red by a too protracted sojourn in the picrocarmine.

Actinomyces is not stained by the usual nucleus-staining preparations; *orseille* is used as prepared by Wedl, and the sections left in it for about an hour; they are then washed superficially with alcohol and transferred to gentian-violet. The wall and contents of the cell of *Molluscum contagiosum* are differentiated by this method.

Sections of tissues containing bacteria may be made by Roy's microtome. The frozen sections are examined either fresh or in salt solution; if they are to be stained and mounted they are spread out

with glass needles on a spatula, the superfluous salt solution is removed with blotting-paper, and the section is slowly immersed in absolute alcohol and left there until all air-bubbles have been removed. In all studies of bacteria by staining sections it is important to remember that the staining is apt to fail in the case of some of the micro-organisms, and thus give misleading negative results; the addition of some acetic acid or caustic potash before staining will generally remedy this defect, although the sections are somewhat impaired by these reagents. It is hardly necessary to record Professor Weigert's warning that really good objectives are an absolute necessity for this work.

Preparing Fatty Acids.*—Mr. F. J. Allen boils up the fat or oil with a not too strong solution of caustic soda or potash (liq. sodæ or liq. potassæ) until the alkali is quite saturated and refuses to absorb any more fat. When it has cooled filter it and add dilute sulphuric or hydrochloric acid (stirring and warming at the same time) until no more fatty acid separates. Boil for a second or two, then set aside to cool. When cold, the fatty acid will be found in a solid mass on the surface, and the liquid part may be thrown away.

It is well to boil the acid in *fresh* water to purify it, when, on cooling, it will be practically pure.

To get crystals, it is simply necessary to melt a small quantity on a slide, and spread it *very thin;* it crystallizes on cooling, and must be mounted "dry."

Carmine Solution.†—Prof. H. Hoyer, believing in the great superiority in all respects of carmine for animal tissues, strongly recommends the following as avoiding the objections which exist to the simple solution on account of the difficulty of keeping it, and other disadvantages. He is able to speak from a year's trial.

Dissolve 1 gr. of carmine in a mixture of 1–2 c.cm. of strong liquor ammoniæ and 6–8 c.cm. of water, and heat it in a glass vessel in a sand bath until the excess of ammonia has evaporated. So long as free ammonia is present large bubbles are formed in the fluid, and the latter shows the usual dark purple-red colour of carminate of ammonia. When the free ammonia has evaporated small bubbles appear, and the solution takes a brighter red tint. It is now left to cool and settle, and by filtering, the bright red deposit (to be used over again) is separated from the neutral dark fluid, which by the addition of chloral-hydrate can be kept for a long time.‡

If the carmine solution is mixed with 4–6 times its volume of strong alcohol a scarlet-red precipitate is formed. This is separated by filtration, washed and dried, or made into a paste with alcohol in which some glycerine and chloral is dissolved. Both the powder and the paste can be kept several months unchanged; they dissolve easily in distilled water, particularly the paste. The solution passes readily through the filter, whilst the ordinary carmine solution can

* Journ. Post. Micr. Soc., i. (1882) p. 193.
† Biol. Centralbl., ii. (1882) pp. 17–19.
‡ Cf. *infra*, p. 142, as to its use in the preparation of a red injection-mass

only be filtered with difficulty; it also keeps a long time unchanged, especially with the addition of 1–2 per cent. of chloral, and it has a much more intense colouring power.

By dissolving the carmine powder in a concentrated solution of neutral picrate of ammonia a combination is obtained which unites all the advantages of ordinary "picrocarmine" without any of its disadvantages.

Prussian Blue and Safranine for Plant Sections.*—Prof. J. Brun refers to the process of double staining for vegetable histology described by him to the Geneva Physical and Natural History Society, in which the action of Prussian blue alternates with that of safranine. The process is to be recommended for the clearness with which the preparations show all the minutest details, even in the interior of the cells. The chlorophyll retains its colour, while the cellulose, the layers of the cell-walls and their contents, the incrusting matter, and the fatty or resinous substances are, on the contrary, differently coloured and readily differentiated. He insists on the value of these histo-chemical processes in distinguishing very minute transparent bodies, and above all to differentiate organs scattered through opaline liquids or colourless histological elements.

Injection-Masses.†—Prof. H. Hoyer describes several compounds which he has found useful for this purpose, the essential point being the use of gelatine, the great objection to which is remedied by adding to it chloral hydrate, which protects it from deteriorating by fungoid growths. It is thus possible to have a stock of different coloured masses eminently suited for injection purposes, and which only require to be warmed before immediate use.

For a transparent *red* mass take a concentrated gelatine solution, and add to it a corresponding quantity of the carmine solution described *supra* p. 141. Digest in a water bath until the dark violet-red colour begins to pass into a bright red tint. Then add 5–10 per cent. by volumes of glycerine and at least 2 per cent. by weight of chloral in a concentrated solution. After passing through flannel it can be kept in an open vessel under a bell glass.

A *blue* mass can be made by mixing a small quantity of a *very dilute* and warm solution of Berlin blue with an equally small quantity of a moderately dilute gelatine-solution, by which a clear homogeneous blue solution is obtained. This is again mixed with larger quantities of concentrated warm gelatine-solution, with the gradual addition of now only a moderately dilute solution of Berlin blue. A homogeneous transparent saturated mass is thus produced. The addition of chloral and glycerine enables it to be kept for a long time.

For a fluid yellow in the capillaries and brown in the larger vessels the following is given. A concentrated solution of gelatine is mixed with an equal volume of a 4 per cent. solution of nitrate of

* Bull. Soc. Belge Micr., viii. (1882) pp. clxix.-lxx. Journ. de Microgr., vi. (1882) p. 500.

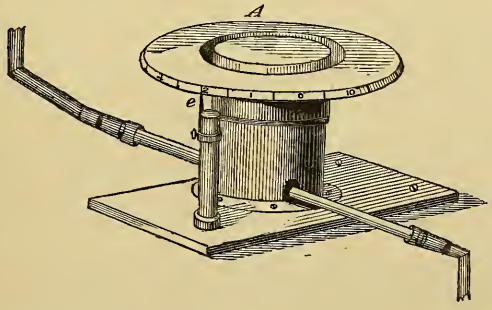
† Biol. Centralbl., ii. (1882) pp. 19–22.

silver, and warmed. To this is added a very small quantity of an aqueous solution of pyrogallic acid, which reduces the silver in a few seconds; chloral and glycerine are added as before. It does not change either in alcohol, chromic or acetic acid, or in bichromate of potash, &c., so that the objects can be hardened in different fluids. Blue and yellow masses mixed give a very useful green.

Prof. Hoyer recalls attention to two other formulæ previously described by him,* but "which have not received any notice in histological text-books." The one is ammonio-nitrate of silver, especially suitable for the endothelium of vessels and fine vessels generally, and much to be preferred to the simple nitrate of silver solution. The other is spirituous solution of shellac.

Taylor's Freezing Microtome.†—This microtome (fig. 29), the invention of Dr. T. Taylor, Microscopist of the Agricultural Depart-

Fig. 29.



ment at Washington, is claimed to present "all the advantages of any plan heretofore employed in hardening animal or vegetable tissues for section cutting, while it has many advantages over all other devices employed for the same purpose.

Microscopists who are interested in the study of histology and pathology have long felt the necessity for a better method of freezing animal and vegetable tissue than has been heretofore at their command. In hardening tissues by chemical agents the tissues are more or less distorted by the solutions used, and the process is very slow. Ether and rhigolene have been employed with some degree of success, but both are expensive and they cannot be used in the presence of artificial light because of danger of explosion. Another disadvantage is that two persons are required to attend to the manipulations, one to force the vapour into the freezing box while the other uses the section-cutting knife. The moment the pumping of the ether or rhigolene ceases, the tissue operated on ceases to be frozen, so ephemeral is the degree of cold obtained by these means.

* Arch. f. Mikr. Anat., xiii. (1877).
† Amer. Mon. Micr. Journ., iii. (1882) pp. 168–9 (1 fig.).

The principal advantages to be obtained by the use of the Taylor Microtome are, 1st, great economy in the method of freezing, and 2nd, celerity and certainty of freezing. With an expenditure of twenty-five cents the tissues to be operated on can be kept frozen for several hours at a time. Small objects immersed in gum solutions are frozen and in condition for cutting in less than one minute."

A is a revolving plate by which the thickness of the section is regulated, and in the centre of which is an insulated chamber for freezing the tissue. A brass tube enters it on each side. The larger one is the supply tube, communicating with a pail on a bracket above the microtome, whilst to the smaller one is attached a rubber tube, which discharges the cold salt water into a pail placed under it. The salt and water liquid, as it passes from the upper to the lower pail, is at a temperature of about zero. The water should not be allowed to waste, but should be returned to the first pail for continual use, or as long as it has freezing properties. As a matter of further economy it is necessary to limit the rate of exit of the freezing water. This is regulated by nipping the discharge tube with the spring clothes-pin supplied for the purpose. Should the cold within the chamber be too intense the edge of the knife is liable to be turned and the cutting will be imperfect. When this occurs the flow of water through the chamber is stopped by using a spring clothes-pin as a clip on the upper tube. In order to regulate the thickness of the tissue to be cut a scale is engraved on the edge of the revolving plate A, which, in conjunction with the pointer *e*, indicates the thickness of the section.

Mr. C. P. Lyman, of the Department of Agriculture, writing in strong commendation of the apparatus, says:—"There is no little box that must be kept full of ice and salt and constantly attended to; neither is there any tiresome bulb to squeeze for a period of anywhere from fifteen minutes to two hours, nor the expense and danger attending the general use of ether or rhigolene. The simplicity of the operation of freezing morbid material for sections, now obtainable through the use of this instrument, will, I think, remove from the study of pathology one of its hitherto greatest bugbears, viz. the great labour of preparation of material for section and the difficulty of obtaining good sections of soft tissues unaltered by the various chemical reagents hitherto used for the purpose of hardening them."

Mounting Media.*—Prof. H. Hoyer has found excellent mounting media not only in L. Bach's solution of gum arabic in liquor ammoniæ aceti, but also in acetate of potash, as well as a third modification with glycerine and chloral. The two former are more particularly suitable for preparations stained with aniline colours, especially bacteria. The latter is suitable for sections hardened in chromic acid, alcohol, &c., and objects coloured with carmine or hæmatoxylin.

* Biol. Centralbl., ii. (1882) pp. 23–4.

The solutions are thus prepared:—A high 60 c.cm. glass with a wide neck is filled two-thirds full with selected white gum arabic (in pieces, not powder), and then acetate of potash or ammonia is added, or a solution of chloral-hydrate (of several per cent.) to which 5–10 per cent. of glycerine has been added. The gum with frequent shaking dissolves in a few days and forms a syrupy fluid, which is slowly filtered for twenty-four hours. The clear filtered fluid will keep a long time, but if spores of fungi begin to develop a little chloral can be added and the fluid refiltered.

Preparation of Dammar Varnish.*—C. J. M. says that none of the receipts given in books enable the amateur to prepare a satisfactory article. Dammar is not entirely soluble in ether, benzole, or turpentine, at ordinary temperatures. If heat be used, the solution is more complete, but, sooner or later, the product will become milky, and then it will be found impossible to clarify it.

To obtain a perfectly limpid solution, permanently remaining so, proceed as follows: To 4 drachms of crushed Indian dammar add 8 liquid drachms of pure benzole, and allow the resin to dissolve at the ordinary temperature. After a day or two, an insoluble residue will be found at the bottom of the vessel. Carefully decant the supernatant clear liquid, and add to it 80 minims ($1\frac{1}{3}$ drachm) of spirits of turpentine. The preparation is then complete. The object of adding turpentine is to ensure toughness in the dried film. Without the turpentine the dried film would be brittle. He does not think that any advantage is derived from the addition of mastic to the preparation.

Hunt's American Cement.†—Mr. J. Ford has received from an American correspondent the following recipe for making the cement, so effectually used by professional mounters, and which has been regarded as a trade secret:—

"Take some zinc white as sold for painters' use, drain off the oil, and mix with Canada balsam, dissolved very thin with chloroform. If it does not flow freely from the brush, add a little turpentine. The mixture should be about the thickness of cream, and kept in a bottle with a glass cap."

Mr. F. J. Allen adds:—Having sealed the slide with the cement, paint on it with artists' oil-colours, thinned if necessary with turpentine, and when dry varnish it with very dilute balsam to give it a gloss.

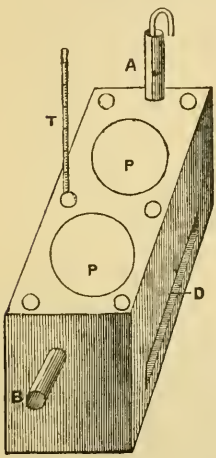
Mayer's Water Bath.‡—A convenient form of water bath, devised by Dr. P. Mayer, is shown in fig. 30.

It is a small brass box, 18 cm. long, 9 cm. wide, and 8 cm. high. The tube A, through which the water is received, and the rod B serve as handles. The receiving tube is closed by a cork provided with a glass tube for the escape of steam, which is bent in the form of

* Sci.-Gossip, 1882, p. 257.
† Journ. Post. Micr. Soc., i. (1882) p. 193.
‡ Cf. C. O. Whitman in Amer. Natural., xvi. (1882) p. 785 (1 fig.).

a siphon to protect against dust. At 1·5 cm. from the base of the box is an oven (D) ·7 cm. high, and 12 cm. long, which passes completely through the box, and serves for warming the slides when shellac is used. Above are two circular basin-like pits (P) 5·5 cm. in diameter, and 4 cm. deep, for receiving the two tin paraffin holders. These are covered by circular plates of glass. There are also six tubular pits, one for a thermometer (T), the other for glass tubes.

Fig. 30.



This water bath will be found useful for other purposes than those of imbedding and mounting. It will of course be understood that the only object of giving its exact dimensions is to furnish a guide where one is required. There are at least two important advantages offered by this water bath over those in general use, viz. the slides are protected from dust, and the paraffin is not exposed to the water.

Packing Slides for Travelling. — Mr. L. Dreyfus describes the mode in which he transported from London to Wiesbaden his collection of over 5000 preparations without a single breakage:—

"I used no wadding whatever, but packed the whole in racked boxes, and over the ends of the slides in the racks only, I put, with the handle of my scalpel, on each side a length of the *smallest* indiarubber tubing, such as is used for feeding-bottles. When the slides were so packed, two more lengths on the top, under the lid, before the latter was fastened down by two of the *stoutest* indiarubber bands across the box in *both* directions (sides and bottom.) This allowed so much spring in every direction that no breakage occurred, although I have no doubt the heavy cases were handled in the usual delicate way by railway porters and sailors on board the steamer.

Besides minimizing the risk of breakage, this style of packing has the advantage of being very easy and expeditious in packing and unpacking, and perfectly clean. The preparations come out as clean as they were packed, and can be packed into the cabinets without the tedious wiping required after the use of cotton wool. Tubes and rings can be used over and over again, so that the extra expense is very small."

Examination of Living Germs in Water.*—At a recent meeting of the Manchester Literary and Philosophical Society, Dr. R. Angus Smith stated that Dr. Koch, of Berlin, advocated the use of gelatine in preserving indications of organic vitality. About $2\frac{1}{2}$ per cent. of gelatine, well heated in a little water, is mixed with the water to be tested, and the mixture forms a transparent mass, in which

* Chem. News, xlvi. (1882) pp. 288–90.

soluble or unobserved matter, developed from the organic matter of the waters and made visible in a solid and insoluble form, does not fall to the bottom, but shows round each active point the sphere of its activity. The gelatine keeps a record, for a time, both of the quality and intensity of life in the liquid, every little centre of life making itself apparent to the eye. It seems, therefore, to Dr. Smith essential that all chemical examinations of water should be supplemented by an inquiry, like this of Dr. Koch's, into the comparative activity of the living organisms. In some waters a centre makes around it a sphere, which has the appearance of a thin vesicle, and is filled with liquid. These spheres form in a day or two, according to the water, and at their bottom is a white mass, containing chiefly active bacteria. The liquid filling the spheres may be taken out by a pipette and examined, with the bacteria which lie at the bottom. Dr. Smith has not yet examined a sufficient number of waters to give general rules, but hopes to do so. He has as yet examined no chalk water for example, but has been confined chiefly to the Manchester district hill water, impure brook and pond water, Mersey, Irwell, and Medlock water, and canal water. In certain specimens of Manchester water the spheres appear on some days to be few in number, on other days the amount is enormous, the whole of the tube in which the experiment is made being filled with them. At such times the water is highly impure, and complained of by the public. Dr. Smith says that when the tests are sufficiently developed, "chemists must prepare for a new condition of things."

Sinel's Embryological Slides. — Sinel & Co. of St. Helier's, Jersey, have issued a series of these slides, in the notice of which they refer to the difficulty of preserving delicate embryological objects for microscopical examination. "The favourite medium of the microscopist has hitherto been Canada balsam, and owing to the non-existence of a cement sufficiently powerful to hold fluid in a cell, this latter medium has been viewed with some suspicion. It would, however, be useless to attempt the preservation of the ova of Crustacea or Mollusca in Canada balsam, but the medium used for these slides, being of the same density as sea-water (and also of such an admirable preservative character that the living appearance of the objects is fully retained) is the most successful yet met with.

"The slides are constructed with a cement of such power and hardness that they have stood a test that would even damage a balsam mount, viz. a temperature ranging from 28° to 120° F., without the slightest effect upon the slide or object, and of the numbers that have been prepared in this manner none have been found to leak, as is frequently the case with ordinary fluid mounts. No slides are sent out till they have been left some considerable time to test and harden."

The list includes the ova, in various stages of development, and the young of Fishes, Mollusca, Insecta, Arachnida, Crustacea, and Echinodermata, with a series of six slides of the anatomy of *Palæmon varians*.

Search for "Atlantis" with the Microscope.* — Under this heading Dr. A. Geikie reviews a paper† by the Abbé Renard "On the Petrology of St. Paul's Rocks," an island nearly on the equator, and about 500 miles east of the South American coast:—

"Are these rocks the last enduring remnant of 'Atlantis'—a continent that has otherwise disappeared, or are they portions of a volcanic mass like the other islands of the same ocean? To those who have not noted the modern progress of geological inquiry, it may seem incredible that any one should propose to solve this problem with the Microscope. To seek for a supposed lost continent with the help of a Microscope may seem to be as sane a proceeding as to attempt to revive an extinct *Ichthyosaurus* with a box of lucifer-matches. Yet in truth the answer to the question whether the St. Paul's Rocks are portions of a once more extensive land depends upon the ascertained origin of the materials of these rocks, and this origin can only be properly inferred from the detailed structure of the materials, as revealed by the Microscope. The importance of microscopical examination in geological research, so urgently pressed upon the notice of geologists for some years past, has sometimes been spoken of disparagingly, as if the conclusions to which it led were uncertain, and hardly worth the labour of arriving at them. We occasionally hear taunts levelled at the 'waistcoat-pocket geologists,' who carry home little chips of rock, slice them, look at them with their Microscopes, and straightway reveal to their admiring friends the true structure and history of a whole mountain-range or region. That the sarcasm is often well-deserved must be frankly conceded. Some observers with the Microscope have been so captivated with their new toy as to persuade themselves that with its aid they may dispense with the old-fashioned methods of observation in the field. But there could not be a more fatal mistake. The fundamental questions of geological structure must be determined on the ground. The Microscope becomes an invaluable help in widening and correcting the insight so obtained; but its verdict is sometimes as ambiguous as that of any oracle. In any case it must remain the servant, not the master, of the field-geologist."

M. Renard has undertaken a most elaborate investigation (chemically and microscopically) of sections of the rocks brought home by the 'Challenger,' with the view of determining whether they were to be considered as volcanic or to be classed among the crystalline schists. If they belong to the latter, they must once have lain deeply buried beneath overlying masses, by the removal of which they have been revealed. They would thus go far to prove the former existence of much higher and more extensive land in that region of the Atlantic; land, too, not formed of mere volcanic protrusions, but built up of solid rock-masses, such as compose the framework of the continents. If, on the other hand, the rock is volcanic, then the islets of St. Paul belong to the same order as the oceanic islands all over the globe. The Abbé inclines on the whole to the side of the crystalline schists,

* Nature, xxvii. (1882) pp. 25-6. † Ann. Soc. Belg. Micr., ix. (1882).

but Prof. Geikie considers that the balance of proof is decidedly in favour of the volcanic origin of the rock.

Cole's Studies in Microscopical Science. — These have now reached the 40th number, and fully support the high praise which has been bestowed upon them in every direction, both for the information contained in the text, the beauty of the coloured illustrations, and the excellence of the accompanying slides. Microscopists have long lamented that it was not possible to obtain a guide to the slides sold, so that the points of interest illustrated could be intelligently appreciated. Now that this is provided, it is to be hoped that they will bear in mind that something more is required than "moral" support in order to ensure a continuation of the series. So many useful ventures have failed through microscopists trusting to their neighbours to provide substantial support, that it is necessary to urge that every one who believes in the value of Mr. Cole's enterprise will himself subscribe to it. No more profitable return can, we are sure, be found for the small outlay required.

Allen, F. J.—Dr. Hunt's American Cement for Ringing Slides. [*Supra*, p. 145.]
Journ. Post. Micr. Soc., I. (1882) p. 193.

„ „ Fatty Acids to prepare for the Microscope. [*Supra*, p. 141.]
Journ. Post. Micr. Soc., I. (1882) p. 193.

Blanc, H.—Encore une méthode pour conserver et colorer les Protozoaires. (Another method for preserving and colouring the Protozoa.) [*Post.*]
Zool. Anzeig., VI. (1883) pp. 22–3.

Bonchut, E.—Traité de Diagnostic et de Sémiologie comprenant l'exposé des procédés physiques et chimiques d'exploration médicale, auscultation, percussion, cérébroscopie, sphygmographie, laryngoscopie, microscopie, analyse chimique et l'étude des symptomes fournis par les troubles fonctionnels.
[Chap. XIV. Emploi de la loupe et du Microscope. (Employment of the lens and the Microscope.) pp. 155–76 (18 figs.).]
8vo, Paris, 1883, xi. and 692 pp. (160 figs.).

Chester, A. H.—Method of making Tin Rings for Cells. [*Post.*]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 282–3.

Cohen, E., & J. Grimm.—Sammlung von Mikrophotographien zur Veranschaulichung der Mikroskopischen Struktur von Mineralien und Gesteinen. (Collection of Microphotographs for the demonstration of the Microscopical Structure of Minerals and Rocks.) Part VII. 8 pls. 4to, Stuttgart, 1882.

Cole, A. C.—Studies in Microscopical Science.
No. 30 (pp. 209–216).—T. S. Thallus of Lichen. *Sticta aurata.* Plate of 15 figs.
No. 31 (pp. 217–220).—The Pancreas. T. S. of Human Pancreas, injected carmine. Plate × 65.
No. 32 (pp. 221–6).—Diabase. South Quarry, Corstorphine Hill, Edinburgh. Plate × 25.
No. 33 (pp. 227–30).—The Spleen. T. S. of Human Spleen (of Infant), injected carmine and stained with hæmatoxylin. Diagrammatic Drawing.
No. 34 (pp. 231–4).—*Juncus communis* var. *effusus.* T. S. of Stem. Plate × 250.
No. 35 (pp. 235–40).—The Spleen. T. S. Spleen of Cat, stained logwood. Plate × 65.
No. 36 (pp. 241–2).—*Euphorbia splendens.* L. S. of Stem, stained logwood. Plate × 65 and 500.
No. 37 (pp. 243–50).—The Salivary Glands. V. S. Submaxillary Gland of Dog, stained logwood. Plate × 500.
No. 38 (pp. 251–6).—Section of Rock—Red Syenite. Ord Hill, Sutherland. Plate × 25. Description by Prof. M. F. Heddle.

Cornil & Ranvier.—Manual of Pathological Histology. Transl. by Hart. 2nd ed. Vol. I. 8vo, London, 1882.

Cutting Sections of Dental Pulp.

["Harden in 1 per cent. aqueous solution of chromic acid, separated from the dentine; or take fresh pulp from the extracted tooth, stain with carmine, harden in glycerine to which add 1 per cent. acetic acid. In three to six months sections could be cut with a keen razor."]

The Microscope, II. (1882) p. 172, from *New England Journal of Dentistry*.

Deecke, T.—Preparation and Mounting of Brain Sections. [*Post.*]

Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 275–80.

Fol, H.—Ein Beitrag zur Technik für Zoologen am Meeresstrande. (A Contribution to Technics for Zoologists at the Sea-shore.) [*Supra*, p. 137.]

Zool. Anzeig., V. (1882) pp. 698–9.

and in French in *Bull. Soc. Belg. Micr.*, IX. (1882) pp. 35–7.

Ford, J.—Dr. Hunt's American Cement for Ringing Slides. [*Supra*, p. 145.]

Journ. Post. Micr. Soc., I. (1882) p. 193.

Freeman, H. E.—Grinding Sections of Teeth.

[Employ ground-glass, using with it in the early stage fine-ground pumice-stone.]

Journ. Post. Micr. Soc., I. (1882) p. 192.

Frenzel, J.—Beitrag zur Microscopischen Technik—Aufkleben der Schnitte. (Contribution to Microscopical Technics—Fixing the Sections.) [*Post.*]

Zool. Anzeig., VI. (1883) pp. 51–2.

Friedlaender, C.—Microscopische Technik zum gebrauch bei medicinischen und pathologisch-anatomischen Untersuchungen. (Microscopical Technics for use in medical and pathologico-anatomical investigations.) viii. and 132 pp., 8vo, Kassel and Berlin, n.d.

Gage, S. H.—Observations on the Fat Cells and Connective-tissue Corpuscles of *Necturus* (*Menobranchus*).

[Contains "Methods of Investigation" and making "Permanent Microscopic Preparations."]

Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 109–26 (1 pl.).

Griesbach, H.—Bemerkungen zur Injectionstechnik bei Wirbellosen. (Remarks on the Injection of Invertebrata.) [*Post.*]

Arch. f. Mikr. Anat., XXI. (1882) pp. 824–7.

Grimm, J. See Cohen, E.

Hager, H.—Arsennachweis auf mikroskopischem Wege. (Microscopical Analysis of Arsenic.) *Chem. Centralbl.*, XIII. (1882) pp. 690–1, from *Pharm. Centralh.*, XXIII. (1882) pp. 367–9.

Hauck, F.—Die Meeresalgen Deutschlands und Oesterreichs. (The Marine Algæ of Germany and Austria.) 8vo, Leipzig, 1883.

[2nd vol. of Dr. L. Rabenhorst's Cryptogamic Flora of Germany, Austria, and Switzerland. 1st part contains Introduction (pp. 1–6) on "The Collection and Preparation of Marine Algæ."]

Hitchcock, R.—Examination and Exhibition of Living Organisms.

[Place a drop of water containing the organisms on a cover-glass and invert over a ring of wax on a slide—melt the wax with a piece of wire to make the cell air-tight. A small bit of *Nitella*, *Anacharis*, or some vigorously growing alga should be placed in the drop. In this way rotifers can be seen to develope and multiply for days. The plan is also recommended for showing cyclosis in a water plant.]

Amer. Mon. Micr. Journ., III. (1882) p. 222.

„ „ The Mounting of Pollen Grains.

[Dry—in wax cells (dusted in). Fluid—in castor-oil in shellac cells.]

Amer. Mon. Micr. Journ., III. (1882) p. 223.

Hurst, G. H.—The Microscopical Structure of Rocks.

[Contains notes on the Microscope required and on preparing rock-sections.]

Field Naturalist, I. (1883) pp. 169–71.

Ingpen, J. E.—Bleaching Leaves.

[Note as to making chlorinated soda and mounting the leaves in glycerine jelly.]

Journ. Post. Micr. Soc., I. (1882) p. 191.

KLAASEN, H. M.—To mount Plants in Glycerine and Water.
[Add to the glycerine a few drops of carbolic acid to guard against fungoid growth—mix with equal parts water—don't cement the cover-glass down, but let the water evaporate, and add more glycerine and water until the plant gets gradually filled with glycerine. Fasten the cover-glass by first ringing it with gelatine, to which any cement will adhere.]
Journ. Post. Micr. Soc., I. (1882) p. 192.

KOSMAN, R.—Zur Microtomtechnik. (On Microtomes.) [*Post.*]
Zool. Anzeig., VI. (1883) pp. 19–21.

LACHMANN, J. P.—See Poulsen, V. A.

LOFTHOUSE, T. W.—Mounting the Proboscis of a Fly—Preparation. [*Post.*]
Micr. News, III. (1882) pp. 21–2 (1 fig.).

MARCHAL, E.—Des moyens matériels dans l'enseignement de la botanique. Le Microscope. 22 pp. (Materials for the teaching of Botany—The Microscope.) 8vo, Bruxelles, 1882.
„ „ Essai d'une liste de préparations microscopiques destinées à l'enseignement. 16 pp. (Attempt at a list of microscopical preparations intended for teaching.) 8vo, Bruxelles, 1882.

Marlow's (E.) Microscopical Compendium.
[Cabinet for turntable, slides, brushes, bottles, &c.]
Sci.-Gossip, 1882, p. 277.

Mikroskopische Präparate von Mikroorganismen, speciell v. pathogenen Bacterien. Collection I. (Unter Controle v. Flügge in Göttingen angefertigt.) (Microscopical preparations of micro-organisms, especially of pathogenous Bacteria. Prepared under the direction of Flügge of Göttingen.) Cassel, 1882.

MÖBIUS, K.—Kleine Mittheilungen aus der Zoologischen Technik. (Minor communications on Zoological Technics.) [*Post.*] *Zool. Anzeig.*, VI. (1883) pp. 52–3.

MOORE, A. J.—The preparation of Crystals.
[The plan proposed has been found very unsatisfactory in England.]
The Microscope, II. (1882) p. 164.

MULLER, C. J.—On the discrimination of different species of wood by a microscopical examination of sections of branches. *Sci.-Gossip*, 1883, p. 9.

PARSONS, H. F.—Preventing growth of Mildew on dry Mounts.
[Paint the specimen and the interior of the cell with a solution of carbolic acid or corrosive sublimate in spirit before mounting.]
Journ. Post. Micr. Soc., I. (1882) p. 193.

PAUL'S (F. A.) Modification of Williams' Freezing Microtome. [*Post.*]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 283–4.

POULSEN, V. A.—Microchimie végétale, guide pour les recherches phyto-histologiques à l'usage des étudiants. (Vegetable Microchemistry, guide to phyto-histological researches for the use of students.) Translated by J. P. Lachmann from the German edition. French edition, considerably enlarged (in collaboration with the author). xx. and 119 pp. 8vo, Paris, 1882.

REDDING, T. B.—Osmic acid—its uses and advantages in microscopical investigations. [*Post.*] *Proc. Amer. Soc. Micr.*, 5th Ann. Meeting, 1882, pp. 183–6.

REINSCH, P. F.—Mikrophotographien über die Struktur und Zusammensetzung der Steinkohle des Carbon entnommen von mikroskopischen Durchschnitten d. Steinkohle. (Microphotographs of the Structure and Composition of Coal from Microscopical Sections.) 73 photographs on 13 plates and a photographic frontispiece. Leipzig, 1882.

ROGERS, W. A.—On a new form of dry mounting.
[Title (only) of paper read in the Microscopical Section of the Amer. Assoc. Adv. Sci.]
Amer. Natural., XVI. (1882) p. 1050.

S., W. J.—Note on Mounting for Hot Countries.
[Cf. II. (1882) p. 288—Report of satisfactory results with balsam and benzol and dammar and benzol.]
Sci.-Gossip, 1882, pp. 276–7.

SARGENT, W., junr.—Bleaching Fluid for Insects.
[Hydrochloric acid, 10 drops; chlorate of potash, ½ dr.; water, 1 oz. Soak for a day or two. Wash well.]
Journ. Post. Micr. Soc., I. (1882) p. 192.

Schiefferdecker, P.—Ueber eine neue Injectionsmasse zur Conservirung der Leichen für dem Präparirsaal. (On a new injection-mass for preserving bodies for the preparing room.) *Arch. f. Anat. u. Entwick.*, 1882, pp. 197–8.

„ „ Ueber die Verwendung des Celloidins in der Anatomischen Technik. (On the use of Celloidin in anatomical technics.) *Arch. f. Anat. u. Entwick.*, 1882, pp. 199–203.

Schulgin, M.—Zur Technik der Histologie. (On histological technics.) [*Post.*] *Zool. Anzeig.*, VI. (1883) pp. 21–2.

Slack, H. J.—Pleasant Hours with the Microscope.

[Disease Germs—Potato, Starches, &c., with Polarized Light.]

Knowledge, III. (1882), pp. 7–8, 34–5.

Stirling, W.—The Sulphocyanides of Ammonium and Potassium as histological reagents. [*Post.*] *Journ. Anat. & Physiol.*, XVII. (1883) pp. 207–10.

Stowell, C. H.—How to preserve Urinary Deposits.

[In Canada balsam, in glycerine, in a 1 per cent. solution of carbolic acid, in equal parts of glycerine and camphor-water, in a solution of naphtha and creosote, &c. Special directions as to the latter.]

The Microscope, II. (1882) pp. 161–2.

„ C. H. and L. K.—Microscopical Diagnosis, viii. 96, 114, 32 pp., 37, 78, and 16 figs., 10 pls. 8vo, Detroit, 1882.

Taylor, T.—A new freezing Microtome. [*Supra*, p. 143.]

Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 153–5 (1 fig.).

Teasdale, W.—Bleaching Leaves.

[Leaves of *Arabis albida* bleach rapidly in chloride of lime, and give charming results.]

Journ. Post. Micr. Soc., I. (1882) p. 191.

Vereker, J. G. P.—To mount in glycerine.

[Heat indiarubber till it becomes sticky, dissolve it in benzol, ring both cover and slide, then let it remain till tacky; arrange the object in glycerine, press down the cover, wash away spare glycerine, and run asphalte varnish or other finish. "The advantages are, the indiarubber sticks in spite of the glycerine, and is elastic, and so a great amount of trouble is saved."]

Journ. Post. Micr. Soc., I. (1882) p. 192.

Wade-Wilton, E.—Pond-hunting in winter.

[Remarks on the importance of collecting in winter as well as summer, and notes of organisms to be obtained.]

Journ. Post. Micr. Soc., I. (1882) pp. 183–5.

Walmsley, W. H.—Some hints on the preparation and mounting of microscopic objects. 32 pp. and 16 figs.

[Forms Part III. of Stowell's 'Microscopical Diagnosis,' *supra*.]

8vo, Detroit, 1882.

Warren, R. S.—Cleaning Diatoms.

[Reply to Mr. Kitton, II. (1882) p. 707, and agreeing that Mr. Kitton's description of his process is very like that of the author, but that is an accidental coincidence.]

Amer. Mon. Micr. Journ., III. (1882) pp. 225–6.

Wasse, G. M.—Continuous observation of Micro-fungi.

[Inquiring for information about observing the germination of fungus-spores under the Microscope.]

Sci.-Gossip, 1882, p. 277.

Whitman, C. O.—Orientation in Microtomic Sections—The reconstruction of objects from sections—Method of reconstruction.

[All in Vol. II. (1879) p. 71.]

Amer. Natural., XVII. (1883) pp. 109–12.

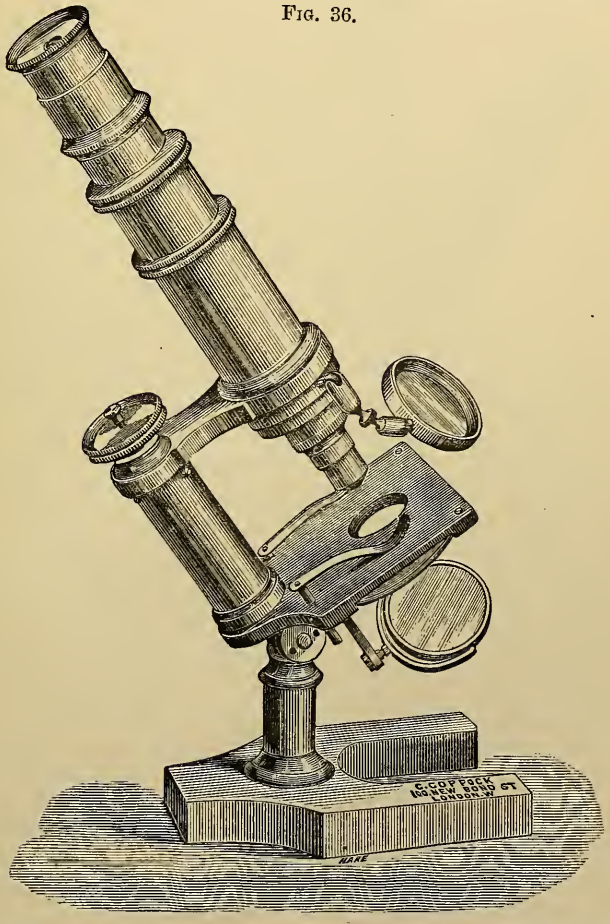
MICROSCOPY.

a. Instruments, Accessories, &c.

Coppock's Combination Microscope.—This Microscope has been constructed by Mr. C. Coppock mainly from data obtained from consultation with the leading teachers of science in Edinburgh.

The general form of the instrument is shown in fig. 36, the stage

Fig. 36.



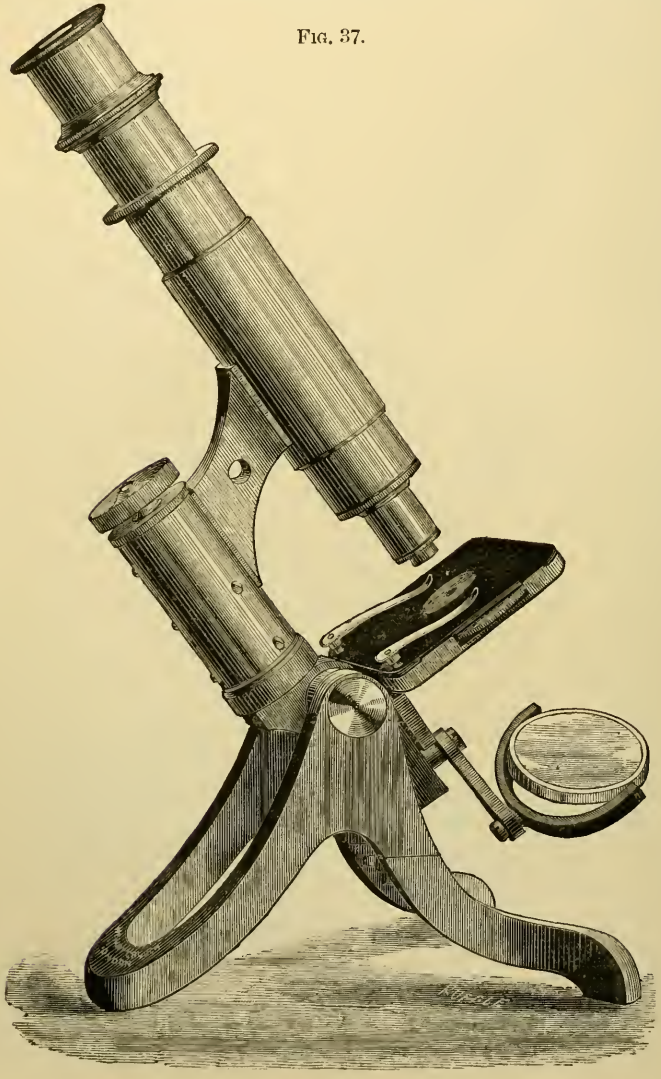
and body being carried upon a turned pillar, after the style of the Continental models, and the stage being as large as is consistent with the relative proportions of the whole instrument. The body-tube allows the highest objectives to be readily focussed by giving a slight spiral movement to the tube, and the draw-tube is stopped when drawn out to the normal nine inches. The side condenser is fixed by

a revolving annulus to the body. The revolving diaphragm plate is recessed into the stage. When the largest aperture is used, the thread in the stage will allow of a fitting being screwed into it to receive the various stage apparatus.

For class demonstration it is found that the hinged joint to the limb is not essential, and it is therefore made in two forms, with and without joint.

Crouch's Portable Histological Microscope.—Mr. H. Crouch has

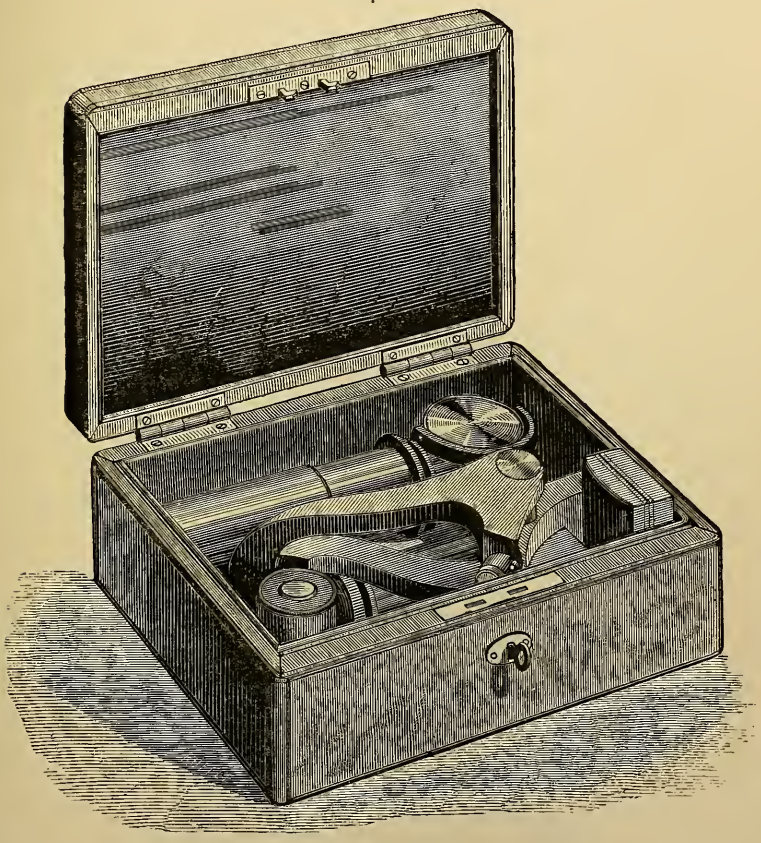
Fig. 37.



issued the instrument shown in figs. 37 and 38, with the view of providing a Microscope which shall combine portability with more steadiness than is usually found in "portable" forms. When set up for use the instrument is shown in fig. 37, and when folded in fig. 38.

The modifications adopted to enable the instrument to be folded

Fig. 38.



up are as follows:—(1) The stage is made to turn laterally at right angles to the normal position, so as to be in a line parallel with the body-tube, which permits the latter to be reversed and inserted at the lower end of the socket; and (2) the two front "feet" of the tripod are made to fold outwards and backwards under the heel.

In packing the instrument, a small milled screw beneath the stage is loosened, and the stage turned at right angles; the body-tube is removed, reversed, and put into the socket at the lower end; the limb

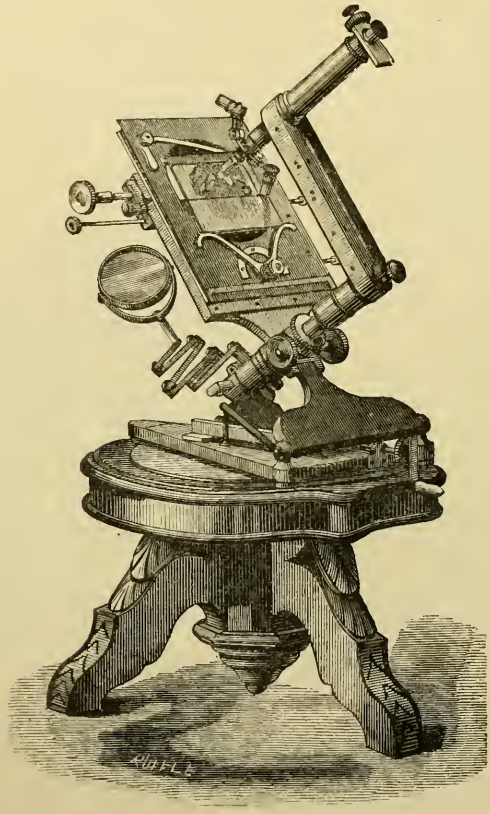
is inclined backwards on the trunnion axis as far as it will go, and the feet are turned back under the heel. Thus folded, the Microscope fits into a leather case 7 in. × 5 in. × 3 in.

The stage, which is only $\frac{1}{4}$ in. thick, contains between its upper and lower plates a diaphragm with four circular apertures, which is rotated by the finger acting on its projecting milled edge at the right-hand side.

Deecke's Large Microscope.—Dr. T. Deecke, special pathologist of the New York State Lunatic Asylum, sends us a description of this instrument (figs. 39–41)* from which the following is condensed:—

The stand became a necessity after he had succeeded in making

Fig. 39.

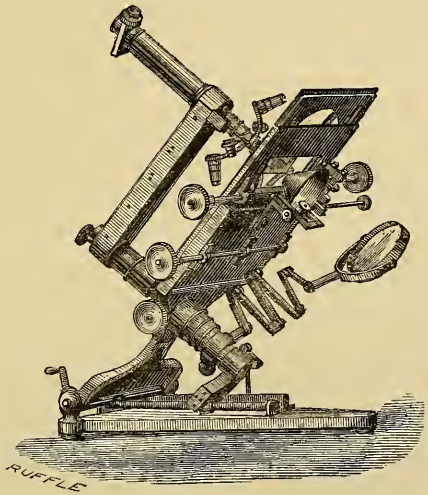


sections of 1-400th to 1-600th in. thickness, and upwards of 6 in. in diameter, in order to facilitate topographical investigations of minute

* The figures are drawn to a scale of about 1–12th actual size.

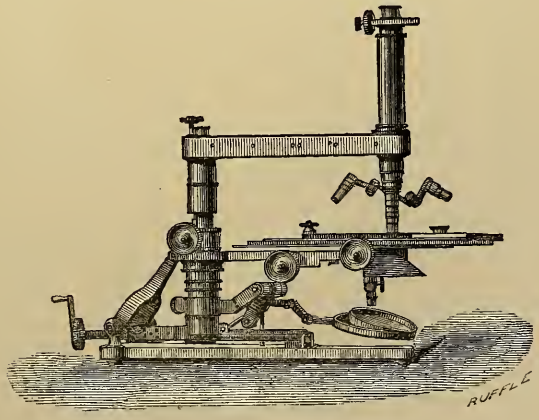
anatomical structure. It was constructed in 1876, and has since been in constant use for ordinary observations and photomicrography.

FIG. 40.



The application of a mechanical stage nearly 12 in. square, permitting 4 in. of motion in all directions from the optic axis, necessitated sundry modifications of design and construction from the usual models

FIG. 41.



in order to secure the utmost freedom for the various manipulations, together with the accuracy of movement required in using high powers.

The chief novelty is the system of inclining the Microscope from the vertical to the horizontal.

The foot is a heavy triangular plate, the base 14 in. and the two sides 19 in. There are two short pillars at the angles of the base which support by pivots a second triangle connected at the truncated vertex by a hinge with a shoulder-piece encircling the main column in which the coarse adjustment slides; the continuation of this shoulder in front is the fixed stage-plate carrying the mechanical stage. The lower end of the main column is provided with a female screw in a pivoted sliding box-fitting, in which acts a powerful 12 in. screw attached to the base-plate and controlled by a crank at the back. This screw causes the main column to travel from the vertical to the horizontal, the suspended triangle at the back moving correspondingly as a hinged stanchion.

The coarse adjustment is similar to that in the older Ross model; but two racks are applied to the column and two pinions are set on the same axis so that the teeth grip alternately in the racks, by which it is stated that lost motion is obviated.

The fine adjustment is also on the older Ross principle.

In consequence of the great length of the arm (13½ in.) carrying the body-tube, and to avoid flexure and tremor, the lever is constructed of two strong double bars connected by cross-bars like the beam of a chemical balance. It moves between conical steel fulcrum-points placed considerably in front of the centre, and very strong flat springs press against each end. Upon the posterior arm of the lever a micrometer-screw of sixty threads to the inch, acts, giving a focussing range of 1-8th in.

The mechanical stage rests upon the fixed rectangular plate which forms one piece with the shoulder encircling the main column. The mechanical movements (4 in. in all directions from the optic axis) are obtained by means of two sliding plates of the usual construction, but with modifications in the mechanism necessitated by the increase of size and greater range of motion. The lower stage-plate is 12 in. from behind forward and 11¼ in. wide, and the upper 12 in. by 11 in. The ordinary rackwork motion of the upper plate was found to be too coarse when high powers were employed, and an arrangement was therefore devised by which this rackwork can be disconnected and the plate then moved by a system of four endless screws on the left of the stage.

Stage clips of somewhat peculiar form allow a slide of any size from the ordinary one to upwards of 10 in. by 8 in. to be securely held. At the lower end of the upper stage-plate a pair of movable legs (like compasses) are applied on one axis, and can be set by a screw at any angle from 10° to 160°, the end-pieces being provided with grooves for the reception of the slides. An adjustable right-angled arm is attached to the upper left-hand corner of the same plate, and can be pressed against the slide.

A centering substage, carrying accessory apparatus, is also applied; it is provided with rack and pinion movement actuated by the small milled head on the right in fig. 40.

The mirror has seven jointed arms, and can be used above the stage for illuminating opaque objects.

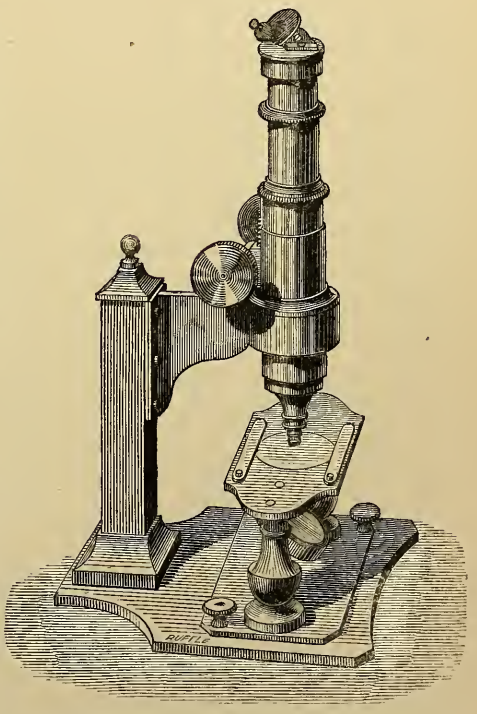
The whole instrument stands upon a strongly made tripod 15 in. high with revolving top 20 in. in diameter. When at an inclination of 45° the eye-piece is 3½ ft. from the floor.

The Microscope was constructed under Dr. Deecke's supervision, and from plans drawn by himself, at the "Utica Engine and Boiler Works" of Mr. P. S. Curtis, Utica, N.Y.

Dr. Deecke also sends us a description of a stage for use in photo-micrography for the purpose of rendering possible the focussing of large areas of sections when low magnifying powers are used.

An ordinary photographic lens can be successfully employed instead of the microscopic objective. It gives at a proper distance, of from 10 to 20 or even 40 ft. from the lens, a picture of excellent definition, but the great difficulty is to bring all parts of a field of such dimensions into the proper focus. Assuming that this difficulty probably originated in slight inequalities in the thickness of the sections in their different parts, or that it was due to their position in the mounting fluid between the slide and the cover-glass, Dr. Deecke corrected the defect by constructing a stage on which the specimen may be placed in any desired plane slightly oblique to a vertical plane drawn through the centre of the magnifying lens, and thus arrived at results which gave perfect satisfaction.*

Fig. 42.



Robin's (Chevalier) Dissecting Microscope.—This (fig. 42) is another form (by A. Chevalier) of Prof. C. Robin's Dissecting Microscope, that made by MM. Nachet having been figured on p. 100, Vol. II. (1882).†

* Description supplied by Dr. Deecke. See also brief note in Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 277–9. No little credit is due to Mr. G. W. Ruffle for engraving the above woodcuts from photographs very much wanting in clearness.

† Cf. also C. Robin's 'Traité du Microscope,' 1877, p. 75.

The stage is intended to be used with transparent objects. The central aperture receives either a wheel of diaphragms or a glass disk. An erecting prism is shown in place over the eye-piece.

When opaque objects are required to be observed they are placed on the base-plate, the plate carrying the two pillars, mirror, and stage being then removed by loosening the two clamp screws at the corners.

Rollet's Polari-spectro-microscope.*—This instrument was devised by Dr. A. Rollet, of Graz, and is a combination of a compound Microscope with a spectral and polarizing apparatus, he having observed, whilst experimenting on the spectra of the colours of thin plates, and the polarization colours of selenite films, that such a combination might be exceedingly useful for certain histological examinations.

The description of the instrument and its use is prefaced by some remarks on the spectroscopic eye-pieces hitherto designed, beginning with the original plan by which parts of a spectrum (or a small spectrum suiting the field) were projected in the plane of the microscopical object. This was effected by spectral apparatus fixed in *front of the objective*, and thus observations could be made on the behaviour of microscopical objects in monochromatic light.

Later the spectroscopic *eye-piece* was adopted, on the suggestion of Dr. W. Huggins, on the model of a star spectroscope, and afterwards improved by the spectroscopic eye-pieces, especially adapted for the Microscope, of Sorby and Browning, Zeiss, and others.

Each of these methods, however, serves different purposes; and careful consideration shows that it is only the older manner of examination which is adapted for true microscopical studies of a more extended application, the use of the spectroscopic eye-piece being much more circumscribed. In the latter the slit is at the point where the inverted image is formed by the objective and field-lens. A linear strip of this image is then spectrally analysed by a direct vision prism. Such an apparatus is excellently adapted for studying the absorption-spectra of uniformly coloured microscopical objects containing no inner contours, and whose images cover the slit either entirely or to a definite extent. It can also be used for the same purpose in the case of the absorption-spectrum of *one* particular absorbing substance which is associated with delicate bodies uniformly distributed in a liquid, as with the red blood-corpuscles or chlorophyll-grains. But in these cases the action of the eye-piece is satisfactory only if the object is somewhat above or below the focus of the Microscope. It is easy to see the reason for this, but an example will explain it more clearly. Place a drop of blood, spread out on a slide, under the Microscope, remove the prism of the eye-piece, and with the slit wide open focus so that the image of the blood-corpuscles may be as sharp as possible, then narrow the slit and replace the prism. A spectrum of unequal brightness will be seen, crossed by numerous dark lines and shadows at right angles to the direction of the slit, and in which both the Fraunhofer lines and the absorption-bands

* Zeitschr. f. Instrumentenk., i. (1881) pp. 366–72 (3 figs.).

will be indistinct and fragmentary. This will also occur if the edges of the slit are defective or if particles of dust have got in. In the case we are considering it is caused by the sharp outlines of the blood-corpuscles. If the Microscope is placed out of focus a uniformly bright spectrum will be obtained with sharp Fraunhofer lines, and the distinct absorption-bands of the hæmoglobin. A band of the

Fig. 43.

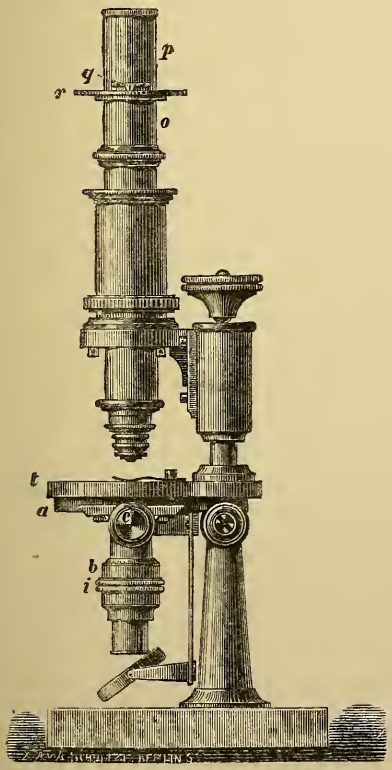


Fig. 44.

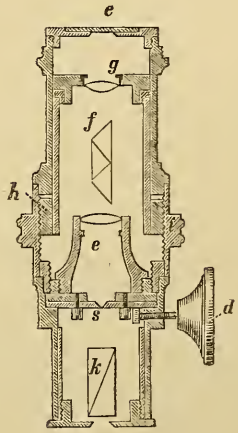
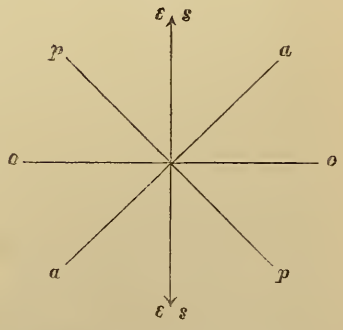


Fig. 45.



sharp image of the object is of course no longer spectrally analysed, but only a band of the circles of confusion, which now fall in the plane of the slit, forming there an indistinct image of the corpuscles. We have, however, in this way, removed the injurious action of their sharp outlines upon the clearness of the absorption spectrum.*

* Besides the value of the spectroscopic eye-piece for the study of absorption-spectra, Dr. Rollet mentions the use he has made of it in the examination of Newton's rings, and the polarization colours of crystalline plates.

"By the above remarks," Dr. Rollet says, "I imagine I have sufficiently shown that the use of the spectroscopic eye-piece in microscopy is somewhat limited, but if it be objected to this that Sorby has made exceedingly numerous observations by this means, it may be replied that these researches were concerned only with the discovery of the characteristic absorption-spectra of colouring matters, that is, always for the solution of a particular problem for which this eye-piece is eminently fitted. There are, however, a large number of problems in micro-spectroscopic research for which the eye-piece is not suitable, i. e. all those in which it is not merely required to examine the absorption-spectra of the colouring matters occurring in microscopical objects, but the objects themselves in monochromatic light, whether in any particular part or all parts of the spectrum. For such purposes the spectrum projected in the plane of the object must be used as it was employed before the introduction of the more recent eye-piece."

The following description is then given of the polari-spectro-microscope which was constructed by Schmidt and Haensch of Berlin, according to Dr. Rollet's directions.

To a Microscope (fig. 43) in which the stage is further than usual from the base, the following pieces of accessory apparatus are fixed.

I. Beneath the stage *t*, is a small spectroscope *b* attached to it by means of a metal plate *a* with an oval hole, and movable by the screw *c* horizontally from right to left in a slide applied to the metal plate.

The spectroscope consists of the following parts (fig. 44):—(1) The slit *s* adjusted by the screw *d*; (2) a collimator lens *e*; (3) a direct-vision prism *f*; and (4) above the prism a convex lens of short focus *g*, which is intended to project a small spectrum in the plane of the object on the stage. That this may be easily done with different objects, on slides of different thicknesses, the prism and the convex lens can be moved vertically, they being in one piece of tubing, while the slit and collimator lens are in another. This movement is effected by a screw *h* cut in the inner tube, and a ring *i* (figs. 43 and 44) on the outer, which act like the correction-adjustment of objectives. (The amount of the vertical movement can be registered on a millimetre scale, divisions on the ring showing fractions of mm.) The dispersion of the prism is such that with a medium magnifying power, the small spectrum projected in the plane of the object, can be completely seen in the field of the Microscope, from the red to the violet end and the Fraunhofer lines also clearly visible. (5) In front of the slit is a polarizing (Hartnack-Prazmowski) prism *k*, and (6) above the convex-lens is fixed a selenite film *e* (Red I. Ord. or Red II. Ord.).

II. Over the tube of the Microscope is an eye-piece *o* (fig. 43), above which a Hartnack-Prazmowski analysing prism is fixed. This is movable over the eye-piece by its tube *p* and its correct position is shown by an index *q* on the tube moving over a circular scale *r* fixed to the eye-piece.

The instrument, when intended to be used for the purposes hereafter mentioned, must be adjusted as shown in fig. 45, which represents a projection upon a horizontal plane of the parts interposed between the eye and the mirror.

s s	Direction of the slit.	
p p	„	vibration of the polarizer.
a a	„	„ „ analyser.
o o	„	„ „ ordinary ray in the selenite film.
e e	„	„ „ extraordinary ray in the same.

In this arrangement of the instrument, when sufficiently strong parallel rays are received from the mirror (either bright, diffused daylight, direct sunlight, petroleum- or gaslight), a dark interference-band will be seen in the spectrum in the field at the point corresponding to the Fraunhofer line E, which moves from E to F or E to D, more or less according to the tint of the selenite film.

The resulting intensity of the light proceeding from the analyser (apart from the loss at the surface) is under the above condition for every given colour

$$R^2 = r^2 \sin^2 \frac{\pi}{\lambda} d\,(\gamma - a), \qquad (1)$$

in which r^2 is the intensity of the incident light, λ the wave-length, d the thickness of the selenite film, γ the greatest and a the smallest principal refraction quotients of the selenite for the given wave-length. The dark interference-band appears in every part of the spectrum for which the condition

$$d = 2\,(n - 1)\frac{\lambda}{(\gamma - a)} \qquad (2)$$

is fulfilled. In this equation n is the ordinal number of the dark interference-band. It has the value 1 for the thickness o of the plate. The colour region red I. Ord., and purple II. Ord. (red I. Ord. of the ordinary selenite films) lies within the value 2, and the region red II. Ord. and purple III. Ord. (red II. Ord. of the ordinary selenite films) lies within the value 3 for n, whilst the value of λ for these regions lies between the 490 and 545 millionth-millimetre of Angström's scale; F Fraunhofer coinciding with 486, E with 527, and D with 589. The interference-band of the red II. Ord. is more sharply limited than that of the red I. Ord.

The object on an ordinary slide is now brought into the field of view (showing the spectrum with the dark interference-band) and is moved till it lies over this band. If the object is singly refracting it remains, in all azimuths, dark upon a dark ground. If it is doubly refracting, then it acts as a thickening of the selenite film when the vibration-direction of the ordinary (or extraordinary) ray in the object corresponds with that of the ordinary (or extraordinary) ray in the film. In the contrary case it acts as a thinning of the film. In both cases the doubly refracting objects are illuminated on a dark ground in the spectral colour extinguished by the interference-bands.

If, however, the spectrum is moved under the object by the

horizontal movement of the spectroscope before described, then in the first case there is a spectral region found towards the red end in which the doubly refracting object appears dark upon a bright ground; but in the second case such a region appears at the violet end, because with augmented or diminished thickness of the plate, the value of λ in the equation (2) is altered. With increasing thickness of the doubly refracting plate, the dark interference-bands move in the spectrum from the violet to the red end, and *vice versâ* with diminishing thickness.

By this method small degrees of double refraction in organized bodies can be more certainly discovered, and for certain histological objects a very safe opinion as to their double refraction can be arrived at. Dr. Rollet has employed the method especially for the examination of striated muscle-fibre, and obtained very good results as to the double refraction of the transverse, the accessory, and the terminal or intermediate disks. If we place a striated muscle-fibre upon the slide so that its longitudinal axis coincides with *es—es* (fig. 45) it will be in the so-called "addition-position" above the selenite film; all its above-mentioned doubly refracting parts will therefore be brightly illuminated in the dark interference-band. If, however, the spectrum is so moved that the spectral regions near the red end lie under the fibre, we obtain an image in a given region which is, as it were, the negative of the former, because all parts of the fibre which before appeared bright on the dark ground of the interference-band, now appear dark upon a bright ground. The second image thus checks the first.

Moreover degrees of double refraction may, in some cases, be distinguished by the extent of the movement of the spectrum which is necessary to obtain the negative image. If the selenite film is turned, while the fibre remains in the direction of the slit, so that not *e e* as in fig. 45, but *o o*, falls in the direction *s s*, then the fibre will lie in the "subtraction-position" above the film. The position in the spectrum of the interference-band of the film remains unchanged and the doubly refracting parts of the fibre shine as before on the dark ground. But now, in order to obtain the negative image, the spectrum must be so moved that a spectral region nearer the violet end lies under the muscle fibre. By this apparatus, therefore, addition and subtraction positions can be directly distinguished from one another.

With regard to the selenite films, the author remarks that these were chosen because they are easily replaced and are abundant in commerce. In the selection of the particular films mentioned above the position of their interference-bands was determined in the central part of the spectrum, so that there was the necessary space between that and the red and violet ends. It is, however, clear that exactly similar observations can be made with interference-bands in other spectral regions and of other orders, by the employment of thicker or thinner films than those which correspond to the red of the first or second order.

The use of interference-bands of a higher order is not suitable, because the increase in thickness, which moves them to a proportionate

extent out of their position in the spectrum, is always greater with increasing ordinal numbers. If the thickness, for which the dark interference-band between crossed prisms corresponds with G Fraunhofer, is

$$d = 2(n-1)\frac{\lambda_G}{2(\gamma_G - \alpha_G)}, \qquad (3)$$

but the thickness, for which the interference-band corresponds with B Fraunhofer, is

$$d' = 2(n-1)\frac{\lambda_B}{2(\gamma_B - \alpha_B)}, \qquad (4)$$

then according to (3) and (4)

$$d' - d = 2(n-1)\left[\frac{\lambda_B}{2(\gamma_B - \alpha_B)} - \frac{\lambda_G}{2(\gamma_G - \alpha_G)}\right], \qquad (5)$$

which shows that when the ordinal number n of the dark interference-bands ascends from unity to unity, the increase in thickness, which is necessary to move the band once from G to B through the spectrum, forms an ascending arithmetical progression.

The instrument can be used as a spectromicroscope alone, without the polarizing apparatus, or it can be employed as an ordinary Microscope if the spectral apparatus be also removed.

Vérick's Travelling or Pocket Microscope.—In this instrument (figs. 46 and 47) portability is obtained, not only by the usual expe-

Fig. 46.

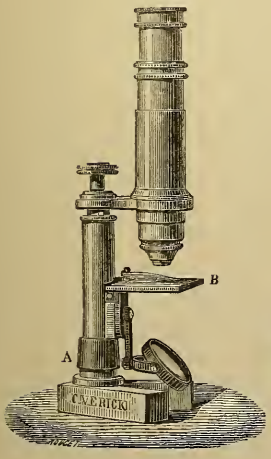
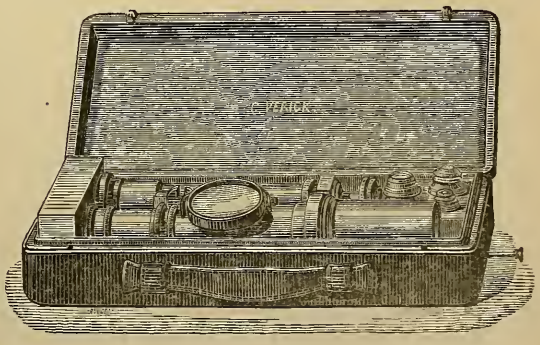


Fig. 47.



dients of reversing the body-tube in its sheath and setting the stage at right angles, but also by making the two legs of the base close

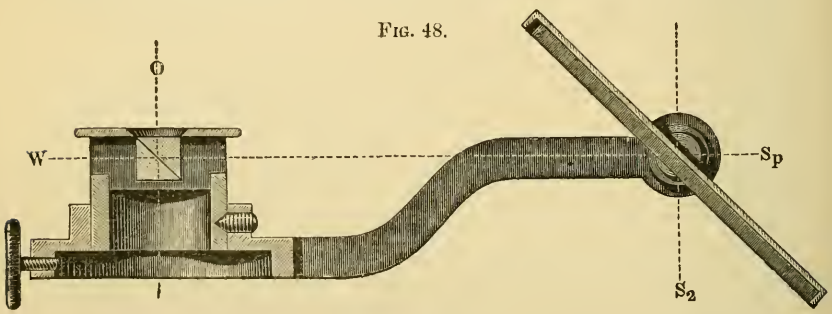
together, as in a pair of compasses. It then packs into a box 20 cm. by 10 cm. and 5 cm. deep.

The instrument was designed by M. C. Vérick, with the co-operation of Dr. L. Malassez.

Abbe's Camera Lucida.—We have already recorded the two or three paragraphs which have appeared as to this instrument,* and now add a figure of it taken from the 2nd edition of Dr. Dippel's work † (fig. 48).

The glass cube (consisting of two prisms, with an hypothenuse surface partly silvered, and leaving a small hole in the centre) is at W, the reflecting mirror at S*p*, the eye at O. The rays from the

Fig. 48.



paper come in the direction S_2, and are reflected first by the mirror, and a second time by the silvered prism to O, while the object is seen through the small hole in the silvered surface.

Herr E. Giltay ‡ writes of it with approval, both for low powers and also for high powers when tinted glasses are interposed to reduce the brightness of the drawing-surface, as described by Dr. Dippel, *ante*, p. 119, an improvement which Herr Giltay claims the credit of suggesting.

The rest of the article is devoted to what is described in the heading "as an improvement applicable to cameras in general," which is simply the very old expedient of introducing suitable lenses between the eye and the paper, but which the author writes of as if it were a new and important discovery now made by him for the first time! The following observations on the theoretical reasons for the benefit obtained by the lenses may be quoted.

Those who are accustomed to use the Microscope allow the accommodation of the eye to remain nearly quiescent. Just for this reason one can bear for so long a time without fatigue work apparently so trying to the eyes. With the camera, however, one is naturally obliged to accommodate the eye to the drawing-surface. In ordinary binocular vision drawing does not present so many difficulties to normal eyes, because, first, the paper is held at a convenient distance before the eyes, and, secondly, the required accommodation is guided and assisted

* See this Journal, ii. (1882) pp. 261, 593, *ante* p. 119.
† 'Das Mikroskop,' 2nd ed., 1882, pp. 631–2 (1 fig.).
‡ Bot. Centralbl., xiii. (1883) pp. 419–22.

by the convergence of the visual axes. It is quite different in drawing with the camera. If it is desired to avoid the inconvenient elevation of the drawing-surface, accommodation is necessary for the distance of this surface, and such accommodation is not assisted by a convergence of the visual axes. Many persons are therefore not able, without great fatigue, to accommodate their eye sufficiently to see the pencil clearly. This consideration suggests the remedy. If the observer is emmetropic (or normal-sighted), it is only necessary to insert a lens in the path of the rays proceeding from the paper to the eye, having a focus equal to the distance from the paper to the lens. The rays from the drawing-point are then changed into parallel pencils, and the eye sees the point with perfect distinctness, although accommodation is quiescent. If, however, the observer is ametropic (short-sighted or far-sighted), then a lens must be interposed which allows the rays proceeding from the paper to be directed after their exit from the lens to a surface situated at the distance of the *punctum remotum*.

The mode of choosing the appropriate spectacle glasses is then given in some detail, and these concluding remarks: "Man, as is well known, is in a high degree a slave of habit. When we begin to use the Microscope, it is difficult, on account of the reversal of the movements, to guide the object. If we are, however, once accustomed to it, and work occasionally with a dissecting lens, then the difficulty presents itself of effecting the movements which we formerly did a hundred times daily. The reversal of the movements has associated itself with the act of using the Microscope. It is the same also with the accommodation of the eye. When we begin to work with the Microscope it is tiring, probably for the most part on account of the effort of accommodation. One soon learns to relax the accommodation-muscles while working with the Microscope. When we have become adepts at this, and wish to draw by means of the camera, then the requisite accommodation again at first gives trouble. If finally an apparatus is fixed to the camera, by which no accommodation is needed, then it may happen that we cannot at once adapt ourselves to it, because in using the camera we had got accustomed to the exertion of accommodation. We soon, however, learn all this, only we must not too hastily consider a lens found by calculation as too strong, for this may occur through a false computation of the *punctum remotum*, or by not relaxing the accommodation in using the Microscope."

Hilgendorf's "Apparatus for Microscopical Geometrical Drawings."*—Dr. F. Hilgendorf describes an apparatus which is essentially a pantograph with the usual four arms, but in which the tracing point is replaced by a sight-vane. This is about 20 cm. above the arm, on which is a lens magnifying three to four times, and having crossed threads on its upper surface. If the outlines of the object are followed with the sight-vane, the pencil at the end of a prolongation of the opposite arm will produce an enlarged drawing of the outlines on the paper beneath it.

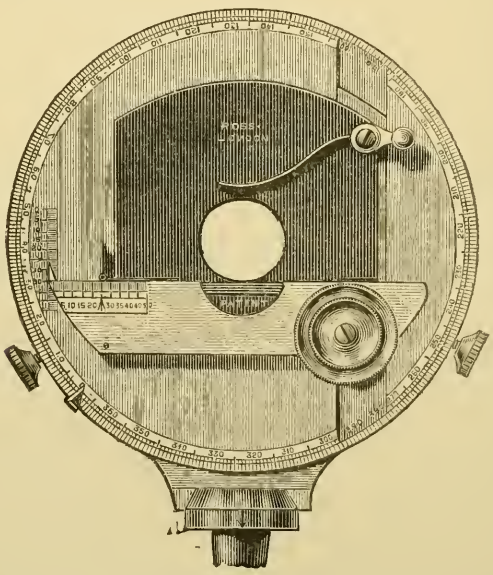
* SB. Gesell. Naturf. Freunde zu Berlin, 1882, pp. 58-60 (1 fig.). Zeitschr. f. Instrumentenk., ii. (1882) pp. 459-60 (1 fig.).

A pantograph for the compound Microscope was described in 1872 by Mr. I. Roberts.*

Wenham's Mechanical Stage.—This stage is shown in fig. 49, and was first described in connection with Wenham's "Universal Inclining and Rotating Microscope" (now termed "Wenham's Radial Microscope") at pp. 256–7 of the previous volume.

The stage rotates completely, and is a modification of that of Mr. Tolles, in which the rectangular motions are effected by two milled heads acting on *one* vertical axis on the surface and entirely within

Fig. 49.



the circumference.† It is attached to the limb of the Microscope on the Zentmayer system, that is, by a conical axis that passes through the socket of the swinging tail-piece and through the limb, being secured at the back by a clamp-nut; it can thus be easily removed, or may be replaced by a glass or other form of stage, &c. The rotating plate is of German silver; a circular rackwork is applied beneath, which is turned by a milled-head pinion; this pinion is fitted so that it can be disconnected from the rackwork by a slight downward pressure; the rotation can then be more rapidly made by hand. The graduations are near the edge of the rotating plate, the index-pointer is therefore in a fixed position, which is convenient for reading

* Mon. Micr. Journ., viii. (1872) pp. 1–2 (1 pl.).

† See the descriptions of similar stages, this Journal, i. (1881) pp. 116–7 (figs. 9 and 10), p. 300 (fig. 46), and for the mechanism of the rectangular movements see specially pp. 944–6 (figs. 221–3).

the angle. "Finders" are also engraved. The milled-heads on the edge are for centering the rotation on the optic axis. A simple and effective plan has been adopted of applying the iris-diaphragm, hemispherical immersion-condenser, or Wenham's semi-disk illuminator beneath the stage, where they are held by a small projecting peg and a spring latchet.

Altmann's "Abend-Condenser." *—Dr. R. Altmann has designed a condenser ("Evening Condenser"), which consists of a convex hemispherical lens of short focus with a disk of ground glass over it, and one of light-blue beneath it. The lens and disks fit into a tube similar to that used for the ordinary (German) cylinder-diaphragms.

Heating Apparatus.†—Thoulet describes a new method of heating objects upon the stage. He has constructed a small "stove" or chamber, to rest upon the stage, and to contain the object and the thermometer. It consists of a glass tube fitting into a copper cylinder which rests upon a disk of copper, furnished with lateral prolongations, which can be heated by a gas jet. The whole is insulated by resting upon a disk of cork. The temperature of the chamber can be raised by heating the prolongations of copper, and lowered by introducing a current of fresh air through a small tube fixed in the side. Very exact measurements can be taken with this simple apparatus, which is well adapted for determining the temperature of the disappearance of bubbles in liquid inclusions, for studying the formation of crystals at various temperatures, or for other micro-chemical investigations.

Abbe's Test-plate.—Dr. C. Zeiss has now issued directions for using this test-plate, which, notwithstanding that the subject was fully dealt with at p. 120, may, we think, be usefully reproduced here (with a few verbal alterations in the original text):—

"This test-plate is intended for the examination of objectives with reference to their corrections for spherical and chromatic aberration, and for estimating the thickness of the cover-glass for which the spherical aberration is best corrected.

The test-plate consists of a series of cover-glasses, ranging in thickness from 0·09 mm. to 0·24 mm., silvered on the under surface, and cemented side by side on a slide, the thickness of each being marked on the silver film. Groups of parallel lines are cut through the films, and these are so coarsely ruled, that they are easily resolved by the lowest powers, yet from the extreme thinness of the silver they also form a very delicate test for objectives of even the highest power and widest aperture.

To examine an objective of large aperture, the disks must be focussed in succession, observing in each case the quality of the image in the centre of the field, and the variation produced by using alternately central and very oblique illumination. When the objective is perfectly corrected for *spherical aberration* for the particular thickness

* Arch. f. Anat. u. Physiol. (Anat. Abtheil.) 1881, pp. 219–24.

† Bull. Soc. Mineral. France. Cf. Amer. Natural., xvii. (1883) p. 76.

of cover-glass under examination, the outlines of the lines in the centre of the field will be perfectly sharp by oblique illumination, and without any nebulous doubling or indistinctness of the minute irregularities of the edges. If, after exactly adjusting the objective for oblique light, central illumination is used, no alteration of the focus should be necessary to show the outlines with equal sharpness.

If an objective fulfils these conditions with any one of the disks, it is free from spherical aberration when used with cover-glasses of that thickness. On the other hand, if every disk shows nebulous doubling, or an indistinct appearance of the edges of the lines, with oblique illumination, or if the objective requires a different focal adjustment to get equal sharpness with central as with oblique light, then the spherical correction of the objective is more or less imperfect.

Nebulous doubling with oblique illumination indicates over-correction of the marginal zone, indistinctness of the edges without marked nebulosity indicates under-correction of this zone; an alteration of the focus for oblique and central illumination (that is, a difference of plane between the image in the peripheral and central portions of the objective), points to an absence of concurrent action of the separate zones, which may be due to either an average under- or over-correction or to irregularity in the convergence of the rays.

The test of *chromatic correction* is based on the character of the colour bands which are visible by oblique illumination. With good correction the edges of the lines in the centre of the field should show only narrow colour bands in the complementary colours of the secondary spectrum, namely on one side yellow-green to apple-green, and on the other violet to rose. The more perfect the correction of the spherical aberration, the clearer this colour band appears.

To obtain obliquity of illumination extending to the marginal zone of the objective, and a rapid interchange from oblique to central light, Abbe's illuminating apparatus is very efficient, as it is only necessary to move the diaphragm in use nearer to or further from the axis by the rack and pinion provided for the purpose. For the examination of ordinary immersion objectives, the apertures of which are, as a rule, greater than 180° in air (1·00 N.A.), and those homogeneous-immersion objectives which considerably exceed this, it will be necessary to bring the under surface of the test-plate into contact with the upper lens of the illuminator by means of a drop of water, glycerine, or oil. In ordinary cases the change from central to oblique light may be easily effected by the concave mirror, but with immersion lenses of large aperture it is impossible to reach the marginal zone by this method, and the best effect has to be searched for after each alteration of the direction of the mirror.

For the examination of objectives of smaller aperture (less than 40–50°), we may obtain all the necessary data for the estimation of the spherical and chromatic corrections by placing the concave mirror so far laterally, that its edge is nearly in the line of the optic axis, the incident cone of rays then only filling one-half of the aperture of the objective, by which means the sharpness of the outlines and the

character of the colour bands can be easily estimated. Differences in the thickness of the cover-glass within the ordinary limits are scarcely noticeable with such objectives.

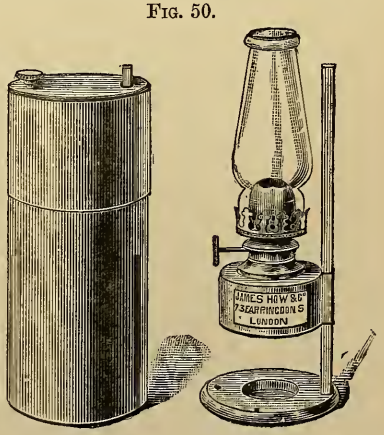
It is of fundamental importance in employing the test-plate to have brilliant illumination and to use an eye-piece of high power. With oblique illumination, the light must always be thrown perpendicularly to the direction of the lines.

When from practice the eye has learnt to recognize the finer differences in the quality of the outlines of the images, this method of investigation gives very trustworthy results. Differences in the thickness of cover-glasses of 0·01 or 0·02 mm. can be recognized with objectives of 2 or 3 mm. focus.

The quality of the image outside the axis is not dependent on spherical and chromatic correction in the strict sense of the term. Indistinctness of the outlines towards the borders of the field of view arises, as a rule, from unequal magnification of the different zones of the objective: colour bands in the peripheral portion (with good colour-correction in the middle) are always caused by unequal magnification of the different coloured images. Imperfections of this kind, improperly called 'curvature of the field,' are shown to a greater or less extent in the best objectives, when their aperture is considerable."

How and Co.'s Pocket Lamp.—The feature of this lamp (fig. 50) is its portability, having been constructed for microscopists who are in the habit of exhibiting at soirées, &c. It fits into a cylindrical tin case which is small enough to be carried without inconvenience in the coat-pocket. When charged with sufficient oil to burn for about 3½ hours it weighs less than 12 oz. As the foot is small, the pillar upon which the lamp slides has been made square, so that the centre of gravity is less likely to be disturbed. The lamp can be elevated so that the flame is 8 inches above the table, but if greater height is required, an additional two inches may be gained by standing the lamp upon the lid of the tin case and fixing it by means of a screw provided for the purpose.

Fig. 50.



Drawings and Paintings from the Microscope.*—The best series of coloured drawings of microscopical objects that have been seen within the memory of the present generation of microscopists, were those drawn and exhibited by Mr. E. T. Draper at the April

* Science-Gossip, 1882, pp. 1–3, 74, 203.]

Conversazione of the Society (Vol. II. (1882) p. 444). Mr. Draper has during the last year published several articles on the subject (giving hints from practical experience of the best methods of procedure), which, in the main, are not susceptible of abstract, but from which we take the following:—

The effect of a microscopical painting is greatly enhanced by its being drawn within a circle surrounded by a black margin forming a square. A circle $3\frac{3}{4}$ inches gives the best effect and approaches nearest the impression made upon the mind by a field with a B eye piece. A brass gauge should be kept for marking the circle and square.

The Wollaston camera lucida is to be preferred. The neutral tint reflector reverses the image, which renders it more difficult to fill in the drawing afterwards.

No drawings can be greatly advanced by the camera lucida. The latter can be used for quickly and accurately fixing and drawing the salient points, but any attempt at elaborate detail will end in confusion, and useful as it is in the earliest steps, it should be discarded as soon as possible.

The colours should be dry cakes. Moist colours in tins soon become contaminated. Everything should be of the first quality—the Indian-ink of superlative excellence. "All the colours should be prepared, and the tints mixed (to use the words of Opie) with brains."

In a later article the author "appends an experience of some importance.

An object for drawing should be magnified to show all the parts necessary for its elucidation, in fact, to understand it as a whole; and, as a rule, it should occupy the entire field of vision. It sometimes, however, happens that many elongated preparations, as for instance, the tongue and appendages of a bee, or a double-stained section of a botanical specimen, cannot without reducing the magnifying power to a useless attenuation be included in a circle, as recommended in a former paper, except at the loss of considerable and important detail; in such cases the circle must be abandoned and the drawing made in parts, by shifting the position of the object until the whole is combined on the paper. This is attended with some difficulty in the management of the camera lucida, but can be overcome in the following manner:—Having an elongated object, which cannot be seen in its entirety in one field of view, the process is, to draw the outline and salient positions of one end, or half-making two prominent points on the paper corresponding with two places in the subject; these positions are easily remembered. The object is then moved by the stage adjustments, upwards or downwards, as the case may be, until the other portion is in the field. The marked points are coincided, by shifting the drawing block, and the remainder of the outlines finished; the minute details of the drawing, and painting, afterwards continued from the object itself. By this method, the camera lucida may be used without difficulty with four combined fields of vision, and the various parts of the object so fitted as to result in a drawing of considerable dimensions, perfectly true in its contours. Botanical sections and elongated parts of insects, under fairly high

powers, may thus be mapped out with all the details exhibited in their relation to each other."

Double Illumination for Insects Mounted without Pressure.—Mr. E. T. Draper in the same article says, "For good artistic work the importance of double illumination cannot be too urgently advocated. Many beautiful objects are often unappreciated from deficiency or inapplicability of the light used to exhibit them. It is never more exemplified than in the combined use of the paraboloid reflector and side speculum, with a class of objects lately introduced, of parts of insects mounted in fluid without pressure, avoiding the disturbance of the more delicate tissues. Many parts of such preparations are necessarily opaque, which is rather an advantage from an art point of view, as, by force of contrast, their density aids in giving a most beautiful appearance to the more transparent structures; nothing being crushed or distorted, all is *in situ*. These preparations immediately awaken the mind to the impossibility of properly seeing or revealing them by the ordinary reflected light from the mirror. The head and adjoining parts of the male wasp prepared in this way by Mr. Enoch is singularly fine, and a case in point; with the paraboloid beneath the stage, and the side speculum above, a combination of form and colour is seen, of surpassing beauty. The light from the speculum touches the opaque parts with reflections revealing the most exquisite tints of a metallic appearance, while the paraboloid beneath shows, in actual perspective, the wonderful parts beyond in all their natural colour, and bathed in light."

Professor R. Hitchcock also points out* that although insect preparations "mounted without pressure" are mounted as transparent, there will always be some parts which are more or less opaque, especially in the larger specimens, and he has found much benefit from the use of a condensing lens above, as for an opaque object, at the same time throwing in light from below. A specimen of *Cimex* mounted in balsam by the carbolic acid process affords a good illustration of the utility of this double illumination.

Behrens' Guide to Microscopical Researches in Botanical Laboratories.†—A collected summary of methods and processes in botanical microscopy is much wanted, the literature on the subject being more scattered than is the case with histological methods in zoology. The author of this book has largely contributed to meet this want by the compilation now published, though it is to be regretted that the descriptions of Microscopes and apparatus occupy so large a proportion of the work, the 4th and 5th sections—the *pièces de resistance* of the book—being limited to pp. 219–387.

There are five sections:—1. General Description of the Microscope (pp. 1–75). 2. Accessory Apparatus (pp. 76–129, Dissecting Microscope, Cameræ, Micrometers, Polarizers, Goniometers, and Microspectroscopes). 3. Preparation (pp. 130–218). 4. Microscopical Reagents (pp. 219–61); and 5. Microscopical Investigation of the

* Amer. Mon. Micr. Journ., iii. (1882) p. 219.

† Behrens, W., 'Hilfsbuch zur Ausführung mikroskopischer Untersuchungen im Botanischen Laboratorium.' xii. and 398 pp., 132 figs. and 2 plates. 8vo, Braunschweig, 1883.

Plant Substances (pp. 262–387). The first two sections contain little new or special information. The third deals with the preparation of objects; those not requiring to be cut, instruments for cutting, the method of making sections (free-hand, in pith and cork, and in imbedding masses), the further treatment of the sections (removing air, clearing, &c.), making preparations of fossil plants, mounting objects (including living organisms), with the various preserving media and varnishes, and directions for drawing. The fourth section gives descriptions of and directions for preparing Microscopical Reagents under 39 headings (19 inorganic and 20 organic), including iodine solutions, staining matters, and the various carmine solutions. The fifth section deals with the following substances:—Cellulose and its modifications, Starch, Dextrin, Mucilage, Gums, Inulin, Grape-sugar (Glucose), Cane-sugar (Saccharose), Albuminous Substances (Aleurone, Protoplasm), Chlorophyll, Colouring Matters of Flowers, Asparagin, Inorganic Constituents (Silica and Lime Salts), Glycoside, Tannin, Alkaloids, Fats, Ethereal Oils, Camphor, Resins, Phanerogamic Colouring Matters, and Cryptogamic Colouring Matters. The bibliography of each substance is placed first, followed by a description of the substance; and, lastly, the methods most suitable for its demonstration.

The book cannot fail to be useful to botanical microscopists, though there is still room for a more extended treatise.

'Micrographic Dictionary.'—A fourth edition of this well-known and useful guide to the microscopist is now completed, edited by Dr. Griffith, one of its original editors, with the assistance of the Rev. M. J. Berkeley and Professor T. Rupert Jones. It bears marks of revision to bring the contents down to date, the article on Angular Aperture in particular embodying the results of the revival of the discussion on aperture reported in the last volume but one of this Journal. The editor gives a succinct explanation of the true view of aperture, and appends to the very ingenious explanation of the effect of oblique light given in the previous editions the statement—"In this way we were wont to account for the action of large angles of aperture and oblique light in rendering visible the finer markings of objects," followed by a brief statement of the Abbe theory of microscopical vision.

In the Bibliography of the Aperture question appears an entry, "Wenham, Amer. Jn. Micros. 1881," which probably refers to something which was to have been.

Behrens, W.—Hilfsbuch zur Ausführung mikroskopischer Untersuchungen im Botanischen Laboratorium. (Guide to Microscopical Researches in the Botanical Laboratory.) xii. and 398 pp., 132 figs. and 2 pls.
8vo, Braunschweig, 1883.

Berkeley, M. J. See Griffith, J. W.

Blackburn, W.—On Dr. Carpenter's Address. [*Post.*]
Micr. News, III. (1883) pp. 29–32.

,, ,, The President's Address to the Manchester Microscopical Society.
[On some of the ways in which natural science has been promoted by the use of the Microscope, and the advantages derived from microscopical research in our social relations, as affecting our well-being.]
Micr. News, III. (1883) pp. 93–105.

BRADBURY, W.—The Achromatic Object-glass. XV., XVI.
Engl. Mech., XXXVII. (1883) pp. 3–4, 74–5 (4 figs.).

COOMBS, C. P.—Notes on the Exhibition of Magnified Objects.
Journ. Post. Micr. Soc., II. (1883) pp. 13–6 (1 fig.).

CUTTRISS' (T. & S. W.) Dynamo.
[Small machines for one 20-candle power Swan incandescent lamp.]
Micr. News, III. (1883) pp. 56–7.

DAVIS, G. E.—The Elements of Microscopy. II.
[Some of the properties of plates, prisms, and lenses.]
Micr. News, III. (1883) pp. 45–51.

„ „ Electric Illumination for the Microscope.
[Note on Mr. Payne's paper, *infra*, and circular of Mawson and Swan's incandescent lamps:—"If they had executed the order given to them in 1881, Mr. Stearn . . . . would probably have been second or third in the field." "We would prefer to have the trouble of cleaning and preparing the oil lamp rather than the overpowering fumes from three cells of a Grove's or Bunsen battery. The electric light for microscopic purposes is no doubt in some instances a good thing, but its conveniences need not be exaggerated."]
Micr. News, III. (1883) p. 56.

ENGELMANN, T. W.—Ueber die Zusammenstellung von Sonnenlicht, Gaslicht und des Licht von Edison's Lampe, vergleichend untersucht mit Hilfe der Bacterienmethode. (On the Comparison of Sunlight, Gaslight, and the light of Edison's lamp investigated by the Bacteria method.) [*Post.*]
Bot. Centralbl., XIII. (1883) pp. 214–5.

FASE, H. J.—On a portable Binocular Dissecting and Mounting Microscope. [*Post.*]
Journ. Quek. Micr. Club, I. (1883) pp. 109–11.

GEIKIE, A.—Outlines of Field-Geology. 3rd ed. xv. and 222 pp. and 66 figs. 8vo, London, 1882.
[Contains a chapter on "Microscopical Investigation," pp. 201–15, including the preparation of thin slices and the use of the Microscope. See also p. 30.]

„ „ Text-book of Geology. xi. and 971 pp. and 435 figs. 8vo, London, 1882.
[Contains the above chapter, "with alterations and additions," pp. 182–91. Also a section on Minute or Microscopic Characters of Rocks: (1) Microscopic Elements of Rocks, and (2) Microscopic Structure of Rocks. pp. 94–108 (8 figs.).]

GRIFFITH, J. W., & HENFREY, A.—The Micrographic Dictionary. 4th ed., by J. W. Griffith, M. J. Berkeley, and T. R. Jones. 2 vols. xlvi. and 829 pp., 818 figs. and 53 plates. 8vo, London, 1883.

H., E. A. C.—Magnifying measurements.
[Inquiring why with 1-in. objective and B eye-piece, said by the maker to magnify 76 times, the 1-100th in. divisions of the stage-micrometer only appear 1-3rd in. long, instead of 76-100ths or 3-4ths in.]
Sci.-Gossip (1883) p. 42.

HARDINGHAM, G. G.—Telescopes and Microscopes.
[Brief note on the question of antiquity.]
Knowledge, III. (1883) pp. 121–2.

HARDY, J. D.—On "The Chromatoscope": a method of illuminating crystals and similar objects by coloured light.
[Already published, *ante*, p. 126.]
Journ. Quek. Micr. Club, I. (1883) p. 108.

HENFREY, A. See Griffith, J. W.

HILGENDORF, F.—Apparat für mikroskopische geometrische Zeichnungen. (Apparatus for microscopical geometrical Drawings.) [*Supra*, p. 279.]
SB. Gesell. Naturf. Freunde zu Berlin, 1882, pp. 58–60 (1 fig.).

His's Drawing Apparatus.
[Vol. II. (1882) p. 402.]
Amer. Natural., XVII. (1883) pp. 227–9 (1 fig.).

Hitchcock, R.—Notes (1) to Subscribers as to punctual payment of subscriptions; (2) as to the change of management (publishers) of the Journal; and (3) on editorial perplexities.
Amer. Mon. Micr. Journ., IV. (1883) p. 12.

„ „ The American Postal Microscopical Club.
[Note as to the obligations of the members in regard to putting slides in the boxes, &c.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 14–15.

„ „ The Projecting Microscope for Class Demonstrations.
[General remarks, especially as to the desirability of opticians devising a better form, and as to the advantages to be obtained by it for purposes of instruction.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 15–16.

„ „ Correction-adjustment for Objectives.
[Discussion of the advantages with particular reference to Dr. L. Dippel's paper in 'Zeitschr. f. Instrumentenk.' "It may be said that the importance of correction-adjustment increases with dry objectives as the angular aperture increases." With reference to homogeneous-immersion objectives, he considers that "practically, the advantage of the collar-adjustment is quite illusory when the microscope is applied to the study of objects the structure of which is unknown."]
Amer. Mon. Micr. Journ., IV. (1883) pp. 28–30.

„ „ Standard Sizes for Oculars and Sub-stages.
[Note on the Committee's Report, II. (1882) p. 595. "It is to be hoped that our American makers will adopt the same sizes."]
Amer. Mon. Micr. Journ., IV. (1883) pp. 35–6.

„ „ See Mendenhall, T. C.

Holman, D. S.—Projecting Microscope of peculiar design.
[Exhibition only.]
Proc. Acad. Nat. Sci. Philad., 1882, p. 359.

Johnson, G. J.—Photomicrography.
[Description of necessary apparatus, manipulation, &c.]
Micr. News, III. (1883) pp. 113–21 (2 figs.).

Jones, T. R. See Griffith, J. W.

Journal of the Royal Microscopical Society. Vol. II. 1882.
[Review.]
Journ. of Sci., V. (1883) pp. 108–110. See also p. 115.

Kitton, F.—Magnifying measurements.
[Reply to H., E. A. C., *supra*, that he must have made some mistake, either in the powers or in making his measurements. Also describes method of ascertaining the magnifying power by observing a scale with one eye.]
Sci.-Gossip (1883) pp. 66–7.

Langley, J. N. See Foster, M.

Loewenherz, L.—Zur Geschichte der Entwickelung der mechanischen Kunst. III. Die Feineintheilung von Kreisen. (On the History of the development of mechanical Art. III. The fine dividing of Circles.)
[Deals with the employment of Microscopes in the process.]
Zeitschr. f. Instrumentenk., II. (1882) pp. 447–59 (7 figs.).

Malassez, L.—Sur les perfectionnements les plus récents apportés aux appareils hémochromométriques et sur deux nouveaux hémochromomètres. (On the most recent improvements in hæmochromometric apparatus and on two new hæmochromometers.)
Trav. Lab. d'Histol. Coll. France, 1882, pp. 105–60 (2 figs.).

Malley, A. C.—Micro-photography, including a description of the wet collodion and gelatino-bromide processes, together with the best methods of mounting and preparing microscopic objects for micro-photography. viii. and 154 pp., 28 figs., and 4 micro-photographs. 8vo, London, 1883.

Mendenhall, T. C.—On the Fasoldt Stage Micrometer.
[Reply to the editor's comments on his paper (*ante*, p. 136), and disclaimer of any desire not to represent Prof. Rogers fairly; and rejoinder of the editor.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 17 and 18.

Miles, J. L. W.—Circular on Dr. Carpenter's Address at the Montreal Meeting of the Amer. Assoc. Adv. Sci. [Vol. II. (1882) pp. 698 and 854]; and his reasons for closing the Aperture controversy [Ibid. p. 864]. 2 pp. 4to, Manchester, Nov. 1882.

Moore, A. Y.—A New 1-6th in. Objective.
[Commendatory of a homogeneous-immersion objective by Spencer and disapproving of wide-angled objectives being made with non-adjustable mounts.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 2–3.

" " The Podura Scale. [*Post.*]
The Microscope, II. (1883) pp. 186–8 (3 figs.).

Moss, R. J.—Micro-photographs of Bacteria [and Yeast-plant.—Exhibition.]
Ann. & Mag. Nat. Hist., XI. (1883) p. 216.

Munson, W. W.—A Country Doctor and his Microscope—Some of his early cases. I.
[Diagnosis of ovarian tumour by examination of fluid from abdomen of patient.]
The Microscope, II. (1883) p. 190.

Nelson, E. M.—Powell and Lealand's 1-25th in. homogeneous-immersion objective 1·40 (1·38) N.A. and fine adjustment to the substage [Vol. II. (1882) p. 554]. *Jour. Quek. Micr. Club*, I. (1883) pp. 142–3.

Newton's (H. J.) Developer for Dry Plates.
[Solution A. Washing soda, 500 grains; water, 10 oz. Solution B. Oxalic acid, 30 grains; pyrogallic acid, 20 grains; ammonium bromide, 10 grains; water, 10 oz. Mix equal parts of A and B.]
Amer. Mon. Micr. Journ., IV. (1883) p. 37, from *Photographic Times*.

Paul, F. T.—Inaugural Address as President of the Liverpool Microscopical Society (in part). *Micr. News*, III. (1883) pp. 85–6.

Payne, J. B.—Stearn's new form of Illumination for the Microscope.
[Sep. repr. of short description given at a Meeting of the Newcastle Chemical Society, 28th Dec. 1882. *Post.*]

Peletan, J.—Editorial Address. *Journ. de Microgr.*, VII. (1883) pp. 3–4.

Price, H. C.—How to make Pictures. 2nd ed. 72 pp. New York, 1882.
["Easy Lessons for the Amateur Photographer," with a short chapter on photography with the Microscope.]

"Prismatique."—Object-glass working. IV.
Engl. Mech., XXXVI. (1883) p. 514 (3 figs.).

Rogers-Bond Comparator.
[Description of Prof. W. A. Rogers' instrument for comparing standards of length.]
New York 'Mechanics,' III. (1883) pp. 57–61 (8 figs.).

Ryder, J.—Upon the Embryology of Fishes. Also upon a Compressorium of special design for study of the above. [Title only.]
Proc. Acad. Nat. Sci. Philad., 1882, p. 360.

Schrauer, L.—"New" form of nose-piece for facilitating the changing of objectives.
[Appears to be identical with Parkes', III. (1880) p. 1048.]
Amer. Mon. Micr. Journ., IV. (1883) p. 17.

Slack, H. J.—Pleasant Hours with the Microscope.
[Observations by polarised light.]
Knowledge, III. (1883) pp. 190–1.

Stodder, C.—The Podura Scale.

[Approval of article by Prof. R. Hitchcock, *ante* p. 135. "Dr. Woodward's theory is the correct one of the structure of the Podura Scale. The spines have no tangible existence."]

Amer. Mon. Micr. Journ., IV. (1883) p. 4.

Van Brunt, C.—*Amphipleura pellucida.*

["Resolved by Mr. Spencer with an unfinished 1-10th in. objective, a flour-barrel being used for a table, and the mirror bar of the Microscope being so loose that it had to be propped up with a stick. Daylight was used for illumination."]

Amer. Mon. Micr. Journ., IV. (1883) p. 39.

White, T. C.—Photo-micrography.

[Report of demonstration at Quekett Microscopical Club. *Post.*]

Engl. Mech., XXXVI. (1883) p. 492 (1 fig.).

" " The President's Address. (Quekett Microscopical Club.)

[Traces "some of the successive steps by which we have attained to our present position in the use of the Microscope."]

Journ. Quek. Micr. Club, I. (1883) pp. 112–24.

Whitson, J.—The Photography of Microscopic Sections.

[Contains description of the method adopted for taking photo-micrographs of Sections of Adeno-sarcoma of Mamma.]

Sep. Repr. *Glasgow Med. Journ.*, 1883, March, 5 pp. (1 photomicr.).

β. Collecting, Mounting and Examining Objects, &c.

Collecting Small Organisms.*—In order to procure small organisms for microscopical examination, living in their natural habitat, Professor K. Möbius fixes some glass slides in a piece of wood in which cuts, a few millimetres deep and of the thickness of the slides, had been made with a saw. The wood was nailed to a pole attached to a landing-stage in Kiel harbour, in such a way that the wood with the slides was a few feet above the sea-bottom. For the examination of the organisms on the glass slides, they were removed from the wood, and immediately fixed in a cork, and floated in a glass vessel full of sea-water.

Upon such glass slides hydroid polyps, annelids, bryozoa, infusoria, rhizopoda, diatoms, &c., attach themselves.

In the aquarium slides may be similarly suspended from corks in order to have infusoria, rhizopoda, &c., for immediate examination.

Chloride of Gold and Cadmium for Nerve-Terminations.†—Prof. G. V. Ciaccio minutely describes a process for treating the terminations of the motor-nerve fibres in the striated muscles (of the torpedo) which is not Loewits', nor yet Ranvier's, but partly one and partly the other.

After detaching the muscles and stretching them on a glass plate their fibrous envelope is carefully removed. The anterior third, which contains nearly all the nerve-terminations, is cut off and again cut up into pieces of 1 mm. These are placed in fresh lemon-juice (filtered through blotting-paper), and left for five minutes. Then with bone forceps each piece is washed in distilled water, and placed in 4 c.cm. of a solution of chloride of gold and of cadmium (1 per cent.), in

* Zool. Anzeig., vi. (1883) p. 53.

† Journ. de Microgr., vii. (1883) pp. 38–41.

which they should lie for half an hour, protected from the light. Again taken out and washed, they are put in 50 cm. of distilled water, acidulated with 1 per cent. of formic acid, and kept in the dark for twelve hours, and then for as many exposed to sunlight. Next they are put in a small glass and wetted with formic acid, so as to cover them, and again kept in the dark for twenty-four hours. Finally, the acid is removed, and they are washed in distilled water, which is in its turn removed and replaced by Price's glycerine.

Thus treated the fibres are tinted in different colours, some in a more or less deep blue, others in an intense or light violet, and others, again, in a cinnabar red or dark reddish brown. The double chloride is, in the author's view, preferable to the use of chloride of gold, because the former is less uncertain in its action, and does not give rise to the disagreeable precipitates produced by the latter when it comes in contact with the "organized and nearly living parts." The method has been successfully used with the cornea of frogs, birds, and mice, and other parts rich in nerves.

Monobromide of Naphthaline for Histological Preparations.*—Dr. M. Flesch refers to the fact that this fluid has apparently not been used in histology, although it has proved to have important advantages for diatoms. Whilst he has not himself arrived at results of a special kind (on the contrary, in many cases which justified a hope of success the result was negative) yet he thinks it desirable to call attention to the medium as it is not improbable that in the case of objects in which everything is not revealed by staining, many parts may be seen better in monobromide of naphthaline than in other media.

The preparations must be very carefully dehydrated as the slightest trace of water produces cloudiness. They can be mounted either direct from absolute alcohol, or after being passed through oil of turpentine (creosote and oil of cloves are less suitable). For cementing, either wax or lac-varnish or thickened Venice turpentine.

Dr. Flesch suggests further experiments to determine whether or not monobromide of naphthaline improves the recognition of minute structures such as fine wrinkles in skin, small granulations, &c.

Sulphocyanides of Ammonium and Potassium as Histological Reagents.†—Prof. W. Stirling calls attention to the value of the sulphocyanides for revealing the presence and arrangement of the intranuclear plexus of fibrils in coloured and colourless blood-corpuscles. For this purpose a drop of a 10 per cent. solution of either agent is added to a drop of the blood of a newt or a frog. After a time the hæmoglobin becomes quite discoloured or removed, and remarkable changes take place in the nucleus; it swells up, becomes more distinct, and shows in its interior an exquisitely arranged intranuclear plexus of fibrils. This plexus can be stained with fuchsin or eosin, and kept for a long while.

The solutions are also admirable "dissociating" media for iso-

* Zool. Anzeig., v. (1882) pp. 555–6.
† Journ. Anat. and Physiol., xvii. (1883) p. 207–10.

lating epithelial cells. Small pieces of the tissue are placed in the solution for twenty-four or forty-eight hours. They may be stained afterwards with picrocarmine, but before doing so it is necessary to remove all traces of the sulphocyanide by steeping the tissue in water for a short time. The sulphocyanide causes a precipitation of the picric acid. The cells show very distinctly an intranuclear plexus of fibrils. What seems to happen is that the interfibrillar ground-substance of the nucleus swells up slightly, and so opens out the network of fibrils. In the liver of the newt and frog an intranuclear plexus of fibrils is also revealed by similar treatment.

The intranuclear plexus is also seen in non-striped and striped muscle and nerve, and in the thin cartilage of the sternum of the frog or newt. The fibres of the crystalline lens after twenty-four or forty-eight hours show a beaded appearance, some of the swellings being apparently due to the action of the reagent upon some chemical constituent of the lens fibres, and some perhaps to the swelling up of the cells on the fibres.

Preserving Insects, Crustacea, Worms, and small Vertebrates.*—Professor K. Möbius finds that convenient preparations of the different stages of development of insects can be made by putting eggs, young and old larvæ, pupæ, and imagos in a glass tube filled with spirit, and having a stopper of cotton wool, then placing them, according to their age, in a stoppered upright vessel filled with spirit, in the middle of which is a cylindrical glass, which presses the glass tube against the side of the upright vessel.

To make tape-worms, long nemertines, long annelids, and similar organisms satisfactorily visible, he rolls them spirally on a thick glass tube and then places them in an upright cylindrical vessel of spirit only a little wider than the tube. The worm is fastened to the top and bottom of the latter by means of a fine white-silk thread, or, better still, with isinglass.†

Very instructive sections of small mammalia, birds, frogs, fishes, and crustacea, can be made by attaching them to a board, dorsally, ventrally, or laterally, according to the section, and imbedding them in a freezing mixture, until they are quite frozen through. Then cut them with a broad-bladed knife, or saw if necessary, attach to the section-plane a glass plate, and lay the preparation in strong spirit until all viscera become so hardened that they retain their place. Then the preparation can be cleaned and mounted. The author's museum contains preparations mounted in this way of fishes in which the spinal marrow, brain, olfactory nerve, swimming bladder, &c., are very beautifully shown. In a longitudinal section of *Turdus merula*, the form of the air-sac is distinguishable within the breast-bone.

Mounting the Proboscis of a Fly.‡—Mr. T. W. Lofthouse directs the fly to be killed by putting it into a bottle containing a little carbolic acid that has been rendered fluid by the addition of a drop or

* Zool. Anzeig., vi. (1883) pp. 52–3.
† Cf. Prof. E. Selenka, ibid. v. (1882) p. 169.
‡ Microscopical News, iii. (1883) pp. 21–2 (1 fig.).

two of water; no more water should be used than is necessary. Cut off the head and place it in a small porcelain saucer, and cover with a little of the acid, which must be changed about every other day for say a week, or until it ceases to become coloured. The tongue will then, in most cases, be found to be protruded, or may be forced out by slightly pressing the head.

Expanding.—To expand the tongue, it should be placed in the centre of a glass slip, and put upon a piece of wood about 5 in. by $1\frac{1}{4}$ in., into one end of which a piece of wire has been inserted and bent over to form a clip, the centre being covered with a circle of white paper to form a light background. A piece of glass about 1 in. by $1\frac{1}{2}$ in., to be used as a presser, is placed upon the glass and under the spring, and is kept apart from the slip by several folds of paper about the thickness altogether of the fly's head. The head, with eyes uppermost, and the tongue protruded towards the right hand, is then placed in a drop of acid under the edge of the presser, and held there; and, if necessary, the tongue forced to protrude further by a slight pressure of the forefinger of the left hand. While in this position, the expander, a piece of glass 1 in. by $\frac{3}{4}$ in., to the under side of which a small cover-glass has been fastened by brown cement, and having a piece of paper by which to hold it gummed to the top, is used to force the lobes of the tongue backwards—that is, towards the left hand, and downwards, into the required position. The palpi, which will usually be found lying against the head, may then be arranged by means of a stiff bristle, and the head laid aside for three or four days to set.

Mounting.—After cutting away the head, transfer the tongue, which must be kept the same side up, to a drop of fresh acid on the centre of a clean glass slip. This may be done by pushing it on to the end of a quill which has been bent a little at the end, to form a kind of spoon. Apply balsam at the right-hand side of the cover-glass, and drain off the acid by holding a piece of blotting-paper to the opposite edge. If any cloudiness appears, warm the slide a little. A light clip may then be put on, and the slide put aside to harden. No needles should be used in any part of the process.

Preserving and Staining Protozoa.*—Dr. H. Blanc whilst recognizing that the methods of preserving Protozoa are already numerous, describes one which he has employed for a year and a half, and which has given satisfactory results, without any loss of the colour in Canada balsam.

Certes and Landsberg use osmic acid; Korschelt, chromic or osmic acid; Kleinenberg's picro-sulphuric acid (also used by Entz) is employed by the author, compounded as follows:—Concentrated picric acid, 100 vols.; sulphuric acid, 2 vols.; distilled water, 600 vols. This solution may be used as it is for preserving the larvæ of Echinodermata, Medusæ, and sponges; but for Rhizopoda and Infusoria, add a little 1 per cent. acetic acid, two or three drops to 15 cc. of liquid. The object of this addition is to bring out

* Zool. Anzeig., vi. (1883) pp. 22–3.

sharply the nuclei and the nucleoli, and if not in excess, it never injures the protoplasm. Thus prepared, the liquid is preferable to osmic acid, because the organisms being perfectly killed or fixed, it allows of a surer and more regular colouring, if care is taken to choose a suitable colouring matter.

Dr. Blanc does not fix the animals until they are covered with the cover-glass, a plan also recommended by Korschelt. This method is very advantageous and easy; for, in spite of Landsberg's opinion, the organisms are quite as well impregnated by the acid solution as if in a watch-glass.

The length of time during which the objects should be subjected to the action of the solution, varies according to the size or number of individuals under the same cover-glass; but it is not until they have all taken a yellowish colour that the preparation can be continued with success. The picro-sulphuric acid is then removed by 80 per cent. alcohol, renewed until the yellow colour has completely disappeared, then 96 per cent. alcohol is substituted, and finally absolute alcohol. The organisms being hardened, their staining may be proceeded with. For that purpose an alcoholic solution of safranin is preferable; 5 gr. of safranin are dissolved in 15 cc. of absolute alcohol, and having stood for some days, the solution is filtered and diluted with half its volume of distilled water. This solution is preferable to picrocarmine, because the colouring is more quickly effected and may be regulated according as it is desired to bring out the protoplasm or the nuclei.

After the object has been sufficiently stained it is washed in 80 per cent. alcohol, renewed until no clouds of colour appear, when the 80 per cent. alcohol is replaced by absolute alcohol and the latter by oil of cloves. Safranin being soluble in alcohol a certain quantity of the colouring matter will naturally be removed by the washing with 80 per cent. alcohol; but by substituting more or less rapidly the oil of cloves for the alcohol, the colour may be regulated; that is, a more or less intense colouring of the protoplasm around the nucleus can be obtained.

The method can also be recommended for marine nematodes, whose thick chitine is not an obstacle to colouring by the alcoholic solution of safranin.*

Preservative for Fungi.†—Three years ago M. E. Banning invented what she thinks a very good and cheap liquid for the preservation of fungi, composed of the following ingredients: 4½ oz. of common salt, 5 oz. of pulverized alum, and 1 quart of white wine vinegar. Mix thoroughly, and keep in a wide-mouthed glass jar. Brush off any dirt that clings to the fungus, and drop the freshly-gathered plant into the liquid.

A large jar of plants that were collected in the summer of 1879 are now in a perfect state of preservation. They have diminished

* Dr. C. O. Whitman (Amer. Nat., xvii. (1883) p. 458) says that "the process of decoloration is not entirely arrested by the application of clove oil, contrary to Blanc's assertion, hence it should be replaced by Canada balsam as early as possible."

† Bull. Torrey Bot. Club, ix. (1882) p. 153.

somewhat in size, but their structure is preserved, and the larvæ are effectually destroyed. The liquid often gets filled with sediment and floating particles, to free it from which it should be poured off, strained through a piece of thin muslin, and returned to the plants.

Osmic Acid for Microscopical Investigations.*—Dr. T. B. Redding gives directions for preparing the proper solutions of osmic acid for microscopic use :—Take a glass bottle, with a ground-glass stopper, and cover it thoroughly with black paper, so as to exclude all light, covering the exposed parts of the stopper in the same manner. If you have the ordinary capsule containing $\frac{1}{32}$ oz., and require a 1 per cent. solution, put 3 oz. of distilled water into the bottle and then drop the capsule into it and shake violently, so as to break the capsule, or, if that does not succeed, break with a clean glass rod. In a few hours the acid will have dissolved, and the fluid will be ready for use. For removing from the bottle, use a dropping-tube kept especially for that purpose.

Dr. Redding also describes the method of using osmic acid for staining purposes. (1) By immersing the object in the fluid; (2) by exposing it to the vapour of the solution; and (3) a third method, that of injection, which is a modification of the first. The objects he used were the nerve-fibres, nerve-plates, blood-corpuscles, epithelium, protoplasmic and other elements connected with or adjacent to the blood-vessels of the frog, toad, kitten, &c., which were stained by first injecting the vessels, through the aorta, immediately after death, with a very dilute solution of osmic acid in water and glycerine, equal parts. Twenty to thirty drops of the 1 per cent. solution should be used to the ounce of water and glycerine, and the injection followed in two or three hours after with an injection of Beale's blue, or with carmine jelly fluid, reduced to a delicate rose-tint by excess of water and gelatine. The preparations may be further differentiated with other stains.

The vapour method changes the elements less and admits of further staining processes more readily than any other method. Log-wood and eosin are the best stains to use after treating with osmic acid. Either will give good results with most tissues. In using carmine, it is best to stain the tissues before exposing to the vapour. Sometimes the vapour will attack the carmine and nearly obliterate it.

For infusoria, algæ, &c., fixed and stained with osmic acid, the following is found to act well, both as a stain and a preservative: Picrocarmine, 1 part; distilled water, 1 part; glycerine, 1 part; apply by allowing a drop to run under the cover-glass on the slide. As a hardening agent, osmic acid is valuable for very delicate structures, such as brain, nerve, and embryonic tissues; especially for soft tissues which are to be cut into sections. For this purpose the following method is best:—Take of a 1 per cent. solution of osmic acid, 1 part; a mixture of equal quantities of water and glycerine, 2 parts; of a 1 per cent. solution of chromic acid, 2 parts; alcohol, $\frac{1}{2}$ part; mix. The specimen to be hardened should be small. After remaining in the solution a few days or hours, according to size,

* Proc. Amer. Soc. Micr., 5th Annual Meeting, 1882, pp. 183-6.

character, &c., the process is finished by transferring the specimens to 25 per cent., 50 per cent., 75 per cent., and absolute alcohol successively.

Where a tissue has become too deeply stained with osmic acid, it may be bleached by putting it into a weak aqueous solution of ferrocyanide of potassium, care being taken afterwards to thoroughly wash the section in water. The cyanide of potassium will effect the same purpose, but must be used with care.

Infusoria, algæ, and other objects, killed, fixed, and stained with osmic acid, have been mounted nearly a year, and show no signs of change as yet. It is also especially valuable in examining the white blood-corpuscles (as it instantly kills and fixes the pseudopodia), and in bringing out clearly glandular, nerve, and fatty structures, and tissues. Sudorific, sebaceous, and other glands are better brought out by its use than in any other method that the author has used. A specimen of the meibomian glands of the upper eyelid is exceptionally fine and beautiful. It is also very valuable in differentiating all structures affected by fatty degeneration, particularly in the early stage of this regressive action.

Carbolic Acid in Mounting.*—Mr. W. J. Pow points out that contrary to the general opinion, carbolic acid is not an acid, and has no acid properties whatever. Chemically speaking it is an alcohol, belonging to a series of alcohols quite different in composition from common ethyl-alcohol, and from wood-spirit, which is closely related to common alcohol. But carbolic acid is, nevertheless, a true alcohol, and for this reason it can be frequently substituted for ethyl-alcohol in microscopical work. One great advantage which it has over the latter is found in the readiness with which it penetrates a specimen, and mixes with the fluids used in mounting, such as water, glycerine, and Canada balsam. Another is, that it does not harden tissues and make them stiff. For this reason insects, or parts of insects, can be preserved indefinitely in carbolic acid, in a fit condition to be mounted at any time. The more delicate parts are made quite transparent by long soaking in the solution, but this is no detriment to them.

The acid used for mounting should be the strongest solution, having just enough water in it to keep it fluid at ordinary temperatures. To use it for mounting, it is only necessary to drop the specimen into the acid, and in a few moments transfer it to the prepared cell containing the medium in which it is to be mounted. Suppose it is desired to mount a mosquito, or a plant-louse, or any minute insect which requires no preliminary treatment, drop the insect into the acid, and in a few minutes it will be seen that the fluid has thoroughly penetrated the body. Then it is quite immaterial whether the specimen is to be mounted in water, or glycerine, or balsam, for carbolic acid will mix as readily with one as with the other. Fill the cell with the medium to be used, place the specimen on a clean slide, and take up the excess of fluid with blotting-paper, then transfer it to the cell, and arrange the parts with needles, when the cover-glass can be applied.

* Amer. Mon. Micr. Journ., iv. (1883) pp. 8–9.

When insects require any preliminary treatment to make them transparent, such as soda solution, the solution should be thoroughly removed by washing with water, after which the specimens should be taken out one by one, the superfluous water removed with blotting-paper, and then thrown into the carbolic acid.

The author has used carbolic acid instead of alcohol in mounting stained sections of wood, with excellent results, and it is much cheaper than alcohol.

Injection Methods.*—Dr. H. Griesbach makes some observations on this subject, with reference more particularly to his investigations † on the vascular system of the Acephalæ.

Whilst injection-masses which are fluid when cold are the simpler and easier in use, those which are fluid only when warmed are indispensable for the coarser vessels.

For the observation of vessels with the naked eye or a lens, glycerine simply may be used with the addition of a bright colouring matter.

Another mass, fluid when cold, can be made by heating equal parts of white and yellow wax, and dissolving in oil of turpentine, and, after cooling, the solution is mixed with olive or rapeseed oil in which sulphate of lead has been ground up. The result is a whitish-yellow syrupy fluid, very useful for many injections. Sulphate of barium or iodide of lead may be substituted for the sulphate of lead. By the addition of spermaceti to the solution in oil of turpentine the mass can be made thinner. The sulphates and the iodide are not dissolved, but are in a very finely divided condition.

If an injected preparation has to be afterwards cut, it should be injected with gelatine (fluid when cold), with or without glycerine. The gelatine can be coloured with all kinds of colouring matters. The canula cannot be too small. With this mass the author has obtained beautiful dry preparations prepared as follows. The injected foot of *Anodonta* or *Unio*, after being laid for a short time in alcohol, was placed in oil of turpentine, and later in a mixture of the same and paraffin and exposed to the air. It dries without any shrinking, and sections can be made with chloroform.

For gelatine masses fluid when warm, chloride of uranium can be used, which dissolves in water, and by which the gelatine gets a glistening yellow colour. The most effective masses are some of the aniline colouring matters, especially the glistening ones, such as Bieberich scarlet, crocein, tropæolin, &c.

The author then discusses the relative advantages of injecting the living or dead animal, and expresses a decided opinion in favour of the former contrary to that of Sabatier. Whilst with the latter he has obtained tolerable injections of the lacunæ of the foot of *Mytilus edulis*, it would be hopeless to attempt to fill the lacunæ of the foot of *Anodonta* or *Unio* after death. Further details are given as to the injection of the lacunæ in these subjects.

* Arch. f. Mikr. Anat., xxi. (1882) pp. 824–7.

† See this Journal, ii. (1882) p. 605.

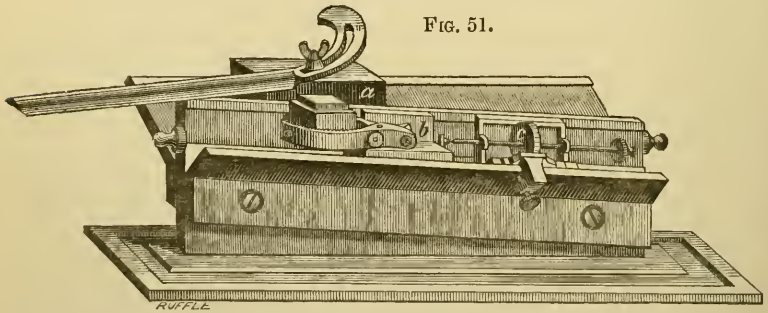
Ceresine and Vaseline for Imbedding.*—Dr. M. Schulgin prefers instead of pure paraffin a mixture of that substance with ceresine and vaseline. The paraffin should melt at 55°, and to it add at discretion ceresine, the density of which is considerably greater than that of the former. Ceresine is like wax, but harder and tougher, properties which make it very valuable as an imbedding substance. The mixture is tolerably hard, but that does not matter, as it is tough at the same time. If a soft mass is wanted vaseline must be added at discretion. Its special property is that it is not greasy but soft and tough.

Paul's Modification of Williams' Freezing Microtome.†—Mr. F. A. Paul modifies this instrument by making the inner cylinder movable while the outer one is fixed. The inner cylinder, carrying the frozen mass, is attached to the short arm of a lever below, the long arm of which is actuated by a fine screw, which extends above the upper plate, and is fitted not with a milled head but with a toothed wheel. The frame to which the knife is attached works on a pivot in the upper plate, and rests by two rounded legs on the plate as it moves over it. A hinge in the frame allows the razor to be lifted clear of the imbedded material on the return movement. An adjustable catch on the razor-frame turns the toothed wheel and its screw through a given part of a revolution, so as to elevate the mass by any desired amount at each cut of the knife.

Thoma's Sliding Microtome (Imbedding Methods).—Dr. R. Thoma, Extraordinary Professor of Pathological Anatomy at the University of Heidelberg, has been good enough to write us the following description (in English) of his instrument, which has acquired considerable reputation both on the Continent and in England.‡ He adds also remarks on its use.

The microtome (fig. 51) consists of a stand of cast-iron, on

Fig. 51.



Thoma's Microtome.—*a*, carrier for the knife; *b*, carrier for the object; *c*, micrometer-screw for fine adjustment.

which slide two carriers. The large knife is attached to one of these *a*, which slides horizontally. The second *b* holds the specimen to

* Zool. Anzeig., vi. (1883) pp. 21–2.

† Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 283–4.

‡ A brief description without figs. appeared in Virchow's Archiv, lxxxiv. (1881) pp. 189–91.

be cut. This second carrier moves on an inclined surface, so as to raise the specimen as required.

This, with a few modifications, is the general character of all sliding microtomes; but hitherto the carriers were constructed to slide with two even surfaces between two even planes of the stand, which intersect at a given angle, with the consequence that all show more or less imperfect results, owing to the fact that it is impossible to obtain sufficiently exact plane surfaces. The inconveniences appear in small irregularities of the movement of the carriers, and the consequent impossibility of making sections as thin as with an experienced hand.

This induced Prof. Thoma to enter upon a consideration of the geometrical and mechanical difficulties to be surmounted. The question to be solved was, how many points at least of a body sliding between two planes must touch the latter for this body to be perfectly steady in its position. It will be found that five points are sufficient, and that a carrier on five points, between two plane surfaces, will slide without difficulty between these planes, even if they are not absolutely geometrical planes, or the angle which they include is not everywhere the same. Such a carrier will always take exactly the same course; and, in consequence, a knife attached to it will cut a series of perfectly parallel sections through an object which is successively raised to a higher plane after each cut. The working of the instrument will therefore be far superior to any microtome with large sliding surfaces which nowhere exactly fit the sliding surfaces of the stand. This indicates the desirability of constructing the carrier for the object on five points also.

The construction resulting from these principles is simple and practical, but it is necessary to take into consideration the centres of gravity of the different sliding bodies. This, however, complicates the matter but very little. We replace the two sliding surfaces of each carrier by five slightly prominent points, and they will then move with exactness on any combination of two planes, not differing too much from geometrically plane surfaces. One condition only must be fulfilled, namely, that the five points are so chosen as to support steadily the centre of gravity of the carriers, including their accessory parts—namely the knife and object. Fig. 52 gives a more precise idea of the details of construction.

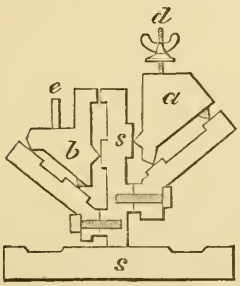
In the figure the lower surfaces of the carrier *a*, which supports the knife show three prominences, which gives the geometrical projection of the five points. Within the limits of the figure these points could not be drawn exactly as they are in the instrument itself. In reality, they appear only as small prominences upon three narrow ridges on the sliding surfaces of the stand. This arrangement was desirable to facilitate the action of the oil with which the sliding surfaces are to be covered. Two of the ridges form together parts of the oblique plane, and the third corresponds to the vertical sliding plane. The same arrangement is found in the carrier *b*, which supports the clamp in which the object is placed.

By this mode of construction the carriers will move gently and regularly even if the sliding surfaces of the stand are not perfect

geometrical planes. It is still, however, of course desirable that as much exactness as possible should be obtained in these planes, as their irregularities cannot fail to affect the sections, especially as they are, in fact, multiplied in the latter. Prof. Thoma highly commends Herr Jung, of Heidelberg, who makes the microtomes under his instructions, for the great exactness which he has obtained.*

As the efficiency of a newly-constructed instrument is best judged of by practical experience of its capabilities, Prof. Thoma (besides stating generally that it has been found that any one can produce sections of great delicacy with this microtome without previous practice), gives the following facts: — Specimens which are well hardened will allow of sections of 3 to 4 sq. cm. surface and 0·015 to 0·010 mm. thickness. In exceptional cases, pieces of so large a surface may even be cut of 0·005 mm. thickness. If the section is smaller (for instance, 1 cm. square), the thickness can be reduced considerably—say to 0·005 mm., or, in extreme cases, to half that. It is not, however, all tissues and objects that will admit of sections of such delicacy. Well-hardened liver may generally be cut to 0·015 mm., this being about the diameter of the hardened cell. Occasionally, however, in this tissue, sections of 0·010 mm. can be obtained. Lymphatic glands and brain may be cut to 0·010 or 0·075 mm.; embryonic tissues, well imbedded, usually admit sections of 0·005 and 0·003 mm. In some cases even sections of 0·002 mm. thickness can be obtained. These numbers refer to the largest size of the microtome, and to serial sections. The two smaller sizes will give sections of the same delicacy, but comparatively smaller in extent of surface. The length of the sliding surfaces of the large instrument is 40 cm., and the edge of the knife is 23 cm. In the medium size these dimensions are 27 and 16 cm., and in the smallest about 21 and 11 cm.

Fig. 52.



Transverse Section of the Microtome.—*ss*, stand; *a*, carrier for the knife; *b*, carrier for the object; *d*, screw to attach the knife; *e*, axis supporting the clamp for the object.

Prof. Thoma also adds some practical remarks on the use of the microtome, and the necessary previous preparation of the specimens, it being his opinion that further progress in section-cutting is to be

* Prof. Thoma remarks that at a time when already a number of his microtomes were in use, an instrument entirely different in its general appearance, but yet constructed on similar principles, appeared in America—the microtome of Mr. Fletcher (Boston 'Medical and Surgical Journal,' 1880). The knife-carrier slides on five points on the bottom of a large basin filled with alcohol. This microtome shows such eminently different qualities to the one explained here, that the independence of the invention is on both sides very evident. The value of the principle, however, is at the same time demonstrated by the relative good results which have been obtained by this American machine. Its limit as regards the thinness of the sections appears to be 0·0004 in.

expected from the perfecting and development of the technical methods of preparing, hardening, soaking, and imbedding the tissues. Personally, he feels sure that any tissue (excluding bone and teeth before decalcification) may be prepared so as to be cut to any degree of delicacy down to 0·002 mm. The microtome will work with sufficient exactness to permit this, but hitherto there are only a few tissues which we can prepare so perfectly as to admit sections of such extreme minuteness. The following are the points to which he most especially wishes to draw attention :—

Sliding microtomes are in general constructed for cutting sections of tissues previously hardened in alcohol, picric acid, chromic salts, and other agents. Fresh tissues are decidedly better cut by freezing microtomes—for instance, on the simple and practical instrument of Hughes and Lewis. The addition of a freezing apparatus to a thoroughly exact sliding microtome is neither advisable nor necessary. The differences of temperature produced in different parts of the instrument would be apt to interfere with the perfect planeness of the sliding surfaces; whilst, on the other hand, section-cutting with frozen tissues is so simple and easy with the ordinary freezing apparatus that any further complication in the way of a sliding support of the knife is superfluous.

In cutting, the microtome is to be placed before the operator as in fig. 51, with the sliding surfaces abundantly covered with oil (bone-oil), and the knife moistened with alcohol. In many cases, it will be sufficient to simply place the hardened specimen between the arms of the clamp attached to the carrier *b* (fig. 51). The clamp should then be fixed in such a position that the specimen is as near as possible to the knife-carrier. The knife will generally have to be adjusted so as to bring the whole length of its blade into action. Very hard specimens are frequently cut with less difficulty by placing the knife more obliquely in regard to the long diameter of the instrument.

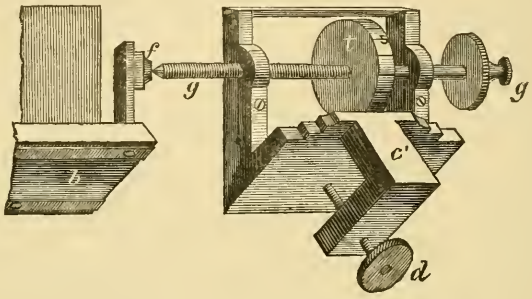
The inclination of the oblique plane upon which the carrier *b* slides is 1 : 20, and, consequently, the section will be 1-20th mm. thick if the carrier is moved 1 mm. on the oblique plane. A scale in millimetres with a vernier allows the operations to be exactly regulated. The vernier will be found sufficient for sections of 0·015 mm. Sections of greater delicacy should always be made by using the micrometer-screw (*c*, fig. 51), which was designed to obtain the utmost exactitude in the management of the carrier *b*. Fig. 53 shows it on a larger scale.

The carrier *c'* slides on the same oblique plane as the carrier *b* which holds the specimen. In all positions of the latter, it is therefore possible to bring the point of the micrometer-screw *g g* close to a small polished plate of agate *f*, which is fixed to the carrier *b*. In this position, *c'* should be firmly screwed to the stand of the microtome by *d*, and every revolution of the micrometer-screw *g g* will then push the carrier *b* 0·3 mm. The periphery of the drum *t*, which is firmly attached to the screw *g g*, is divided into 15 equal parts; and consequently each division marks a thickness of section

equivalent to 0·001 mm. The finest sections hitherto produced reach only 0·002 mm. thickness.

Since the first microtome was taken into use, a series of minor improvements have been made. One of them consists in a clamp

Fig. 53.

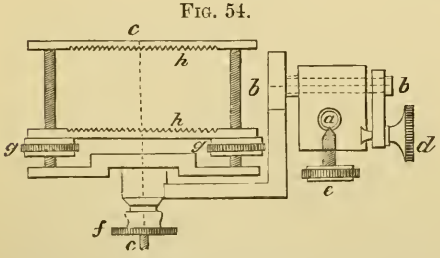


Micrometer-screw for delicate sections.

(fig. 54) for holding the object which can be turned round three axes, and admits therefore of a very easy adjustment of the object in regard to the knife. It was devised to meet the desire for occasionally turning the object between two successive series of sections.

The two metal plates *h h* form the jaws of the clamp. Between them is placed the cork which carries the specimen, and the latter is fixed by turning the screws *g g*. The three axes are *a*, *bb*, and *cc*, and round these the clamp can be turned, *a* being vertical, and *bb* and *cc* horizontal. In all positions these three axes can be made immovable by the screws *d*, *e*, *f*. The axis *a* is formed by the vertical rod *e* (fig. 52), on the carrier supporting the clamp and object. The details of the construction are partly new, and are very solid and durable. Their arrangement is such as to admit of a division of the circles in which the clamp can be turned.

Fig. 54.



Clamp to be turned in three directions (as seen from above).

Another improvement has been devised by Mr. Jung. This is an arrangement which regulates the movement of the micrometer-screw, in such a way, that after a given number of divisions of the drum, a spring registers to the ear and finger of the manipulator the number of micromillimetres which the object has been raised. These intervals can be varied within certain limits by a simple adjustment comparable to a vernier. The construction of this apparatus is

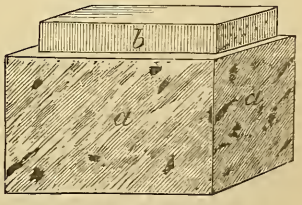
decidedly very elegant, but the divisions of the drum of the micrometer-screw are so large and easily visible, even to weak eyes, as in Prof. Thoma's opinion to make such complications useful only for very special conditions.

Other improvements by different manipulators relate merely to secondary points, and do not touch the essential principles of construction.

Taking the hardened specimen directly between the arms of the clamp is generally not advisable, as by such a proceeding sections of great delicacy cannot be obtained. It should be fastened with gum arabic to the even surface of a square piece of cork, and the latter inserted in the clamp. In this way compression is avoided. A concentrated solution of the gum is placed on the surface of the cork, and the hardened specimen is watered a few moments to drive away the alcohol from its surface, and it can then be adjusted on the gummed cork and plunged again into alcohol. The latter will in a few hours harden the specimen as well as the gum, and we obtain a preparation like fig. 55.

These methods are sufficient for the great majority of cases, and the different animal and vegetable tissues can be cut into sections varying according to their structure between 0·030 and 0·005 mm. Sometimes, however, and always if sections of extreme delicacy are required, it is necessary to use more complicated procedure. For example, the normal human lung hardened in alcohol and prepared as above, will perhaps admit of sections of 0·030 mm.; a human lung affected by acute pneumonia may perhaps be cut to 0·015 mm., but if greater delicacy is required, the tissue must be soaked in gum arabic, or other substance which admits of a more solid hardening. In this case human lung will allow of sections down to 0·007 mm. Objects of very small dimensions, like embryos, small animals, leaves of plants, &c., must be imbedded in suitable masses, which may be adapted to a cork as above before they are cut.

Fig. 55.



Hardened specimen *b* adapted to cork *a*.

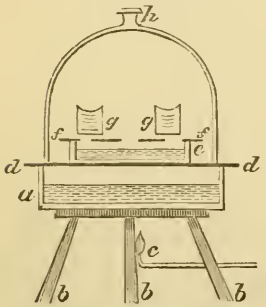
Imbedding Methods.—Prof. Thoma adds to his description of his microtome some remarks on the imbedding methods more generally used. The method of treating tissues with gum arabic, first brought into use by Rindfleisch and Ranvier, is now very generally known and practised. The same may be said of the method of cutting sections between two pieces of elder pith or hardened liver, &c. These in certain conditions are very useful and simple, but other methods of imbedding of more recent date give sections of the utmost perfection and unsurpassed delicacy.

The method of imbedding in emulsions containing fat and albumen, originated with Bunge, and was subsequently modified by Calberla and Ruge. The following is very nearly the formula of the

latter:—The albumen and yolk of several hen's eggs is placed in a porcelain mortar and well stirred, until it forms a thin yellow fluid, a result generally obtained in a few minutes. This fluid is subsequently passed through thin linen in order to remove the remaining membranaceous fragments. The specimen previously hardened in alcohol is then fixed by pins in a paper box, and covered with the fluid. The preparation cannot, however, be immersed directly in alcohol for the purpose of hardening. It must be first hardened by alcohol steam, taking care never to raise the temperature of the steam above 30° C. For this purpose Prof. Thoma uses a simple apparatus represented in fig. 56.

A shallow water-bath *a* stands on an iron tripod *b b b*, and is heated by a small flame *c*. The water-bath is covered by a thin plate *d d*. Upon this plate is a small glass vessel *e*, filled with common alcohol and covered with a perforated disk of tin *f f*. On this disk are placed the paper boxes *g g*, containing the specimens and the imbedding fluid. The latter and the alcohol vessel are again separated from the external air by a glass cover *h*. This apparatus slightly heated will harden the imbedding masses within a few days, after which time they are removed and subsequently fully hardened in a bottle containing ordinary alcohol. The latter process determines the degree of consistence of the imbedding mass. It can be made extremely hard by repeated use of strong alcohol. After a few trials it will be easy to find the convenient degree of consistence for each specimen.

Fig. 56.



Apparatus for hardening egg-emulsion.

If the temperature of the alcohol steam is more elevated, it will be found that the imbedding mass, instead of shrinking, will appear to increase in volume, innumerable air-bubbles developing in the emulsion. This can be easily avoided by using lower temperatures. Another danger, however, exists in the holes which the pins make in the walls of the paper boxes. The emulsion before hardening is so very liquid, that it will pass through the smallest opening; this renders it necessary not to withdraw any of the pins from the sides of the paper box, and to use boxes without any openings. It will be found that this mass adapts itself perfectly to all surfaces of the specimens without penetrating into their interior structure, and that it can be cut admirably at all thicknesses down to 0·003 mm. Another very agreeable quality results from the fact that the newly prepared emulsion will adapt itself readily to hardened pieces. This enables us to spread out fine membranes on pieces of the hardened imbedding mass, and subsequently to imbed both in the way just described.

After this praise of the egg-emulsion, it will be just to mention a property which is occasionally disagreeable. It cannot be easily detached from the sections, and we have no means of dissolving it in media which do not injure the objects. The mass also colours in all

the staining fluids generally used, and therefore becomes very visible in the preparations. The latter inconvenience should in all cases be avoided by colouring the specimen *in toto* before imbedding. For this purpose the fluids of Grenacher,* and especially alum-carmine, may be recommended. The imbedding mass remains nearly absolutely colourless if the specimen, after staining and before imbedding, is hardened again in alcohol.

Very elegant results may also be obtained by an imbedding mass originally invented by Duval, and recently much improved by Merkel and Schiefferdecker.† This is collodion, or, preferably, a solution of so-called *celloidin*. If this substance cannot in general be cut to such extreme delicacy as the albuminous mass just described, it has a great advantage in being extremely pellucid. The original communication of the last-named author is easily accessible, so that Prof. Thoma considers it is superfluous to give a detailed account of it, but adds a few remarks on his own experiences with it.

According to the formula of Schiefferdecker, the imbedding fluid consists of a concentrated solution of celloidin in a mixture of equal parts of absolute alcohol and ether. The specimen is soaked successively in absolute alcohol and ether, and in the imbedding fluid. This requires at least several days. After this time the imbedding proper may be undertaken, and for this we have the choice of two methods.

The even surface of a cork is covered with a thick solution of celloidin, so as to form by evaporation a strong collodion membrane on the cork. Upon this is put the specimen, covered layer by layer with fresh quantities of the solution of celloidin, each being allowed to dry only partially. When the object is thoroughly covered, we immerse it in alcohol of 0·842 sp. gr. In twenty-four hours the whole is ready for cutting.

The other method makes use of little paper boxes for the imbedding. The specimen, soaked in celloidin solution, is fixed in the box by pins, and the box filled with celloidin. The preparation is then placed on a flat piece of glass and covered with a glass cover, which does not exactly fit the glass plate. In a few days the ether will have evaporated gently and slowly from the imbedding mass, and the latter will shrink a little. If necessary, further celloidin solution can be poured in the paper box, to fill it again. It is only necessary to moisten the surface of the first mass with a drop of ether, in order to allow of a perfect junction between the old and the new layers. The preparation is again exposed to slow evaporation below the glass cover, and a few days later the imbedding mass will be consolidated to an opaline body, whose consistency can well be compared to that of the albumen of a boiled egg. The walls of the paper box can now be removed, and the imbedding mass placed in very dilute alcohol, which will in a few days produce a proper degree of consistency to admit of cutting.

This method differs in some degree from that which Schiefferdecker gives for imbedding in paper boxes. As other observers have re-

* Arch. f. Mikr. Anat., xvi. (1879) p. 465.

† Arch. f. Anat. u. Physiol. (Anat. Abtheil.) 1882.

marked, his method frequently gives rise to a great number of air-bubbles in the imbedding mass. Consequent upon the altered manipulations of Prof. Thoma, we have to adapt the imbedded specimen to a cork for the purpose of cutting. This may be done in the following way. The even surface of the cork is covered by a thick layer of celloidin solution. This is allowed to dry up perfectly, so as to produce a hard membrane of celloidin. This is again covered with further celloidin solution. In the meantime the lower surface of the imbedding mass is cut even, and washed with absolute alcohol, and subsequently moistened with a drop of ether. This moist surface is adapted to the stratum of liquid celloidin on the cork, and exposed for a few minutes to the open air. After this the whole is placed in dilute alcohol, which in a few hours will unite the imbedding-mass solidly with the cork.

In a great number of cases it may be regarded as a great advantage of the celloidin that it penetrates the tissues thoroughly, and yet remains pellucid, so as to be more or less invisible in the specimen. This quality can be made use of in another direction for the purpose of soaking specimens which are too brittle to be cut after hardening alone. We may make use of celloidin in a similar way to the gum arabic mentioned above. The minute normal and pathological anatomy of the lung in particular will derive great advantage from such a proceeding. Indeed, we are not able to get a perfect idea of the changes produced by pneumonia if we do not by this method or by the following (with paraffin) prevent the loss of a great part of the exuded substances which in this disease lie loose in the alveolar cavities. The study also of micro-organisms in the lung will derive great benefit from the celloidin method, and it will be very welcome to many to know that the tissues imbedded in celloidin may be stained with the different fluids, ammonium-carmine, alum-carmine, borax-carmine, hæmatoxylin, anilin colours, and various others. The reaction of acids and alkalies, particularly acetic acid and solution of potash, is, moreover, not interfered with. And, further, we are able to colour the object before imbedding with all staining fluids which are not soluble, or only little soluble, in alcohol and ether.

After staining and cutting, the sections may be mounted in glycerine and various other fluids. Mounting in Canada balsam requires, however, some precautions on account of the chemical character of the celloidin. Absolute alcohol and oil of cloves should be avoided and replaced by alcohol of 96 per cent., and by oleum origani. This is, at least the advice of Schiefferdecker, and Professor Thoma has had no occasion to be dissatisfied with the result.

The efforts of Bütschli and Blochmann * have given us another splendid imbedding mass, paraffin dissolved in chloroform, which admits of sections of the highest delicacy. Bütschli was able to cut in this imbedding substance small specimens down to 0·002 mm. This method seems particularly adapted to researches in embryology and zoology, where hitherto imbedding masses formed of paraffin and turpentine have been frequently used.

* Biol. Centralbl., i. (1881) pp. 591–2. See this Journal, ii. (1882) p. 708.

Usually it appears advisable to stain the specimens *in toto* before imbedding in paraffin and chloroform, and for this purpose Grenacher's alum-carmine and borax-carmine are very highly to be recommended. The long-known ammonium-carmine is also occasionally useful.

Dr. M. Schulgin,* in order to obviate the inconvenience that the same portion of the knife has always to be used, has had a knife of a somewhat different construction made (but which he does not explain). The advantage of this is that it can be moved along its whole length, so that different portions can be used for cutting.

Professor R. Kossmann writes,† "Many to whom the turning back of the micrometer-screw of the microtome is an annoying delay, will be thankful to me for pointing out to them that in two or three seconds it can be turned back its whole length by using a kind of fiddlebow, such as is used for drilling holes. The loop of the bow-string (made of strong silk cord, waxed or rosined) is passed round the smooth neck of the screw, and the bow is moved alternately to the left with stretched, and to the right with slackened cord."

Fixing Sections.‡—Dr. J. Frenzel considers that the method of Giesbrecht for fixing the preparation with shellac upon the slide has the disadvantage of preventing the colouring of the sections, so that the entire object must be coloured. To obviate this often serious drawback, he employs the following method:—Dissolve guttapercha in chloroform and benzine, and filter the solution when it has settled until it is clear and almost colourless. With this solution, which must not be too thin, and must only spread slowly over the glass, smear the middle of a carefully-cleaned slide, and after it is dry, lay the section on it. (1) If the preparations have been imbedded in paraffin or a mixture of paraffin (e.g. four parts of paraffin and one of vaseline), absolute alcohol must be dropped upon them, in order to make them unroll and lie flat. After this they must be exposed to a temperature of from 35° to 50° C. for about five to ten minutes, in order to make the guttapercha viscous; and after exposure to the air for five to ten minutes, they must be put in a vessel with warm absolute alcohol (from 40° to 50° C.), to extract the paraffin. This requires five to fifteen minutes. Alcohol must be used freely, as it is not capable of dissolving much paraffin. When the alcohol is saturated it can be filtered cold, and used as before. The preparation is now put in 70 per cent. alcohol and gradually into water, and coloured at discretion. After the washing it is put in absolute alcohol, in order to withdraw the water; and, finally, oil of cloves is dropped upon it to soften the guttapercha; and it is finally mounted in balsam or some similar substance. (2) If the object has been imbedded in celloidin, as is now very often done, the sections are also laid on the layer of guttapercha, and benzine or chloroform dropped on them, by which means they stick fast. After they are dried, they are coloured, and finally put in absolute alcohol, and treated with oil of cloves (in drops), by which the celloidin is dissolved.

* Zool. Anzeig., vi. (1883) p. 21. † Ibid. ‡ Ibid., pp. 51–2.

The latter is scarcely necessary for objects that are not very delicate. The colouring succeeds perfectly in this way also.

Mounting Sections in Series.*—Prof. R. Kossmann considers that the paraffin method of Dr. Giesbrecht † is far the best for the preparation of sections in series, and especially indispensable when it is desired to retain *in situ* in the completed preparation detached portions (such as embryos in the ovary). The soaking of the object in chloroform, suggested by Giesbrecht, before placing it in paraffin, is especially necessary when dealing with chitinous membranes, which are very impermeable. Prof. Kossmann has found that the complete evaporation of the chloroform is a very tedious operation; bubbles of chloroform are easily left behind in the cavities of the prepared paraffin mass; and he therefore uses an air-bath instead of the less easily managed water-bath. It is made of sheet-iron with glass sliding doors, and two small horizontal glass shelves. Two openings in the top are for a thermometer and a Kemp–Bunsen gas-regulator for low temperatures. Beneath is a Bunsen burner connected with the regulator. This air-bath is heated day and night, and a constant temperature of 50° C. kept up. On one of the shelves stands the glass vessel with the paraffin mixture. Two kinds of paraffin are used, of 56° and 36° melting power. It is *very* important, for the success of the sections, to have a mixture corresponding to the temperature of the room. A temperature of 18° requires a mixture of 48° melting point. On hot summer days the hardest kinds of paraffin must be used pure.

The object, soaked with chloroform, is put into the paraffin bath (without any mixing with chloroform), and left there from a few hours to two or three days, according to its size; after which it is quite uniformly penetrated with paraffin, even in the smallest cavities. The paraffin mass is poured into moulds of thick tinfoil.

The second shelf of the air-bath is for the slides. The shellac layer on the slide is brushed over with creosote, according to the old method of Giesbrecht, and Prof. Kossmann finds that no running together of the creosote takes place if the brush is lightly used and the slide slightly warmed. The creosote evaporates in a few minutes in the air-bath whilst the next slide is being filled, without danger of over-heating, and without being exposed to dust or damp deposits.

Creese's Turntable.—The speciality of this form of turntable (the design of Mr. E. J. E. Creese) is the method by which it is driven. A strong steel spring coil, on being wound up, starts a clockwork train of three cog-wheels. The sleeve of the table is made narrow and grooved, the whole train being arranged to secure 750 revolutions of the table for one of the driving-wheel, thus providing sufficient power to admit of speed-regulating appliances. The spring is wound from the top of the box, underneath the hand-rest, and the rotation of the table is stopped by pressing down a small brass bead placed at the side of the box. The slide

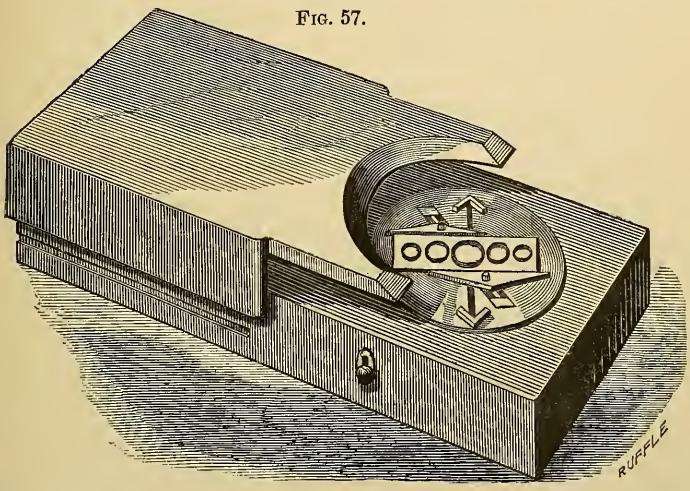
* Zool. Anzeig., vi. (1883) pp. 19–21.

† See this Journal, i. (1881) p. 953, ii. (1882) p. 888.

is clipped at the corners by two jaws, working in slots (as in Cox's and other forms), and is thus accurately centered. One of these jaws is fixed and the other attached underneath to the sleeve of the table by a spiral spring and drawn back upon the slide. Provision is made for re-touching slides the circles upon which are not truly central by two brass clips traversing oblique slots cut in the table, and being held in by brass split springs. Several cells can also be placed upon one glass slip.

A new form of hand-rest, sliding along two grooves cut in the

FIG. 57.



sides of the box, can be conveniently adjusted for every class of work. Underneath this rest, and at the opposite end of the box, is a sliding lid, which when drawn back opens a compartment sufficiently large to contain the key, brass clips, small bottles, brushes, rings, cover-glasses, slips, &c.

B., M. A.—Breakage of Slides in the Mail.

[Inquiring for a method for safe transmission, and note by the Ed., "We hear no complaints about it in England," &c.]

Amer. Mon. Micr. Journ., IV. (1883) p. 38.

BALKWILL'S (F. P.) Slides of 50 Foraminifera.

Journ. Post. Micr. Soc., II. (1883) pp. 60–1.

BANNING, M. E.—Preservative for Fungi. [*Supra*, p. 294.]

Bull. Torrey Bot. Club, IX. (1882) p. 153.

CAMERON, P.—On a simple method of mounting objects for microscopical examination.

[The object is to avoid the formation of two distinct collections, the dissection on the ordinary slide being kept in one place and the insect in another. The author, therefore, uses very fine cardboard in pieces 9 lines by 6. A hole 2½ to 3 lines across is punched at one end in the centre and 1½ to 2 lines from the edge. The lower side is closed by a cover-glass, and the object mounted in balsam. The dissection can now be placed alongside the insect in the collection. The author also explains his method of preserving larvæ by the roasting process, also Aphidæ.]

Proc. Nat. Hist. Soc. Glasgow, V. (1882) pp. 4–7, 65.

Chadwick, H. C.—The Marine Dredge, as an implement for collecting material for microscopical and zoological study.

[Describes the construction of a small net-dredge for the larger forms of crustacea, molluscs, and polyzoa.]

Micr. News, III. (1883) pp. 41–5 (3 figs.).

„ „ On mounting Insects in Balsam without pressure. [*Post.*]

Micr. News, III. (1883) pp. 105–6 (1 fig.).

Ciaccio, G. V.—Note sur la terminaison des fibres nerveuses motrices dans les muscles striés de la torpille traités par le chlorure d'or et de cadmium. (Note on the termination of the motor nerve fibres in the striated muscles of the *Torpedo* treated with chloride of gold and cadmium.) [*Supra*, p. 290.]

Journ. de Microgr., VII. (1883) pp. 38–41.

Clark, J. W.—Preliminary Note on the Bacillus of Tuberculosis (Koch).

[Contains remarks on Staining.]

Nature, XXVII. (1883) p. 492.

Cole, A. C.—Studies in Microscopical Science.

No. 39 (pp. 257–8). Text.—Notes on the Comparative Anatomy of the Alimentary Canal. Slide.—V. T. Section Tongue of Dog, injected carmine, stained logwood. Double Plate.—Human Tongue, Papillæ, Glands, &c.

No. 40 (pp. 259–60).—*Ficus elastica*. T. S. upper portion of Leaf with Cystolith, stained logwood. Plate × 333·3.

No. 41 (pp. 261–4).—The Alimentary Canal. The Oral Cavity. V. S. Tongue of Dog. Circumvallate Papilla, stained logwood. Plate × 65.

No. 42 (pp. 265–70).—White Syenite. Lairg, Sutherland. Plate × 25.

No. 43 (pp. 271–4). Text.—The Alimentary Canal. The Tongue. Slide and Plate (× 65) of T. S. Œsophagus of Dog, injected and stained logwood.

No. 44 (pp. 275–80).—*Ribes nigrum* (the Black Currant). T. S. of Stem, showing the formation of Cork, stained in carmine and aniline green. Plate × 500.

No. 45 (pp. 281–4). Text.—The Alimentary Canal. The Pharynx; and description of plate and slide accompanying No. 43. Slide of T. S. Cardiac end of Stomach of Dog, stained logwood. Plate.—The Stomach. Cardiac Glands of Bat (× 420); Dog (× 350 and 450).

No. 46 (pp. 285–6).—*Pinus sylvestris*. The Scotch Fir. T. S. of Leaf, stained logwood. Plate × 500.

No. 47 (pp. 287–92). Text.—The Alimentary Canal. The Stomach. Slide and Plate of V. S. Stomach of Dog. Pyloric end, × 65.

Coppock's directions for staining and preparing sputum to show *Bacillus tuberculosis*.

[Cf. II. (1882) p. 896.] *Micr. News*, III. (1883) pp. 121–2.

Davis, G. E.—Preparing Illustrations of Microscopical Objects.

[Describes the danger of woodcuts from photographs, unless the engraver is somewhat acquainted with his subject, illustrated with two figs. showing the different renderings of the same object.]

Micr. News, III. (1883) pp. 52–4 (2 figs.).

Dippel, L.—Nachtrag zu E. Boecker's Mikrotom. (Supplement to description of E. Boecker's Microtome.)

[Brief supplementary note to previous description in *Bot. Centralbl.*, XII. (1882) p. 212 in commendation, &c., and introducing an outline fig. of it.]

Bot. Centralbl., XIII. (1883) pp. 249–50 (1 fig.).

„ „ Das neue Mikrotom von Dr. C. Zeiss. (The new Microtome of Dr. C. Zeiss.) [Vol. I. (1881) p. 699.]

Bot. Centralbl., XIII. (1883) pp. 388–9 (1 fig.).

Griesbach, H.—Die Azofarbstoffe als Tinktionsmittel für menschliche und thierische Gewebe. (The nitrogenous colouring substances as staining media for human and animal tissues.) [*Post.*]

Arch. f. Mikr. Anat., XXII. (1883) pp. 132–42.

Groves, J. W.—Hudson's Extract of Soap for Cleaning Slides.

[Hurts nothing, and cleans the slides to perfection. If they are put in a solution of the extract and left for a few days, the balsam, cement, &c., will clean off beautifully.]

Journ. Quek. Micr. Club, I. (1883) p. 144.

HEITZMANN, C.—Microscopical Morphology of the Animal Body in Health and Disease. 847 pp. and 380 figs. 8vo, New York, 1883.

HITCHCOCK, R.—Photography and its value in Microscopical investigations. [*Post.*] *Amer. Mon. Micr. Journ.*, IV. (1883) pp. 33–4.

HUNT, J. G.—Upon Special Methods of Preparation and Mounting of Microscopical Objects. [*Title only.*] *Proc. Acad. Nat. Sci. Philad.*, 1882, p. 360.

HURST, G. H.—The Microscopical Structure of Rocks. III. Crystals. IV. Minerals. *Field Naturalist*, I. (1883) pp. 198–202.

INGPEN, J. E.—*Volvox* mounted in a dilute solution of iodide of potassium. *Journ. Quek. Micr. Club*, I. (1883) pp. 135–6.

JEAFFRESON, J. B.—The Microscope in Medicine. *Journ. Post. Micr. Soc.*, II. (1883) pp. 16–27.

KEY, A., & RETZIUS, G.—Ueber die Anwendung der Gefrierungsmethode in der histologischen Technik. (On the use of the freezing method in Histological Technics.) [*Post.*] *Retzius's Biolog. Untersuch.*, II. (1882) pp. 150–3.

KINGSLEY, J. S.—The Naturalist's Assistant: a Handbook for the Collector and Student. 228 pp. 8vo, Boston, 1882.

[Contains directions for collecting and for using the Microscope, and general laboratory work.]

LAKE, H. C.—Pond Life in Midwinter.

[Records living objects found in January.]

Sci.-Gossip, 1883, pp. 63–4.

MASON'S (R. G.) Anatomical Objects.

[Sections illustrating the normal anatomy of the mammalian lung, with full instructions for mounting, &c.]

Sci.-Gossip, 1883, p. 66.

MAXSON, E. R.—The Microscopy of Nutrition.

[Concluding words of Address to the Syracuse Microscopical Society.]

Amer. Mon. Micr. Journ., IV. (1883) p. 38.

MAYER, S.—Beitrag zur Histologischen Technik. (Contribution to Histological Technics.) [*Post.*]

SB. K. Akad. Wiss. Wien, 3e Abtheil., LXXXV. (1882) pp. 69–82 (2 pls.).

MULLER, C. J.—On the discrimination of different species of Wood for microscopical examination.

[The tabular classification of cross-sections of wood alluded to in previous note *ante*, p. 151.]

Sci.-Gossip (1883) pp. 39–41.

NICAT, W. See Ranvier, L.

PARKER, T. J.—On the preservation of Invertebrata. *New Zeal. Journ. Sci.*, I. (1882) pp. 21–4.

PFITZER, E.—Ueber ein Härtung und Färbung vereinigendes Verfahren für die Untersuchung des plasmatischen Zellleibs. (On a hardening and staining process for the investigation of the protoplasm of the cell-body.) *Ber. Deutsch. Bot. Gesell.*, I. (1883) pp. 44–7.

POW, W. J.—Carbolic Acid in mounting. [*Supra*, p. 296.] *Amer. Mon. Micr. Journ.*, IV. (1883) pp. 8–9.

RANVIER'S (L.) Technisches Lehrbuch der Histologie. (Ranvier's Technical Compendium of Histology.) Translated by W. Nicat and H. von Wyss. 898 pp. and 324 figs. 8vo, Leipzig, 1877–82.

RETZIUS, G. See Key, A.

RICHARDSON, B. W.—Treble Staining with picrocarmine and iodine green. Exhibition of sections illustrating Triple Staining.

[Preliminary to I. (1881) p. 868.]

Ann. & Mag. Nat. Hist., XI. (1883) pp. 212–3.

SCHULZE, F. E.—Ein Schnittstrecker. (A section-stretcher.) [*Post.*] *Zool. Anzeig.*, VI. (1883) pp. 100–3 (1 fig.).

SELENKA, E.—Zur Aufstellung von Spirituspräparaten. (On putting up spirit preparations.)

[Deals principally with a guttapercha (3-7ths) and tallow (4-7ths) cement for glass vessels, and isinglass and white of egg for fixing the objects on glass plates.]

Zool. Anzeig., V. (1882) pp. 169–72.

Shepard's (C.) Preparations of Mineral Crystals.

[Cells turned from 3-8ths in. and 1-4th in. brass tubing, with upper edge rounded off—cork bottom—crystals mounted on sealing-wax—no cover—can be attached to a slide or not as desired.]

Amer. Mon. Micr. Journ., IV. (1883) p. 37.

Sigsworth, J. C.—Paper clip for mounting.

[Cf. Vol. II. (1882) p. 446. Small curved steel spring screwed upon a piece of cedar. More useful than the American clips, which have a want of parallelism.]

Journ. Quek. Micr. Club, I. (1883) p. 138.

Slack, H. J.—Pleasant Hours with the Microscope.

[Silica films—*post.*]

Knowledge, III. (1883) pp. 82–3.

" " [On making vinegar and the vinegar plant.]

Knowledge, III. (1883) pp. 114–5.

" " ["Tool and implement-making processes" in lower organisms. (Sponges and Insects).]

Knowledge, III. (1883) p. 163.

Smith, J.—A Method of Making and Mounting Transparent Rock-sections for Microscopic Slides. *Journ. Post. Micr. Soc.*, II. (1883) pp. 28–33 (2 figs.).

Tschirch, A.—Micro-chemical reaction Methods. [*Post.*]

Journ. Chem. Soc. Abstr., XLIV. (1883) pp. 376–8, from *Arch. Pharm.*, XX. (1882) pp. 801–12.

Van Brunt, C.—Removing air from Diatoms.

[The frustules are dried on the cover-glass, which is then placed on a slide, diatoms up, and plain balsam is dropped upon them. By heat the balsam is caused to flow round the diatoms. It does not replace all the air within them, but by alternately heating the balsam up to the boiling-point and then cooling it, two or three times, all the air can be expelled.]

Amer. Mon. Micr. Journ., IV. (1883) p. 39.

Vorce, C. M.—The Detection of Adulteration in Food. Illustrated.

Amer. Mon. Micr. Journ., IV. (1883) pp. 24–6.

Walmsley, W. H.—Some hints on the preparation and mounting of microscopic objects. IV.

[Fluid mountings—best method of using the fluids and rendering the mount permanent.]

The Microscope, II. (1883) pp. 179–86 (5 figs.).

Winchell, A.—The use of the Microscope in Geology.

[Suggestions to use the Microscope for the examination of fossil corals and Brachiopoda, *Eozoon*, and rock sections.]

The Microscope, II. (1883) pp. 177–9.

Wyss, H. von. See Ranvier, L.

is only affected by the direction of the motion of the gelatine on one valve—the one that comes in contact with a surface. The motion is only on the sides, or valves. If a frustule is turned with its so-called front view up, it cannot move, at least those under my investigation did not, unless one of the valves comes in contact with some body of greater weight than itself, if we may so put it; for small particles will move along the valves, while the diatom remains stationary. The ribs have much to do with this power to creep, for the pallium is folded to the ribs, and being striated lengthwise it is plain to see how the pallium covers the valves with thousands of little feet. There is great room here for investigation with the recent very wide-angled glasses, but let me here give common glasses their due, for all that I have discovered has been done with only such."

Pfitzer's Diatomaceæ.*—In his account of the Diatomaceæ contributed to Schenk's 'Encyklopaedie der Naturwissenschaften,' E. Pfitzer commences with the simplest types, such as *Pinnularia*, proceeding then to the complicated structure of some marine algæ. With regard to their power of spontaneous motion, he adopts Schulze's view that it is due to extensions of the protoplasm which protrude through fissures in the cell-wall, although these have not yet been actually detected; rejecting that of Mereschkowski, that it is the result of an osmotic process. The jerks and vibrations described by this latter writer as observable in bacteria which are located close to the suture of diatoms, Pfitzer states are in no way due to motile processes. The ordinary mode of fission is then described, as well as the formation of auxospores. As regards their systematic position, Pfitzer regards the diatoms as most nearly allied to the Schizophytæ rather than to the Conjugatæ.

MICROSCOPY.

a. Instruments, Accessories, &c.

Bertrand's Petrological Microscope.†—This instrument (fig. 60) is designed by M. Bertrand, the Director of the 'Comptoir Mineralogique,' at Paris, and has several specialities :—

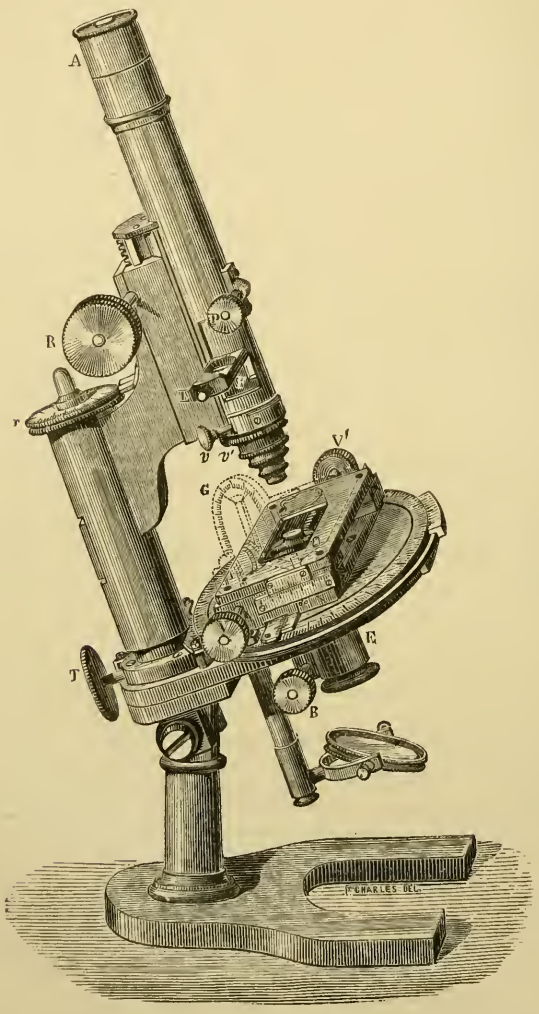
Above the objective at F is inserted a slide L with an achromatic lens so as to use either parallel or convergent light as may be desired, the slide being raised or lowered by a rack-and-pinion movement, the milled head of which is shown at P. A slow motion is given to the rotating plate of the stage by a tangent screw terminating in the

* Pfitzer, E., 'Die Bacillariaceen' (Diatomaceæ).

† Trutat's 'Traité élémentaire du Microscope,' 1883, pp. 266–70 and 300–1 (3 figs.). In addition to the references given in the text, A is the eye-piece, R the milled head of the coarse adjustment, *v v'* the centering screws for the objective, V V' the milled heads of the stage movements, and B that of the substage tube, E, for the polarizer. At F can be inserted a mica quartz-plate or a quartz prism.

milled head T. This screw works in a clamp which can be screwed to the stage, and when tightened up the rotation of T causes the clamp, and with it the stage, to revolve. When the clamp is

Fig. 60.



loosened the stage can be revolved by the hand. This mechanism effecting the slow rotatory motion of the stage is similar to that generally applied in the construction of theodolites and alt-azimuth instruments.

The body-tube is graduated and the focal distance is read by means of a vernier on the limb; the milled head of the fine adjustment r is divided; the rectangular movements of the mechanical stage are also each provided with a scale and vernier, while the margin of the stage is graduated and has two fixed verniers.

There is a spring clip for rapidly attaching the objectives.

A special form of goniometer (figs. 61 and 62) is adapted to the stage, for measuring the distance apart of the optic axes in air or in oil or other liquids. The object is held in forceps attached to a

Fig. 61.

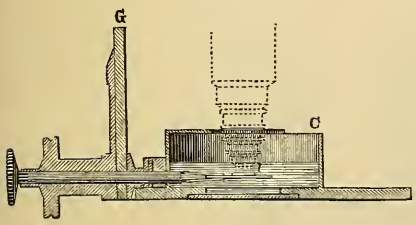
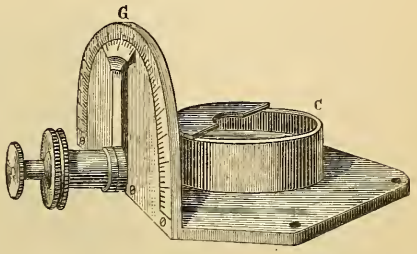


Fig. 62.



spindle connected with the smaller of the two milled heads. This rotates independently for adjusting the object or can be withdrawn if required. When the adjustment has been made the rotation of the larger milled head, to which a vernier index is attached, carries with it the inner spindle and forceps, and the extent of the inclination thus given to the object is measured by the index on the graduated semicircle G. The circular box C holds the liquid, and has an aperture at the bottom closed with a glass plate admitting light from the mirror.

Fase's Portable Binocular Dissecting and Mounting Microscope.*—The Rev. H. J. Fase describes an arrangement by which all the things required for dissecting and mounting, as well as a binocular for observing, can be carried in a compact form, and comprising:—

I. A full-sized, steady dissecting stage, with sloping rests for the hands. Two pairs scissors, knives, two pairs forceps, watch-glass, needle-points, &c.

II. An arm so constructed that it will carry a large low-power lens for dissecting. A ring, into which various objectives can be dropped for the same purpose, and a binocular body, which can be easily substituted for the ring, and allows of the manner in which the dissection is progressing to be inspected, and also steady enough to make an efficient binocular for ordinary observation.

III. Places in the case for a small number of cements, and media most usually required by working microscopists. Brushes, dipping tubes, lamp clips, slides, glass circles, troughs, a hot plate, and turn-

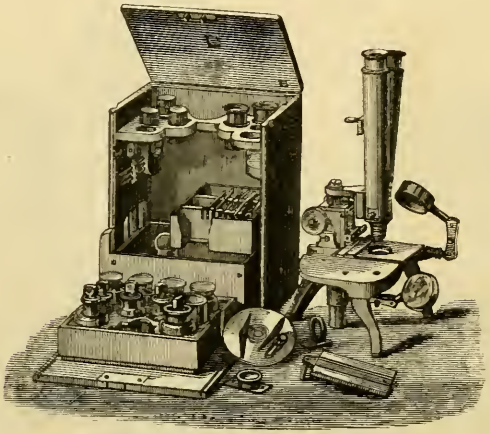
* Journ. Quek. Micr. Club, i. (1883) pp. 109–11.

table, packed in such a way that each of them should be safely carried, easily got at and replaced, every fitting being full-sized.

In fig. 63 the Microscope is shown on the right, with the binocular tube and condensing lens in place. Beneath is the ring for the objectives, which replaces the tube when a compound Microscope is not required. The turntable and hot stage are shown separately. The three trays contain the various reagents, cements, &c. The objectives are at the top of the case.

In packing, the small tray seen inside the case is dropped into the large bottom tray. The second large tray (in front) is placed on

Fig. 63.



the first, and the Microscope without the tube stands over both, the legs fitting into places in the trays. The binocular tube lies horizontally parallel to the back of the case. The front and top of the case opens as shown in the fig.

Mr. Fase calls attention to one or two points which he thinks might escape notice on a first inspection :—

The condenser is formed of two lenses, and besides acting as an ordinary condenser, makes a capital long focus dissecting lens. The mirror is removable, and can be utilized as a side reflector above the stage. The achromatic condenser, fitted with stops, giving a good black-ground effect, works by a milled head *above* the stage, and conveniently near the other adjustments. The rest for the hands while dissecting,, which the stand gives, is equally available when the binocular is being used for general observation. It is comfortable, and will be found to increase delicacy in the manipulation of objects.

Though rigid, the stand can be made lighter than can that of the ordinary form. The whole apparatus will not be more weighty than an ordinary binocular instrument; while it will, with all the helps to dissection, mounting, and observation, pack in a space not larger than

ordinary small monocular instruments, viz. 9 in. × 5 in. × 5 in. A larger number of cements could be carried if the bottles were of a slightly smaller size, and it is proposed that, instead of the outside case being of polished mahogany, it should be of painted canvas, such as portmanteaus are made of.

Whilst specially constructed for travelling, the instrument may be useful to workers, as comprising in a small compass many things necessary for microscopical work.

Klönne and Müller's and Seibert's Demonstration Microscopes.—In Klönne and Müller's instrument (fig. 64) the body-tube, with the eye-piece and objective, slides (for coarse focussing) in an outer tube, and can be secured in any position by the screw acting on a split ring at the upper end of the outer tube. At its lower end the latter tube is screwed to a plate about 3 in. square with four supports at the corners, on which the instrument rests when it is not in use. Beneath this plate is a second one, which is attached to the former at one side only, and is movable on a hinge joint. Two springs between the plates pull them together, and a screw (shown above the upper plate) forces them apart when desired and forms the fine focussing movement.

Fig. 64.

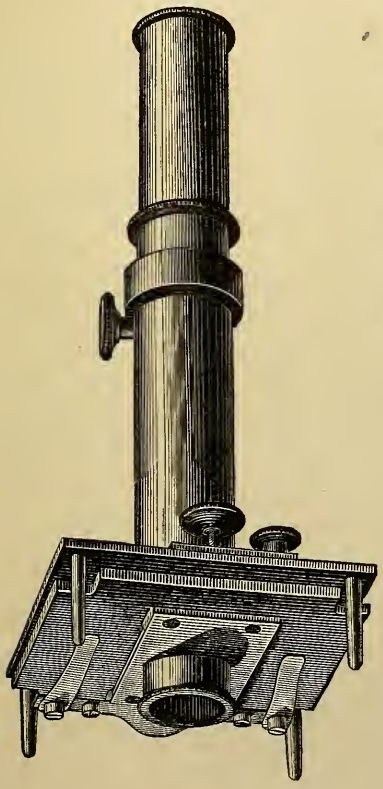


Fig. 65.

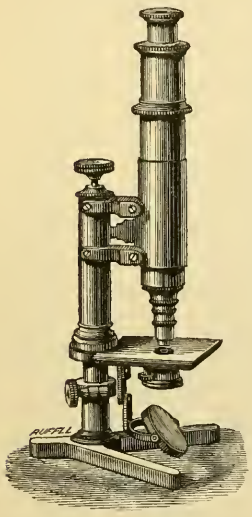
The slide is placed beneath the lower plate, and is held in position by two spring clips.

A condensing lens slides into the short tube attached to the small plate shown at the bottom of the figure, the plate being supported on two side-pieces to keep it clear of the slide.

Seibert also supplies the Microscope shown in fig. 65, the construction of which, as will be seen, is very similar to that of Klönne and Müller.

Seibert's Travelling Microscope. — This instrument (fig. 66) is reduced in height (within a range of an inch) for packing, by making the standard which carries the body-tube and stage, slide in a socket attached to the tripod base. A clamp screw tightening a ring on the socket allows the standard to be secured at any given point.

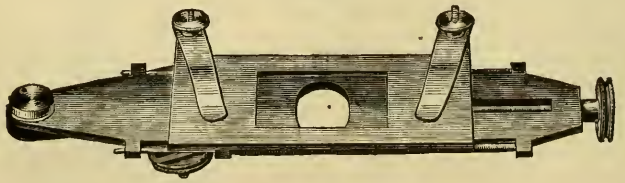
Fig. 66.



Klönne and Müller's "Pendulum Stage." *— This (fig. 67) is another form of mechanical stage (of German construction) intended to be attached to the ordinary stage of a Microscope (as shown in fig. 68) when it is desired to examine flesh infected with *Trichinæ*, or other objects which require a systematic examination of the whole surface.

It consists of three plates, the lowest being connected with the middle one by a pivot "like that used for the hands of a clock." By means of a clamping arrangement attached to the lowest plate, the apparatus can be fixed to the stage, care being taken that the circular aperture in the middle plate is centered with the axis of the microscope-tube. The upper plate has a square aperture, and carries the object. It slides on the middle plate by a screw (the milled head of which is seen on the right). The move-

Fig. 67.

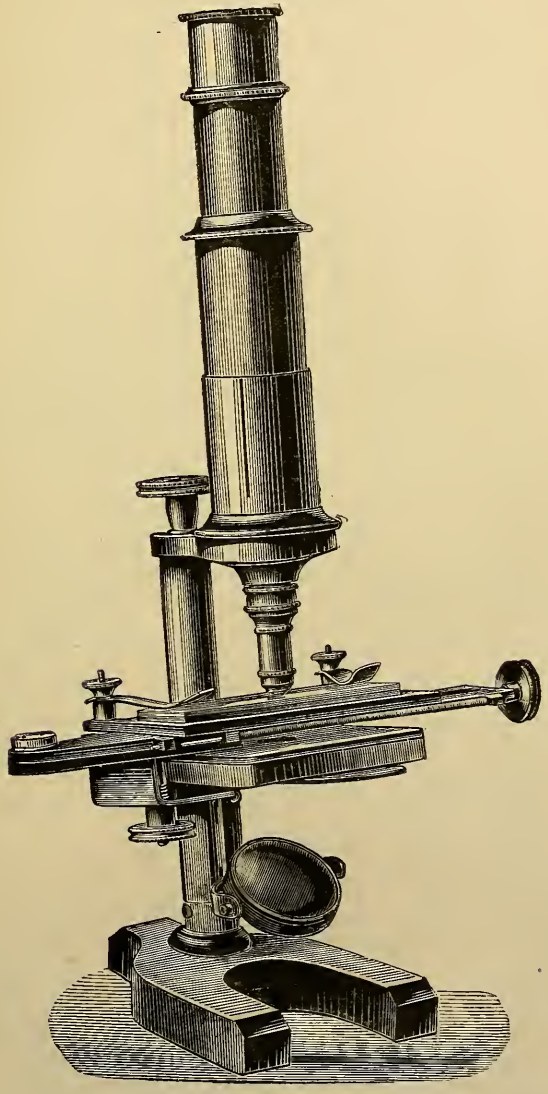


ment is regulated by two spiral springs. The object being in the field, the two upper plates are moved slowly from front to back, or

* See Centr. Ztg. f. Opt. u. Mech., ii. (1881) p. 113 (1 fig.).

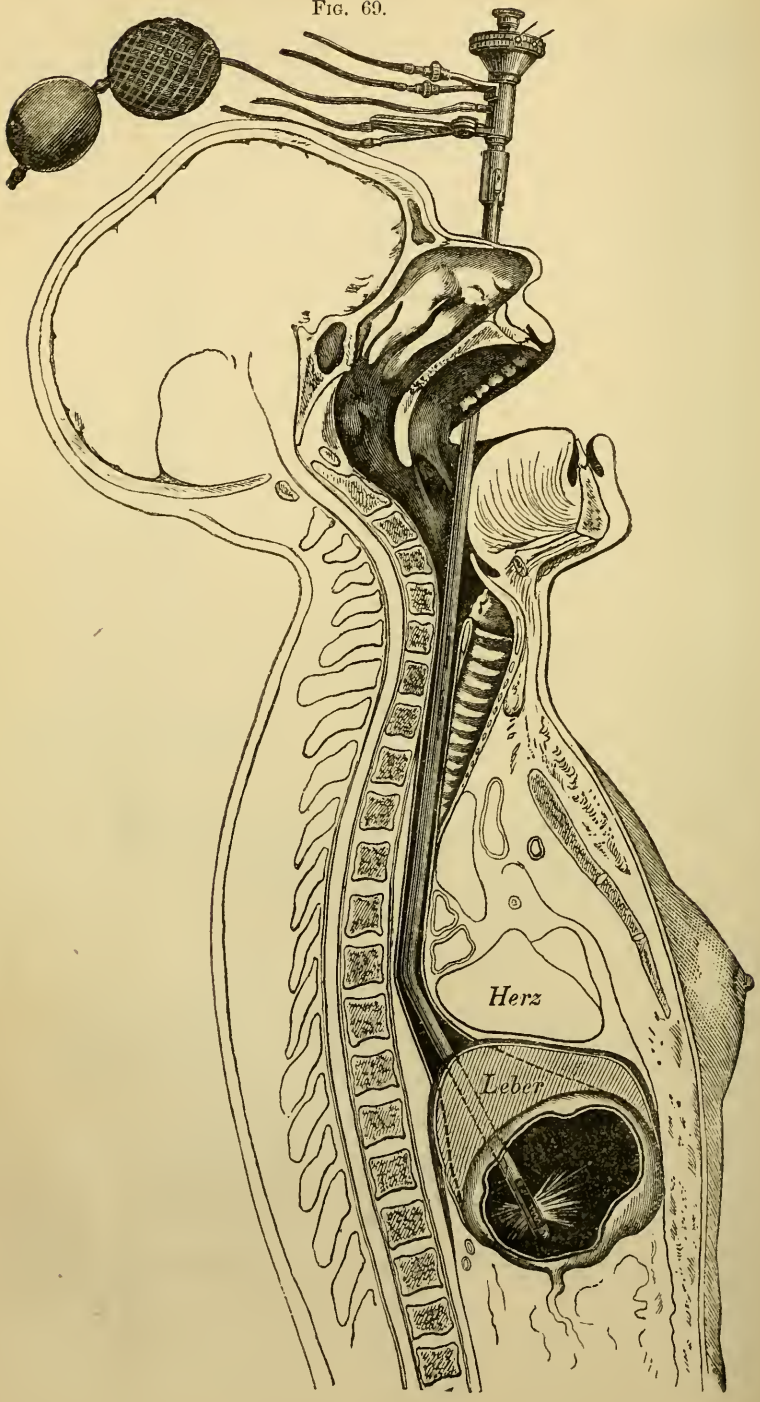
vice versâ, on the pivot (i. e. like a pendulum, whence the name). It is then shifted slightly by the screw on the right, and the pendulum

FIG. 68.



movement repeated, and so on until the whole of the object has passed under observation.

Fig. 69.



Leiter and Mikulicz's Gastroscopes. — J. Leiter * has devised a great variety of instruments intended for inspecting various more or less inaccessible parts of the body, including the mouth, larynx, œsophagus, stomach, intestines, urethra, bladder, vagina, rectum, ear, nasal fossæ, &c. They all agree in providing for the introduction of a small electric light into the cavity to be examined, with a special provision for preventing any inconvenience from heat by the circulation of a stream of water—a plan originally suggested by Dr. Bruck.

Most of the instruments also provide for the introduction of an objective, which forms an image of the part examined, the image being received by an eye-piece either direct or, where necessary, after being diverted in the proper direction through prisms.

Leiter's original gastroscope in particular was a marvel of ingenuity in the various arrangements for allowing the walls of the stomach to be illuminated and examined by the aid of lenses, but has apparently been found too complicated for practical use, and a simplified form is described by Dr. J. Mikulicz † (with a great elaboration of detail on all points), which has been devised by him in collaboration with Herr Leiter.

The tube A (fig. 70) is 65 cm. long and 14 mm. thick, and is bent at F at an angle of 150°. At B is the platinum wire for the electric light covered with a glass plate and connected, by wires running up the tube, with the key C and a Bunsen battery. Two water-tubes also run up the main tube, their ends being shown at D, a constant stream of water being maintained during the observation so as to prevent the lower end of the tube becoming heated. There is an additional tube for pumping water into

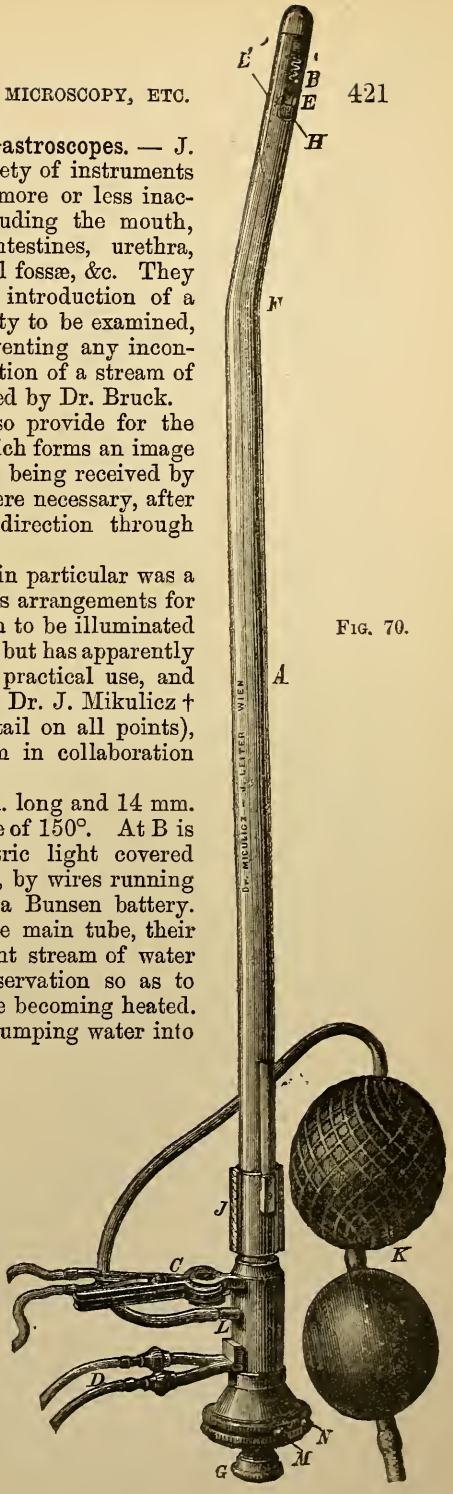


Fig. 70.

* Leiter, J., 'Elektro-Endoskopische Instrumente. Beschreibung und Instruction zur Handhabung der von Dr. M. Nitze und J. Leiter construirten Instrumente und Apparate zur direkten Beleuchtung menschlicher Körperhöhlen durch elektrisches Glühlicht.' 65 pp. and 82 figs., 4to, Wien, 1880. Cf. also Engl. Mech., xxxiii. (1881) pp. 27–8 (9 figs.).

† Mikulicz, J., 'Ueber Gastroskopie und Oesophagoskopie.' (Sep. Repr. from 'Wiener Medizinischen Presse,' 1881.) 32 pp. (3 figs.) 8vo, Wien, 1881.

the stomach, which commencing at the indiarubber balls K passes into the main tube at L and is continued to L′ where there is a small aperture.

The optical apparatus consists of a prism and an objective at E (the prism being right-angled and acting as a reflector to transmit the rays from the side of the instrument up the tube), a second prism at the bend at F, and an eye-piece at G. To prevent the glass plate at B from being smeared whilst the instrument is passed down the œsophagus a metal shutter H slides over it and can be drawn back by moving the collar at J.

The fact is enforced in italics that the instrument can be introduced into the bottom of the stomach without difficulty, and fig. 69 is given in illustration of the statement; another figure showing the advantage of the bent end in allowing different parts to be illuminated and observed by simply rotating the tube, the stomach being distended to facilitate the excursions of the tube. The author's pamphlet contains not only a very full description of the instrument, but minute directions for its use.

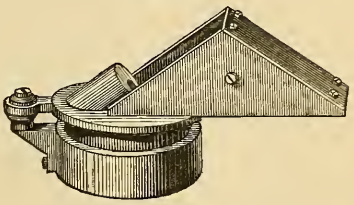
Dr. T. Oliver describes * a successful experiment of examining the interior of a patient's liver by one of the small Swan incandescent lamps described by Mr. Stearn *ante*, p. 29. The apparatus used was an electro-plated brass tube 9½ in. by 11-16ths in., closed at the lower end by glass, down which was inserted a narrow cylinder carrying a lamp and wires. Mr. J. B. Payne (a Fellow of this Society), who devised the arrangement, considers it to be much simpler than Leiter's platinum wire as it gives a perfectly pure light and developes less heat. He says "a Swan's electric lamp is used—the filament of which is carbon, and rendered incandescent by means of battery power. It is hermetically sealed in a glass shade; and water, conveyed to and fro through very small brass tubes, is made to circulate round the lamp. The light from this lamp is perfectly pure, and exhibits the condition of things in their true and natural colour. For prolonged observation I should prefer to use either a Grove's or Bunsen's battery, but in the demonstration just referred to, four cells of a modified Leclanché battery were employed and answered admirably. It is advisable to have as great a pressure as possible for the water supply, so as to insure perfect circulation, and for this I suspended from a hook fixed near the ceiling of the room a tin can containing water, connecting it with the brass tubes by means of lengths of indiarubber tubing."

Cobweb Micrometers.†—Mr. G. F. Dowdeswell prefers a cobweb micrometer which has the second web movable instead of being fixed as in the usual form. This both saves time and promotes accuracy, as when only one web is movable it is almost impossible, by means of the mechanical stage, to bring an object into exact contact with the fixed web, which is done at once with ease and certainty by the second movable one.

* Brit. Med. Journ., 1883, Jan. 27.
† Quart. Journ. Micr. Sci., xxiii. (1883) p. 337.

Chevalier's Camera Lucida.—Dr. Carpenter describes * a form of this camera intended to be used with the horizontal Microscope. Fig. 71 shows a modification designed by Dr. A. Chevalier † for a vertical Microscope. The reflecting prism is made much larger and is brought close to the small perforated metal speculum. The whole field is readily seen without any part being obstructed.

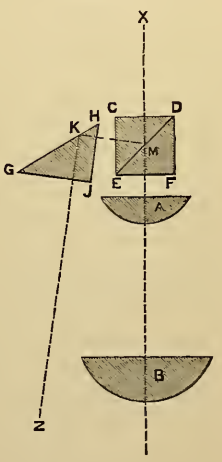
Fig. 71.



Grunow's Camera Lucida.—This camera (*ante*, p. 120) was the subject of discussion at the May meeting of the Society, and for convenience of reference we add fig. 72, showing its construction.

A and B are the lenses of the eye-piece; D C E, D F E, and G H J three right-angled prisms, the first two having their hypothenuses cemented together with balsam to make a cube. Prior to cementing, the upper of the two prisms has its hypothenuse silvered, but a small spot, not more than 1-16th in. in diameter, is afterwards denuded of silver as nearly as may be in the geometrical centre of the silvered face at M. The prism G H J is movable on an axis, to provide for its use when the instrument is either upright or inclined. Rays from Z, the table, are totally reflected from the face G H (say at K), and entering the upper prism, are reflected to the eye at X by the silvered surface D E, while the object is seen at the same time through the unsilvered spot in the middle of the same face.

Fig. 72.



A writer in the 'English Mechanic' ‡ says that it is not a *sine quâ non* to silver the surface, but the effect is wonderfully improved by doing so, the blue tint that otherwise appears to cover the object being almost entirely eliminated by the white reflection from the silver; and that this form of apparatus can be used with less straining and eye-fatigue than any he ever tried.

Holle's Drawing Apparatus.§—The device of Dr. H. G. Holle differs essentially from all other forms of drawing apparatus, and was

* 'The Microscope and its Revelations,' 6th ed., 1881, p. 114 (1 fig.).
† 'L'Étudiant micrographe,' 3rd ed., 1882, pp. 167–8 (1 fig.).
‡ Engl. Mech., xxxvii. (1883) p. 154 (1 fig.).
§ Nachr. K. Gesell. Wiss. Göttingen, 1876, pp. 25–7. Cf. Behrens' 'Hilfsbuch z. Ausfuhrung mikr. Untersuch. im bot. Laborat.,' 1883, pp. 90–1.

suggested with the view of obviating the difficulties found with the ordinary forms in regard to the eye and hand having to be placed in very inconvenient positions.

The principle of its construction is that neither the pencil itself nor its reflected image is seen, but an image of it formed by convex lenses. With this object the eye-piece of the Microscope in its ordinary position serves at the same time as the eye-piece of a telescope, whose axis is twice bent at a right angle. This is provided with two mirrors, the first of which (0·2 mm. thick, and necessarily transparent) is immediately beneath the eye-piece, and the second (which need not be so thin) is over the objective of the telescope. Between the two mirrors is a lens which again erects the inverted image of the pencil.

By the use of this apparatus the microscopical image is seen direct and without any fatigue to the eye. The drawing hand also lies on the right directly beneath the Microscope and therefore in the most convenient position.

To avoid the glare of the paper drowning the image of the object, Dr. Holle recommends—not the more simple process of modifying the light—but that the drawing should be made with a white pencil on a black ground. "In order, however, not to copy what has been already drawn, it is best to take black unglazed paper, blacken it on the reverse side with lead pencil, and lay it on the drawing paper. The marks of a pointed piece of bone can be seen on the unglazed black paper with sufficient clearness to know which lines of the image already exist on the drawing paper and which not."

Manipulation of the Beck Vertical Illuminator.* — Dr. J. Edwards Smith considers that this illuminator is a difficult one for the tyro to use, and that his first attempts will probably result in failure, and whilst it is not easy to give the necessary instruction in writing a few hints may prove of value.

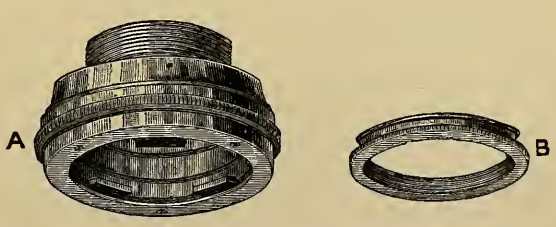
A dry mount of *Podura* answers very well for the novice to work upon. Select the widest aperture objective, and examine the object in the ordinary way and get a tolerable correction. Next put on the illuminator, and using transmitted light "hunt through the slide; among the numerous scales will probably be found one or two which, in order to bring into focus, the objective will require to be withdrawn from the cover slightly. In such a case the chances are that that particular scale is nearer the cover, and if in good condition may be selected for further operations. Next, bring the lamp (a flat-wicked one) towards the observer, revolving the tube of the illuminator so that the lateral aperture shall be in proper position to receive the light from the lamp, the latter being about seven or eight inches distant, and the flame about the same height as the aperture of the illuminator. Now grasp the little knob connected with the interior glass disk and turn it so that light shall be reflected to the rear of the objective; at the same time, and looking through the tube as you

* 'How to see with the Microscope,' 1880, pp. 221–3.

catch the first glimpse of light, revolve simultaneously the main tube and also the little knob carrying the glass disk, the object being to secure as great an amount of light as possible. A little manipulation of this kind ought to result in illuminating the object with a horizontal (or nearly so) band of light. The next step will be by a slight movement of the lamp, keeping its edge *exactly* towards the aperture, to endeavour to make the band of light crossing the field as *narrow* as possible, and the outlines of the band clear and distinct. By this time the operator will have probably discovered that a slight rotation of the main tube will separate the horizontal band into two parts, or, as some of my pupils express it, 'two tongues.' The best position is when these are made to coalesce as completely as possible. It is also probable that in the attempts thus far made the image of the scale has been well seen. When this occurs it should be at once focussed. The next procedure is to correct the objective; the correction obtained by transmitted light will not suffice for the purpose in hand. It will be noticed that as the glass is made to approach the correct adjustment, the horizontal band of light will be correspondingly improved. So true is this, that one might almost be governed thereby in the adjustment of the object. Having got thus far along, and without any serious mishap, it will be easy, by closing the shutter, to admit the precise and most favourable amount of light, and also to try the effect of sundry *very slight* changes in the position of the main tube, glass disk and lamp. Very beautiful resolutions are sometimes obtained by bringing the lamp within five or six inches and interposing the bull's-eye condenser, flat side to the lamp, in which case the shutter must be further closed. It will happen also, occasionally, that the best exhibition of striæ on very difficult objects, such as extremely close *Frustulia saxonica*, is when the striæ are placed at right angles to the horizontal band of light."

Pease's "Facility" Nose-piece.—This appliance (fig. 73) has been devised to facilitate the rapid interchange of objectives. The

Fig. 73.



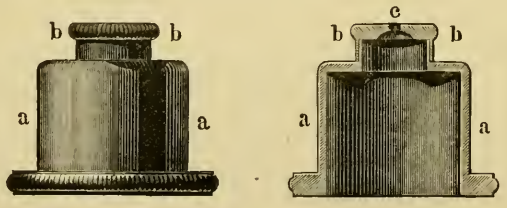
adapter nose-piece A screws on to the nose-piece of the Microscope by the usual "Society" screw, where it may remain permanently. It is provided with mechanism similar to that applied in the "self-centering" chuck. By the partial rotation of the milled collar three

sections of a flat spiral are made to act upon three sprung steel teeth, causing them to project from slots within the cylinder, or to return to their normal positions at will. B is a small ring with which each objective must be provided; it screws on the objective, where it may remain, and on its outer edge is a flanged groove. The objective, having the ring B attached, can then be slid into the "Facility" nosepiece, when about one-tenth of a turn of the milled collar on the latter causes the teeth to grip in the flanged groove of B, thus securing the objective in place; the reverse movement releases the teeth from the flanged groove, when the objective will drop into the hand.

As a piece of mechanism this device is ingenious. It appears to us, however, that with high powers unsteadiness and defects of centering will prevail to such an extent as to be fatal to its general adoption.

German "Cylinder-Diaphragms" and Condensers.—It is very much to be desired that the old wheel of diaphragms so distinctive of English instruments should be done away with, even with the smaller stands. To replace it no expensive apparatus is necessary, the "cylinder-diaphragm" of the German opticians serving all the purposes for which the "wheel" is used, and having the advantage of lying quite flush with the stage and exactly central, neither of which points can be secured with the old form. The contrivance consists simply of a tube *a*, *a*, fig. 74, having a narrow neck over which fit small caps *b*, *b* (the exact size of the opening in the stage) pierced with larger or smaller holes, *c*, as desired.

Fig. 74.



The usual condenser of the German instruments is also a very simple and convenient apparatus for the smaller stands. It consists only of a plano-convex lens *l* (fig. 75) in a fitting (*a*, *a*) nearly identical with that of the cylinder-diaphragm holder.

W. Behrens * considers the contrivance shown in fig. 76 *a*, *a*, with three small movable disks, as convenient for use in combination with these condensers for stopping off the central rays.

For attaching the fitting of the cylinder-diaphragms to the stage (as also the condenser) the slide *e e*, fig. 77, is useful and renders unnecessary any alteration of the mirror, as is the case when the dia-

* 'Hilfsbuch z. Ausführung mikr. Untersuch. im. bot. Laborat.,' 1883, p. 69.

phragms fit into a fixed tubing below the stage. The diaphragm-tube slides in *f*, and the milled heads *d* serve to remove the plate when it is

Fig. 75.

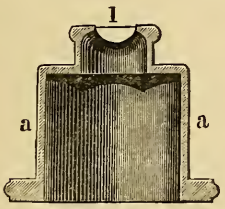
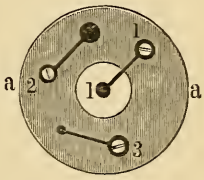
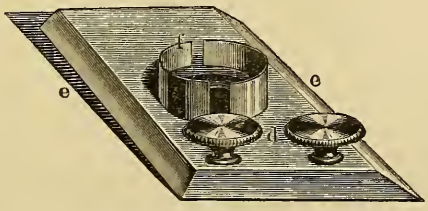


Fig. 76.



required to change the diaphragms. In some cases centering arrangements have been adapted. M. Nachet uses, in place of a sliding plate,

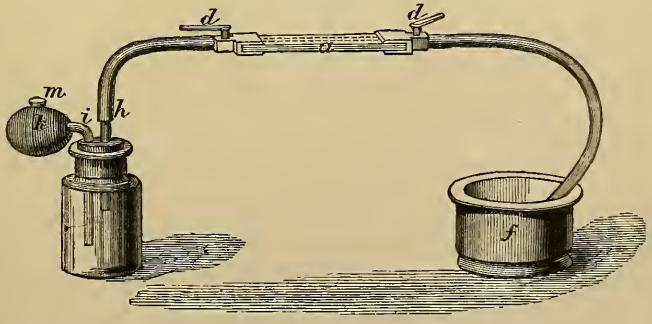
Fig. 77.



a movable arm which swings away from the stage in changing the diaphragms.

Pinkernelle's Apparatus for the Examination of Fluids.*— W. Pinkernelle's apparatus is shown in fig. 78. It consists essen-

Fig. 78.



tially of a glass plate *a*, in which is a channel closed at both ends by taps *d*, and having two indiarubber pipes, of which one dips into a

* Specification of German Patent, 1881, No. 18,071, and explanations issued by the author.

vessel *f* containing the fluid under examination, and the other communicates with a glass tube *h* leading into a bottle. There is a second tube *i* with an indiarubber ball *k*, having an orifice *m* at its upper end. The glass plate is laid on the stage of the Microscope, and the opening in the ball closed with the forefinger; the ball being first pressed between the middle finger and thumb of the left hand, and then relaxed, the fluid will be drawn from the vessel *f* into the bottle.

When the taps are completely open, the fluid flows so quickly that the particles which it contains are not seen, but by more or less closing one of the taps, they either pass slowly across the field, or (by quickly shutting them in the field) they can be retained for closer inspection. Pressure on the indiarubber ball will also cleanse the apparatus with water after using it. The channel is from 0·2 mm. to 1 mm. in depth.

The designer adds that the "apparatus is also suitable for drawing-room use, when say a binocular Microscope is exhibited for the amusement of spectators. The apparatus can be easily adjusted so as to pass a whole microscopic aquarium over the field of view." It can also be connected with a hand Microscope constructed for it, which when used is held towards the light, and in this way is useful on excursions. The vessel which holds the fluid must, however, be provided with a fine sieve, the meshes of which must correspond with the size of the channel. The material—mud, sand, chalk, clay, &c.—is rubbed over the sieve, and a little water poured on so that the finer parts may be washed through. It can also be used as a moist chamber, in order to observe the development of the various infusoria, diatomaceæ, bacteria, &c.

Moist Chamber.*—Mr. R. Hitchcock finds the following very convenient for cultivations:—

A piece of glass, 4 in. square, is placed upon a support so that it is about on a level with the top of a dish to hold water—an ice-cream saucer is what he used. A piece of blotting-paper is then placed on the glass, and the edge allowed to dip into the water. Objects to be examined are placed on large cover-glasses, and either covered with a small cover, or left exposed. These cover-glasses are laid upon the blotting-paper and covered with watch-glasses. A single large watch-glass of 3½ in. diameter may be used, or a number of small ones, one for each specimen. Objects can be kept fresh and moist in this way, with far less trouble than by any other method he has tried.

Hartnack and Prazmowski's Polarizing Prism.†—It is surprising that this prism is not to be found in England, when it presents such advantages over the old form of Nicol prism. As this may be due to the fact that the description of it has not hitherto appeared in English, we subjoin a translation of the original article by its designers:—

"The Nicol prism possesses valuable qualities which unquestion-

* Amer. Mon. Micr. Journ., iv. (1883) pp. 56–7.

† Annales de Chimie et de Physique, vii. (1866) pp. 181–9.

ably make it the best of known polarizing instruments, whether employed as an analyser or as a polarizer. Being constructed of a perfectly colourless substance, it transmits the light without altering the colour or dispersing the rays, and also without sensible diminution by the two partial reflections at the surfaces of entrance and exit.

A careful investigation of the course of the rays in this apparatus shows, however, some rather considerable defects, arising primarily from the direction in which the crystal is ordinarily cut, and also from the nature of the medium hitherto employed to reunite the two parts.

As is well known, the Nicol prism is simply a parallelopiped of Iceland spar, the length of which is equal to 3·7 times its thickness (fig. 79), and which is cut in two along the diagonal A B which joins the obtuse angles. The planes of section are carefully polished, and then cemented together with Canada balsam, the index of refraction of which (1·549) is intermediate between the *ordinary* index of the spar (1·658) and the minimum of its *extraordinary* index (1·483).

The limiting angle for the ordinary ray on the film of Canada balsam being 69° 5′, every ordinary refracted ray which is incident at a more oblique angle undergoes total reflection.

If, for instance, the ray *o d* enters obliquely at the face A C, it will undergo at *d* a refraction which causes it to take the direction *d f*. If it forms with the plane A B an angle of 20° 5′, this ray will limit the field from which ordinary rays are excluded, since all such rays arriving on the film of balsam at a greater angle would undergo total reflection. Thus all the rays comprised between the extreme directions *o d* and *e* A, ordinarily refracted in the spar, will be reflected at *f*, and will form a luminous cone *h f g*, which will be lost on the blackened face C B. The extraordinary rays, on the contrary, their index being lower than that of balsam, will traverse the latter, and will spread out at their exit into the space *i k*. It is not, however, the plane of the section which limits the field on the side A *e*. The extraordinary ray, in proportion as it approaches this plane, makes, with the principal axis of the spar, larger and larger angles; its index diminishes, it is true, but never reaches a value so small as to traverse under all angles of incidence the film of balsam. Under sufficiently large angles it undergoes in its turn total reflection. This is the other limit of the field of the prism. The inequality of the dispersive power of the balsam and of the spar reduces still more this limit, and renders the field still smaller.

As the index of the Canada balsam is very little inferior to that of the spar for the ordinary ray, and the limiting angle for this ray is 69° 5′, it is necessary to make the prism of considerable length—equal, as mentioned above, to 3·7 times the small side. The total length of the prism is represented by the projection of the long diagonal on the axis of the prism, i. e. four times the length of the small side.

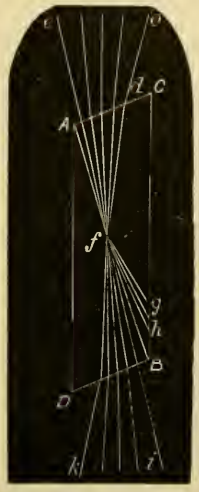
To obviate these inconveniences it has been proposed to employ different cementing substances, and particularly balsam of copaiba, the index of refraction of which is lower, which would allow of the prism being shortened. But the prism was still always cut

in the same direction, so that the extraordinary rays underwent total reflection long before reaching the plane of section, and if the field gained in extent on the side of the ordinary rays, it lost much more on the side of the extraordinary rays. In fact the field was reduced.

From this it will be seen that, so long as the direction of the plane of section relatively to the axis of the crystal remains the same, it would be useless to resort to any other cementing substance than balsam. Before insisting further on the effect of the direction of section, it is desirable to consider the result of the obliquity of the faces of incidence and emergence of the prism relatively to its axis, and to the direction of the luminous rays which traverse it.

Fig. 79 shows that the rays which pass from air into the spar on the side of the limit of the field A, traverse the face A C nearly normally, and that in proportion as they approach the other limit they incline more and more to the face of entrance; the same phenomenon being produced identically on the emergence of the rays

Fig. 79.



Path of the ordinary and extraordinary rays in a Nicol prism.

Fig. 80.

Path of the rays with different cementing media. C O A limit of the field for Canada balsam, K O A for balsam of copaiba, I O A for linseed oil, P O P' for poppy oil; *mm.* direction of the axis of the crystal.

at the opposite face. This progressive increase of the obliquity of the incident rays produces an increasing partial reflection and a proportionate diminution of the transmitted light; so that the field whilst very luminous on one side becomes darker and darker towards the other.

This obliquity of the faces of incidence and emergence gives rise

to a still greater inconvenience. Iceland spar is very soft, and the optician has much difficulty in producing true surfaces with it. The polishing always deforms the surfaces notwithstanding all the care and skill of the workman; and the slight deviations which cannot be avoided in the surfaces affect the direction of the transmitted rays the more injuriously, according as the angles of incidence are large.

In fact, whenever the rays form after their passage through the prism a real or virtual image, this image is always confused and badly defined. But it is especially when the image has to be again amplified that the defects in the surfaces give rise to the most troublesome consequences.

These considerations led the authors to think that the first thing to be done by way of remedy was to give to the faces of incidence and emergence, a direction normal to the axis of the prism. This direction allows the rays which traverse the centre of the field to reach the eye of the observer without having undergone any deviation, and it reduces by half the angles of incidence of the rays which limit the field. Under these conditions the choice of a more suitable section and the application of a better cementing substance would suffice to give to the polarizing prism all the qualities desirable.

The lower the index of refraction of the cementing medium, the greater the limiting angle under which the ordinary ray is totally reflected, and the more the dimensions of the prism may be reduced. But if its index has a value less than the minimum of the extraordinary index, notwithstanding the best selection of the plane of section, it is this ray which in its turn will undergo in a part of the field total reflection, and which will be stopped. Hence, as in a prism of ordinary construction, a diminution in the angular extent of the field of vision. The most suitable cementing substance should be one whose index has the same value as the extraordinary index in the section perpendicular to the axis. Linseed oil, a substance sufficiently drying for this purpose, has an index (1·485) identical with that of the spar; it allows therefore of a length less than that which is necessary when Canada balsam is used, and gives at the same time the large field of 35°. Poppy oil, which has a lower index, allows of a still greater diminution in the length of a prism, but it at the same time reduces the field to 28°.

We are now able to consider the following questions:—

1st. What is the direction which should be given to the plane of section to obtain the most advantageous size of field?

2nd. What inclination should be given to the faces of incidence and emergence relatively to this plane in order to insure the condition of normal incidence on these faces to the rays which correspond to the centre of the field?

To reply to these questions it is desirable to consider the path of the rays in the interior of the prism. Divide a parallelopiped of spar in two parts by the plane A B, fig. 80, perpendicularly to the principal axis of the crystal. The lines oblique to A B represent the limiting angles of the ordinary ray for the following substances by means of which the two halves may be cemented together.

	Index.	Limiting Angle.
Canada balsam	1·549 ..	69° 1′
Balsam of copaiba	1·507 ..	65° 3′
Linseed oil	1·485 ..	63° 6′
Poppy oil	1·463 ..	61° 9′

For the first three substances, even the extraordinary ray which grazes the surface A B does not undergo reflection. The plane A B forms the other limit of the field. It is not the same for poppy oil: the extraordinary ray is reflected at an incidence of 79° 9′ represented by the dotted line O P′.

In the *interior of the spar* the extent of the field with these different substances is as follows:

Canada balsam	20° 9′
Balsam of copaiba	24° 7′
Linseed oil	26° 4′
Poppy oil	17° 0′

The position of the faces of incidence and emergence must be such that the rays which limit the field on the two sides are equally inclined to these faces so as to give a field symmetrically disposed relatively to the axis of the prism. As on one side the limiting ray is refracted according to the ordinary index, whilst on the other side it is refracted according to the extraordinary index, the faces of incidence and emergence cannot be perpendicular to the line which divides in two the field in the interior of the prism. These faces should have a less inclination on the side of the ordinary ray than on the other.

In the calculation of this inclination there is a consideration which must not be omitted: it is that the dispersive power of spar for the extraordinary ray is higher than that of the fatty oils, and that their relative indices diminish in passing from red to violet. At about the limit of the field the blue and violet rays will still traverse the film of oil, whilst the red are arrested. The field is terminated on this side by a somewhat broad violet band which darkens it to a certain extent. It is, therefore, necessary to arrange to have on this side a larger portion of the field so as to employ only the part which is the most uniformly illuminated.

In consequence of this the following angles have been adopted, the crystal being supposed to be cut perpendicularly to the principal axis

	Angles of the faces of incidence and emergence with the plane of the section.	Angular extent of the field.	Length of the prism.
	° ′	°	mm.
Canada	79 0	33	52
Copaiba	76 5	35	37
Linseed	73 5	35	34
Poppy	71 0	28	30

of the spar, which assures, according to what we have above stated, the absolute maximum of angular extent of the field with cementing substances whose index very nearly approaches the extraordinary index of the spar in the plane normal to the crystalline axis.

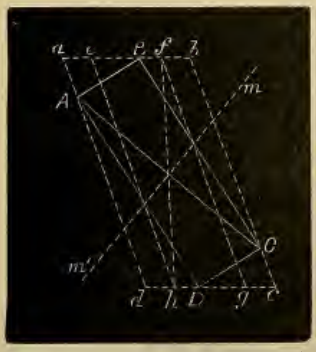
It must not be forgotten that the figure of the new prism is that which is really adopted in our instruments. Although the length of the longest side of the Nicol prism is only 3·7 (that of the smallest being taken as unity), the acute angles of this prism give it a length which is four times that of the small side.

Fig. 81 represents the new prism A B C D, with its section A C in a plane perpendicular to the axis of the crystal cut out of the parallelopiped *a b c d*. This construction requires a piece of spar larger than what is required in the Nicol prism. The same piece of spar, however, would only give a Nicol prism *e f g h* of nearly the same thickness as the new one but which would be more than a third longer than the latter, and that with a field of a third less in extent.

It is above all as an analyser that the new prism presents great advantages over the old form. It may, for instance, be placed very conveniently between the eye and the eye-piece of a Microscope without reducing the field of view; whilst the Nicol prism not only narrows directly the field in a notable proportion but also hinders the observer from approaching his eye sufficiently near to the point where the rays cross, an indispensable condition for embracing the whole field at one view."

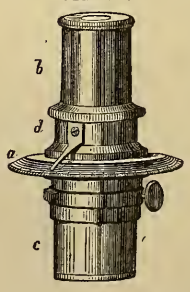
In Hartnack's analyser of recent construction (fig. 82) the mounting is united to the eye-piece *b c*, and there is a graduated disk *a*, in which the tube with the lenses and the analysing prism can be

Fig. 81.



Prazmowski (A B C D) and Nicol (*e f g h*) prisms. A C section of the crystal perpendicular to the axis *mm'*.

Fig. 82.



rotated. The pointer *d*, which rotates with the prism, indicates the angular magnitude of the revolution which has been made.

Leitz, and Seibert and Krafft have also constructed this apparatus of Hartnack's, adding a vernier and crossed wires; and Merz, Wasser-

lein, and Vérick have adopted the graduated disk. "There is no doubt," say Nägeli and Schwendener,* "that such contrivances are convenient for certain observations (for instance, on circular polarization); but in most cases it is, at any rate, more important, with crossed Nicols and immovable plates of selenite, to bring the object by means of a rotating plate to the different positions with regard to the planes of polarization of the Nicols, and thus be enabled to determine the angles."

Apparatus for Rotating Polarizing Objects.†— C. Nägeli and S. Schwendener recommend as "practical and fully satisfactory" the

Fig. 83.

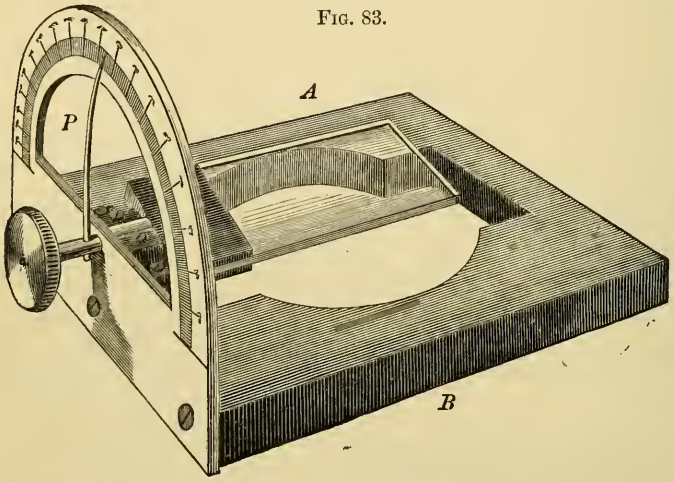
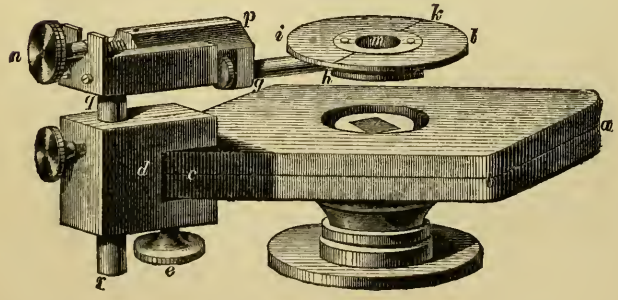


Fig. 84.



apparatus (to lie on the stage) shown in fig. 83, for obtaining rotation round a horizontal axis.

* 'Das Mikroskop,' 2nd ed. 1877, Engl. transl. (in the press), pp. 323-7.
† Ibid., pp. 326-7 (2 figs.)

To the brass plate A B, having a large central opening, is attached vertically a graduated semicircle, in the centre of curvature of which the pinion with a milled head is fitted in such a manner that it may be turned round an axis at right angles to the plane of the semicircle. This pinion carries on the other side of the semicircle two sprung brass plates, between which the glass slides are inserted. The slides are best applied so that an object lying upon them is adjusted to be in the axis of rotation, and consequently suffers little or no lateral displacement on rotation. The indicator P connected with the milled head, moves along the graduated scale, and thus gives the angle. It is advisable for certain purposes to arrange the apparatus so that the object can be turned under water or other liquid. This is the case, for instance, in the trough apparatus of Ebner,* which in other respects is constructed on the same principle as the author's.

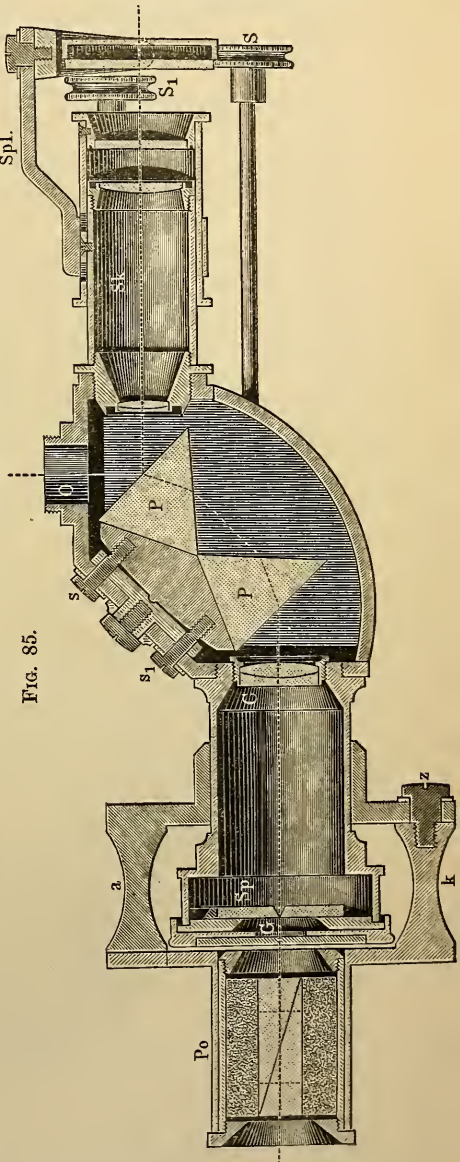


FIG. 85.

The same authors consider that Valentin's object-stage with double rotation (fig. 84) "does not answer satisfactorily the purposes required, as it affords no angular determinations: it may nevertheless be used in many cases. It is arranged for screwing to the ordinary stage, and is provided with adjusting screws for centering. The disk *h*, *i*, *k*, *l* can be revolved in its own plane, and likewise round the horizontal axis *g*.

Abbe's Spectro-polarizator. †—Dr. L. Dippel proposed to Prof. Abbe the construction of this piece of apparatus (fig. 85) in order, amongst other advantages, to obtain the benefit of Rollett's Spectro-polari-Micro-

* SB. K. K. Akad. Wiss. Wien, 1874. See also Bertrand's, *supra* p. 415.

† Bot. Centralbl., xii. (1882) pp. 284–6. L. Dippel, 'Das Mikroskop,' 2nd ed., 1882, pp. 620–2 (1 fig.).

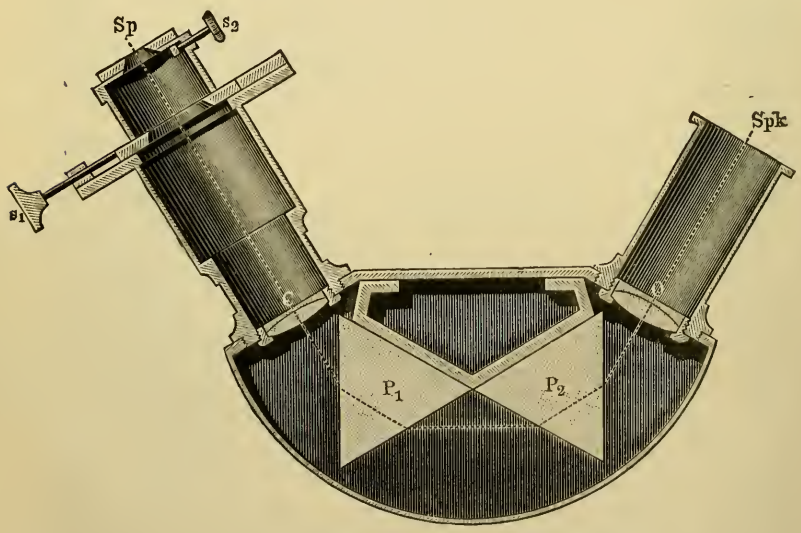
scope, without, however, being obliged to have a special Microscope for the purpose.

The apparatus is attached to the substage of the Microscope at O, lying parallel with the anterior side of the stage. The light passing through the slit Sp and the achromatic collimator C, is bent by the white flint prisms P P at an angle of 90°, so as to pass in the direction of the axis of the Microscope through an objective at O, which may be a low or high power as required. In front of the slit is a Prazmowski polarizing prism Po, which can be turned away on the frame a k z when ordinary light is required to be used. Selenites are introduced at G. The prisms give a much wider and better spectrum than a direct vision prism.

The arrangement on the right consists of an Angström scale, the image of which is projected by the lenses at Sk on the surface of one of the prisms P, and is thus reflected into the field of the Microscope in conjunction with the spectrum. As in the Zeiss Microspectroscope, the wave-lengths are given direct. The milled heads S and S_1 serve to move the apparatus from left to right, or from back to front, so as to obtain an exact adjustment of the spectrum, the proper focus being obtained by the rack to the substage. The screws *s* and s_1 also serve to adjust the prisms accurately.

Hartnack's Illuminating Apparatus for Monochromatic Light.—The arrangement of prisms in the preceding apparatus is adapted

Fig. 86.



from that of Hartnack for obtaining monochromatic light. Two white flint-glass prisms P_1 and P_2 direct the rays passing through the slit Sp and collimator lens C, so that they are projected on the stage

through the lens at O. The milled head s_1 shifts the slit from side to side so as to bring various portions of the spectrum into the centre of the field, whilst that at s_2 opens and shuts the slit. The apparatus is attached to the substage at Spk. With ordinary daylight it is only available with low powers. With direct sunlight (and a heliostat) high powers can be used.

Physiology of Variable Apparent Magnification by the Microscope.*—In estimating the size of an object viewed in the Microscope, it is commonly assumed that the image is seen as if at the distance of easiest vision, which is taken to be 10 in. The invalidity of this latter assumption, Mr. W. Le Conte Stevens considers, is strikingly shown in the table of estimates exhibited and discussed by Prof. Brewer in his recent paper.†

"It is well known that the distance of easiest vision is variable during the life of the same individual. The 'near-point' for a normal eye varies from 3 in. for a child of three years, to 18 or 20 feet for a man of eighty, the power of accommodation diminishing with increase of age. For such an eye, when in a relaxed state, parallel rays will be converged to the exact distance of the retina. If the radiant point be but 10 in. distant, the sheaf of divergent rays from it, if transmitted through the same refracting medium, would be focalized behind the retina, were there not an instant contraction of the ciliary muscle, resulting in an increase of convexity of the crystalline lens at its front surface. The ease or difficulty with which this is done depends mainly on the age of the person, if the eye be normal. The effort exerted by a little child will be far less than that of an old man.

All that the Microscope can do is to increase the visual angle under which the object is seen, and hence increase the size of the retinal image. The extent to which this may be advisable depends upon several considerations well known to microscopists. Since the visual angle is simply the measure of the difference of direction between two rays passing axially through the crystalline lens, from the opposite marginal points of the magnified image, as seen through the eye-piece, it is quite possible for this to remain sensibly constant, while the refracting power of the crystalline lens varies. The adjustment of the eye-piece, or the distance of the eye from it, may vary while distinct vision is retained, the limits of variation depending upon the power of accommodation in the eye of the observer. For a hypermetropic eye, the rays from a given crossing-point near the focus of the eye-piece may emerge from the latter either parallel, or slightly convergent, or divergent, and yet be distinctly focalized on the retina in consequence of appropriate action of the ciliary muscle.

The interpretation which we put upon a retinal sensation is quite unconscious, and always accompanied with equally unconscious interpretations of attendant muscular sensations. The experience of the individual is the only guide in reading visual judgments. It is not

* Amer. Mon. Micr. Journ., iii. (1882) pp. 189–91.
† See this Journal, ii. (1882) p. 861.

at all remarkable that different persons should vary in the interpretation they put upon sensations produced under the same external conditions, although the general effect of controlling the condition of the eye among them may be much the same. The author has elsewhere detailed numerous experiments on this subject.* The result may be briefly stated by saying that, while the visual angle remains constant, an increase in the contraction of the ciliary muscle, or of the internal rectus muscle if both eyes be employed, produces the illusion that the object is much smaller and nearer. Under such conditions, the apparent diminution in size, together with imperfect focalization, may produce as a secondary effect the illusion that the visual angle has been diminished, and the imagination that the object is more distant. Thus the unmistakable illusion is that of diminution of size, and this may be coupled with great lack of determination in the judgment of distance. Upon the author the most usual effect is that of diminution of distance.

The internal rectus and ciliary muscles are supplied from the same nerve, and their contractions are usually simultaneous, though dissociation to a limited extent is by no means impossible. The relaxation of these muscles, with contraction of the external rectus, produces the illusion of greater distance and size for the object retinally pictured. This is in accordance with the laws of association; for, under ordinary circumstances, near vision requires contraction, and distant vision relaxation, of internal rectus and ciliary muscles; while unusual contraction of the external rectus muscles is not unfrequently necessary in the ordinary use of the stereoscope, involving discomfort and an illusion of increased distance in the binocular picture.

All our judgments, whether visual or otherwise, become vitiated when the conditions are very different from those to which we are most accustomed. Prof. Brewer's 440 observers accommodated their eyes, as nearly as possible, to the same external conditions. The striking diversity in the conclusions reached by them shows how various were the muscular conditions under which they interpreted their own sensations. To this must be added the important fact to which attention was called by him, that for the same eye much depends upon education. The mechanic who thought the picture looked to be 5 feet long, and projected upon a screen, was quite unaccustomed to forming judgments with no actual objects for comparison; and in any event there was, doubtless, room for improvement in his visional education.

Another striking example of variation in judgment by the same person, under changed ophthalmic conditions, is found in early experiences with the binocular Microscope by the original inventor of this instrument, Prof. J. L. Riddell, of New Orleans, La. In looking with both eyes at an object 10 in. distant, the two visual lines form an angle of a little over 14°, and a corresponding degree of contraction of the internal rectus muscles is necessitated. The two tubes of Dr. Riddell's first binocular Microscope were sensibly parallel, the sheaf of rays after passing through the objective being divided, and

* Amer. Journ. Sci., November and December 1881, April and May 1882.

each half subjected to two reflections before reaching the observer's eye. In a subsequent improvement, a pair of prisms were placed with the lower edges in contact, and rays transmitted with two refractions and one reflection, reaching the eyes in such manner that the optical angle was less than 14°. In either case, therefore, to adapt the eyes to this condition, the internal rectus muscles were relaxed, and a slight change of adjustment in the instrument was necessary. Dr. Riddell describes the result as follows:—'Thus, a mite of a wheel-animalcule, the 100th of an inch long, will perhaps appear to be a foot off, and as large as a mouse; but bring the prisms nearer together, and tilt the oculars to correspond, and the image waxes marvellously immense; and, taking a position perhaps apparently more than 100 feet distant, the being, too small to be seen with the naked eye, vies with the great whale of the ocean in size; wearing an aspect more awful to behold than the savage beasts of the African forests; exhibiting a complex transparent structure, more unique and wonderful than the mind of man can well conceive.'

We can good-naturedly forgive a little exuberance of imagination when the reality which it accompanies is the first revelation from such an instrument as that introduced to science by Dr. Riddell."

Visibility of Ruled Lines.*—Prof. W. A. Rogers states that he has ruled bands of lines in which the lines were so fine and delicate that they could not be seen with a Microscope, although their spacing was much within the power of the Microscope to resolve. Yet he was assured of the existence of the lines. The evidence in support of this assertion was of three kinds: the pressure of the diamond upon the glass was sufficient to produce a cut; the diamond produced a peculiar singing sound while moving over the surface, which is always indicative that it is working well; and finally, the lines become visible when filled with fine graphite.

There is a limit beyond which lines cannot be satisfactorily filled with graphite. It is difficult to fill lines finer than about 1-80000th or 1-90000th of an inch.

A most surprising result of some of the experiments of Prof. Rogers, is that the naked eye can discern not only single lines that cannot be seen with a Microscope, but that it can detect errors which the Microscope will not show. Thus, he has a bar upon which lines are distinctly visible to the unaided eye, and, although an objective of low power will show them, one of high power will not. But even errors or imperfections in ruling which cannot be seen or measured with the Microscope, may reveal themselves to the eye by a peculiar wavyness of the image. He attributes the failure of the objective to show the lines, as mentioned above, to the inability to illuminate the lines with light of the exact angle of incidence required, and the proper angle of illumination he thinks deserves more careful attention.

* Amer. Mon. Micr. Journ., iv. (1883) pp. 45–6.

Bale, W. M.—How to make an Eye-piece Micrometer. [*Post.*]
Southern Science Record, III. (1883) pp. 13–6.

Bond, G. M.—A Standard Gauge System.
[Describes a comparator and the Microscopes used and their illumination, &c.]
Journ. Franklin Institute, CXV. (1883) pp. 330–9.

Bradbury, W.—The Achromatic Object-glass, XVII.–XIX.
Engl. Mech., XXXVII. (1883) pp. 100–1 (2 figs.), 188–90 (5 figs.), 259–60.

Braman, B.—The usefulness of the Microscope as an Instrument of Recreation.
[President's Address to the New York Microscopical Society. The subject is dealt with under four heads. (1) The Microscope serves for diversion. (2) Microscopical recreation possesses the virtue of enthusiasm. (3) Recreations with the Microscope minister to benevolence and (4) serve for education.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 65–7.

Conversaziones, the Microscope at.
[Remarks on devices for preventing the coarse adjustment from being moved.]
Southern Science Record, III. (1883) p. 32.

Detmers, H. J. See Thomas, B. W.

Dolbear, A. E.—The Art of Projecting. A Manual of Experimentation in Physics, Chemistry, and Natural History, with the Port-Lumière and Magic Lantern. vi. and 158 pp. and 112 figs. 8vo, Boston, 1883.
[Includes projections of microscopical objects and the solar microscope.]

Dowdeswell, G. F.—Note on Cobweb Micrometers with the second web movable. [*Supra*, p. 422.]
Quart. Journ. Micr. Sci., XXIII. (1883) p. 337.

Flesch, M.—Beleuchtungsvorrichtungen zum Mikroskopiren bei künstlichen Lichte. (Illuminating Apparatus for microscopical observations by artificial light.)
[Vol. II. (1882) pp. 699 and 726.]
SB. Phys.-Med. Gesell. Würzburg, 1882, pp. 37–8.

Folsom, D.—A Home-made Substage Condenser.
[A piece of substage-tube is made to carry within it an objective to be used as a condenser. At the lower end of the tube, in which the objective is screwed, there is "a carefully-cut thread for focussing the objective operated by a milled head."]
Amer. Mon. Micr. Journ., IV. (1883) p. 46 (1 fig.).

Forbes, S. A. See Thomas, B. W.

Halley, J. J.—The Vice-President's Address to the Microscopical Society of Victoria. [*Post.*]
Southern Science Record, II. (1882) pp. 285–9.

Hitchcock, R.—Distortion produced by Camera-Lucidas. [*Post.*]
Amer. Mon. Micr. Journ., IV. (1883) pp. 43–5 (2 figs.).

,, ,, A Moist-chamber for Cultivation. [*Supra*, p. 428.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 56–7.

,, ,, An evening with *Amphipleura pellucida*.
[Results of testing the new 1-10th in. Spencer objective.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 57–8.

,, ,, Postal Microscopical Club.
[Note on the first box received this season.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 75–6.

,, ,, See Reddots, C.

Jennings, T. B.—A Work-table.
[A box-arrangement on the top of the work-table. "Internal height 18 in. There are two strong uprights let through the top and screwed to the hind legs of the table. The back is stationary, and is screwed on the outside of the two uprights; the sides swing by hinges from the back; the top is also hinged to the back and opens upward, and the front is in

turn hinged to the top. The sides are tongued to fit into grooves in the top and front. Some small shelves are arranged against the back."]

Amer. Mon. Micr. Journ., IV. (1883) p. 78.

Moore, A. Y.—Testing Microscope Objectives.

[Bad centering and bad form tested by the mercury globule. Chromatic and spherical aberration by the mercury globule, a diatom, or *Podura* scale. Aperture by graduated rotating base or swinging substage bar. Flatness of field by *Echinus*-spine and blood-corpuscles. Also working distance and magnifying power.]

Amer. Mon. Micr. Journ., IV. (1883) pp. 52–5.

Morrison's (W. J.) New Lamp-shade.

[Instead of the ordinary porcelain shade, a similar conical shade of tin is provided, having a cylinder extending nearly to the top of the chimney. A similar conical shade (without any chimney however) extends downward from the shade ring so that the light is entirely confined by the two cones—except what reaches the ceiling from the chimney. The lower cone has an opening of suitable shape and size to allow the light to be directed upon the mirror.]

Amer. Mon. Micr. Journ., IV. (1883) pp. 63–4.

Park, R.—The Electric Light in Surgical Diagnosis. [*Supra*, p. 421.]

Knowledge, III. (1883) pp. 281–2 (1 fig.), from *Ann. of Anatomy and Surgery* and *Scientific American*.

Powell and Lealand's 1-12th in. Homogeneous-immersion Objective.

[*Ante*, p. 320.]

Engl. Mech., XXXVII. (1883) p. 104.

"Prismatique."—Object-glass Working. V.

Engl. Mech., XXXVII. (1883) pp. 99–100 (1 fig.).

Reddots, C.—On Objectives.

[As to "the difference in results between first quality and $15 lenses," and comment by Editor.]

Amer. Mon. Micr. Journ., IV. (1883) p. 78.

Rogers (W. A.) on the Visibility of Ruled Lines. [*Supra*, p. 439.]

Amer. Mon. Micr. Journ., IV. (1883) pp. 45–6.

" " A Correction [of two or three errors in his paper on the "Conditions of Success in the Construction and the Comparison of Standards of Length."]

Amer. Mon. Micr. Journ., IV. (1883) pp. 78–9.

"Roi ne puis, Souza je suis."—Grunow's new Camera-lucida.

[Described *ante*, p. 120, and *supra*, p. 423.]

Engl. Mech., XXXVII. (1883) p. 154 (1 fig.).

Soret, C.—Sur un réfractomètre destiné à la mesure des indices et de la dispersion des corps solides. (On a Refractometer for measuring the refractive indices and dispersive powers of solid bodies.)

Comptes Rendus, XCV. (1882) pp. 517–20.

Abstr. in *Zeitschr. f. Instrumentenk.*, II. (1882) pp. 414–5.

Stowell, C. H.—Our new 1-50th Objective.

[Made by Spencer—four systems—1·17 N.A. Working distance about 1-100th in. Used with homogeneous-immersion fluid, glycerine or water.]

The Microscope, III. (1883) pp. 14–15.

Thomas, B. W.—Resolving *Amphipleura pellucida* with central light.

[Accompanying letters from H. J. Detmers and S. A. Forbes.]

The Microscope, III. (1883) pp. 9–12.

β. Collecting, Mounting and Examining Objects, &c.

Preparing and Cutting Amphibian Eggs.*—Although the amphibian egg has long been a favourite object of study among embryologists—and quite as much so since section-cutting came into vogue as before—comparatively little progress has been made in overcoming the difficulties that attend its preparation for the microtome. The chief difficulties are found in freeing the egg from its gelatinous envelope, and preparing it so as to avoid brittleness.

The best method that has thus far been proposed for these eggs is unquestionably that of O. Hertwig, and Dr. C. O. Whitman † therefore gives it in detail.

1. In order to facilitate the removal of the gelatinous envelope, the eggs are placed in water heated almost to boiling (90–96° C.) for 5–10 minutes. The eggs are thus coagulated and somewhat hardened, while the envelope separates a little from the surface of the egg and becomes more brittle. The envelope is then cut under water with sharp scissors, and the egg shaken out through the rupture. With a little experience a single cut suffices to free the egg.

2. By the aid of a glass tube the egg is taken up and transferred to chromic acid (½ per cent.), or to alcohol of 70, 80, and 90 per cent. Chromic acid renders the egg brittle, and the more so the longer it acts; therefore the eggs should not be allowed to remain in it more than twelve hours. While eggs hardened in chromic acid never change their form or become soft when transferred to water, those hardened in alcohol, when placed in water or very dilute alcohol, lose their hardness, swell up, and often suffer changes in form.

3. Alcoholic preparations are easily stained, but chromic acid preparations are stained with such difficulty and so imperfectly that Hertwig omitted it altogether.

There is an important difference between alcohol and chromic acid in their effect on the pigment of the egg. Chromic acid destroys the pigment to some extent, and thus obliterates, or at least diminishes, the contrast between pigmented and non-pigmented cell-layers. As the distribution of the pigment is of considerable importance in the study of the germ-lamellæ, it is well to supplement preparations in chromic acid with those in alcohol, in which the pigment remains undisturbed.

4. Eggs hardened in chromic acid were imbedded almost exclusively in the egg-mass recommended by Calberla. The great advantage offered by this mass is, that it supplies a sort of antidote to the brittleness of the egg. It glues the cell-layers together, so that the thinnest sections can be obtained without danger of breaking.

5. As the dorsal and ventral surfaces, and the fore and hind ends can be recognized in very early stages, it is important to know precisely how the egg lies in the egg-mass in order to determine the

* Jen. Zeitschr. f. Naturwiss., ix. (1882) p. 249.
† Amer. Natural., xvii. (1883) pp. 272–4.

plan of section. In order to fix the egg in any given position in the imbedding mass, Hertwig proceeds as follows:—

a. A small block of the hardened mass is washed in water to remove the alcohol, and in the upper surface of the block, which has been freed from water by the aid of filtering paper, a small hollow is made. This hollow is then wet with the freshly-prepared *fluid* mass.

b. The egg is washed in water to remove the alcohol, placed on a piece of filtering paper to get rid of the water, turned on the paper by a fine hair brush until it has the position desired; the point of the brush is next moistened and pressed gently on the upper surface of the egg; the egg adheres to the brush, and may thus be transported to the hollow prepared for it in the block.

c. After the egg has thus been placed in position, a drop of absolute alcohol carefully applied will coagulate the "fluid mass" with which the hollow was wet, and thus fix the egg to the block. The block is again washed, and finally imbedded in the egg-mass, which is prepared in the following manner.*

The white of several eggs is separated from the yolk, freed from the chalazæ, cut with shears, and thoroughly mixed by shaking with a 10 per cent. solution of carbonate of sodium (15 parts of the white to 1 part of the solution). The yolk is next added, and the mixture shaken vigorously. After removing the foam and floating pieces of yolk by the aid of filtering paper, the so-called "egg-mass" is ready for use. It is this fluid with which the hollow in the solid block is wet, as before mentioned, the block itself being only a piece of the same mixture after it has been hardened in alcohol.

Calberla soaks the egg a few minutes (5–20) in the fresh white of the egg before imbedding. Hertwig appears to omit this part of the process.

After the egg has been fixed to the block as before indicated (*c*), it is placed in a paper box and covered with the fresh mass (1–2 cm. deep). The box is then placed in a vessel that contains alcohol (75–80 per cent.), enough to bathe its lower half; the vessel, covered with a funnel, is heated over a water-bath for 30–40 minutes, care being taken not to *boil* the alcohol. The imbedding substance, thus hardened, is next placed in cold alcohol (90 per cent.), which should be changed once or twice during the first twenty-four hours. After remaining in alcohol for about forty-eight hours, the imbedded egg is ready for cutting.

Preparing Sections of and Examining Embryos.†—The second edition of Foster and Balfour's 'Elements of Embryology' contains an Appendix, in which are given some very succinct directions for preparing sections of the embryo of the chick, divided into three heads:—(1) *Hardening* (picric acid, corrosive sublimate, osmic acid, chromic acid, and alcohol); (2) *Staining* (hæmatoxylin, borax-carmine, carmine, picro-carmine, and alum-carmine); (3) *Imbedding* (in paraffin);

* Calberla's method of imbedding. Morph. Jahrb., xi. (1876) p. 445.

† Foster and Balfour's 'Elements of Embryology,' 2nd ed. (1883) pp. 423–70.

(4) *Cutting* and *Mounting Sections*. Directions are also given for obtaining embryos from the earliest stages to the fourth day, and for their examination as transparent or opaque objects.

The rabbit is similarly dealt with, commencing with ova from one to sixty hours old to embryos of fourteen days.

Imbedding.*—Mr. J. S. Kingsley describes the following method of imbedding:—

"The substance to be imbedded is hardened after any of the usual methods, and placed from alcohol into turpentine, then transferred to a saturated solution of paraffin in turpentine, the same as in other methods of paraffin imbedding. Here is where the novelty comes in. The specimen is removed from the mixture, and the superfluous fluid removed by means of blotting paper, and then placed on a cylinder of paraffin (or paraffin and vaseline). A piece of stout iron wire is now heated in the flame of a spirit-lamp, and with it a hole is melted in the end of the cylinder, and the specimen then pushed into the melted paraffin, and placed in any desired position.

The advantages of the method are: the quickness with which it may be performed, for from the time when the operation is begun until sections can be cut is not over three minutes, while the melting of so small an amount of paraffin prevents any injury to tissues by overheating. In imbedding solid bodies a slight variation sometimes results in the saving of more time. The specimen may be imbedded directly from alcohol without the intervening turpentine, and then when the section is cut it readily separates from the shaving of paraffin without the use of turpentine to dissolve it. This, of course, applies to solid bodies without cavities or irregular outline."

Mounting Insects in Balsam without Pressure.†—Mr. H. Chadwick gives the following directions:—

Preparation.—I. Soak the specimens in liquor potassæ until they are transparent. Wash well in distilled water, using a pipette and camel-hair pencil. Transfer to 50 per cent. spirit, then to a small quantity of pure spirit in a watch-glass or soaking bottle, and allow them to stand for some hours. Then add oil of cloves, and allow the spirit to evaporate. By this method, the formation of air-bubbles in the interior of the specimens may generally be avoided.

II. Wash well in distilled water. Soak in pure spirit or alcohol for some days. Transfer to carbolic acid until sufficiently transparent. Then transfer to oil of cloves, but many mounters do not consider this necessary. This method should be used in all cases where the integument is not too opaque to allow light to pass through it before treatment, and it is especially useful in the study of the muscles.

Mounting.—Take a clean 3 × 1 slip, having a sunk cell in its centre. Just inside the edge of the cell, equidistant from each other,

* Amer. Mon. Micr. Journ., iv. (1883) p. 58, from 'Scientific and Literary Gossip.'

† Micr. News, iii. (1883) pp. 105-6 (1 fig.).

cement three white glass beads with hardened balsam. Put a small quantity of soft balsam in the centre of the cell, and gently warm it over a spirit-lamp. Take the object, a wasp's or blow-fly's head, for example, and place it upon the previously warmed balsam, arranging it in the required position. Now take a clean cover-glass, the diameter of which should be a little less than that of the cell, and holding it between the points of a pair of forceps, place a large drop of balsam in its centre, and allow it to fall upon the object. The edge of the cover should rest upon the three beads. If the quantity of balsam under the cover-glass is not sufficient to fill up the whole of the space between it and the slide, a little more must be allowed to run in, and if the object has become displaced, it may be rearranged by means of a fine blunt needle, introduced beneath the cover-glass. A clip should be used during the last operations, but only to prevent displacement of the cover. The slide must now be put aside in a warm place, until the balsam is hard enough to allow the superfluous portion to be removed safely. Sufficient balsam should be left to form a sloping edge around the cover-glass, and it should be hardened for a few days after cleaning. Be sure that the balsam is quite hard before applying brown cement. The ease with which an object can be re-arranged, or a chance air-bubble removed, without disturbing the cover-glass, constitutes the chief advantage of using beads. A supply of different sizes should be kept, and the size used must be regulated by the thickness of the object. Pure balsam in collapsible tubes is to be strongly recommended, on account of the nicety with which the quantity of balsam required for mounting a slide can be regulated. The neck of the tube should be wiped with a clean cloth moistened with benzole before the screw-cap is replaced, in order to prevent the possibility of a little balsam hardening in the screw, and so prevent the easy removal of the cap when next required.

Reagent for Simultaneous Staining and Hardening.*—In view of the objections to the various combinations of staining and hardening reagents hitherto employed, E. Pfitzer, in order to meet the requirements of vegetable microscopy, has devised a fluid which both hardens and stains. It consists of the colouring matter, nigrosin, dissolved with picric acid, in water or alcohol.

a. To a concentrated watery solution of picric acid is added a small quantity of a watery solution of nigrosin; if the object to be studied contains much water, some crystals of the acid are added, in order to maintain the strength of the liquid.

The deep olive-green fluid kills with great rapidity. After some hours' immersion of the object which is to be examined, it may be transferred to common spirit, especially if it is desirable to dissolve out chlorophyll, &c., or if the object has to be kept for some time. By this means the denser masses of protoplasm are stained pale violet, the chromatophores darker, while the pyrenoid, nucleoli, and other coloured parts of the cell-nucleus come out deeply stained; thin

* Ber. Deutsch. Botan. Ges., i. (1883) pp. 44–7.

films of protoplasm and ordinary cellulose membrane are scarcely, if at all, stained, starch-grains not at all. By washing the objects in *water* after staining, instead of in spirit, a grey-blue colour is obtained: transference to concentrated glycerine makes the colour purer. The colour comes out best, however, after washing in alcohol, treating with oil of cloves and mounting in one of the resins (dammar or Canada balsam). To avoid contraction, the clove oil may be diluted with alcohol and allowed to concentrate upon the object by evaporation of the alcohol. The watery solution is especially adapted for rapidly killing and staining objects already under the Microscope.

b. Nigrosin and picric acid may also be used in solution in alcohol; the solid acid and nigrosin are left for some time in absolute alcohol; by this solution the chromatophores and pyrenoid are less deeply stained, the coloured contents of the nucleus very deeply so.

Anilin Colouring Matters as Staining Media for Human and Animal Tissues.*—Dr. H. Griesbach discusses the value of anilin colours as staining media for human and animal tissues, and gives the results of his own experience. His paper is not capable of useful abstract, being already in a condensed form, but the following brief account is given to call attention to its existence and to enable reference to be made to the original.

Anilin-yellow he considers unsuitable. *Säure-gelb* colours bone a beautiful orange, tracheal cartilage and connective tissue lemon. In sections of the intestinal sac of *Unio* the epithelium is orange, muscle gold, glandular tissue brownish, and the nuclei of the cells are very clearly shown. Nerve-elements are not so well coloured, nor any isolated cells except gland-cells. It does not appear to be suitable for chromic acid preparations. *Chrysoidin* is useful for bone and all kinds of connective tissue, which it colours a bright yellow. Its best effect is with fresh preparations. *Bismarck brown* has its best effect with nuclei (either alcohol or chromic acid preparations) and unicellular organisms, bacteria of all kinds, colourless blood-corpuscles, &c. *Tropæolin*, Y, 0, 00, 000 No. 1, and 000 No. 2. The first is good for human spinal cord hardened in chromic acid, and alcohol preparations of bone, the others serve for connective tissue, cartilage, nuclei, and bone. The colours are lemon-yellow, straw-yellow, orange, orange-red, and brown. *Crocein* he has found to be a very useful medium. It colours bone, cartilage, muscle, and connective tissue (whether fresh or alcohol or chromic acid preparations) a beautiful purple-red. *Rocellin* colours bone and connective tissue, muscle, glands, and epithelium cherry-red. *Xylidinponceau*, *Ponceau* R R, G, and G G are not suitable for chromic acid preparations. The first gives good colours with bone, connective tissue, and muscle. The second gives red and scarlet-red colours. The third colours bone dark orange; connective tissue, muscle, and epithelium saffron-yellow; nerve substances bright yellow. The fourth has only been found useful for bone, gelatinous connective tissue, and muscle, which it colours a bright

* Arch. f. Mikr. Anat., xxii. (1883) pp. 132-42.

orange. *Bordeaux* R and G. colour the three last mentioned substances, nuclei, and glandular tissue, the former giving a red and the latter a more yellow tint. Fresh are less successful than alcohol preparations. *Biebrich scarlet* colours the most different tissues deep red. It is not suitable for chromic acid preparations. Cell-nuclei stand out sharply. *Gold-orange* serves for fresh or alcohol or chromic acid preparations. Bone is deep orange-red, cartilage gold, connective tissue reddish. It is especially valuable for glandular tissue; it gives a splendid appearance to liver injected with Berlin blue, the blue vessels showing on a gold ground; sections of skin give fine images.

The preparations after washing and clearing are best mounted in balsam. Oil of cloves is mostly used for clearing. Very delicate colours are, however, often injured by the yellow of the oil of cloves, and in such cases oil of lavender should be substituted, or a quite colourless oil of aniseed.

Dr. Griesbach gives a word of caution against the too hasty abandonment of the older media in favour of the new anilin colours, pointing out in regard to their use in permanent preparations that our experience of their durability is not yet long enough. Whatever the future may bring, however, in this respect, they cannot fail to be of the greatest use in histology.

Double Staining Nucleated Blood-Corpuscles with Anilin Dyes.*—Dr. V. Harris describes a series of experiments the object of which was to find out the best combination of anilin dyes for double-staining. With hæmatoxylin and picrocarmine it is believed that a definite effect may be always calculated upon when they are used in combination. With anilin stains, however, the results arrived at appear to differ very materially if the methods of employment are made to vary in even a very slight degree. It is only in the case of a very few combinations that any certain result has hitherto been expected.

The only entirely successful combinations were the following:—Rosein and anilin green; fuchsin and methylen blue; fuchsin and Bismarck brown; eosin and vesuvin; iodine green and Bismarck brown; Hoffman's violet and Bismarck brown; anilin violet and methylen blue.

The green dyes were not at all permanent. This was proved with both malachite and iodine greens.

Even with the above successful combinations the results varied in a most extraordinary manner, whilst the circumstances of the staining operation and the solutions appeared to be unvaried, the very greatest care being required to produce a constant result. One thing necessary for success was certainly that the solutions should be quite fresh. This is likely to prove a great objection to the general introduction of anilin dyes into use.

The result was materially affected by the time each dye was allowed to remain in contact with the blood.

* Quart. Journ. Micr. Sci., xxiii. (1883) pp. 292–301.

Dr. Harris gives the following classified list of the chief anilin dyes, with their solubilities in water and in spirit.

Brown.	Red.	Orange.	Yellow.	Green.	Blue.	Violet.
Bismarck — partially soluble in water; soluble in dilute spirit.	*Eosin*, pink — freely soluble in water.	*Aurin*—insoluble in water; partly soluble in strong spirit; more so in absolute alcohol.	*Fluorescein*, greenish yellow—insoluble in water; soluble in spirit, the solution being beautifully fluorescent.	*Iodine Green*, blue green — freely soluble in water or spirit.	*Soluble Anilin Blue*—freely soluble in water.	*Hoffman's Violet*—freely soluble in water and in dilute spirit.
Vesuvin—soluble in water.	*Anilin Scarlet*—insoluble in water; freely so in methylated spirit.	*Anilin Orange*—ditto, ditto.	*Anilin Primrose*—only partly soluble in methylated spirit.	*Malachite Green*, a less blue green—freely soluble in water and in spirit.	*Bleu de Lyon*—insoluble in water; freely so in strong spirit.	*Methyl Violet*, the red predominating — soluble in water partially; freely soluble in spirit.
Chrysoidin—soluble in water.	*Flamingo*, deep brownish red—partly soluble in water; freely so in methylated spirit.	*Tropæolin*, in deep yellow glistening scales—partly soluble in water; more so in methylated spirit.			*Methylen Blue*, a very deep blue—freely soluble in water, and in spirit.	*Gentian Violet*, the blue predominating—freely soluble in water.
	Ponceau,* deep red crimson—partly soluble in water; freely in dilute spirit.	*Phosphin*, yellowish orange—partially soluble in water; more so, but not freely, in spirit.			*China Blue*—freely soluble in water.	*Tyrian Blue*, near to violet—soluble in water.
	Rosanilin—partly soluble in water; freely soluble in dilute spirit.	*Saffranin* — soluble in water and in spirit.			*Serge Blue*—ditto.	*Spiller's Purple*—soluble in spirit.
	Fuchsin — partly soluble in water; soluble in dilute spirit.				*Blue Black*—freely soluble in water.	

* Ponceau is a mixture of rosanilin and phosphin.

Deecke's Microtome.—Cutting and Mounting Sections through the Entire Human Brain.*—Dr. Deecke's microtome used for this purpose is a heavy brass cylinder of the Ranvier form, and is 9 in. in diameter and 14 in. high. The piston can be raised by the screw with great accuracy, the 1200th, the 600th, the 400th, &c., part of an inch, thus by the aid of an index graduating the thickness of the sections. As the sections must be cut under alcohol, the microtome is inserted in a basin of copper, 18 in. by 30 in. by 4 in., placed on a suitable table frame. The brain to be cut is placed upon the piston and held *in situ* by several pieces of soft cork. It is then imbedded in a cast of paraffin, olive oil, and tallow which, after it has become hard, is held in position by a number of small curved rods attached to, and projecting upwards from the piston to the height of about an inch. Before cutting, and as it proceeds, the cast is carefully removed from around the specimen to the depth of about ½ in. (which is easily done by the use of a good sized carpenter's chisel), so that the knife never comes in contact with the cast.

The knife has a blade to which upright handles can be fastened by screws; the cutting edge is 16 in. in length, the blade 1½ in. broad, and 1-4th in. thick at the back. To this a steel rod is attached by screws, which project 1-16th in. downwards, so that the knife, when placed upon the microtome, rests only upon its edge and the rod, leaving a free space between the lower surface of the blade and the upper of the cylinder, by which arrangement the alcohol is allowed access to this space, thus preventing almost entirely adhesion between the two surfaces. The general form of the knife is that of a chisel. When the instruments are made accurately their construction enables the operator to move the knife forward with a slight sawing motion or, better, in short cuts, while the weight of the knife itself fully suffices to prevent any deviation from its course, and renders it unnecessary to use any amount of pressure. This manner of cutting of course requires practice and a light, firm, and steady movement of the hands. It becomes necessary, after each step forward, to draw the knife a little back, in order to be sure of not losing a particle of the section. The sections will, it is true, show slight traces from this way of cutting; this does not, however, interfere in the least with the examination of the specimens or with their beauty; in fact, they are so slight that they can scarcely be recognized after the sections are mounted. Moreover, the longer the instruments are in use the more perfect they become when carefully kept and handled.

This method offers great advantages over that by one sweep, in that the sections come out much more uniform in thickness and more perfect in all their parts, and the loss in a series of successive sections of from four hundred to five hundred to the inch—for example through the entire cerebrum of man—by an experienced operator, may not amount to more than 2 or 3 per cent. Furthermore, there is no necessity, as in the German method of cutting in one sweep (Gudden's), to remove, before hardening an organ like the brain, the

* Description supplied by Dr. Deecke (slightly condensed). See also Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 275–7, 279–80.

membranes, the choroid plexus, &c., which can never be done without extensive injury to the specimen, often rendering impossible the preservation of the structure of its most delicate parts or, in pathological preparations, preventing the full presentation of the morbid appearances. In the majority of cases a most important link in the chain of pathological evidence may thus be lost.

The sections, even of the largest size, are handled, without difficulty or danger of becoming torn, by floating them (in the basin, filled with alcohol in which they were cut), with a fine camel's-hair pencil on sheets of glazed writing-paper, to which they will not adhere as long as the paper is kept wet. They will adhere sufficiently however, to be easily removed when the paper is slowly raised by one corner. They are thus transferred with the paper, which is at once numbered and marked, as desired for storing them away or into the staining fluid, the washing or the fixing fluid, &c., and the oil for clearing them up. From thence, when placed on the mounting slide, the sheet of paper can easily be pulled off, which can be done without injuring the delicate specimen in the least. It is then advisable to put all parts of the section in their proper position and to remove all foreign material visible to the eye, aided by a low magnifying lens. After most of the oil has been removed by placing the slide gradually, for a short time, in a vertical position, the section will adhere so firmly to the glass surface that the mounting fluid can be poured on it and the cover adjusted without displacing any of its parts. It is necessary, however, to remove at once, and as quickly as possible, by the use of blotting-paper, any surplus of mounting fluid, and to drive out all air-bubbles by gentle stroking pressure on the cover-glass from the centre towards the periphery.

The sections are preferably mounted in balsam, diluted with chloroform or benzole, on plate-glass slips 5 in. by 7 in., and 6 in. by 8 in. and 10 in., and with proper care no more difficulty from air-bubbles is found with these than with the ordinary slides.

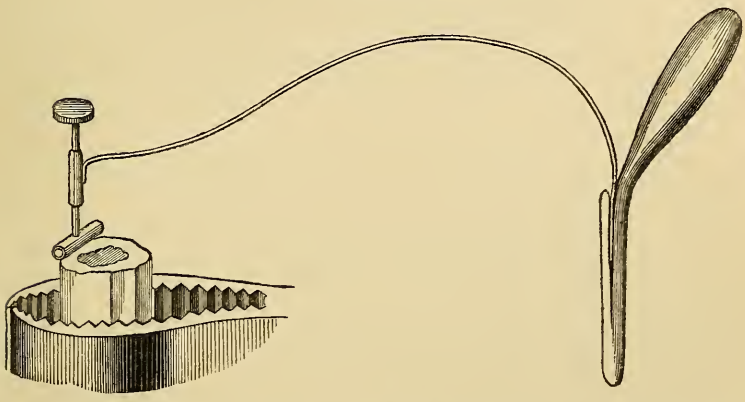
To harden the entire brain so that the inside and the outside shall be hardened equally and properly, Dr. Deecke finally adopted bichromate of ammonia in ½ to 1 per cent. solution, according to the consistence of the brain. When nominally soft he adds say 1-6th to 1-10th per cent. of chromic acid to the solution, and always 1-6th to 1-4th of the whole volume of alcohol. It is then placed in a refrigerator and the fluid changed frequently. After a month add a little more alcohol from week to week until the alcohol is 90 per cent. This is changed as often as it is discoloured. The treatment requires from 12 to 18 months.

Schulze's Section-stretcher.*—Dr. F. E. Schulze holds down the section whilst it is being cut, preventing it from rolling up, by means of a small weight, shown in fig. 87. This weight, which is about 8 mm. long and rounded at the ends, is attached to a small steel rod. The rod passes through a tube, so that it can easily be turned within it, and slipped up or down. To this tube is soldered a thin watch-

* Zool. Anzeig., vi. (1883) pp. 100–3 (1 fig.).

spring, the other end of which is bent down vertically, and fastened in the cleft of a split peg. This has a long oval handle projecting upwards obliquely, and it is fixed in a hole in the object-holder of the microtome, to a depth of from 2 to 3 cm. It can be turned in this

Fig. 87.



hole, and fixed more or less deeply as desired, whereby the end of the spring and the weight can be moved to a considerable extent laterally or slightly perpendicularly.

In practice, the position of the hole for the reception of the split peg must be so arranged relatively to the length and curvature of the spring, that the small weight rests lightly along its whole length on the anterior part of the upper surface of the paraffin mass to be cut. This can be easily managed by a slight lateral movement of the end of the spring in the cleft of the peg. By turning the perpendicular steel rod attached to the weight, the latter can be made parallel with the edge of the knife. Slight alterations in the pressure of the weight can be made by raising or lowering the rod in its tube; greater alterations, by a slight bending of the spring.

On cutting the section the tendency of the anterior end to rise and roll up will be restrained by the weight, and thereby the whole section be prevented from rolling up. As the knife advances the weight slides upon the blade, and the section always remains flat and even, with one end held down by the weight and the other adhering to the edge of the knife.

It is easy to adjust such a section-stretcher to any sliding microtome.

Preparation of Marine Algæ.*—Working under the inspiration of Dr. Paul Mayer, G. Berthold has experimented with iodine and other reagents on delicate marine algæ. The aim was to find solutions that would produce the least possible disturbance in the structure of the cell-protoplasm. It was found that satisfactory results could not

* Pringsheim's Jahrb. f. Wiss. Bot., xiii. (1882) pp. 704–5. Cf. Amer. Natural., xvii. (1883) pp. 456–7.

be obtained with the ordinary aqueous solutions of picric acid, osmic acid, &c. The disturbance of the osmotic equilibrium, on transferring delicate cells from sea-water to fresh-water solutions, resulted in intracellular derangements. Parallel trials were therefore made of picric acid, osmic acid, and iodine, three different solutions of each being made; one in distilled water, one in alcohol, and another in sea-water. The solutions in distilled water and alcohol proved almost worthless in each case, while each of the solutions in sea-water gave good results. It was found, curiously enough, that the protoplasm of the cells was more easily injured than the nuclei and karyokinetic figures.

Solutions of osmic acid and corrosive sublimate in sea-water gave good preparations, but the iodine solution was regarded as the best reagent.

A few drops of a saturated alcoholic solution of iodine, added to the sea-water, gives the desired results. The algæ remain in the solution $\frac{1}{2}$–1 minute, and are then transferred directly into 50 per cent. alcohol.

Dr. C. O. Whitman considers this a valuable method which may be of considerable importance to zoologists as well as to botanists.

Arrangement of Diatoms.*—M. P. Barré gives the following directions:—

Canada balsam is spread by a metal or ivory blade a few millimetres in breadth on a cover-glass, so as only to leave a layer of extreme thinness. The balsam will become hard if the cover-glass thus prepared is warmed over a spirit-lamp; bubbles will form if the heat is too great, but these are easily avoided by care during the heating, and the balsam forms a hard brittle enamel, free from streaks and blisters. This heating should be prolonged until the balsam becomes modified in colour and slightly reddened. The cover-glass is then placed on a black ground, and we proceed to the arrangement of the diatoms by means of a very fine eye-lash fixed in a handle, using the Microscope to pick them out and a strong magnifier to arrange them on the smooth and even surface of the balsam. When the diatoms are in place, we ascertain whether they are perfectly straight, and those which are not in their proper place are lightly slipped along by means of an eye-lash soaked in chloroform, in order to remove all grease from it, and prevent the diatoms from sticking to it.

The cover-glass is then again slowly heated. The balsam becomes again softened, and the diatoms sink into it, and, without altering their arrangement, become semi-transparent, at which point the heating must be stopped.

Many lines may thus be arranged on the same cover-glass, the balsam being reheated several times, in which case it is better not to overheat it the first time, in order to avoid its becoming reddened by repeated applications of heat.

The cover-glass with the diatoms has now to be fixed on the slide.

* Bull. Soc. Belg. Micr., ix. (1883) pp. 74–7.

A drop of balsam, about the size of a grain of pepper, is placed on the slide, and the latter put, *with the balsam on the under side*, on a horizontal plate pierced with an aperture 4 cm. in diameter, and allowing of movement to the extent of about 10 cm. up and down by means of a rack and pinion. The spirit-lamp is put below the aperture in the plate, and consequently underneath the drop of balsam on the slide.

The flame of the lamp ought to be very small. Sudden heating must be carefully avoided. On the neck of the lamp a tube is fixed, which serves as a chimney. Its object is to make the flame steady, and prevent its flickering.

The drop of balsam is soon seen to oscillate; the chloroform which it contains evaporates, and after about a minute of heating there remains a small solid hemisphere, whose hardness should be kept below that of the balsam which secures the diatoms. If any bubbles are formed, they should be removed with a needle, in such a way as not to alter the regular shape of the hemisphere.

After it is perfectly cold the slide is turned over, and on the hardened drop is placed, exactly centrally, the cover-glass holding the diatoms. Heat is then applied gradually, and the cover-glass (if necessary, held in its place by a needle) slowly settles down and finally rests flat on the slide. There is no reason to fear any alteration in the diatoms in consequence of its weight, as the author has never found any trace of disarrangement, even with the most delicate diatoms. If the quantity of balsam forming the drop has been well calculated it will form round the cover-glass a raised edge, very neat in appearance, and dispensing with the external ring of varnish.

The preparation is then complete: the diatoms are inclosed in a real matrix of enamel which abnormal heat alone can soften. Exposed to the summer sun in a closed apartment no disturbance of the arrangement of the diatoms takes place.

In the last operation bubbles often form which disfigure the preparation. These may be avoided by introducing, with a needle, a very small drop of common oil in the centre of the cover-glass.

The process may be applied for mounting diatoms dried into dust. In this case there must be spread on the cover-glass a small quantity of balsam made very fluid with chloroform, in order to secure its being as thin as possible, and the heating and mounting are then proceeded with as above described.

On the occasion of the paper being read, a practical demonstration of the process was given, of which it is said that the "preparation was perfectly successful, and was not inferior to the celebrated slides of Möller. It may be said that if the process of Möller remains unknown the means of rivalling him is at least discovered. The members were above all struck with the great simplicity of the manipulations."

Paper Cells.—Mr. G. Busk writes as follows:—

"As I have found the use of paper cells very convenient for the mounting of objects where it is advantageous to avoid compression beyond a certain point (as for instance Hydroids, Polyzoa, &c.), I

have thought that a few hints on the mode of preparing such cells might interest others.

The porosity of ordinary paper is of course an insuperable bar to its employment for cells intended to be filled with watery or even with resinous or oily media; but when the porosity is got rid of, the facility with which cells may be made of paper of varying thickness renders them very convenient. The paper may be rendered perfectly non-absorbent if it is saturated with a resinous substance, which should at the same time maintain, when dry and hard, its adhesion to the glass.

Paper used for this purpose should be more or less spongy or porous, such as ordinary printing paper, or the cheaper kinds of writing paper, and the cells when made should be allowed to soak for some time in the resinous menstruum, until they are completely saturated with it. When in this condition they should be taken out dripping, and placed in proper position on the slide, care being taken that no air-bubbles are left between the paper and the glass.

There are, no doubt, numerous compounds that may be used as the cement. That which I have found convenient and suitable for the purpose of saturating the paper, and insuring its permanent adhesion to the glass, is the ordinary solution of canada-balsam-resin in benzole. But when used for this purpose the balsam should not have been completely desiccated, otherwise a little turpentine should be added to the solution.

The cells should be allowed to dry and harden for several days, when the superfluous balsam can be washed off with a little benzole and spirit.

These cells are perhaps particularly adapted for watery media, such as glycerine or Farrant's medium, but they serve very well also for balsam or castor-oil. Of these media, it seems to me that Farrant's is the most generally useful and most convenient in use.

In conclusion I may remark that, in mounting an object, great convenience will be found in the use of a small lead weight (2 or 3 oz.) supported on three short pins. This allows of the cleaning of the edges of the cover-glass, and the application of varnish of any kind to fix the glass and prevent the entrance of air. After having been kept for a day or two under the weight, the cell may be finished off in any way that may be desired. But there is one point with respect to the finishing off that should be noticed if the usual zinc-white paint is employed. This material appears to possess a great power of insinuating itself under the cover, and thus disfiguring the preparation, if the cell has been merely sealed with a resinous cement. The evil, however, can be completely avoided by the application over the cement of a little gum-mucilage, through which, when dry, the zinc-white has no power of penetration."

Making Tinfoil Cells.*—Professor A. H. Chester believes that cells from pure tinfoil satisfy better than any others the conditions

* Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 282–3. See also this Journal, i. (1881) pp. 702–3.

of being permanent, not affected by heat or cold, and being cheap and easily worked. Tinfoil ·03 in. thick is the more generally useful. The rings can be punched out by two punches of different size. It is almost impossible to make the two circles concentric and smooth, so after a number are punched out they should be placed on a maudrel fitting the inner circle exactly, and putting it in a lathe, turn down the outside perfectly true. If deeper cells are wanted it is easy to cement any number of the rings together.

Professor A. McCalla finds it easier, after punching out the inner hole, to cut the rings apart with scissors, without attempting to make them round on the outside as lathe cutting does that perfectly. It will probably be a good plan to fit rotary cutters on the lathe to cut out several consecutive circles at once somewhat as leather washers are cut.

Ivory Drop-Black.*—Mr. E. Graham uses this material† as a background for all opaque mounts. It makes when properly applied a beautiful smooth surface.

Press a small quantity of the colour into a one-ounce wide-mouth bottle, and thin it sufficiently with *fresh* turpentine. The slide being on the turntable, apply the colour with a brush. If the colour is too thick, it will be found that it cannot be smoothly spread, and that it will dry in ridges. If too thin it will be found necessary to make several applications. If it is necessary, a second application can be made within fifteen or twenty minutes.

Selection of Cover-glass.‡—Dr. J. E. Smith tries to confine himself to three thicknesses of cover-glass, namely 1-70th in., 1-120th in., and 1-200th in. These may respectively be denominated as thick, medium, and thin. It is a matter of the first importance that those working first-class objectives should be well posted as to the thickness of cover employed, and yet this telling point has been utterly lost sight of in the books. For example: by knowing the thickness of the cover, one is enabled to approximately adjust the objective at sight, and thus save time. He has thousands of mounted objects in his cabinets, and every cover has been measured with all the accuracy obtainable. Those who have long had their attention called to this matter can, by dint of practice thus obtained, tell closely the thickness of the cover by simply *feeling* it; and this, he assures the novice, is an accomplishment worth having.

"To take a case from practice: Suppose I desired to examine a brand-new mount. Let it be a difficult diatom this time. First, I run my finger over the cover, and instantly discover that it is a thin one, say about like those used on the Möller plates. Now, if I elect to use the 1-6th objective, I know that this cover is too thin for water immersion; hence glycerine is chosen. I know, too, that over such a cover, and with the glycerine intermedium, the objective will correct some three or four divisions from closed, therefore the collar is at

* Amer. Mon. Micr. Journ., ii. (1881) p. 113.

† The "XXX ivory drop-black" of Sherwin Williams and Co., of Cleveland, Ohio, put up in collapsible tubes and ground in japan, and not in oil, which will not do, as it always dries with more or less gloss.

‡ 'How to see with the Microscope,' 1880, pp. 213-15.

once placed near such position. Now, on looking through the tube at the object in position and focussed, suppose I do not get as good views as I had reason to expect, then *I let the collar stand as it was*, and change the illumination until things are approximately as desired; this done, a slight turn of the collar adjustment will insure the maximum working of the objective. Now just contrast this with the usual *modus*. Eight operators out of ten would have at once twisted round the collar, haphazard-like, by 'rule of thumb,' probably wasting plenty of time, and, more unfortunately still, condemning a really good objective, and one that would have, with the proper manipulations, given charming displays."

Labelling Slides.*—Mr. S. Lockwood describes a device which he has found of much service in labelling slides. It often happens that the label does not afford room enough to contain the facts which should accompany the specimen. In such cases he writes all he can on the *back* of the label with a medium hard pencil, and then, with a mucilage made of gum arabic one part and gum tragacanth four parts, attaches the label to the slide in the usual way. As soon as dry, the labelling is finished by writing the rest in ink on the upper, or face side, of the label. The pencil writing on the back can be easily read through the slide simply on turning it over. In this way both sides of the label are utilized.

Economical Cabinet for Slides.†—Dr. B. A. Randall, referring to the want he has found for some form of cabinet which would hold securely several hundred slides and yet would not be expensive, describes, as the result of some experimentation, the following arrangement:—

It consists of trays of binder's board of two sizes, the large 11 by 8 in., the smaller 11 by 4 in. Each of the smaller consists of a solid bottom of binder's board upon which is glued a second piece of the same size, from the centre of which a piece 10 by 3 in. has been cut. This then forms a tray about a line in depth, capable of holding ten slides. A third piece, from the centre of which a portion 10 by 1 in. has been removed, is hinged to the others so as to form a cover, the slot in its centre securing even deep cell preparations from pressure. The larger trays differ only in being of double size and holding twenty slides. Some of the trays have a fourth piece of lighter material, covering the slots in the top and thus rendering them complete dust-tight boxes. In series, however, this is unnecessary, as the covering of each tray is completed by the bottom of the one above. Each tray is, therefore, independent, a rubber strap about it rendering it entirely secure for holding or transporting specimens, while any number of them can be combined and further secured in a wooden case, making a neat and safe cabinet.

Such a cabinet, 12 in. by 9 in. by 10 in. in height, will contain a series of closed trays capable of holding 500 slides. Each tray must be withdrawn from beneath those above it in order to get at its

* Amer. Mon. Micr. Journ., iv. (1883) p. 64.

† 'The Microscope,' ii. (1882) pp. 134-5, from 'Western Medical Reporter.'

contents, and they must be lifted again in order to replace it; otherwise it is as convenient as any other form, while it has the great advantage that any one of its trays may be used at any time as an independent box; still further, its cost is about one-third of any comparable cabinet. The binder's board trays have, when first made, a little tendency to warp, and had better be kept under pressure, but this is only temporary.

Möller's Typen- and Probe-Platten.—The catalogue just issued by Mr. J. D. Möller contains a somewhat startling item—a "type plate" of 1600 arranged diatoms, the price of which is 1600 marks or 80*l.*! With 800 or 400 diatoms, 20*l.* and 3*l.* 15*s.* is asked.

Mr. Möller also issues type plates of 100 and 400 diatoms with the names of each photographed beneath.

All the type plates are mounted in monobromide of naphthaline.

Twenty-four test objects (diatoms) are now issued in eight different forms—viz. in air, balsam, monobromide of naphthaline, and phosphorus, and with cover-glasses of 0·16–0·20 mm. or 0·06–0·08 mm. These include *Amphipleura pellucida*, *Frustulia saxonica*, *Pleurosigma angulatum*, and *Surirella gemma*. The "Probe-platten" of 20 and 60 diatoms are also supplied in the four different forms of mounting.

Slack's Silica Films.*—Mr. H. J. Slack suggests an alternative mode of obtaining the silica deposit to that originally published. The old plan was to mix a teaspoonful of powdered fluor spar and rather less of powdered glass in a wide-mouthed 6-oz. bottle, pouring on it enough sulphuric acid to thoroughly wet it. Then place a loose moist tuft of cotton wool in the mouth of the bottle, put a paper cap over it to check evaporation and leave for some hours, when the cotton will be found to have a deposit of silica upon it like hoar frost. This deposit being scraped off into a watch-glass, and water poured softly on it and run off quickly, pure hydrate of silica is left in various curious shapes, some very much like portions of well-known diatoms. By the modified method, instead of allowing the silicic-fluoride gas to come into contact with wet cotton, some of it is passed through a mixture of four parts of glycerine and one of water. This is readily managed by using a very small flask or a tube bottle to contain the fluor spar, glass, and acid, and fitting to its mouth a few inches of bent glass tube. A gentle heat from a spirit-lamp causes the gas to be given off freely, and by dipping the tube just under the glycerine and water, which may be held in an egg-cup, silica films are instantly formed. The experimenter must be on the watch lest the tube gets stopped up with the silica deposit. As soon as it shows any signs of this, clear it out with a fine wire. Only a very small quantity is required of the various chemicals—a quarter or less of the quantities in the original experiment. The films should be washed, and then gently crushed and mounted, to be viewed with 1-4th and 1-8th in. objectives and dark-ground illumination. This is easily managed if the objectives

* Knowledge, iii. (1883) pp. 82–3.

are either old ones of small angular aperture or supplied with a movable stop to reduce their larger apertures when required.

Utility of the Microscope in Chemistry.*—In a paper by H. Reinsch on the detection and separation of certain minerals under the Microscope, it is claimed that the use of the Microscope in chemical analysis is not only rapidly increasing, but that it is approaching the spectroscope, and, in some respects, surpassing it in usefulness. It is admitted, however, that great skill is required in manipulation, and in preparing test objects to verify results, as appearances vary according to the degree of concentration of the solutions used, and different reactions will sometimes be obtained from the same salt. The following are some of the more interesting experiments:—

Silica, of all substances, yields the most varied and beautiful forms, resembling plants and ferns, often presenting, in the most glowing colours, five-leaved flower-forms in infinite varieties. To obtain these forms, we place a drop of a 4 per cent. solution of potassium silicate on an object slide, and then add a drop of a 2 per cent. solution of sodium bicarbonate, and then allow the liquid to evaporate at the ordinary temperature; after a few hours have elapsed the most beautiful flower-forms will be found spread over the slide, and will be readily recognized by a pocket lens, but when examined by the Microscope with the Nicol at 90°, will exhibit the crystals gleaming with a most magnificent play of colours. By moistening the object with a drop of copal varnish, and covering it with a thin glass, these forms may be permanently preserved. If we mix a drop of the 4 per cent. solution of the silica solution with a drop of the 1 per cent. sodium bicarbonate solution, we fail to obtain any plant-forms, but find polarized spheres, which, when the Nicol prism is at 90°, exhibit a dark cross, such as are obtained with calcspar; on further turning of the prism it seems to revolve visibly, and at 0° almost entirely disappears or passes over into a green cross. The most minute traces of silica can, by this means, be readily detected in a mineral, by melting a small sample of the substance with a little potassium hydrate, and dissolving it in a little water, and then placing a clear drop of the solution on an object slide in the manner previously indicated.

It is just as easy to microscopically determine *aluminium oxide* as it was to detect the silica. It may be recognized as well from its sulphates as from its alkali solutions. If we place a drop of a 4 per cent. solution on an object slide, and allow it to evaporate, spherical crystals will be obtained, which, turning at 90°, show a white cross formed of pencils of rays; if we cover the object with a mica plate, and place the Nicol at 0°, the rays of the little spheres appear as if composed of a number of small black grains; placing it at 60°, they appear as two blue rays opposite to each other, which at 90° assume a corresponding position, and on further turning of the prism dis-

* Cf. Journ. Chem. Soc., xlii., Abstracts (1882) p. 245, from Ber. Deutsch. Chem. Gesel., xiv. (1881) pp. 2325–31. Amer. Natural., xvi. (1882) pp. 614–8, from 'Scientific American,' Supplement 1.

appear entirely. If we mix a saturated aluminium oxide solution in potassium hydrate with sufficient water to produce a 2 per cent. solution, and place a drop or two of it on the slide, then mix the sample with a drop of a 1 per cent. solution of sodium bicarbonate, after evaporation there will remain a dull white spot, which, when still moist, shows peculiar spheres; by means of these alumina can easily and positively be distinguished from silica; for they appear when the prism is at 90° as a white cross whose diagonal axis ends in two round or rhombic scales. If we mix the alkali solution of silica and aluminium oxide with a drop of bicarbonate solution, the silica will appear as silvery, partly closed dendrites, while the alumina assumes lengthy forms which, when covered with a mica plate, seem blue, while the dendrites of silica are seldom coloured.

Glucina may be very easily distinguished microscopically from both of the preceding earths. A drop of a 4 per cent. solution of glucium sulphate, when evaporated on the slide, leaves large stars, which may be detected by the naked eye, whose fern-like leaves spread themselves over the entire surface of the drop. The star in the centre, when the prism is at 90°, exhibits prismatic colours, the leaves appear of a dull silver white or brownish colour, and they are often perforated.

Boric acid is likewise very easy to detect, for from its 2 per cent. aqueous solution there is obtained, after evaporation, a series of very small plates hardly 2 mm. in diameter, which, when they are magnified eighty times, do not show any cross. If the residue of the boric acid be moistened with a drop of the 2 per cent. solution of sodium bicarbonate, the dried drop will be found to consist of beautiful polarizing spheres, which in their centre enclose a small white cross; this, on turning the Nicol prism, also revolves. Occasionally dendritic stars instead of the spheres are formed.

The alkalies possess such optic properties that they can be definitely and certainly distinguished by the Microscope. In making these tests it is best to employ the sulphates for the examination, as they are the most constant in their composition, and in the drying the samples will not absorb moisture from the air, and so produce forms which may readily be recognized. Four per cent. solutions were made of the alkalies soluble in water.

The test with *potassium sulphate* gives, at 0° of the Nicol, a series of rhombic plates, which are not very well defined; at 90° blue rims with yellow or red spots are developed; these cannot be taken for any other alkali.

Sodium sulphate will be recognized as soon as it becomes dry by its precipitation. In the darker field of the Microscope it appears dull, and silvery-white in hopper-shaped quadratic crystals.

The *ammonium sulphate* assumes such peculiar shapes that it cannot be mistaken for any other salt. At 0° the crystals are hardly recognizable; at 90° they appear like partly decomposed walls built of grey blocks, with blue and brown rims.

Lithium sulphate forms clusters of prismatic needles which at 0° show beautiful colours and a blue cross, which at 90° becomes black.

The most minute quantities of lithia can be recognized by their optical behaviour.

Lime may be detected in several different ways; if a drop of a 2 per cent. solution of calcium chloride is mixed with a drop of a 1 per cent. sodium bicarbonate solution, the drop will become cloudy; and after drying it appears white and shows distinct dendritic stars, which consist of an accumulation of small crystals. Barium and strontium salts fail to show this reaction, or only in a very indistinct manner. Lime is best recognized under the Microscope when it is in the form of the sulphate, and is prepared by mixing a drop of the soluble lime salt with a drop of sodium sulphate. The sulphate crystallizes in stellar-shaped crystals, which cannot readily be mistaken for any other forms.

Barium nitrate assumes mossy, glistening like silver, colourless dendritic forms; while *strontium nitrate* takes the form of radiating needles, which are bluish at 0°, and at 90° are blue, green, and red.

Magnesia may, even when present in the most minute quantities, be detected by the Microscope. The *sulphate* forms colourless clusters of needles, which do not become coloured even at 90°.

The *copper sulphate* takes the form of step-like prisms, which at 0° are almost colourless, becoming at 70° light blue with green stripes, and at 90° show brilliant colours.

The 4 per cent. solution of *manganese sulphate* shows broad scales, silver white to grey in colour, and which are partly serrated at 0°, as well as at 60° and 90°. If the sample is left by itself for several days, polarizing spheres will appear; these are so peculiar that the manganese can readily be recognized from them, especially as no other metal forms such spheres.

Cadmium presents the most characteristic formation of all the metals; a 4 per cent. solution of the *sulphate* produces large spheres containing ellipsoids, which radiate from the centre, and are marked by regular transverse depressions. This formation can be recognized without a Nicol prism, and therefore it is not the result of the polarized light, but evidently depends upon the mechanical arrangement of the crystals. On using the Nicol the spheres show at 0° a beautiful blue or green cross, whose colour-zones increase with the turning of the prism until 90° is reached, when the most beautiful colours of the rainbow are manifested, while the ellipsoid becomes darker, better defined, and the transverse depressions are marked with dark spots. These phenomena become still more characteristic when observed over a plate of mica. From more dilute solutions of the cadmium sulphate, it is possible to obtain the spheres, but the peculiar structure is not observed.

If a 2 per cent. solution of *iron sulphate* be mixed with a 1 per cent. solution of sodium bicarbonate, the drop soon becomes cloudy, and is covered with a gold lustrous film of the oxide; after drying the specimen shows no spheres, but if it is allowed to remain quiet for two days, small crystals of iron *carbonate* are formed; these show the phenomena of polarization distinctly, but in a very peculiar manner.

Uranium sulphate assumes the most beautiful forms of all the metals; a 4 per cent. solution is used, and at least twelve hours are necessary to produce the desired formation. It can readily be recognized with a pocket lens, and resembles beautifully coloured asters or corn-flowers. Less frequently it occurs in the form of envelopes with velvet-blue, narrow, and purple-coloured broad triangles, which may also be recognized without the Nicol, and therefore are not produced by polarized light, but result from the mechanical arrangement of the crystals.

The *mercuric sulphate* is soluble with difficulty, but it can easily be brought into solution by the addition of a few drops of nitric acid. It forms figures similar in shape to a Maltese cross, of superimposed scales, which are very unstable.

Silver may easily be determined, and in such a way that it is not easily mistaken for any other metal. A drop of a 2 per cent. solution of silver *sulphate* deposits bright points which may be detected with the naked eye; at 0° these appear as complete rhombic octahedrons, with the edges cut off, at 90° they glisten with the most beautiful play of colours, like the diamond; at times groups are formed which seem exactly like a set of diamond jewellery.

Preparing Thin Slices of Rocks and Minerals.—Dr. A. Geikie, the Director-General of the Geological Survey of Great Britain and Ireland, in his 'Outlines of Field-Geology,' * deals with the advantages of microscopical investigation in the study of minerals and rocks, by which means we are enabled to trace the minuter structures of the earth's crust, and to follow many of the stages in the formation of its rocks. We can tell which mineral of a rock crystallized first, and, indeed, can follow every phase of crystallization in such a way as to explain many otherwise unknown parts of the history of the rocks. Moreover, by this method we can trace the subsequent changes which rocks have suffered in the chemical alteration of their minerals by percolating water, with the resulting secondary products. While a chemical analysis informs us of the ultimate chemical constitution of a rock, a microscopic analysis brings before us its mineralogical composition, showing in what forms the chemical elements have been combined, and how diverse two rocks may be in structure and texture, though in chemical composition nearly alike.

A cutting machine will greatly facilitate the process of preparing rock slices. The thickness of each slice must be mainly regulated by the nature of the rock, the rule being to make it as thin as can be conveniently cut, so as to save labour in grinding down afterwards. Perhaps the thickness of a shilling may be taken as a fair average. This thickness may be still further reduced by cutting and polishing a face of the specimen, cementing that on glass, and then cutting as close as possible to the cemented surface. The thin slice thus left on the glass can then be ground down with comparative ease.

Excellent rock sections, however, may be prepared without any

* 3rd ed. 1882 (Macmillan & Co.), pp. 30, 201–15. See also 'Text-Book of Geology' by the same author (Macmillan & Co.), 1882, pp. 94–108, 182–91 (figs.).

machine, provided the operator possesses ordinary neatness of hand and practice. A dexterous use of the hammer will break off from a sharp edge of the rock a number of thin splinters or chips about an inch square.

For the preparation of the thin slices for the Microscope, the following simple apparatus is all that is absolutely needful, though if a grinding machine is added it will save time and labour:—(1) A cast-iron plate 9 in. square and $\frac{1}{4}$ in. thick; (2) two pieces of plate-glass 9 in. square; (3) a Water-of-Ayr stone 6 in. × $2\frac{1}{2}$ in.; (4) coarse emery; (5) fine or flour emery; (6) putty powder; (7) Canada balsam; (8) a small forceps, and a common sewing needle in a wooden handle; (9) some oblong pieces of common flat window-glass 2 in. × 1 in.; (10) glass slides with ground edges; (11) thin cover-glasses; (12) a small bottle of spirits of wine. The following are the directions given by Dr. Geikie for the subsequent processes:—

"The first process consists in rubbing down and polishing one side of the chip or slice (if this has not already been done in cutting off a slice affixed to glass, as above mentioned). We place the chip upon the wheel of the grinding-machine, or, failing that, upon the iron plate, with a little coarse emery and water. If the chip is so shaped that it can be conveniently pressed by the finger against the plate, and kept there in regular horizontal movement, we may proceed at once to rub it down. If, however, we find a difficulty, from its small size or otherwise, in holding the chip, one side of it may be fastened to the end of a bobbin or other convenient bit of wood by means of a cement formed of three parts of rosin and one of beeswax, which is easily softened by heating. A little practice will show that a slow, equable motion with a certain steady pressure is most effectual in producing the desired flatness of surface. When all the roughnesses have been removed, which can be told after the chip has been dipped in water so as to remove the mud and emery, we place the specimen upon the square of plate-glass, and with flour-emery and water continue to rub it down until all the scratches caused by the coarse emery have been removed, and a smooth polished surface has been produced. Care should be taken to wash the chip entirely free of any grains of coarse emery before the polishing on glass is begun. It is desirable also to reserve the glass for polishing only. The emery gets finer and finer the longer it is used, so that by remaining on the plate it may be used many times in succession. Of course the glass itself is worn down, but by using alternately every portion of its surface, and on both sides, one plate may be made to last a considerable time. If after drying and examining it carefully we find the surface of the chip to be polished and free from scratches, we may advance to the next process. But it will often happen that the surface is still finely scratched. In this case we may place the chip upon the Water-of-Ayr stone, and with a little water gently rub it to and fro. It should be held quite flat. The Water-of-Ayr stone, too, should not be allowed to get worn into a hollow, but should be kept quite flat, otherwise we shall lose part of the chip. Some soft rocks, however, will not take an unscratched surface even with the Water-of-Ayr

stone. These may be finished with putty-powder, applied with a bit of woollen rag.

The desired flatness and polish having been secured, and all traces of scratches and dirt having been completely removed, we proceed to grind down the opposite side, and reduce the chip to the requisite degree of thinness. The first step at this stage is to cement the polished surface of the chip to one of the pieces of common glass. A thin piece of iron (a common shovel does quite well) is heated over a fire, or is placed between two supports over a gas-flame. On this plate must be laid the piece of glass to which the specimen is to be affixed, and the specimen itself. A little Canada balsam is dropped on the centre of the glass, and allowed to remain until it has acquired the necessary consistency. To test this condition, the point of a knife should be inserted into the balsam, and on being removed should be rapidly cooled by being pressed against some cold surface. If it soon becomes hard, it has been sufficiently heated. Care, however, must be observed not to let it remain too long on the hot plate, for it will then become brittle, and start from the glass at some future stage, or at least will break away from the edges of the chip, and leave them exposed to the risk of being frayed off. The heat should be kept as moderate as possible, for if it becomes too great it may injure some portions of the rock. Chlorite, for example, is rendered quite opaque if the heat is so great as to drive off its water.

When the balsam is found to be ready, the chip, which has been warmed on the same plate, is lifted with the forceps, and its polished side is laid gently down upon the balsam. It is well to let one end touch the balsam first, and then gradually to lower the other, as in this way the air is driven out. With the point of a knife the chip should be moved about a little, so as to expel any bubbles of air, and promote a firm cohesion between the glass and the stone. The glass is now removed with the forceps from the plate, and put upon the table, and a lead weight or any other small heavy object is placed upon the chip, so as to keep it pressed down until the balsam has cooled and hardened. If the operation has been successful, the slide ought to be ready for further treatment as soon as the balsam has become cold. If, however, the balsam is still soft, the glass must be again placed on the plate and gently heated, until on cooling the balsam resists the pressure of the finger-nail.

Having now produced a firm union of the chip and the glass, we proceed to rub down the remaining side of the stone with coarse emery on the iron plate as before. If the glass cannot be held in the hand, or moved by the simple pressure of the fingers, which usually suffices, it may be fastened to the end of the bobbin with the rosin cement as before. When the chip has thus been reduced until it is tolerably thin—until, for example, light begins to appear through it when held between the eye and the window—we may, as before, wash it clear of the coarse emery, and continue the reduction of it on the glass plate with fine emery. Crystalline rocks, such as granite, gneiss, diorite, dolerite, and modern lavas, can be reduced to the required thinness on

the glass. Softer rocks may require gentle treatment with the Water-of-Ayr stone.

The last parts of the process are the most delicate of all. We desire to make the section as thin as possible, and for that purpose continue rubbing until after one final attempt we perhaps find to our dismay that great part of the slice has disappeared. The utmost caution must consequently be used. The slide should be kept as flat as possible, and looked at frequently, that the first indications of disruption may be detected. The thinness desirable or attainable depends in great measure upon the nature of the rock. Transparent minerals need not be so much reduced as more opaque ones. Some minerals, indeed, remain absolutely opaque to the last, like pyrite, magnetite, and ilmenite.

The slide is now ready for the Microscope. It ought always to be examined with that instrument at this stage. We can thus see whether it is thin enough, and if any chemical tests are required they can readily be applied to the exposed surface of the slice. If the rock has proved to be very brittle, and we have only succeeded in procuring a thin slice after much labour and several failures, nothing further should be done with the preparation unless to cover it with glass, as will be immediately explained, which not only protects it, but adds to its transparency. But where the slice is not so fragile, and will bear removal from its original rough scratched piece of glass, it should be transferred to one of the glass slides (No. 10). For this purpose the preparation is once more placed on the warm iron plate, and close alongside of it is put the glass slide, which has been carefully cleaned, and on the middle of which a little Canada balsam has been dropped. The heat gradually loosens the cohesion of the slide, which is then very gently pushed along to the contiguous clean slip of glass. Considerable practice is needed in this part of the work, as the slice, being so thin, is apt to go to pieces in being transferred. A gentle inclination of the warm plate is advantageous, so that a tendency may be given to the slice to slip downwards of itself on to the clean glass. We must never attempt to lift the slice. All shiftings of its position should be performed with a point of a long needle or other sharp instrument. If it goes to pieces, we may yet be able to pilot the fragments to their resting-place on the balsam of the new glass, and the resulting slide may be sufficient for the required purpose.

When the slice has been safely conducted to the centre of the glass slip, we put a little Canada balsam over it, and allow it to be warmed as before. Then taking with the forceps one of the well-cleaned thin cover-glasses, we allow it gradually to rest upon the slice by letting down first one side, and then by degrees the whole. A few gentle circular movements of the cover-glass with the point of the needle or the forceps may be needed to insure the total disappearance of air-bubbles. When these do not appear, and when, as before, we find that the balsam has acquired the proper degree of consistence, the slide containing the slice is removed, and placed on the table with a small lead weight above it in the same way as already described. On becoming quite cold and hard the superabundant balsam round the

edge of the cover-glass may be scraped off with a knife, and any which still adheres to the glass may be removed with a little spirits of wine.

Small labels should be kept ready for affixing to the slides to mark the locality and reference number of the specimen. Thus labelled the slide may be put away for future study and comparison.

The whole process seems, perhaps, a little tedious; but in reality much of it is so mechanical, that after the mode of manipulation has been learnt by a little experience, the rubbing down may be done while the operator is reading. Thus in the evening, when enjoying a pleasant book after his day in the field, he may at the same time with some practice rub down his rock-chips, and thus get over the drudgery of the operation almost unconsciously.

One final remark may here be required. The learner must not suppose that, having prepared his slices, he has nothing to do but to place them under the Microscope, and at once determine the composition. He will find it by no means an easy task to make satisfactory progress, and at first he may be inclined to abandon microscopic work in despair of ever gaining confidence in it. Let him, however, begin by studying individual minerals, and make himself acquainted gradually with their various characters. He should procure numerous sections of minerals which enter into the composition of the rocks which he wishes to investigate. By degrees he will be able to discriminate them as they occur in the rocks, and once able to do this, his progress will be comparatively smooth. But he must be prepared for a long, patient course of training, and ought on no account to speak confidently about the microscopic structure of rocks until he feels assured that the confidence arises from sound knowledge."

Under the head of "The Microscope" the author explains the requirements of the field-geologist to be 1½ in., 1 in., and ½ in. objectives, giving powers from 30 to 300. It is always desirable to observe the characters of a rock as an opaque object; titaniferous iron, for example, appears by transmitted light in black structureless grains or opaque patches, whilst with reflected light the cleavage and lines of growth of the mineral can often be clearly seen, and what seemed to be uniform black patches are then found in many cases to inclose bright brassy kernels of pyrite. With transmitted light somewhat different appearances will be presented by two slices of the same rock, according to the thinness of the section, brown or almost black minerals appearing pale yellow, green, or almost colourless, when thinner. Dichroism and polarized light are also dealt with, and the author concludes with six questions which the student is to propound to himself for his satisfaction in the determination of rocks.

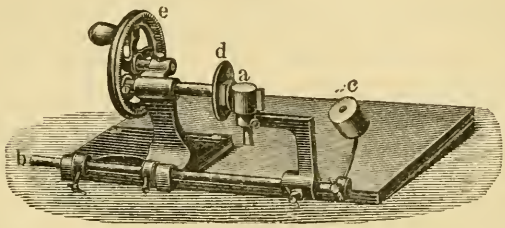
In his directions for preparing sections of fossil plants,* Dr. H. Conwentz describes two grinding and polishing machines made by Voigt and Hochgesang of Göttingen.

The first (fig. 88) is a hand-machine. The specimen is cemented

* In Behrens' 'Hilfsbuch zur Ausführung mikroskopischer Untersuchungen im Botanischen Laboratorium,' 1883 (Schwetschke u. Sohn, Braunschweig), pp. 162-73 (5 figs.).

to the carrier *a*, which is movable on the axis *b*, and can also be rotated in two directions. The object is pressed by the weight *c*

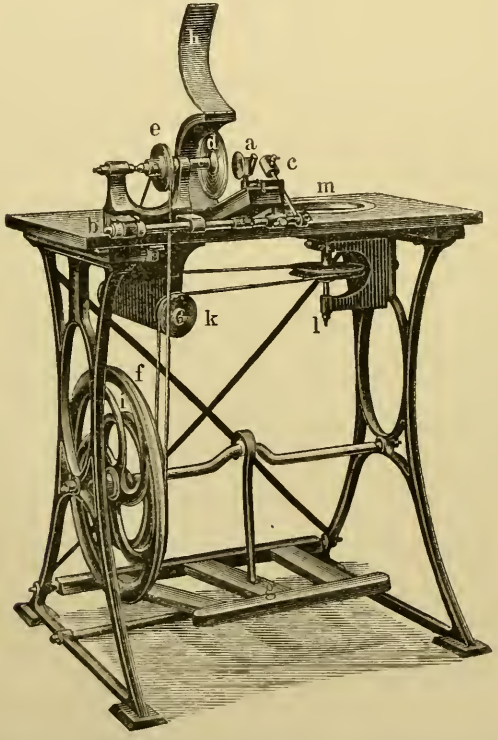
FIG. 88.



against the steel disk *d*, which is revolved by the wheel *e* acting on a smaller toothed wheel on the axis of *d*.

The second (fig. 89) is intended to be worked by the foot. The

FIG. 89.



parts *a*, *b*, *c* and *d* are the same as before. The wheel and treadle at *f* and *g* work the pulley *e*, by which the steel disk *d* is revolved; *h* is

part of the cover for the disk, to prevent the emery flying about. A box beneath also catches the powder that falls. (This arrangement is also supplied with fig. 88, though not shown in the woodcut.) A second wheel at *i*, with a cord passing over *k*, actuates a vertical spindle *l*, which rotates a horizontal cast-iron plate at *m* for polishing.

Making Sections of Rock, Bone, Ivory, &c.*—Mr. J. Smith describes the following method of making and mounting transparent rock-sections. The first step is, of course, to get a suitable piece of rock, say a fragment of trap or basalt. This should be broken as thin as possible, and to do this, having struck off a fragment from the parent rock or boulder, take it between the fingers and thumb of the left hand. Hold one edge on the rock from which it was struck, or any hard stone which may be convenient, and strike it a sharp blow with the hammer fair on the opposite edge. If this is well done thin fragments about 1-8th in. thick will fly off.

The fragments of rock should be roughly clipped in the field by wire nippers into disks of about 7-8ths in. diameter, and having reached home the next thing is to make the disks roughly circular, and to flatten and polish one side. To do this, a flat slab of polished sandstone, 18 in. square by 4 in. thick, is used, on which the edge of the disk is rubbed, using water and giving it a slight turn at every rub; a very little practice will enable any one to make the disks almost circular. But what is chiefly to be aimed at in making them circular is to get a smooth edge, as a disk having a perfectly smooth edge will not break so readily in the subsequent process as a rough-edged one. It should now measure about 5-8ths of an inch in diameter. The flat face must next be polished so as to remove every trace of scratching caused by the sandstone, and it is necessary at the same time to make this face perfectly flat. To accomplish this, a water-of-Ayr hone, 7 in. square by 2½ in. thick, is used, having one of the faces perfectly flat. On this face the disk is rubbed with water, until it also becomes perfectly flat and free from scratches. It must then be made thoroughly clean and mounted on a piece of hard wood (well seasoned beech wood) 2 in. square by ¾ in. thick. The disk is fixed to the block with gum arabic, putting plenty round the sides, so as to form a collar, and allowed to harden for two or three days.

The specimen is now to be ground down until the beech can be seen distinctly through it. It will not do to rub it on the sandstone now, as water would dissolve the gum, and the specimen would be at once detached. For the purpose of rubbing it down use a flat metal plate, coarse emery powder, and paraffin, turpentine, or benzoline, as none of these substances will dissolve gum arabic. After it has been reduced to about 1-20th in., more speed may be obtained by using a Turkish whetstone sprinkled with a little of the finest emery powder, rubbing on this till the wood may be *dimly* seen through the specimen. At this stage, the specimen, wood, and whetstone are cleaned with a piece of rag soaked in turpentine, and rubbed down on the bare stone, using the same fluid, till the specimen is thin enough to be taken off

* Journ. Post. Micr. Soc., ii. (1883) pp. 28–33 (2 figs.).

the wood. This is the most critical period in the rubbing process, which must be done very gently.

In making sections of flints, agates, and stones of like hardness, it is of no use rubbing them on the sandstone; they must be ground down from the very first on the iron plates with emery. The rest of the process is the same as above.

When the beech can be well seen through the specimen, a few light rubs should be given on the water-of-Ayr stone, using water. The specimen is then ready to be mounted in Canada balsam.

Remove with a wet cloth all the gum from the edge of the specimen, and thoroughly clean the wood of all impurity. Boil the kettle. Stick the blade of a pen-knife into the side of the beech, to act as a handle, and hold the specimen in the steam from the kettle-spout till it slides down the face of the wood. There need be no fear of its falling off. The water from the steam will prevent this. It may come off in less than five minutes, or it may take half an hour. It is useless to try to hasten the process, by pushing the specimen with the edge of the knife-blade; this will only end in a vexatious smash. After all, on an average, about a dozen specimens can be "steamed" from the wood and mounted in balsam in about two hours. With every care, a specimen will sometimes break in two or more pieces, in which case a slide may perhaps be made of each fragment. The specimen having at last become loose on the wood, heat a glass slide over an argand burner, and with the blade of a penknife move the specimen gently to the edge of the wood. Put the knife-blade under the edge that projects beyond the wood, steadying the hand on the side of the wood, and not attempting to lift the section, but drawing it off the wood gently; the water from the condensed steam will keep it attached to the knife. Put a drop or two of warm balsam on the heated slide, have ready a slide template covered with paper, having a circular hole cut in the middle of it, 5-8ths in. in diameter, or the same size as the specimen. Put the template under the heated slide, holding both in the left hand. Dry the free side of the specimen (still on the knife) over the argand lamp. Place the specimen gently on the balsam, directly over the hole in the template. Draw the knife off sideways. If it is attempted to lift it up, the specimen will break in pieces, the water holds the section so firmly to the knife. Heat a 3-4ths in. glass cover over the argand lamp, and put two drops of balsam on it; lay it gently on the specimen, which by this time should be perfectly flat; do not squeeze; heat the template, slide, and section over the lamp, and let the balsam gently boil, to expel the air-bubbles. Again, do not squeeze, but keep the object in position over the template with the point of the knife-blade. Allow the slide to cool a little; now gently squeeze down the glass slip so as to expel all superfluous balsam.

Mr. Smith says that the process is also suitable for making transparent sections of bone, ivory, &c., and is much superior to the old method of rubbing down a specimen fixed with balsam to a glass slip.

Babes, V.—Ueber einige Färbungsmethoden, besonders für krankhafte Gewebe mittelst Safranin und deren Resultate. (On some staining methods especially for diseased tissue, with Safranin, and their results.) [*Post.*]
Arch. f. Mikr. Anat., XXII. (1883) pp. 356–65.

Balfour, F. M. See Foster, M.

Barré, P.—Sur l'alignement des Diatomées dans les préparations. (On the arrangement of diatoms in preparations.) [*Supra*, p. 452.]
Bull. Soc. Belg. Micr., IX. (1883) pp. 74, 75–7.

Bayles, J. C.—Microscopic Analysis of the structure of Iron and Steel. [*Post.*]
Science, I. (1883) p. 101.

Bedriaga, J. v.—Eine neue Kittmasse zum Verschliessen der Cylinder und Büchsen. (A new cement for sealing cylinders and boxes.)
[Hofmann's "White Universal Cement."]
Zool. Anzeig., VI. (1883) pp. 229–30.

Bennett, R. A. R.—Mounting legs, &c., of Insects.
[Contains the following:—"The chief difficulty is the appearance of air-bubbles in the object after it has been mounted. To avoid this, there is a little dodge not mentioned in most books. When the leg is taken out of the turpentine, instead of placing it at once on the slide, boil it for a few moments in some balsam, kept for the purpose in another tube. While it is being boiled the air will escape, and the balsam will take its place. There will, therefore, be not nearly so much chance of air-bubbles arising when the object is mounted. Of course, this would be rather rough treatment for some objects; but with the legs of insects (especially such as *Dytiscus marginalis*) it generally answers admirably, and saves a vast deal of trouble."]
Engl. Mech., XXXVII. (1883) p. 253.

Berthold, G.
[Description of a method for preparing marine algæ, *supra*, p. 451.]
Jahrb. f. Wiss. Bot., XIII. (1882) pp. 704–5.
Abstr. by Dr. C. O. Whitman in *Amer. Natural.*, XVII. (1883) pp. 456–7.

C., T.—Reply to M. A. B. (*ante*, p. 309) as to Breakage of Slides in the Mail.
[Uses wooden boxes and wraps tissue paper round the slide several times until it fits very tight into the grooves in the box, so tight that the slides have to be forced in with some pressure.]
Amer. Mon. Micr. Journ., IV. (1883) p. 78.

Carbolic Acid Process.
[Note as to the process having been originated by Dr. Ralph in 1874, and the balsam and chloroform mixture in 1857.]
Southern Science Record, III. (1883) p. 31.

Chadwick's (H. C.) use of alcohol for mounting *Lophopus crystallinus* with the tentacles expanded.
[The spirit is blown as a spray upon the surface of the water containing the organisms; it mixes slowly, and the tentacles are thereby not retracted.]
Micr. News, III. (1883) p. 150.

Cole, A. C., Studies in Microscopical Science.
No. 48 (pp. 293–8). Porphyritic Basalt. Arthur's Seat, Edinburgh. Plate × 25.
No. 49 (pp. 299–302). The Alimentary Canal. The Small Intestine. Explanation of plate to accompany No. 51.
No. 50 (pp. 303–4). Serpentine.—The Lizard Serpentine. Plate × 25 with No. 52.
No. 51 (pp. 305–12). The Alimentary Canal. The Large Intestine. Two plates of T. S. Large Intestine (slide) and Duodenum of Dog × 25.
No. 52 (pp. 313–8). Serpentine. Portsoy, Scotland. Plate × 25. Also Plate (× 25) of Serpentine between Kynance Cove and Lizard Town, Cornwall.

Fawcett, J. E.—Mounting with Wax-cells. [*Post.*]
Micr. News, III. (1883) pp. 153–4.

Fehleisen.—Ueber neue Methoden der Untersuchung und Cultur pathogener Bacterien. (On new methods for the investigation and culture of pathogenous Bacteria.) [*Post.*]

SB. Phys.-Med. Gesell. Würzburg, 1882, pp. 113–21.

Foster, M., F. M. Balfour, A. Sedgwick, and W. Heape.—The Elements of Embryology. 2nd ed., xiv. and 486 pp., 141 figs. 8vo, London, 1883.

[Pp. 423–71 consist of an Appendix containing "practical instructions for studying the development of the chick," and "practical directions for obtaining and studying mammalian embryos."]

[Geinitz, E.]—Hunting for lost glaciers with a Microscope.

[Review of the author's paper in *Nova Acta Acad. Leop.-Carol.*, XLV. p. 35.]

Science, I. (1883) p. 177.

Griesbach, H.—Beiträge zur Verwendung von Anilinfarbstoffen in der Microscopischen Technik. (Contributions to the use of aniline staining substances in microscopical technics.) [*Supra*, p. 446.]

Zool. Anzeig., VI. (1883) pp. 172–4.

Hanaman, C. E.—Improved Filtering Reagent Bottle.

[A wide-mouth bottle with three glass tubes through the cork. The delivery tube reaches nearly to the bottom of the bottle and is curved above the cork. Just beyond the curve this tube is attached to a larger tube filled with absorbent cotton forming a filter, and to the lower end of which is a short piece of tubing contracted at its distal end. Another of the three tubes has a "thistle-bulb" top to readily introduce the reagent from dishes, &c.

Amer. Mon. Micr. Journ., IV. (1883) pp. 41–3 (1 fig.).

Harris, V.—On double staining Nucleated Blood-corpuscles with Anilin Dyes. [*Supra*, p. 447.]

Quart. Journ. Micr. Sci., XXIII. (1883) pp. 292–301.

Heape, W. See Foster, M.

Hertwig's method of preparing and cutting Amphibian Eggs. [*Supra*, p. 442.]

Amer. Natural., XVII. (1883) pp. 572–4,
from *Jen. Zeitschr. f. Naturwiss.*, IX. (1882) p. 249.

Hitchcock, R.

["It may interest some readers, especially those who are studying the diatoms, and would like to find the rare forms that occur occasionally in the stomachs of certain animals, to know that the contents of an oyster's stomach can be withdrawn by inserting a tube through the mouth. If this can be done with the oyster there is no apparent reason why it cannot also be done with many other animals, and the contents could be far more easily cleaned than when they are obtained by dissection in the usual way."]

Amer. Mon. Micr. Journ., IV. (1883) p. 77.

Instrucçoes para a colheita e preparação de productos botanicos. (Instructions for the collection and preparation of botanical products.)

Soc. Brotcriana, Bol. Annual., I. (1880–2) [Coimbra, 1883] pp. 5–20.

Jackson, E. E.—Crystals of Sodium Chloride.

[Method of exhibiting under a low power by mixing on a slide a little solution of salt and alcohol.]

The Microscope, III. (1883) p. 5.

" " The Microscope in Medicine.

["Notes from my record of microscopic work . . . . to illustrate the value of the instrument in correct diagnosis." Pea in the ear. Urine.]

The Microscope, III. (1883) p. 16.

Kingsley, J. S.—Imbedding. [*Supra*, p. 444.]

Sci. and Lit. Gossip, see *Amer. Mon. Micr. Journ.*, IV. (1883) p. 58.

Lockwood, S.—Labelling Slides. [*Supra*, p. 456.]

Amer. Mon. Micr. Journ., IV. (1883) p. 64.

Molisch, H.—Ueber den mikrochemischen Nachweis von Nitraten und Nitriten in der Pflanze mittelst Diphenylamin oder Brucin. (On the microchemical analysis of nitrates and nitrites in plants by means of diphenylamin or brucin.) *Ber. Deutsch. Bot. Gesell.*, I. (1883) pp. 150–5.

REINSCH'S (P. F.) Preparations of Coal. [*Post.*]
Bull. Soc. Belg. Micr., IX. (1883) pp. 87–8.

RICHARDSON, B. W.—Sections to illustrate multiple staining. [Exhibition.]
Ann. & Mag. Nat. Hist., XI. (1883) p. 282.

S., J. C.—Pond-life in Winter.
[Description of the Rotifers, Infusoria, &c., found in a dipping through a hole cut in the 10-in. thick ice of a pond.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 62–3.

SEDGWICK, A. See Foster, M.

SLACK, H. J.—Pleasant Hours with the Microscope.
[Examination of aphides and cells for same. *Post.*]
Knowledge, III. (1883) pp. 219–20, 245–6, 288.

VAN BRUNT, C.—Preparation of *Bacillaria paradoxa*.
[Exhibition of a preparation showing the frustules burnt upon a cover-glass, maintaining their position just as in life. This was made by adding alcohol to the water containing the diatoms. They were suddenly killed and did not separate.]
Amer. Mon. Micr. Journ., IV. (1883) p. 60.

WHITMAN, C. O.—Note on Blanc's method of preserving and staining Protozoa. [*Ante*, p. 293.]
Amer. Natural., XVII. (1883) p. 458.

ZIETZ, A.—Mittheilungen betreffend Aufstellung und Behandlung von Alcohol-präparaten. (Communications on the putting up and treatment of alcohol preparations.)
[Additions to Dr. K. Möbius' communication, *ante*, p. 292.]
Zool. Anzeig., VI. (1883) pp. 199–200.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

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Edited by

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1883.

We must caution the reader that it is not yet known whether the frustules are perforated or not, as will be seen from an article soon to be published in these columns. As for the presence of cilia within the diatoms, we have no more reason to expect to find cilia there than in any other cells in which the movement of protoplasm has been observed—as in desmids, or in the cells of higher water-plants, for example. Moreover, diatoms are not the only plants which move without visible cause. The desmids, for instance, move with vigour, and they are not inclosed in a silicious shell which obstructs examination of the interior. In young desmids especially the cyclosis can be examined with satisfaction by high powers. Looking over the algæ, we find that the *Oscillariæ* are quite as remarkable in their movements as the diatoms, and we cannot yet explain it; and in the animal kingdom the Gregarinæ also move without giving the least indication of how the motion is produced. It is a subject for still further investigation, and we have no doubt that with good objectives, supplemented by staining fluids properly applied, the cause of the movement will soon be discovered."

Fossil Diatoms of Austria-Hungary.*—A. Grunow describes the following fossil diatoms from Austria-Hungary :—(1) In the "Saugschiefer" of Dubravica, a large number of species. (2) The "Polierschiefer" of Tallya. The diatomic remains are here united together with extraordinary firmness by silicic acid, forming variously radiating microscopic masses of crystals, which renders the examination extremely difficult. (3) The argillaceous neogenous basalt-tufa of Holaikluk. The most abundant form here is *Melosira tenuis*, also closely united by silica, and often containing petrified silica in the interior of the cells. (4) The diatom-stratum of Kis-ker, of unknown age, with ordinary still existing fresh-water forms. (5) "Kieselguhre," vivianite, and "ocker" stratum of Eger and Franzensbad. Several new forms. All the new species are depicted in phototypic illustrations.

Diatom Types.—Dr. H. van Heurck is preparing a series of preparations to illustrate his synopsis of Belgian diatoms, representing the principal types and elucidating the critical species. There will be about 350 slides, containing at least 400–500 forms, and 25 will be issued monthly. M. Grunow will examine the slides to check the determinations.

MICROSCOPY.

a. Instruments, Accessories, &c.

Bausch and Lomb Optical Co.'s New Binocular.†—The Bausch and Lomb Optical Company have completed a binocular of their "Investigator" pattern, which has some variations in the construction and adaptation of the prism, and in the nose-piece in which the prism is fixed. The notices which have so far appeared of its con-

* Beitr. zur Palæont. Oesterr.-Ungarns u. d. Orients von Mojsisovics u. Neumayr, ii. (1882). See Bot. Centralbl., xiv. (1883) p. 146.

† 'The Microscope,' iii. (1883) p. 89, from the 'Odontographic Journal.'

struction and advantages are not a little perplexing both theoretically and practically, but we transcribe them as they are given:—

"1. A very large prism, with perfectly plane surfaces, cemented upon a glass disk.

2. As this combined prism and disk is fixed by the maker, it remains in place regardless of the whim of or want of skill in the observer.

3. The mounting of this combination is a brass nose-piece, which slides into the tube and is fastened by a new form of bayonet-catch, a novel feature in itself.

4. The monocular nose-piece is separate and is fastened in the tube in the same manner.

5. The effect with the prism in place is quite as good in this instrument as it is in the old forms when the prism is withdrawn, as it permits the passage of [more] light [than is] possible in objectives with the Society screw.

6. While a little more time is consumed in changing from monocular to binocular and back again than is the case in the old form, the loss is fully compensated for by the absolute accuracy of the new, which cannot get out of place.

7. As low powers only are used in binocular instruments, a given objective may be kept in the binocular nose-piece and the higher power in the monocular, an arrangement almost as convenient as in the well-known double nose-piece.

8. The bayonet-catch above mentioned may be applied, and probably will be in the near future, to objectives as a substitute for the Society screw. The fit is as good, and the time saved in changing objectives great."

The binocular is also thus referred to in the 'Amer. Mon. Micr. Journ.,' iv. (1883) p. 97:—

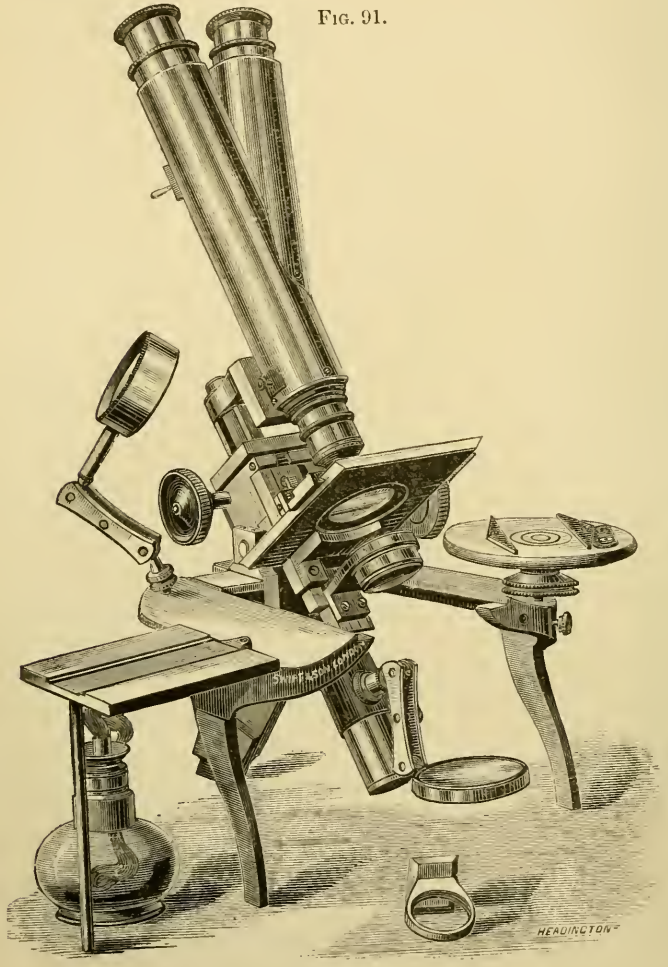
"Mr. Edward Bausch has devised a modified form of the Wenham binocular. . . Instead of mounting the prism in a metal frame which can be moved in and out, as in the ordinary form of binocular, the prism is cemented to a glass disk which is fixed in a special nose-piece. The nose-piece can be readily attached to the Microscope by a spring-catch.

In this way the prism is always secured in exactly the right place, and when a plain nose-piece is substituted, as when high-power objectives are used, there is nothing in the tube to reduce the angular aperture of the lens. The arrangement is less convenient than the ordinary plan, but if the advantages claimed for it are found not to be of sufficient practical importance to lead to its final adoption, there is no reason why the prism should not be mounted in the old way. We do not yet appreciate the advantages of the separate nose-pieces, and we understand that the makers desire to have the verdict of microscopists concerning this matter, before they adopt the plan.

The prism is a very large one, and as the face which receives the rays is fully exposed it will transmit a larger angle of aperture than the Wenham prism, which is much smaller. It is well known that the mounting of the Wenham prism cuts down the angular aperture

of some objectives.* A large prism, however, gives a correspondingly large pencil of rays, and in the instrument we examined there was a glare of light in the left ocular, which led some one who used it to think there was a defect in the fitting of the prism. On covering the right-hand half of the eye-lens of the left ocular, the glare was entirely stopped out, and the binocular effect was perfect."

Fig. 91.

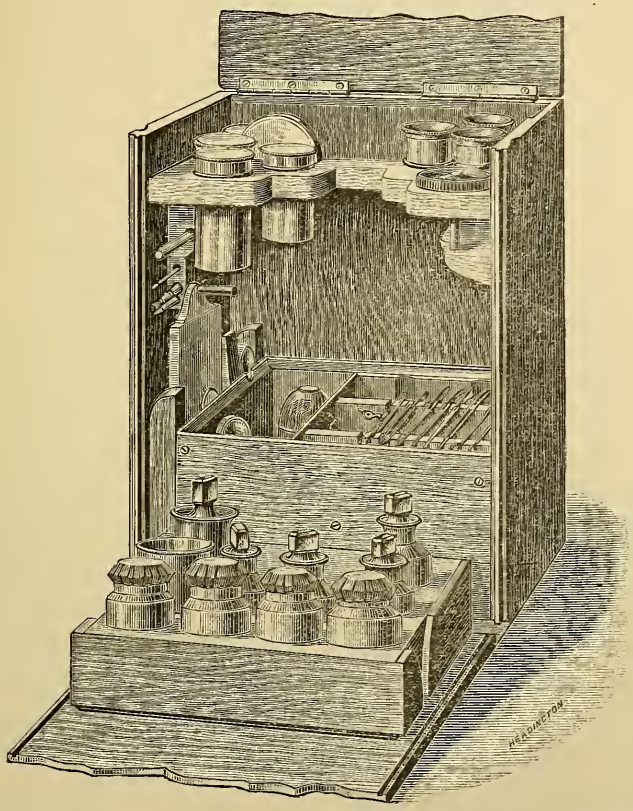


Fase's Portable Dissecting Microscope.—We regret to have omitted to state in describing this instrument at p. 415 that it was

* There is some confusion here between the mechanical cutting down of the opening of the objective caused by the setting of the prism and the optical cutting down of the aperture-angle, which with the Wenham prism is necessarily one-half, only half of the rays from the objective being directed into each tube.—[Ed.]

made for the Rev. Mr. Fase by Messrs. Swift and Son. Mr. Swift, with characteristic modesty, wrote us, asking us to take care to refer to it as "Fase's Microscope" and not as "Swifts'," inasmuch as the

Fig. 92.



credit of the design was so largely due to Mr. Fase; in consequence we lost sight of the maker, to whom so much is always due, more than we should otherwise have done.

Figs. 91 and 92 give a better idea of the instrument than that at p. 416.

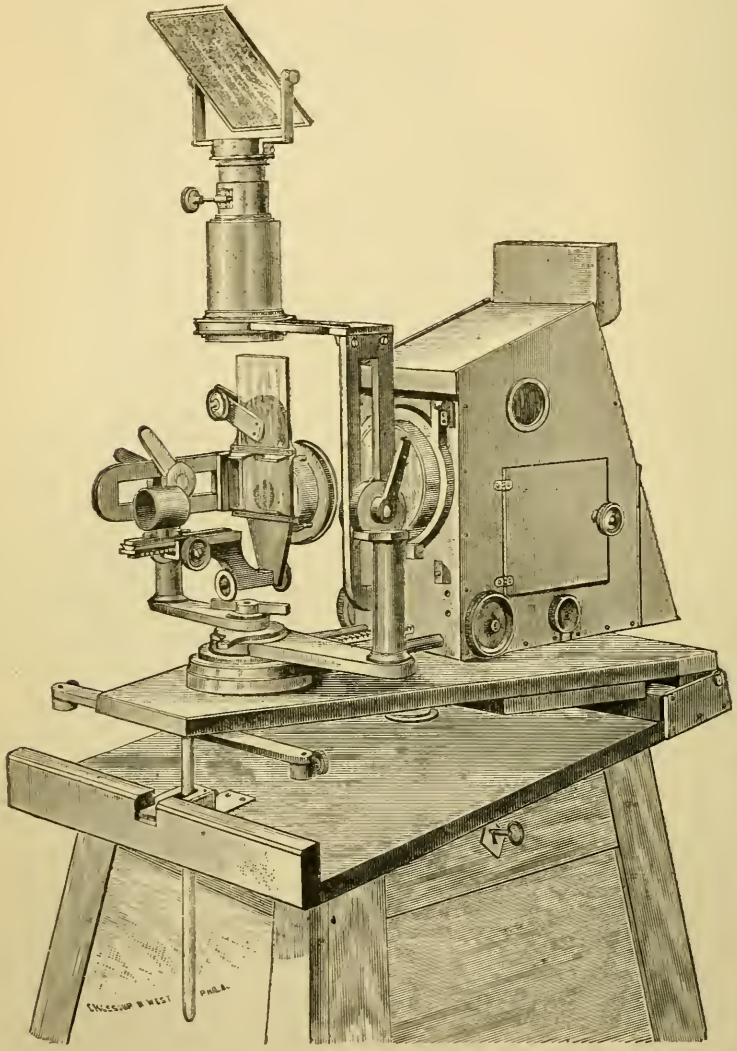
Holman Lantern Microscope.*—Mr. J. A. Ryder describes this instrument (fig. 93) as follows:—

"The instrument illustrated was recently made by Mr. Joseph Zentmayer, of Philadelphia, and presented by subscription to the Franklin Institute. It is the invention of Mr. D. S. Holman, Actuary of the Institute, and is not only adapted to show transparent photographs, but may also be converted, in a few minutes, into a pro-

* Journ. Franklin Institute, cxvi. (1883) pp. 67–9 (1 fig.).

jecting Microscope, polariscope, megascope, vertical lantern, as well as into a table Microscope. The condensers of the lantern are five

Fig. 93.



inches in diameter, and the whole apparatus is constructed in the most substantial way, and every part and accessory is of the best workmanship.

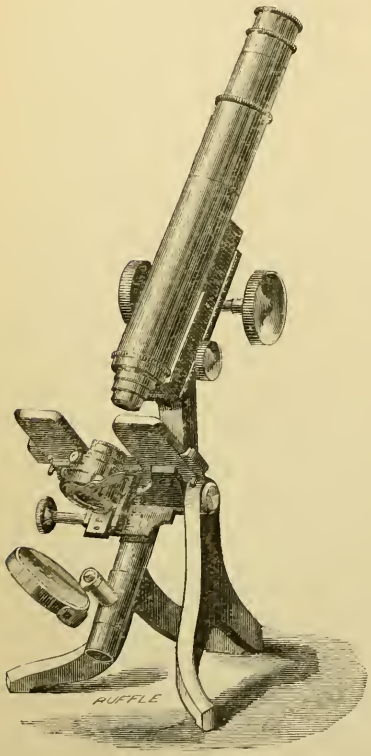
The principal and most important feature of the apparatus consists in making the object to be projected when the apparatus is to be used as a Microscope, or as a megascope, the centre of all the projecting and illuminating apparatus. The lantern-upright which carries the projecting lens or Microscope, and the upright which carries the lens and mirror for the vertical lantern, and the lantern itself, swing around a common centre, which is placed exactly below the centre of the stage on which the object rests. This enables the operator to arrange, with the greatest facility, the relative positions of each of these parts in any desirable position in respect to the object. This feature, it is claimed, has never before been accomplished, and makes the lantern more complete, especially as a megascope. The lantern and jet are movable, independently of each other, by means of racks and pinions. By this arrangement the conjugate foci of the condenser may be changed to suit low and high powers and narrow and wide angle objectives, doing away with all secondary condensers and accomplishing these adjustments better and with much greater facility. The raising and lowering of the lantern is effected by a peculiarly constructed clutch, which rigidly holds the instrument in an inclined position. The instrument is packed in a truncated pyramidal box, containing also the accessories, and forming at the same time a firm stand for the lantern, on which it may be rotated when in use.

In consideration of the fact that the instrument can be used for such a variety of purposes for lecture illustrations, it cannot be regarded as other than a marked improvement upon a similar class of instruments hitherto used for such purposes. In the illustrating and projecting of living forms alone, in conjunction with a number of ingenious devices serving as live cages, Mr. Holman has done a real service for the cause of education. While it is, perhaps, not possible to enter into an elaborate or detailed study of any organic forms of even a moderate degree of complexity, if projected only for a few moments upon a screen, it is, nevertheless, a fact that the correct likeness of such creatures so shown gives the beholder a far truer appreciation of what the things are of which he reads in books than he might possibly obtain elsewhere, provided the lecturer is able to explain in a lucid manner, and unravel the complicated life-histories of the living beings of which he displays enlarged images. In these living animal or perhaps plant-pictures we have displayed two classes of facts, namely, those of type and those of function. To the trained biologist they call to mind the occult processes of growth and reproduction by which the forms become what we see them to be. This implies that a wide range of data is to be considered: first, there is the development and evolution of the form, together with what this indicates as to its systematic relationship; second, the vital actions displayed involve the consideration of physiological processes, and these again those internal quasi-chemical and physical actions and interactions by means of which the creature is enabled to maintain its existence and individuality. If such problems are not worth elucidating, we may ask what others there are which are worthy of elucidation? The physiologist who solves the problem of the life-

actions of an amœba or a maggot has put us in a fair way of appreciating those of a man. If, therefore, better and clearer ideas of animal existence can be fostered in young minds by the aid of any optical appliance whatsoever, that appliance should be welcome as an aid in practical objective instruction. No less effective is this instrument in the illustration of many common facts in physical science. The range of its applicability seems indeed to be limited only by the resources, ingenuity, and ability of the lecturer."

Nelson's Student's Microscope.—Fig. 94 shows a medium-size Microscope, constructed by Messrs. Swift and Son, embodying some suggestions of Mr. E. M. Nelson with special reference to histological research with high powers where only a moderate outlay is allowable.

Fig. 94.

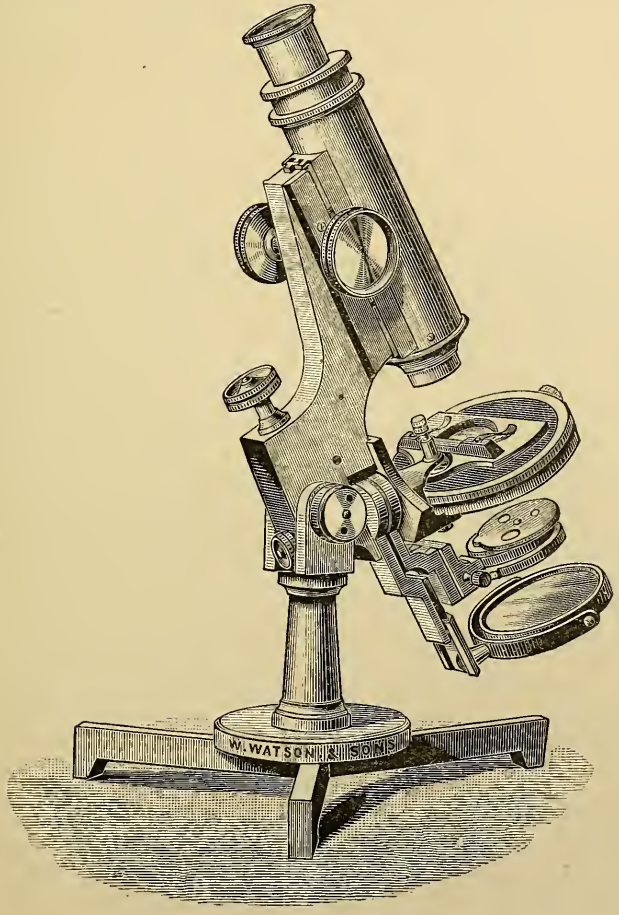


The principal point of novelty is that the front of the stage is cut away so that the position of the substage, with the diaphragms, condenser, &c., may be readily seen from above the stage, and the diaphragms rapidly changed; also permitting the finger to be placed on the upper edge of the slide for safety in focussing with high powers. Amongst other additions it may be noted that finders are applied to the stage by which the position of an object may be recorded without the use of mechanical movements, the graduations for the vertical movement being on the stage plate, and those for the lateral movement on the sliding bar carrying the object. The optical body divides in two for portability. The eye-pieces are fitted with different lengths of tubing, so that the 10-inch length is maintained with each from the diaphragm to the nose-piece, as with Powell and Lealand's Microscopes. Mr. Nelson's centering substage with lateral swinging diaphragm-carrier is also applied (for description and fig. see Vol. I., 1881, pp. 125–6).

Watson's Portable Swinging Mirror and Substage Microscope.—We have always considered Bulloch's Biological Microscope (Vol. III., 1880, p. 1078) to be one of the handiest and most practical forms of

stand made, and equally useful for biological examinations and for the more special examinations of test objects. Hitherto the instrument could only be obtained in America, which was necessarily a drawback to its use in England. Messrs. Watson have now, however, undertaken

Fig. 95.



its manufacture (with some modifications), their instrument being shown at fig. 95.

The fig. shows sufficiently the general form of the instrument: its special feature is that the substage bar and mirror bar are fixed to separate collars, so that they swing separately below and above the stage, the movement of each being independent of the

other. The feet on which the instrument stands are made to close together for portability, so that it occupies a space of $12 \times 7 \times 4\frac{1}{4}$ in.

The slides of the coarse adjustment fit on knife-edges in V-shape grooves, reducing friction, with perfect steadiness and smoothness, and working without loss of time.

The fine adjustment moves the whole of the body of the instrument (instead of the nose-piece only), so that there is no change of distance between the eye-piece and object-glass, and obviating the necessity of altering the collar-correction as the fine adjustment is used—the correction being found once for any given object, no further alteration is required.

The stage is glass and has universal motions, and by a screw-adjustment the friction can be increased or diminished; it is arranged to take off and be replaced by one with mechanical movements if desired.

Altogether the Microscope is likely to be one of the most useful forms for those who do not desire a stand of large size.

Walmsley's Photomicrographic Apparatus.—This simple and inexpensive form of camera (fig. 96), the design of Mr. W. H. Walmsley,* is intended to produce, by the aid of gelatine dry plates and ordinary lamplight, photomicrographs of a high order of excellence, and of almost all transparent objects requiring microscopical examination. It will answer equally well for photographing opaque bodies, if the latter be illuminated by the light of the sun reflected from a silvered mirror.

Any Microscope, monocular or binocular, having an axial joint whereby the body can be inclined to a horizontal position, may be employed. The Microscope is placed upon a base-board 4 feet in length and 9 inches in width, upon one end of which is constructed a platform for holding the camera, of such a height that the tube of the Microscope when inclined shall be precisely in the centre of the camera, which is firmly secured to the platform by a thumb-screw beneath.

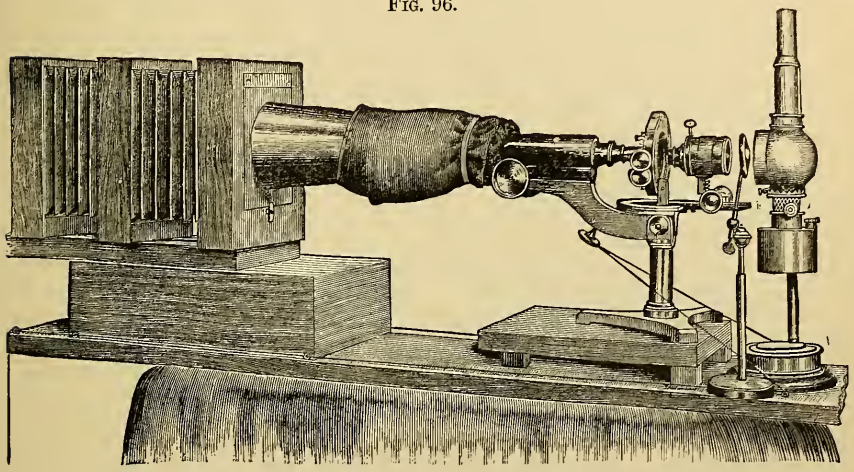
The camera box, which is square to allow a lateral turning of the plates, has a removable cone front, and bellows sliding upon a frame, with an extension of three or four feet, which has been found sufficient for all ordinary work, though it could be increased to any desired extent. A simple form of clamp holds the focussing frame tightly at any point of extension. A second front is provided to replace the one carrying the cone, to which any ordinary photographic lens may be fitted, thus providing an excellent camera for copying or other studio or laboratory purposes. The focussing screen is of glass, with an exceedingly fine ground surface, mounted in a hinged frame, which is turned aside when the plate-holder is inserted. This screen is only used, however, in adjusting and centering the object, the final and delicate focussing being done on a sheet of plate glass, as presently to be described.

* Description kindly supplied by Mr. Walmsley.

The plate-holder (single) is square, opening at the back to admit the plates, which can be placed either vertically or horizontally. The usual size of plate employed is $4\frac{1}{4}$ by $5\frac{1}{2}$ inches, but there is a "kit" furnished also, which permits the use of plates $3\frac{1}{4}$ by $4\frac{1}{4}$—the proper size for lantern positives—which can be very readily made by contact printing from the finished negatives.

Any coal oil or petroleum lamp of good illuminating power, and which can be placed at any desired height above the table, may be used. The Fiddian Illuminator (originally intended for microscopic

Fig. 96.



purposes) has been found admirably adapted to use with the camera, and is the one figured in the illustration. It gives a strong white light through the lens composing its front, all the other rays being cut off by the metallic chamber and chimney containing the flame. It can be raised to any required height, and is recommended as being the best lamp for the purpose.

Although any microscope-stand with axial inclination may be used, Mr. Walmsley finds that those of the size and general form of Beck's National and "Ideal" stands are the best adapted to this class of work. The shortness of tube of the "Ideal" renders it specially valuable, whilst the revolving stage adds greatly to the proper adjustment of the object in the centre of the focussing screen, and the substage carrying an achromatic condenser is almost indispensable. A mechanical stage will also be found to greatly facilitate the necessary manipulations, though the very simplest form of stage, with clips, will, with a little care and patience, answer every requirement.

In using this apparatus, the base-board is to be placed upon a

solid table and the camera firmly secured to the platform, as shown in the illustration. The Microscope (from which the eye-piece has been removed, and the tube, lined with a roll of dead black paper) is to be inclined to a horizontal position and firmly secured to the board by turn-buttons, with the end of the body inserted in the cone front of the camera, about the joining of which a piece of black cloth or velvet is to be wrapped to exclude all extraneous light. The lamp is now to be lighted and raised to such a height as will bring the flame exactly even with the centre of the stage, the direct light being used without the mirror, which must be removed. It is presumed that the proper object-glass has already been attached to the microscope-body, and that an achromatic condenser has likewise been inserted in the sub-stage. A Kellner eye-piece answers admirably for this purpose. A secondary condenser is sometimes necessary between the lamp and stage, as shown in the woodcut, to secure a bright and even illumination all over the focussing screen. This accomplished, the object to be photographed is placed upon the stage, secured in position by the clips or slides, and focussed, which is readily done with the coarse adjustment, for the bellows of the camera being still closed, one can observe the image on the screen and manipulate the milled head of the adjustment at the same time.

The image having been accurately centered on the screen, the bellows is to be extended until the desired magnification is reached, when it will be found that its sharpness is considerably reduced, whilst the screen has been removed so far from the object that it is impossible to readjust the focus and observe the image at the same time without some special appliance, controllable from the screen end of the camera. A very simple contrivance has been adopted in this case, which works with the utmost smoothness and delicacy. A groove is turned in the periphery of the fine adjustment screw, around which a small cord is passed, and carried through a succession of screw-eyes on either side of the base-board to the rear, where a couple of small leaden weights are attached to its ends, thus keeping the cord tant. A very slight pull on either side, whilst the eye is fixed upon the image on the screen, suffices to adjust the focus with the utmost exactness. A glance at the illustration will show the arrangement of this focussing cord, which is applicable alike to stands having the fine adjustment screw on the nose-piece or at the rear of the compound body.

Since no ground-glass has a sufficiently fine surface to admit of really sharp focussing of the image, with even moderately high powers, the final adjustment is made as follows:—The front and back of the plate-holder having been removed, a sheet of plate glass the size of the gelatine plate to be used is inserted, and the holder adjusted to the camera, when, by means of a focussing glass placed against the outer surface of the plate, a sharp and accurate adjustment can be made in a moment, after which nothing remains to be done toward securing the negative but to substitute (in the dark room) a sensitive plate for the plain glass, attach the holder to the camera, and make the exposure.

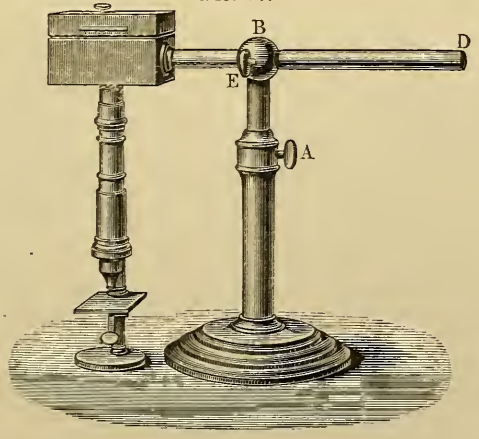
Gelatine plates, possessing the two qualities of extreme sensitiveness and great density after development, are essential for the production of the finest negatives by the foregoing process. The brands known (in America) as "Beebe," "Eastman Rapid," and "Carbutt's Special" combine these qualities in an eminent degree, and are recommended accordingly. Either ferrous-oxalate or pyro-developer may be used with equal success, but they should be strong and active, as a rapid development is necessary to the best results. If ferrous-oxalate be employed, it should be made quite acid with citric or oxalic acid.

It having been found by actual work that the chemical and visual foci of the rays from a lamp are almost exactly coincident, there is no need of employing specially corrected objectives with this apparatus. And the following table of exposures with Beck's objectives may be depended upon as an accurate basis for work with the average of objects to be photographed:—

$1\frac{1}{2}$ inch, 2 to 3 minutes.	1-5 inch, 8 to 12 minutes.
2-3 „ 3 „ 4 „	1-10 „ 15 „ 20 „
4-10 „ 7 „ 10 „	

For opaque objects, illuminated by sunlight, exposures of six to twenty seconds, depending upon the power employed and reflecting qualities of the specimen itself, will generally be found sufficient.

Fig. 97.



Hauer's Photomicrographic Apparatus.*—This (fig. 97) is a very simple method, devised by Max Hauer, of combining a camera with the Microscope. The standard which carries the cross-bar D slides vertically in the hollow pillar, and can thus be set (by A) at any

* Dippel's 'Das Mikroskop,' 1882, pp. 576-7 (1 fig.).

desired point in a vertical direction. The cross-bar also slides through B, so that it can be set (by E) at any point in a horizontal direction. The camera is fixed to one end of the bar. It has an opening on its lower side, to which is attached a piece of tube, into which the eye-piece end of the Microscope passes. To keep out the light, a broad indiarubber band can be passed over the point of junction.

Seibert and Krafft's Small Camera Lucida.—This (fig. 98) is but an unimportant variation of the apparatus of Nachet and others, though somewhat cheaper. Two reflecting plates at *a* and *b* are inclosed in a small box, open below, and with an aperture at *c*. A portion of the reflecting surface is removed at a point *d* concentric with the optic axis, so that the direct rays, *h*, from the object are seen through the apertures at *d* and *c* at the same time as those, *g*, from the paper. The camera is supported on the pillar *e*, and is attached by the ring *f* to the body-tube.

Fig. 98.

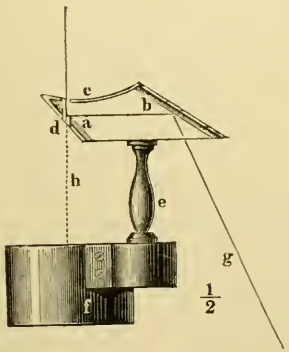
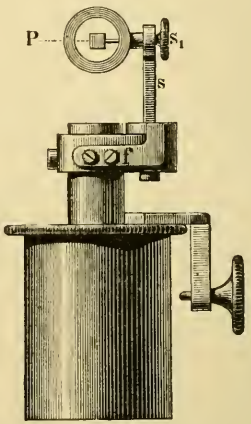


Fig. 99.



Winkel's Small Camera Lucida. — This again (fig. 99) is not distinguishable in principle from Oberhauser's apparatus.* A small right-angled prism P is protected by a ring and attached to a No. 2 eye-piece. The prism fastening can be turned on *s*, and centered by the spring *f*. It is inclined on its horizontal axis by means of s_1. The prism projects the image of the object upon the drawing-paper inclined at an angle of 45°, the pencil being viewed direct.

Correction of the Distortions produced by the Camera Lucida.† —The following is a translation, somewhat abridged, of Professor L. Malassez's paper on this subject. It was directed specially to the

* Cf. this Journal, ii. (1882) p. 680.

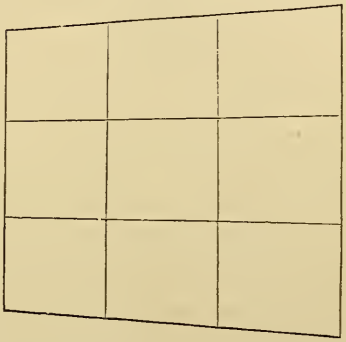
† 'Laboratoire d'Histologie du Collège de France, Travaux de l'Année 1877–8, publiés sous la direction de L. Ranvier, Professeur d'Anatomie générale' (8vo, Paris, 1879), p. 188.

camera lucida of Milne-Edwards and that of Nachet, but so far at any rate as the latter is concerned, the supposed distortion does not exist, at least it cannot be detected by the micrometer. The paper may, however, be of interest from a theoretical point of view.

"1. *Nature of the Distortions.*—These cameræ lucidæ which are so convenient and so generally employed have the grave inconvenience of giving drawings which do not exactly reproduce the form of the objects drawn, assuming, that is, that the Microscope and the paper are in their usual position—the Microscope vertical and the paper placed on the table or on any other horizontal plane.

To be assured of this fact draw, for instance, a series of parallel and equidistant lines like the divisions of an object micrometer. Then if the micrometer is placed transversely on the stage of the Microscope, so that the divisions are directed from front to back in the drawing, we shall see that the lines drawn will no longer be equidistant; they will be the wider apart according as they have been drawn at a greater distance from the foot of the Microscope. If the micrometer is placed so that the divisions are transverse in the drawing, the lines will no longer be parallel; they will diverge from the foot of the Microscope (fig. 100).

Fig. 100.



If we draw a square, we shall obtain a trapezium, a quadrilateral figure of some kind more or less irregular according to the position of the square on the stage of the Microscope, but never a perfect square. A circle will never give a circle, but always an ovoid, &c.

These distortions are little noticeable so long as the parts drawn occupy only a small portion of the field of view, and so they may be disregarded if absolute exactness is not required. But if the microscopic field is large, the distortions are considerable. A square, for instance, has given me a trapezium, the small base of which was 114 mm., and the sides 136. There were therefore differences in the drawings of equal lines (the sides of a square) amounting to 22 in 114, exceeding 19 per cent.

We see therefore to what errors we may be exposed if we use such drawings for exact measurements—measurements of the histological elements, of magnifying power, &c.

2. *Cause of these Distortions.*—The distortions are due to the fact that in these cameræ lucidæ the two surfaces at which the total reflections take place are very close to one another, so that the reflection upon the table is not made along a vertical axis. In fact, if it were so, a part of the image would be seen on the stage and foot of the Microscope, and could not be received on the paper: such an obliquity

must therefore be given to the axis of reflection, as that the microscopic image shall be brought completely outside the foot of the Microscope.

But the axis of reflection not being vertical—not being consequently perpendicular to the surface of the table, the microscopic image is formed on a plane which is obliquely inclined to the optic axis; whilst the object itself being on the stage of the Microscope, is on a plane perpendicular to the object axis. The result of this is that the relative distances which exist between the eye and the various points of the drawing are different to those which exist between the eye and the corresponding points of the object.

Consider, for instance, two points of the object equally distant from the axis. These two points will necessarily be at equal distances from the eye, whilst in the drawing the corresponding points will be at unequal distances, that on the right being further from the eye than that on the left. These differences will be produced so long as the plane of the drawing is not, like that of the object, perpendicular to the optic axis.

By comparing the position of the table with that of a plane which is perpendicular to the axis, and meeting the table near the foot of the Microscope, we can exactly determine the differences which the relative distances introduce. The table is the further from the plane according as it is further from the Microscope, and the result of this is as if the different parts of the drawing had been made on planes perpendicular to the axis, but more and more distant from the eye.

But as the amplifications of the drawings obtained by the camera lucida are larger according as they are received at greater distances from the eye, it follows that in a drawing made on the table the amplification would increase without limit in proportion as the drawing is distant from the foot of the Microscope.

This explains the results of the experiments above mentioned. If with the cameræ lucidæ of Milne-Edwards and Nachet the divisions of a micrometer are the wider apart, according as they are drawn in positions further from the Microscope; if a square gives a trapezium, a circle an ovoid, the large base of the trapezium and the large extremity of the ovoid being on the right, it is because from the construction of these cameræ lucidæ the amplification of the drawing increases from left to right in proportion as it is further off from the foot of the Microscope.

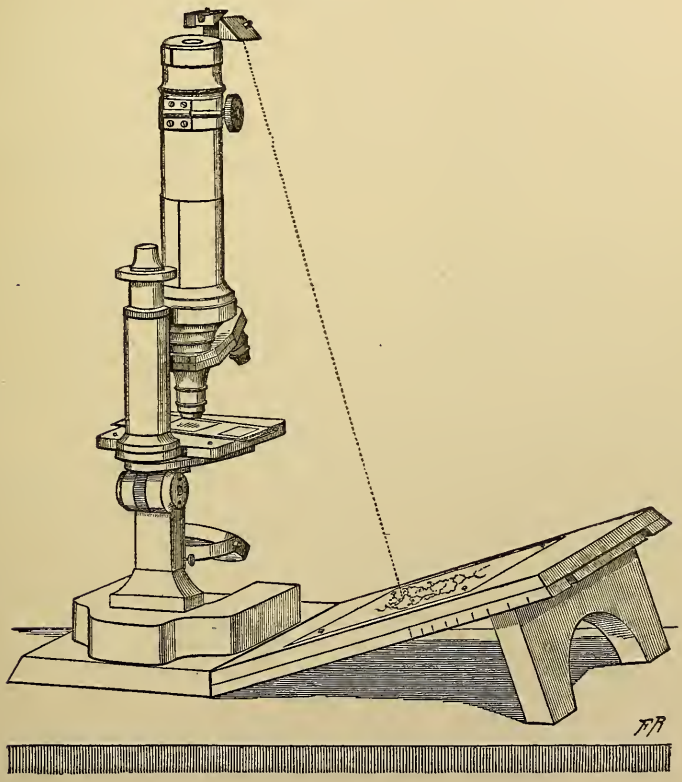
3. *Means of Correcting these Distortions.*—I assume that it is not desired to change the construction of the cameræ lucidæ. It is plain from what has been said, that to obtain a drawing like the object it is necessary that the microscopic image should be collected not on a plane oblique to the optic axis, but on one perpendicular to it.

It is easy to fulfil this condition. Two methods may be employed —(1) Either incline the Microscope so that the axis of reflection becomes vertical, or (2) leaving the Microscope in its ordinary position, draw not on the table but on an inclined plane, the inclination being such that this plane may be perpendicular to the axis of reflection.

I have tried both these methods. The first has certain advantages, in that it allows the drawing to be made on the table or other horizontal plane, and also that the eye looks in the direction of the pencil. But the inclination of the Microscope is not without practical difficulties. It requires a special arrangement in order that in this position the instrument may preserve a sufficient stability (I except, of course, Microscopes made to be inclined, which can be readily adapted to this purpose). This process, moreover, cannot be employed when it is desired to draw preparations which contain moving parts, or otherwise require to be kept horizontal.

With the second method it is necessary, it is true, to draw on a

FIG. 101.



plane which is not horizontal, and the hand is therefore outside the direction of sight, which is less convenient; but by way of compensation the process may be applied to any Microscope whatever, without its being necessary to modify its position or construction. All that is required is an inclined plane whose inclination may be varied at

pleasure, all the cameræ lucidæ not sending the image in the same direction according to the same angle. It is necessary also that this plane should be able to maintain a fixed position relatively to the Microscope, so that the agreement between the drawing and the microscopic image may be preserved during the whole process. Such a plane may be made in many different ways. The following is the one which I prefer:—

Inclined Drawing-board.—This board (fig. 101) is composed (1) of a horizontal part on which the Microscope is placed, (2) of an inclined part on which the drawing is made, and (3) of a bracket, which serves to maintain the inclination of (2).

The bracket is not fixed to the inclined part, but is carried by a slide, which, guided by grooves, may be pushed more or less under the inclined part, and so raise it. In these movements the bracket passes before a graduated scale at the margin of the board, which indicates the degree of inclination obtained. The slide may be completely drawn out of the grooves so as to allow a drawing, the outline of which has been made at the proper degree of inclination, to be completed in a horizontal and more convenient position. Moreover, if it is necessary to refer again to the cameræ lucidæ, the slide and the bracket may be replaced exactly in the same position by means of the scale.

The horizontal part of the board is fixed to the inclined part by hinges, which enables the inclination of the latter to be varied as desired, whilst at the same time keeping it in a constant relation with the Microscope so that the coincidence is maintained between the drawing and the microscopic image. The position in which the drawing was made may be easily found again by means of marks.

The different pieces of this board may be folded upon each other to make it more portable, and when folded it forms a square with sides of about 18 to 20 cm. and 3 cm. in thickness.

Modified Table of M. Künckel d'Herculais.—Where it is necessary to make the drawing at given heights above the table (for the measurement of the magnifying power, for instance), I modify slightly the excellent drawing table of M. Künckel d'Herculais (fig. 102).

This is composed of a board resting on a base formed of a double box. The box on which the board is fixed may be raised more or less from the other. Two screws keep it firmly in any given position. The board may thus be more or less elevated as desired. In order to incline the board, all that is necessary is to fix it, by hinges on one of its sides, to the box on which it rests, and then to raise more or less the opposite side by means of a movable bracket or other means.

4. *Determination of the Degree of Inclination.*—Whatever may be the apparatus employed, the important point is to give the appropriate inclination to the plane on which the drawing is made, and to determine this inclination I have employed two processes.

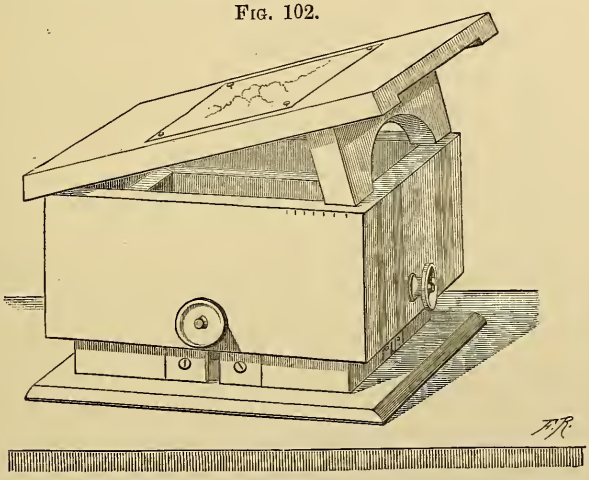
The first, entirely empirical, consists in laying down on the drawing-paper a given length, a micrometric division, for example; then to modify little by little the inclination of the inclined plane until the division being shifted about in the different points of the field of view

always gives a drawing of the same length. It is necessary in this process to use objectives thoroughly aplanatic.

In the second process we simply determine the direction of the optic axis in its path from the camera lucida to the table. This direction being known, we shall evidently know the inclination which it is necessary to give to the board so that it may be perpendicular to the optic axis.

How is the direction of the optic axis to be determined? Being a straight line, it is sufficient to know two points of its path, and this may be obtained in the following manner:—Selecting a very limited point of the field of view and as central as possible, the crossing of two lines of a micrometer in squares, for example, this point is trans-

FIG. 102.



ferred to the drawing-paper. The latter is placed successively at two different heights—on the table, for instance, and then on a box. When the paper is placed on the table, the point by virtue of the obliquity of the axis naturally falls further from the foot of the Microscope than when it is higher, on the box. We ascertain then very exactly (1) the distance between the verticals passing through the two points, and (2) the distance between the horizontals passing through these same points (the height of the box). Then we construct a right-angled triangle having for height the distance between the horizontals, and for base the distance between the verticals. The hypothenuse of this triangle will evidently give the direction of the optic axis.

To find that of the inclined plane, it is sufficient to take any given perpendicular to this hypothenuse, or, what is still simpler, to reverse the triangle, making the base the height, the inclination of the hypothenuse being then that which the board ought to have. This may be readily understood, since the angle which the inclined plane makes with the horizontal is evidently equal to that which the optic

axis makes with the vertical, for this angle is no other than that which the apex of the triangle formed before it was reversed.

The first of these methods is very easy to execute, but it requires much time and patience on account of the numerous trials which it necessitates. The second is very easy also, and much quicker, since it gives at once the result sought. I therefore prefer it, but in order to be quite sure that no error has been committed, it may be checked by the first.

When the plane of the drawing is very exactly perpendicular to the optic axis, all the distortions will disappear. Equidistant lines will remain so, squares will remain squares—in a word, the drawings will be faithful copies of the objects. This correction is very striking when we employ the drawing-board above described. If the board is horizontal, all the distortions are produced; when it is suitably inclined, they immediately disappear.

We may therefore, without changing in any respect the cameræ lucidæ of Milne-Edwards and Nachet, obtain with these instruments drawings as exact as possible.

Are these facts known? I believe so, and in a previous article* I have been content to allude to them; but having seen that they were not noticed in our classical authors, I have thought it well to direct the attention of microscopists to them."

Mr. R. Hitchcock, in a discussion on the relative merits of the Zeiss (double prism) and Grunow cameræ lucidæ, adds some remarks† concerning the distortion produced by the two forms. A stage-micrometer ruled in hundredths of an inch, and a 2-3rds in. objective were used.

The Grunow instrument was first used, the inclination of the stand being, in two different experiments, 30° and 40° from the vertical.

1. Inclination 30°, lines of the micrometer running vertically across the field.

The diameter of the field projected upon the paper was, approximately, 7 in. The distance between the lines, near the margin of the field nearest the Microscope on the paper was 1·03 in.; at the margin furthest from the stand it was 1·15 in. Hence the difference in magnification at the two extremes of the field was 12 diameters.

2. Inclination 40°. Repeating the same experiment under this inclination, the results were respectively 95 and 100 diameters; difference, 5.

Zeiss' camera lucida, inclination about 13°. As only half the field was projected on the paper, the lines had to be extended across to 7 in. to make the results comparable with those of the Grunow.

3. Lines vertical. Magnification at the extremes of a field of 7 in. diameter, respectively 104 and 113; difference, 9. This is greater than with the Grunow, but the actual distortion of vertical lines produced by this camera is only 4·5 at the greatest.

4. Lines horizontal. Owing to the small field visible, only two

* *Infra*, p. 567.

† Amer. Mon. Micr. Journ., iv. (1883) pp. 43–5 (2 figs.).

contiguous spaces were measured, showing an increase from the centre outward of 3 diameters.

The above figures should not be considered as absolutely accurate, but approximately correct—sufficiently so to illustrate the subject.

The Grunow instrument shows the entire field of view on the paper. Measuring from the middle of the surface of the prism to the margin of the field on the paper, we find the angle of view to be 16·5°, the margin nearest the Microscope being only 3° from the vertical, the centre being 17° from that margin, and 14° from the opposite side. Hence, the distortion produced diminishes slightly toward the centre from either side; but the real difference from side to side is shown by the above results.

The Zeiss instrument only gives half the field; but the centre is almost directly beneath the centre of the face of the prism, 3·5° from the vertical, hence the distortion is about equal on either side of the centre, and does not increase from one side to the other as in Grunow's instrument. Such being the facts, a camera lucida should, the author thinks, be used with great discretion in making drawings for purposes of measurement—as, for example, in drawing blood-corpuscles for microscopical expert testimony. He does not think, however, the distortion produced is of very great consequence in most cases. It is only when large objects are to be drawn or measurements to be made that it deserves serious attention.

Measurement of Microscopical Magnitudes.—The article which Professor Melassez refers to above is contained in an earlier portion of the same volume,* in which he states his view that the different processes for measuring the linear magnification of objects seen under the Microscope give only approximative and inexact results, and after describing briefly the two methods generally employed, viz. the micrometer eye-piece and the camera lucida, he proceeds to consider the causes of the want of exactness proper to the latter, and explains how, by modifying it slightly, its errors may be corrected.

In the following diagram (fig. 103) A B is the object† of unknown dimensions on the stage of the Microscope, C D the camera lucida, O the optic centre of the eye. Unite by lines the point O to each of the extremities of the object A B, and draw the visual rays which, starting from the point O, follow at first the direction of the rays O A and O B, but which, instead of going through the camera, are reflected at C and at D, and then pass out of it. We know that by interposing a sheet of paper in the path of these rays we are able to see and to draw on the paper the image of the object A B. *a b* is the drawing obtained at a distance from the eye equal to that of the eye from the object; *a′ b′* that obtained at the distance of distinct vision; *a″ b″* that obtained on the table on which the Microscope stands. As is shown in the figure, the drawings will be the larger as the paper is further from the eye, although the image in all these positions always appears of the same size to the person drawing, which is due to the fact that

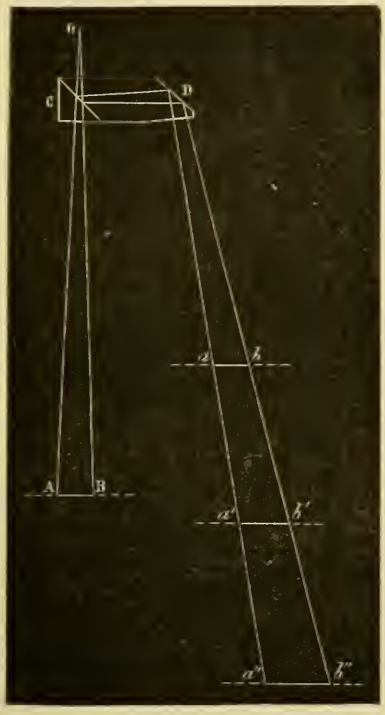
* Ranvier's Travaux, p. 114.

† Strictly speaking, A B is the *image* of the object.

it is always seen under the same angle, and corresponds to a retinal image of the same size.

Let us now suppose the image to be received at the distance of distinct vision, and let us see what, in these conditions, are the relations which exist between the dimensions of the object A B and those of the drawing $a'b'$.

Fig. 103.



Observe in the first place that A B and $a'b'$ form the base of two similar isosceles triangles, O A B and O $a'b'$; but in order that the bases may be equal, it is necessary that the altitudes should be so also, that is, that the distance of the drawing from the eye should be equal to that of the eye from the object. Is this so in practice? Certainly not, or at least very exceptionally. Indeed, if the distance of the drawing from the eye is constant (the distance of distinct vision), that of the eye from the object is very variable. It varies according as the tube of the Microscope is more or less raised above the stage, and thus varying it may be either greater or less than that of distinct vision.

If the distance of the drawing from the eye is greater than that of the eye from the object, which is the usual case with our ordinary Microscopes with short tubes, the drawing $a'b'$ will be necessarily larger than the object A B. If it is less, on the contrary, the drawing will be smaller.

A calculation may serve to give an idea of the extent of these variations. Let us suppose an object of 10 mm. in diameter at a distance of 20 cm. from the eye. Take for the distance of distinct vision 10 Paris inches, say, 27 cm., and calculate what will be the diameter of the drawing. In the similar triangles O A B and O $a'b'$ the bases being proportional to the altitude, we shall have

$$\frac{x}{10} = \frac{27}{20}; \quad \therefore x = 13{\cdot}5 \text{ mm.}$$

Suppose, on the contrary, that the distance of the eye from the

object is 30 cm., we shall have for the same object of 10 mm. in diameter a drawing having the diameter x',

$$\frac{x'}{10} = \frac{27}{30}; \quad \therefore \; x' = 9 \text{ mm.}$$

Thus an object of 10 mm. may, according to the arrangement of the instrument, give at the distance of distinct vision either a drawing of only 9 mm., or one of $13\frac{1}{2}$ mm. These are not exaggerated cases selected for the express purpose of making the variations greater, but are such as are habitually met with, and we may even observe still greater ones.

The following is one mode of remedying these errors. Remove the eye-piece and objective (having taken the measure of the amplification), and replace the camera lucida exactly in its original position, that is to say, at the same distance from the stage of the Microscope; then ascertain experimentally the increase or diminution produced by the image being referred to the paper, and thus by a very simple calculation we can correct the result previously obtained.

Suppose, for example, that we had found by the old method a magnification of 270 times for a given optical system, and that having applied the above method we find that 10 mm. referred to the paper gives an image of $13\frac{1}{2}$ mm. The magnifying power of the optical system having been increased 1·35 times, it is therefore in reality 1·35 times smaller than that which we obtained, i. e. $\frac{270}{1 \cdot 35}$ or 200.

This correction may be applied whatever is the distance at which the drawing is made, and it therefore becomes entirely useless to make it at the distance of distinct vision. The paper should be placed on the table which carries the Microscope, the magnification measured as usual, and then corrected in the mode above mentioned.

This method has the inconvenience of requiring two very delicate experimental operations, which have to be undertaken at each examination; but by modifying in another way the old method, we may avoid this and obtain directly the magnification produced by any given optical system.

It is obvious, in the first place, that if the eye-piece and objective are removed, and the paper is placed on the table at $a'' b''$, the drawing will be much larger than the object. Since the triangle O $a'' b''$ is of greater altitude than the triangle O A B, its base $a'' b''$ will necessarily be greater than the base A B. But if we raise the paper little by little, the drawing will diminish proportionately, and finally a point will be reached where the drawing will be exactly the same size as the object. It is the point where the two triangles O $a b$ and O A B become equal, where their altitudes being equal their bases are equal also.

The position being found in which the drawing and the object are equal in diameter, this equality continues whatever the changes in the tube of the Microscope. In raising or lowering the tube we increase or diminish by equal quantities the altitude of the triangles O A B

and O *a b*, and being equal, their bases enlarge by equal quantities. It would not be the same if the paper was in any other position.

If we now replace the eye-piece and objective, the enlargement which the drawing will have will be produced entirely by the optical system formed by the eye-piece and objective, and that will be true whatever is the length given to the tube of the Microscope.

As we see, this process consists in referring the microscopic image to paper which is no longer placed at the distance of distinct vision as in the old method, nor on the table which carries the Microscope, as in the process above indicated—positions which all require corrections —but at a distance from the eye equal to the distance of the eye from the object.

How is this position to be determined? The surest way is to find it experimentally by varying the position of the paper until the drawing and the object are of equal size (the eye-piece and objective being removed). If to refer the image to the paper we utilize the phenomenon of double sight (*double vue*), the paper must evidently be placed at the height of the stage, assuming that the sight is exactly similar in the two eyes, which is not always the case. If we employ the camera lucida, the paper must necessarily be placed higher than the stage, because the double reflection and the refraction which the visual rays undergo in the camera produce a diminution in the direct distance between the eye and the paper. With the new camera lucida of Nachet, for instance, the loss being about 3 cm., the paper must be placed 3 cm. above the stage of the Microscope. For greater exactness the paper must, of course, be raised on one side, as previously described.

Simple and Cheap Eye-piece Micrometer.*—Mr. W. M. Bale points out how a simple but efficient eye-piece micrometer for ordinary work may be constructed without any expense, except of a little time and patience. The material is fine silk, a single fibre of which is not perceptibly thicker than a cobweb, and is far less difficult to manipulate. It may be ravelled out of a ribbon; a corded ribbon, in which the transverse threads are straight, and woven over by two series of longitudinal threads, is better than an ordinary one, in which the threads of the warp and woof have acquired a series of "kinks" which are difficult to get rid of. The best eye-piece for the purpose is a C or D. The method of procedure is as follows:—

Unscrew the field-lens, and at two opposite points on the under side of the diaphragm (not close to the edge) apply minute spots of rather stiff balsam. Cut a piece of the silk fibre about as long as the diameter of the eye-piece, and with the forceps place one end of it in contact with one of the spots of balsam, to which it will adhere, after which the other end is similarly attached to the opposite spot of balsam. With a pointed but blunt penknife the two ends are pressed well into the balsam and drawn apart till the line is "taut,"

* Southern Science Record, iii. (1883) pp. 13-16.

the balsam being at the same time spread out and made drier and stiffer. The field-lens is now screwed in, and the eye-piece held to the light and examined, to see if the thread is straight; and if it be found to have in it a number of small flexures due to the weaving, it is best to replace it by another. So far there is no particular difficulty, but the next step, which is to attach another fibre parallel with the first and very close to it, is rather a delicate operation, as it must be done without disturbing the first, and the distance apart of the two must be regulated with the utmost nicety. This distance will of course depend on the space to be measured; assuming that it is desired to measure 1-1000th in. with a C eye-piece and a 1-4th in. objective, it will be about 1-30th in. The field-lens having been replaced, the eye-piece is inserted in its proper position, and a stage-micrometer laid on the stage, with the thousandth divisions in the field (under the 1-4th in.); the eye-piece being now placed so that the silk lines are parallel with the ruled lines on the stage-micrometer, it can at once be seen whether the fibres are too close or too distant. If either is the case the field-lens must be removed and one of the fibres shifted, which may be done without much difficulty with the blunt-pointed penknife, pressing down the ends in the balsam and at the same time gently rolling them almost imperceptibly to one side. The field-lens is again replaced and the eye-piece placed in position and examined, and if necessary the operation repeated till the two fibres are exactly coincident with two of the lines on the stage-micrometer, when the space between them, as seen on the magnified image, will represent 1-1000th in. I have fixed a third line at the same distance as the second from the central one, or 1-100th in. from each other. These last two threads are near the opposite sides of the diaphragm, their actual distance apart being about 7-16ths in.

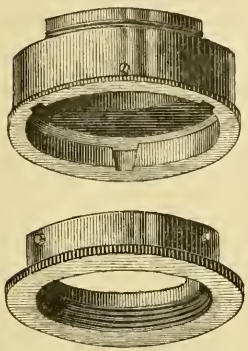
Finding the balsam scarcely sufficient to keep the fibres tight I cut very small narrow slips of postage-stamp paper, moistened them, and fastened down the ends of the fibres with them, at the same time pulling them "taut," with a slight pressure, but taking care not to move them laterally; there is a good deal of risk, however, of the latter, and as the mucilage dries immediately, it will be necessary, should the fibres prove on examination to be displaced, to remove the paper forcibly, most likely breaking the fibre, and necessitating its renewal. The dots of balsam being placed well back from the margin of the diaphragm, there is room for the attachment of the slips of paper between them and the edge. If a transverse line is desired crossing the others, it is best to fix two fragments of the paper on the opposite sides of the diaphragm, and mount the ends of the thread *upon* them (fastening them down with other pieces), so that the fibre is clear of the others, and there is no risk of dragging them out of place in attaching it.

The eye-piece, as described, gives direct measurements of 1, 2, 4, 5, 6, and 10 thousandths of an inch. The lines on an ordinary stage-micrometer appear with the 1-4th in. fully six or eight times as thick

as the silk fibres, and the latter should therefore be made to coincide with the centres or corresponding edges of the ruled lines; it is, however, impossible to attain perfect accuracy unless the stage-micrometer be much more truly divided than those in ordinary use.

Nelson's New Nose-piece Adapter.—Mr. E. M. Nelson has devised a new form of adapter (fig. 104), for rapidly changing objectives, founded on the principle of the bayonet-joint. A collar is screwed upon the objective furnished with three radially disposed projecting pins placed at equal distances apart. The adapter, which screws into the nose-piece, is provided with three internal annular slightly sloping grooves and three vertical notches. The pins are slipped up the notches and a partial turn given to the objective secures it firmly in place.

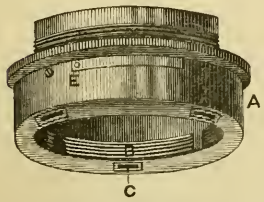
Fig. 104.



Curties' Nose-piece Adapter.—Fig. 105 shows the first rough model of this device, which is designed as an improvement on Pease's "Facility" nose-piece (*ante*, pp. 425–6).

The nose-piece screws on the Microscope by the usual "Society" screw shown at the top, and may remain there permanently. A is a box, or cap, fitting over three equal segments B of a ring having the "Society" screw on the inner surface. Each segment has on its upper edge a grooved tooth working against a flat spiral, and on its lower edge a guide-piece C passing through a slot on the edge of A. The rotation of A acting on the guide-pieces forces the segments to travel in the spiral, in one direction moving them towards the periphery, consequently expanding their circle, so that the objective may be slid in, and in the other direction causing them to move towards the centre when they grip on the threads of the objective. E is a fixed pin to limit the rotary motion of A.

Fig. 105.



With this device no alteration is required to the usual brass-work of the objectives. Any objective having the "Society" screw can be slid into the nose-piece at once, when one-sixth of a turn of A to the left will cause the segments to grip it in place, whilst the reverse movement will release it.

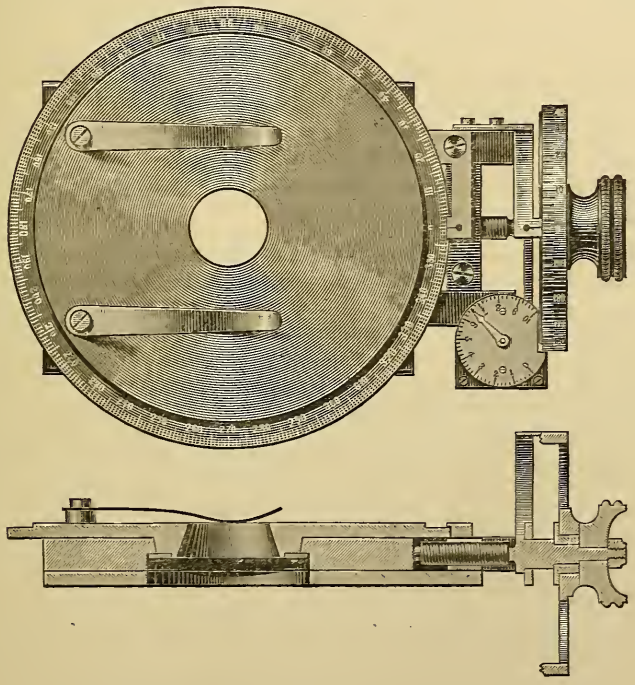
The objections to the nose-piece appear to us to be, 1st, the difficulty of centering,—the segments have to be made so loose, that there can be no good centering; and, 2ndly, the liability to injure the thread of the objective through there being no provision to insure

the position of exact correspondence of the outer and inner threads. This is apart from the objection common to all these forms of adapter, that they are liable to let the objective drop off when the adjustment-collar is turned, especially if it moves somewhat tightly.

Zeiss's Stage-Micrometer.—This micrometer (fig. 106) is intended more particularly for the measurement of objects, the whole of which cannot be seen in one field of view.

The upper plate is graduated, and rotates on the middle plate.

Fig. 106.

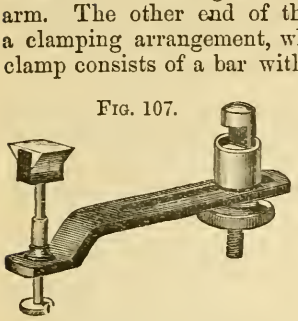


The latter is moved laterally on the lower fixed plate by the screw shown on the right. The number of whole turns of the screw is registered on the small dial with index, by means of an endless thread on the periphery of the drum, working on a toothed wheel on the same axis as the index, while parts of turns are shown by the graduations on the drum of the screw.

Queen's Holder for Woodward's Prism.—Fig. 107 shows an arrangement issued by J. W. Queen and Co., of Philadelphia, for readily applying the Woodward prism. The prism is mounted between jaws

attached to a sliding and rotating rod carried at one end of a bent arm. The other end of the arm has a slot 1½ in. long fitting on a clamping arrangement, which can be attached to the stage. The clamp consists of a bar with a notch cut in its upper end, and with a short piece of tube fitting over it. The bar is pushed up by a spiral spring, but when the milled head beneath is turned, it is drawn down within the tube, thus shortening the length of the notch correspondingly with the thickness of the stage. The slot enables the arm to be moved so that the prism may be adjusted in the optic axis with varying diameters of stage.

Fig. 107.



The hemispherical lens might be substituted for the prism, which, indeed, we think, would be found more generally useful.

Impromptu Condenser.*—Prof. Rindfleisch suggests that the absence of a condenser may, on emergency, be supplied by a drop of distilled water placed on the lower surface of the slide, where it will act as a convex lens.

Illumination by Sunlight.†—Dr. J. Edwards Smith says that "in the study of very minute and delicate structures requiring the utmost separating or resolving power of the objective, remarkable effects are to be secured by condensing sunlight *on the top* of the object by means of the concave mirror, the object being mounted with a cover in the usual way. The objective used should, of course, have wide aperture. The mirror being posed slightly above the level of the stage, the sunlight is thrown on the surface of the cover, and making a very acute angle therewith. Although not absolutely necessary for this purpose, those stands furnished with swinging substages, allowing the mirror to rise above the level of the stage, are extremely handy and convenient. By the employment of this illumination in conjunction with object-glasses of wide apertures, the most difficult diatoms, such as *Amphipleura pellucida*, *Frustulia saxonica*, &c., are easily and forcibly displayed."

Monochromatic sunlight is procured most easily as follows: cut with a diamond, or a point of a file, a small piece of blue glass roughly to fit the *cap* of the eye-piece, so that when the cap is restored to its place the blue glass shall be between the eye and the eye-lens of the eye-piece, and the light is thus modified before it reaches the eye. This is the handiest method of obtaining monochromatic light he has ever tried, and the resolutions are quite as strong and effective as when the cupro-ammonia cell is used in the usual manner. In working with sunlight care should be taken to exclude the full strength of the solar beam; that is, if the sun be clear and bright.

* 'Berliner Klinische Wochenschrift,' 1883, p. 183, but the above noted from Bizzozero's 'Manuel de Microscopie Clinique,' French transl. by Dr. C. Firket, 1883, p. 333.

† 'How to See with the Microscope,' 1880, pp. 186–7, 191–2.

Too much light, supposing the manipulations are tolerably well attended to, will be manifest by the appearance of a multitude of diffraction lines, and these, as a rule, may be recognized by their extending beyond the objects observed. Under very high amplifications, involving the use of powerful eye-pieces, we can, of course, make use of a little more of the solar beam.

Another method of sunlight illumination will be found useful at times—the "reflex" illuminator with direct sunlight. In this case the solar beam can be received through the closed window and reflected from the plane mirror. "This illumination is only suitable for work with wide apertures, and over the most minute objects, and the mount must be free from surrounding objects of a coarse character, else, from the extremely oblique character of the illumination, these stronger and coarser objects will project their strong shadows across the field, causing nothing but confusion and chaos. With the genuine form of the Wenham 'reflex' an epithelial scale would hardly be recognized were there several in the field. The principal advantage in the use of the 'reflex' with sunlight is in arriving at a knowledge of surface markings, and for this purpose it is indeed very valuable." "The mirror may be substituted for the hand-lamp when working in the evening, but the most favourable results are obtained with the light direct. This reflex and sunlight illumination is especially desirable when one wishes to trace out structure situated in one particular plane, to the exclusion of that lying in adjacent planes. In the general squabble to produce the so-called penetration, this very important item has been lost sight of."

Blue-tinted Lamp Chimneys, Light Moderators, &c.*—Dr. J. E. Smith, referring to the attempts made to modify artificial illumination by the introduction of blue-tinted chimneys, white-ground illuminators, &c., says that he has patiently tried the entire list and rejects them all, from the fact that there is no real advantage secured by their adoption, which cannot be obtained in a simpler way without them. The neutral tint "light moderator," so-called, is a pleasant thing enough for use with moderate amplifications; yet there is nothing seen with it that cannot be as well shown without it.

The blue-tinted chimney cuts down seriously the intensity of the lamp illumination to an extent which will defeat the resolution of any severe test, while, on the contrary, any and all work with the lower powers can be as well accomplished without its aid.

Thompson's Polarizing Prism.†—Neither the polarizing prism of Nicol nor that of Foucault can be regarded as perfect. The latter especially has so small an angular aperture available, as to be very inconvenient for any but narrow beams of parallel light. Prof. S. P. Thompson has sought to improve upon the existing forms of polarizing prism; and his investigations into the cause of their defects have led him to produce prisms having a considerably wider effective angular aperture.

* 'How to See with the Microscope,' 1880, pp. 189–90.
† Lond., Edin., and Dubl. Phil. Mag., xii. (1881) pp. 349–51.

In the text-books it is usual to tell students that in the Nicol prism the ordinary ray is suppressed by total reflection, because the ordinary index of refraction is greater than that of balsam, and that the extraordinary ray is transmitted because the extraordinary index of refraction is less than that of balsam. Neither of these statements is completely true. All that its inventor claimed for the Nicol prism, and all that it actually performs, is as follows:—The critical angle of total reflection being different for ordinary and extraordinary rays, the ordinary ray is totally reflected and thrown out of the field at an incidence at which the extraordinary ray is still transmitted, the available field of polarized light being the region between the points where the extraordinary ray itself vanishes by total reflection and the ordinary ray enters by lack of total reflection. The former limit is in all ordinary Nicol prisms marked by a broad blue iris or band of colour, the latter is delimited by a curved band at the opposite side of the field, in which, amidst a prevailing line of red and orange, a system of interference-bands can be seen. The existence of these interference-fringes was examined by the author in 1877, in a paper which appeared in the 'Proceedings of the Physical Society of London,' vol. ii. p. 157. In the Foucault prism a similar limitation of the field occurs, interference-fringes being visible at both limits.

The refractive index of balsam for light of mean refrangibility may be taken at 1·54, that of the ordinary ray in calc-spar as 1·66, that of the extraordinary ray as 1·487. The reciprocals of these are very nearly in the respective proportions of 65, 67, 60. The extraordinary index, however, is 1·487 only for rays at right angles to the crystallographic axis, having there a minimum, and increasing up to 1·66 for rays whose direction coincides with that of the axis. The ellipsoidal wave-surface of the sheet of extraordinary waves lies partly without and partly within the spherical wave-surface for Canada balsam, while the spherical wave-surface of the sheet of ordinary waves lies wholly within. Hence total reflection may occur for the extraordinary as well as the ordinary rays, but of the extraordinary rays only those can suffer total reflection which are situated in such a direction with respect to the optic axis that their corresponding portion of the ellipsoidal wave-surface lies within the spherical wave-surface for balsam. As the Nicol prism is usually constructed, this limit of possible extraordinary total reflection occurs for rays (in a principal plane of section) inclined at about 10° to the balsam film, giving rise to the limit of the polarized field marked off by the blue iris before mentioned.

Prof. Thompson has succeeded in widening the available field of polarized light by constructing polarizing prisms in which this blue iris, and the total reflection of the extraordinary ray which produces it, are got rid of. This can be done by cutting the crystal so that (1) the balsam film lies in a principal plane of section, and (2) the crystallographic axis is at right angles to the axis of the prism.

The result of this mode of orientation of the axis and film is to gain 9° of angular aperture at this side of the "field," supposing the

angles respectively made by the film and by the terminal planes with the axis of the prism to be the same as in the Nicol prism.

It is possible to produce a further increase in width of available aperture at the other side of the field by reflecting back the ordinary ray more than in the Nicol prism by making the terminal faces more oblique; but there is then more loss of light by reflection at the surfaces.

Besides the advantage of a wider angular aperture, this new form of polarizing prism has the advantage of producing a field in which the rectilinear polarization approximates more uniformly and symmetrically to a polarization in one plane than is the case in the ordinary Nicol. There is, however, more waste in cutting the spar, with proportionate increase in cost.

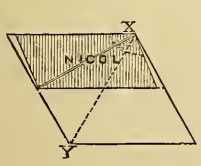
Prof. Thompson has been good enough to supplement his original paper by the following additional remarks and diagrams.

Fig. 108 is the ordinary Nicol prism, as cut from a symmetrical rhomb of spar. (Such a rhomb might be split so as to give four ordinary Nicols.)

Fig. 109 is the Hartnack prism, so cut that the film lies at right angles to the optic axis.

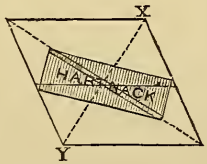
Fig. 110 is the Thompson wide-angled prism, cut so that the film of balsam is in a principal plane of section, and the longitudinal axis at right angles to the optic axis of the crystal.

Fig. 108.



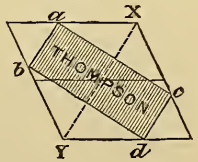
Film inclined about 23° to long axis of prism. End faces mostly make 68° with the long axis. Optic axis inclined at about 43° to planes of end faces. (X Y optical axis).

Fig. 109.



Film perpendicular to optic axis. Longitudinal axis of prism does not lie at right angles to the optic axis of the crystal.

Fig. 110.



Film runs from front edge *a b* to the back edge behind *c d*, and therefore it is in a principal plane of section and contains the optic axis, and the optic axis is at right angles to the longitudinal axis of the prism.

The reason why the new method of cutting secures a wider angle to the field of the extraordinary ray may be further elucidated by the diagrams figs. 111 and 112.

Fig. 111 is to demonstrate the point that in the ordinary Nicol, although the maximum refractive index of extraordinary rays is less than the refractive index of Canada balsam, yet that at certain angles of incidence the extraordinary ray does not pass through the balsam film, but suffers total internal reflection. In this figure

the dotted line X Y represents the optical or crystallographic axis of the spar, inclined obliquely to the plane of the film of balsam. Following out Ampère's modification of Huygens's construction for the wave-surfaces, the smaller circle represents the wave-surface of ordinary rays (with which we are not dealing here), and the ellipse the wave-surface (much exaggerated in ellipticity) of extraordinary rays. The wave-surface of the ray in the balsam film will be then represented by the dotted circle whose radius has a certain value

Fig. 111.

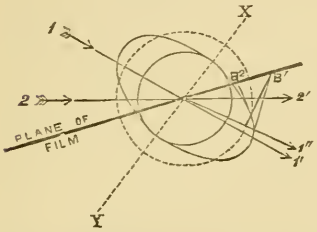
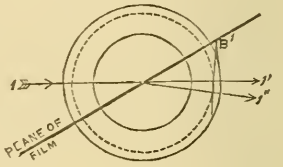


Fig. 112.



intermediate between the major and minor semi-axes of the ellipse. Suppose a ray 1, 1′, to strike through the spar obliquely upon the film, its path will be found by producing it till it cuts the further side of the ellipse; there drawing a tangent to the ellipse meeting the bounding surface at B^1, and thence drawing a tangent to the dotted circle, giving as a radius through the point of contact the direction marked 1″, which is the direction of this ray through the film. This may be taken as the typical case of all the rays in the useful polarized field of the Nicol. But now consider another ray 2, 2′, which traverses the spar in a direction making a greater angle of incidence with the film. A tangent drawn at its point of emergence from the ellipse meets the limiting surface at B^2, *which falls inside the dotted circle.* In this case it is impossible to draw a tangent back to the dotted circle: signifying that total reflection takes place internally. Rays then whose directions through the spar are at very small angles with the balsam film, are in the ordinary Nicol cut off totally, and the limit of their transmission is in the ordinary Nicol marked by the well-known blue band.

Fig. 112 shows the wave-surfaces in the new prism, the ellipsoid here appearing as a circle whose radius is equal to the semi-major axis of the ellipse of fig. 111, since the optical axis is in this case in the plane of the film and at right angles to the longitudinal axis of the prism. Take, as before, a ray of 1, 1′, draw a tangent at the point of emergence, meeting the plane of the balsam surface at B^1, the tangent drawn from B^1 back to the dotted circle gives the direction 1″, of the transmitted ray; and since it is obvious that in no case can the point B^1 at any incidence fall within the outer circle, much less within the dotted circle, it is clear that in *all* cases, and at every incidence, the extraordinary ray is transmitted. Hence the greater width of the field.

Mr. R. T. Glazebrook also describes * a polarizing prism designed to obviate the lateral displacement in the image produced by the Nicol prisms and to give a field in which the plane polarization should be as nearly as possible complete. It was not, however, designed for microscopical work.

Depth of Vision in Photomicrography.†—Mr. G. E. Davis, in an article on "Penetration in Objectives," calls attention to the difference that must necessarily exist between the appearance of a solid object seen by the eye through the Microscope and the same object in a photomicrograph. What is seen through the Microscope is the result of the combined effects of the accommodation of the eye and the focal depth of the objective, but when a picture is thrown upon a sensitive plate it is evident that the first element is nearly eliminated, and the only depth of vision attainable is that which the objective itself possesses.

The following table shows the focal depth of the objective, the accommodation depth of the eye, and the total depth of vision for objectives from 4 in. to 1-20th in. (A eye-piece.)

Objective.	N.A.	Focal Depth of Objective.	Accommodation Depth of Eye.	Total Depth of Vision in Air.
in.		μ	μ	μ
4	0·07	522	2080	2602
4	0·14	262	2080	2342
1½	0·14	86	230	316
1½	0·17	69	230	299
1½	0·21	57	230	287
½	0·34	10·6	20	30·6
½	0·57	6·3	20	26·3
½	0·82	4·4	20	24·4
⅙	0·60	1·99	2·3	4·29
⅙	0·76	1·57	2·3	3·87
⅙	1·20	0·99	2·3	3·29
1/12	0·83	0·72	0·58	1·30
1/12	0·97	0·61	0·58	1·19
1/12	1·10	0·54	0·58	1·12
1/20	0·98	0·37	0·21	0·58
1/20	1·10	0·33	0·21	0·54

From this table it will be seen that large objects cannot possibly be penetrated even with objectives of low angle and medium power. The seeds of *Betula alba* measure 1100 μ across, and require therefore 550 μ of penetration to see the whole of one of them under one focussing.‡ This cannot be obtained from a 1½ in. objective of 0·14 N.A., even allowing the 230 μ which the accommodation of the eye affords, and if we wish to photograph such an object, the 4 in. of 0·07 N.A. will not have sufficient focal depth.

* Proc. Phys. Soc. Lond., v. (1883) pp. 204–16 (6 figs.).
† Micr. News, iii. (1883) pp. 172–6.
‡ i. e. half the depth—diameter in the case of a spherical object.

The spherical Foraminifer *Orbulina universa* is 600 μ in diameter, consequently a depth of vision of 300 μ is necessary to see the whole under one focussing. The 1½ objective and A eye-piece magnifying together 30 diameters, will just suit this, provided it does not possess an aperture exceeding 0·17, but if we wish to photograph this spherical body a much lower objective than the 1½ in. must be employed, as the focal depth of this objective is not higher than 86 μ. *O. universa* affords a good proof of the accuracy of Prof. Abbe's figures. Under the 1½ in. objective of 0·14 N.A. the spheres are splendidly seen, and the same may be said of the 2 in. of 0·14 N.A. and B ocular, but when the picture is thrown upon a ground-glass screen the want of penetration is soon apparent, for it is only when the amplification of the picture has been reduced to rather less than 10 diameters that a satisfactory result is obtained.

Similar illustrations may be offered of the higher power objectives. The larger species of Polycistina require a depth of 75 μ to show them distinctly, whereas a 1-2 in. objective of 0·34 N.A. in air, when used with the A eye-piece, to produce 100 diameters of amplification, possesses but 10·6 micras.

A 1-6th objective, magnifying 300 diameters, loses exactly 1 μ in depth between 0·60 N.A. and 1·2 N.A., so that while the spores of *Penicillium glaucum* (diameter of spores 3 μ) could be photographed with the former, it would be impossible to obtain perfect sharpness with the latter.

The figures in the table for the 1-12th in. and 1-20th in. objectives are equally confirmed by the results obtained in practice. The short diameter of *Bacterium termo* may be taken as 0·8 μ, requiring a penetration 0·4 μ to yield a clear picture, and this is obtainable by using a homogeneous 1-12th in. of 1·10 N.A. to produce an amplification of 600 diameters. A 1-20th in. objective, magnifying 1000 diameters, although producing a fairly sharp picture to the observer's eye, cannot produce an equally sharp image on a prepared plate, as the focal depth of such an objective will only approximate to 0·37 μ, and this statement is borne out by the photographs published by Dr. Sternberg, in his translation of Magnin's 'Treatise on the Bacteria,' wherein those pictures taken with a Beck's 1-5th in. are much clearer, though smaller, than the plate taken with Zeiss' 1-18th. There is more detail in the latter, and here comes in the value of amplification and aperture.

Reference is also made to the increase in the depth of vision in direct proportion with the refractive index of the mounting medium. The great gain in stereoscopic effect, on objects mounted in a medium of high refractive index, has led Mr. E. Ward, of Manchester, to mount opaque objects in balsam, with extremely good results.

Value of Photography in Microscopical Investigations.*— R. Hitchcock discusses the question whether photography affords a means of illustration or demonstration in any wise equal or superior to drawing by hand. On the one side it may be said that a photo-

* Amer. Mon. Micr. Journ., iv. (1883) pp. 33–4.

graph is necessarily a faithful and absolutely correct representation of the object. This may be true and it may not be true. Ordinarily it is so. But somewhat depends upon the nature of the object. A transparent object does not appear the same as an object shown by reflected light, and it will not be produced the same upon a photographic plate. The colour of the parts influences unequally the actinic power of the transmitted light. Thus, in an insect preparation, the yellow chitinous portions obstruct the most active rays of light. In order that the detail observed in these parts by the eye shall be impressed upon the sensitive plate, a rather longer exposure is necessary than for the other parts. The dry plates, however, are far more sensitive to rays of yellow light than the wet plates heretofore commonly used, and they will give better pictures than the latter. Still, there is a loss of detail in many preparations because of the absorption of actinic rays by certain portions of the objects.

On the other hand, it may be said that the photograph only clearly represents what is in focus at one time, while the observer studies and gets the relation between different planes by moving the focussing screw backward and forward. Hence a pencil drawing more truthfully represents an object as it appears to the mind of the observer. This is undoubtedly a fact; and for this reason there can be no doubt of the superior value of the drawing. Yet drawings require a much longer time for execution, and their excellence partly depends upon the skill of the artist, and partly upon his familiarity with the use of the Microscope.

Both the photographic and free-hand methods have, in fact, advantages of their own, the photographic, however, furnishing evidence of the accuracy of the observations which it is relied upon to sustain.

Abbe's Refractometer.*—Since the introduction of homogeneous-immersion objectives it has become a matter of increasing importance to be able to readily determine the refractive index and dispersive power of a fluid, without having to resort to the old cumbrous methods by hollow prisms, &c. The refractometer devised by Professor Abbe enables this to be done with a facility and accuracy that leaves nothing to be desired.

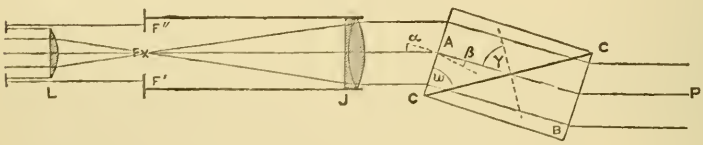
The leading principle of the apparatus depends upon the obstruction of the rays by total reflection at the surface of the fluid under examination. Wollaston and others have previously adopted the method of observing the *maximum* intensity of the reflected ray, but a great advantage is gained by observing instead the *minimum* intensity, so to say, of the transmitted ray. In the former case there is a difficulty in ascertaining the precise point when the light reaches its maximum, whilst in the latter a very small amount of light is easily detected in the darkened field.

The principle will be better understood by reference to fig. 113. Two similar prisms A and B of highly refracting flint glass, with

* Abbe, E., 'Neue Apparate zur Bestimmung des Brechungs und Zerstreuungs-vermögens fester und flüssiger Körper,' 8vo, Jena, 1874, 79 pp. (1 pl. and 7 figs.).

their hypothenuse surfaces contiguous so as to form a parallel plate, are placed in front of a telescope having an object-glass at J, with crossed threads in its focus at F, and a second (eye-piece) lens at L. Suppose that any fluid, or semi-fluid, of *less* refractive index than the prisms, is spread in a thin layer between them, and they are rotated on an axis at right angles to the plane of the paper. When the telescope, with the prisms in front of its objective, is now directed to any bright object, a given point P of the latter will send a pencil of parallel rays through the prisms in a direction parallel to the axis of the telescope. These rays will therefore be collected by the objective J to the centre of the ocular-field, at F, and the eye behind the ocular will see that point of the field illuminated. This, however, will only be so as long as the angle γ, under which the parallel rays reach the internal surface of the prisms, is less than the critical angle corresponding to the difference in the refractive indices of the flint and the fluid between the prisms. If, according to the position

Fig. 113.

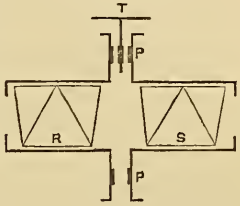


of the prisms, this angle should exceed the critical angle for the rays which are directed to F, no ray can reach this point of the ocular field, nor any other point F′ of the *lower* half of the field (as the diagram is drawn). For the rays which could be collected by the objective J to such a point F′, must of necessity enter the objective as a parallel pencil inclined *upwards* in front of J, and (as will be readily seen by considering the refraction of the prisms) must meet the surface C under *greater* obliquity than the axial pencil just considered; consequently they will undergo total reflection if the axial pencils are totally reflected. Under the condition assumed above, the points of the *upper* half of the field only could possibly receive light through the prisms, because the parallel pencil which is directed to such a point (F″) is inclined downwards, and is therefore transmitted through the surface C under a smaller obliquity. If now, by rotating the prisms, the angle γ for the rays directed to the central point F of the field, should *just* be equal to the critical angle, *all* points of the field above F will receive light through the prisms, whilst all points below F will remain dark, provided monochromatic light is used; the observer will therefore see through the ocular one half of the field bright and the other half dark, the intersecting line of both halves just coinciding with the crossed threads at F. By noting the angle α at which this occurs the refractive index of the fluid is readily obtained. For $\sin \beta = \frac{1}{v} \sin \alpha$ (v being the refractive index of the glass prisms) $\gamma = \beta + w$ and $n = v \sin \gamma$.

With white light the boundary line between the dark and bright parts of the field of view is coloured on account of the difference between the refractive indices of the differently coloured rays, a fact which is made use of to determine the dispersive power of the fluid.

For this purpose a "compensator" is added consisting of two direct vision (or Amici) prisms, R and S fig. 114, so constructed that rays of a given colour D will pass through each without deflection, whilst rays of a different colour will be deflected towards the former, and make with it an angle k in the direction of the principal section. By turning the screw head T of the pinion acting on a circular rack at P the prisms simultaneously revolve in *opposite* directions, and starting from the position shown in the figure (the "primitive plane") in which the two principal sections are parallel, and the refracting edges directed to the same side, they pass through *equal* angles in opposite directions, so that the two principal sections remain always symmetrically inclined to the primitive plane. The principal sections will again coincide after revolving 90°, 180°, &c., with this difference, however, that at 90° the refracting edges will lie in reversed directions, whilst at 180° both will be in the same direction, the opposite of that which they occupied in the original position.

Fig. 114.



It follows, therefore, that the rays corresponding to the line D will pass through the prisms (provided they can pass at all, i. e. are not totally reflected) without deflection, whatever their relative position, and that all other colours will undergo deflection only in that plane in which the two prisms coincide, i. e. the principal plane. During the revolution the extent and direction of the dispersion within that plane varies for any two colours as the diagonal of a parallelogram whose sides are proportional to the dispersion k of the single prisms, and correspond with the direction, whatever it may be, of the principal sections.

Hence the "compensator" acts as a single direct-vision prism for the colour D, with a *constant* principal section, but variable dispersion within that section; and in every position of the prisms, by their revolution (either way) through an angle z, the amount of their dispersion for the assumed colour, and for all others proportionately, is

$$\kappa = 2\,k \cos z.$$

Consequently this amount may have all values from $2\,k$ to $+\,2\,k$.

If we look through such a combination of prisms at a luminous line perpendicular to the central plane of the principal section, it will be seen to extend into a spectrum constantly lengthening as the prisms revolve, becoming contracted again, as the revolution is continued, to a colourless image, and again expanding into a spectrum with the colours in reversed order.

By means of this device any desired amount of dispersion between the limits $-\,2\,k$ and $+\,2\,k$ may be introduced into the pencils

of rays transmitted through the film of fluid at C; and by properly regulating this amount, the relative dispersion of the fluid and the flint-glass of the prisms may be exactly compensated for, or balanced, and the dividing line of the ocular field made to appear *colourless* even with white light. At the same time the position of the compensating Amici prisms (the angle z with which the compensation is obtained) affords all necessary elements for computing the dispersion of the fluid under investigation, provided the refraction and the dispersion of the glass-prism A is exactly known from previous measurement. The author shows that the dispersion of the fluid (for any definite interval of the spectrum) may be obtained by means of the formula

$$\delta n = A + B\,\sigma,$$

where A and B are co-efficients which depend on the refractive index of the prism A and of the fluid, and the dispersive power of the prism A at the same time, whilst σ depends on the angle z of the compensating prisms only. The co-efficients A and B may be easily computed for every instrument and arranged in a tabular form, a definite interval of the spectrum (e. g. from D to F) being assumed for δn.

Fig. 115.

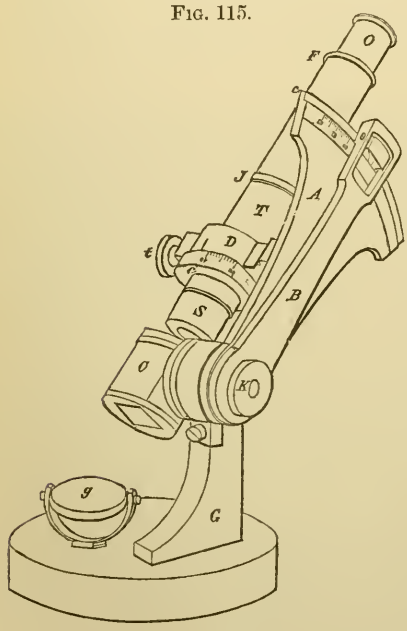


Fig. 115 shows the instrument complete. F J is the small telescope magnifying two or three times. In the focus F of the object-glass are the double cross threads. At the upper end the telescope is attached to a tube, in which the eye-piece O (consisting of a convex lens) slides. At its lower end the telescope is screwed to T D S, containing the two prisms of the compensator; D again is fixed to the sector A. The two prisms between which the fluid is placed are at C. One of these is fixed to an axis which passes through the support G, and has also attached to it at K an alhidade or movable index-arm B. The refracting edge of the prism is at right angles to the plane of the sector and the axis of the telescope. The second prism is simply ledged on the former, being held in place by a spring. The graduation on the sector is arranged so as to give the refractive index directly, and shows thousandths, so that with the naked eye the refractive index to three

places of decimals is readily obtained, and with a lens an approximation to the fourth place is possible. The prisms of the compensator are revolved by a pinion acting on circular racks, the milled head of the pinion being shown at *t*. A drum *e* moving with the lower prism is graduated from 0 to 60, and back to 0, the graduations showing the angle *z* for every 3 degrees.

The instrument is attached to a metal base, and has a concave mirror *g*. In its normal position for observation it is inclined as shown in fig. 115, but in order to insert the fluid between the prisms, the telescope, sector, &c., can be turned completely away from the observer so that the upper end *c* of the sector nearly touches the table, the hypothenuse surface of the lower prism being then horizontal. This is accomplished by the sector not being fixed to the support G, but to an axis passing through it, the prisms with the alhidade being on another axis within the former. Thus the prisms and index can be moved together on the inner axis, or the whole sector, together with the telescope, can be moved on the inner axis, carrying with them the prisms and index.

The following are the directions for use issued with the instrument by Dr. Zeiss, of Jena, by whom it is made:—

"On removing the instrument from its box (taking hold of it by the foot and support G only) it should be placed so that the sector with the telescope is turned away from the observer, the prisms C being towards him. After taking out the small wood, or cork, wedge (used for security in transit) the movable prism should be slipped off by slightly pressing down the spring and drawing it backwards; the surfaces of the two prisms which come into contact are thus free.

After the prisms have been thoroughly cleaned, and the hypothenuse surface of the fixed prism brought into a horizontal position by turning the alhidade, a drop of the fluid to be examined is to be placed in the centre of the prism by a glass rod, the movable prism being replaced by pressing the spring down with the finger.

The sector with the telescope is now to be turned up so that the eye-piece is towards the observer, and the alhidade brought to the beginning of the scale.

Looking through the telescope, the mirror is adjusted so that the whole field of view is uniformly illuminated, and the eye-piece drawn out till the cross threads are seen sharply defined.

The alhidade is then moved forwards till the lower half of the field of view is obscured, and the screw turned until the boundary between light and dark becomes a line *as colourless as possible*. By again turning the alhidade this line is adjusted to lie along the two adjacent points of intersection of the double cross threads.

The position of the alhidade-index on the graduated arc, and the position of the drum, are then to be read off on the respective scales, a lens being preferably used for the former. After further turning the screw till the boundary line a *second time* becomes colourless, it is again adjusted on the cross threads, and the sector and drum read off.

The *mean* of the two readings on the sector gives, direct, the refractive index of the fluid (to the third decimal place), for the then temperature of the instrument and for the Fraunhofer line D. By estimating the fraction of the intervals the fourth decimal may be obtained.

The mean of the drum-readings gives the value of z from which the dispersion of the fluid for the colour interval between D and F may be obtained from the dispersion table which accompanies the instrument, and gives the value of the quantities A, B, and σ of the formula at p. 584, for every reading of the sector and the drum. The elements on which the figures of the table have been computed are taken in such a way, that the formula

$$\delta n = \mathrm{A} + \mathrm{B}\,\sigma$$

gives the dispersion of the fluid for the interval from D to F of the spectrum, i. e. *the difference of the refractive indices* for the Fraunhofer lines F and D. The value of the factor σ corresponding to z is to be taken with a negative sign when z *exceeds* 30.

The index of the alhidade is properly corrected if pure water at about 18° C. gives as the mean of the two readings $n = 1{\cdot}3330$. If the index should have been displaced it can be adjusted by loosening the two screws at the back of the alhidade, by which the index is attached to it, and shifting the latter until the proper reading with water is obtained."

It is also pointed out that it is imperatively necessary that in cleaning the prisms (with water or alcohol) only *soft* and very *clean* linen should be used, and that, as the prisms are made of heavy and therefore easily injured flint-glass, they should be cleaned *immediately* after use.*

Two simplifications of this instrument are also described by Professor Abbe, enabling the refractive index only to be determined. They are both intended to be held in the hand. One has the sector and scale, with a direct vision prism over the eye-glass, and has the full range of scale. In the other the sector is replaced by an eye-piece scale, and is limited to fluids of refractive indices between $1{\cdot}30$ and $1{\cdot}43$. It is a very handy instrument for use with aqueous or saline solutions. All the forms can be made use of for readily determining whether substances have been adulterated or are pure, or the degree of concentration of solutions such as sugar.

As, however, these two forms are of more limited use, and in particular do not admit of the determination of the dispersive powers, it is unnecessary to give here any more detailed description.

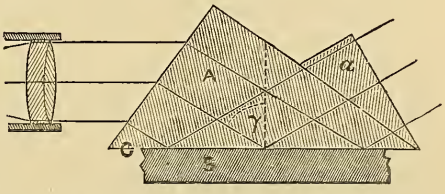
The paper contains very full descriptions of all the three instruments, with directions for use, and elaborate discussions on the principles and limits of exactness of the methods, and on the influence of the errors of observation on the results. It also con-

* Formerly strips of paper were placed between the prisms to keep them a little apart, but recently the movable prism has been ground slightly concave so that the paper is not necessary.

tains a description of a new form of "spectrometer," for the exact measurement of the refractive indices and dispersive powers of *prisms*, which, however, is mainly of interest to physicists.

Professor Abbe subsequently suggested * an addition to the refractometer, in order to enable the refractive indices of *solid* bodies to be determined. For this purpose a small part of the metal back of the fixed prism is removed and a small prism is cemented on. A piece of the substance to be examined is then attached to one of the faces of the large prism by a fluid of high refractive index. In fig. 116, A is the prism of the refractometer, S the solid substance —a plate with one surface polished and cemented to the face C of the large prism by means of a drop of cassia-oil, or monobromide of naphthaline; *a*, the small prism cemented to A, in order to admit rays *from above* to the face C. If the angle γ of the incident rays at C, on rotating the prism A, becomes equal to the critical angle for the substance S —relatively to the flint-glass of A—*total* reflection begins, and the *under* half of the ocular-field appears *brightly* illuminated, the upper half *less* so. The line of intersection being brought just upon the cross-wires and made colourless by means of the compensator, we have again the same conditions as in the case of transmitted light.

Fig. 116.



In order that the total reflection shall be obtained from the solid substance S, and not from the fluid film by which it is cemented to A, the refractive index of this fluid must of course *exceed* that of the solid under investigation.

Refractive Indices and Dispersive Powers of Solids and Fluids.† —Professor L. Matthiessen of Rostock gives a table of refractive indices and dispersive powers, prefaced by the following observations:—

"It is well known that recently in practical optics the theory and technic of microscope objectives have attained special interest. Important advances in the perfecting of the Microscope are connected with the names of Helmholtz, Abbe, Amici, and Stephenson. The problem of eliminating spherical and chromatic aberration in objectives has through them (in different directions) been brought nearer a solution, although in the optical properties of transparent solid and fluid bodies there are still many obstacles to further perfection to be overcome. In the substances hitherto observed the dispersive power generally increases with the refractive index, and substances are wanted which combine small dispersion with a high refractive power or *vice versâ*. Moreover the fluids hitherto observed all have a propor-

* "Ueber die Bestimmung der Brechungs-Verhältnisse fester Körper mittelst des Refractometers," SB. Jenaisch. Gesell. f. Med. u. Naturwiss., 1879, pp. 35–44.

† Centr. Ztg. f. Opt. u. Mech., iii. (1882) pp. 73–4.

tionately larger dispersion than solids of equal refractive index. For the homogeneous-immersion method, however, fluids are required which agree in refraction and dispersion with the glass of the objectives. Finally, it is found that with an increasing total dispersion

Refracting Substances.	Observer.	^nD.	$^nH - {}^nB$.
Fluor spar	St.	1·43390	0·01004
Distilled water, 22° C.	v. W.	1·33292	0·01305
Sulphuric acid—(hydr.) 4·5 per cent.	„	1·33862	0·01350
Sugar candy—sol. 10 per cent.	v. O.	1·34756	0·01351
Alcohol, 38·8 per cent.	v. W.	1·35686	0·01368
„ 86·8 „	„	1·36343	0·01376
Calcspar (*e*) Hofm. III.	„	1·48639	0·01381
Chloride of sodium—sol. 8·6 per cent.	„	1·34702	0·01428
Sugar candy—sol. 30 per cent.	v. O.	1·38080	0·01451
Chloride of ammonium—sol. 9·7 per cent.	v. W.	1·35098	0·01466
Arragonite (γ)	R.	1·53013	0·01477
Glycerine, 49·7 per cent.	v. W.	1·39242	0·01493
Acetic acid, 97·6 per cent.	„	1·37455	0·01501
Chloride of zinc—sol. 18 per cent.	„	1·36719	0·01559
Chloride of calcium—sol. 16·7 per cent.	„	1·37392	0·01599
Topaz (β)	R.	1·61375	0·01691
Quartz (*o*) Hofm. I.	v. W.	1·54417	0·01711
Glycerine, 100 per cent.	„	1·46196	0·01712
Chloride of sodium—sol. 26·6 per cent.	„	1·37963	0·01715
Topaz (a)	R.	1·62109	0·01715
Chloride of ammonium—sol. 24·8 per cent.	v. W.	1·37947	0·01720
Chloride of zinc—sol. 31·0 per cent.	„	1·39169	0·01757
Quartz (*e*) Hofm. III. R.	„	1·55323	0·01777
Crown glass	Lo.	1·50867	0·01867
Heavy spar (γ)	H.	1·63630	0·02043
Chloride of calcium—sol. 40·6 per cent.	v. W.	1·44313	0·02106
Heavy spar (a)	H.	1·64797	0·02145
Crown glass (Merz IV.)	v. W.	1·53032	0·02194
Turpentine	„	1·47212	0·02311
Rock salt, 22° C.	St.	1·54400	0·02904
Arragonite (a)	R.	1·68589	0·02950
Calcspar (*o*) Hofm. III.	v. W.	1·65844	0·03032
Flint glass	Lo.	1·56945	0·03086
Naphthaline in Benzol	Ve.	1·49513	0·03815
Benzine, A.	v. W.	1·49721	0·03853
Benzole, pure	Ve.	1·49947	0·03893
Sassafras oil	B.P.	1·53215	0·04360
Oil of anise	„	1·55725	0·05977
Thallium glass	Ve.	1·75303	0·06709
Flint glass (Merz II.)	v. W.	1·75139	0·07008
Monobromide of naphthaline	Ve.	1·65815	0·08369
Bisulphide of carbon	v. W.	1·62403	0·08411
„ „ 13·7	„	1·63307	0·08576
Oil of cassia	v. W.	1·61883	0·11270

there is generally a larger partial dispersion in the blue. It is to this point, as it seems to me, that the opticians will in future have to direct their attention in the correction of the chromatic aberration.

A comparison of the above three conditions can, however, only be made by means of a tabular statement of the measurements hitherto

carried out. These measurements, which were extended to the whole spectrum, are scattered here and there in books, and moreover are not all of equal value, being affected partly by personal and partly by instrumental errors. For the purpose of forming a normal table for the partial dispersions, I have collected about 200 of the best and most authentic series of refractive indices, which embrace the Fraunhofer lines A, *a*, B, C, D, E, *b*, F, G, H_1 or at least the seven lines B, C, D, E, F, G, H_1. From this series the accompanying table has been compiled for optical purposes, in which the substances with the index D or ^nD are arranged according to the total dispersions $H_1 - B$ or $^nH - {}^nB$."

[We have not thought it necessary to print the whole table of 173 data but have selected 44.] The observers were Fraunhofer (F.), van der Willigen (v. W.), Baden-Powell (B. P.), Rudberg (R.), Mascart (Ma.), Dutiron (Du.), Heusser (H.), Ditscheiner (D.), Stefan (St.), Verdet (V.), Veress (Ve.), von Obermayr (v. O.), Swan (Sw.), Lohse (Lo.)."

"The Genus Microscopista."*—The Annual Address for 1882 to the Microscopical Society of Victoria was delivered in November last by the Vice-President, the Rev. J. J. Halley.

After referring to the small number of members and the still smaller number who contributed papers, the address continued as follows:—"In such circumstances, perhaps, this Annual Address may properly take the form of what would in theology be called apologetic. We must defend our position, and show the *raison d'être* of our existence. Looking, then, at our Society as we are accustomed to look at the various divisions of sentient life as they come under our investigation, we will proceed to examine the various species of what we may call the genus *Microscopista*, the generic characteristics of which are, that they examine minute objects with artificial aid more or less elaborate and that they do this with a more or less useful end in view.

Of this great genus, whose habitat is the civilized world, the first species is the *M. delectata* (*sic*), or the playing microscopist. This is the lowest species in the scale of development, and some observers consider that the other species are all derived from this one, while a few who have no love for the genus affirm that this is the one and only species, the others so-called being only transient varieties. But *M. delectata*, though often despised, is by no means to be set aside. We will grant that in his hands the instrument is a plaything and nothing more,—that he looks at the wondrous beauties revealed merely to please the eye,—that he peers into quaint and curious forms merely to satisfy curiosity,—that the valve of a diatom is interesting to him merely as it is strange, and that the organs of an insect or the home of a Bryozoon only allure as they are novel. In this there is nothing to be despised. The great order of the Bimana must be amused, and the more rational the amusement the better; and surely it is not less rational to find amusement in examining the wonders of

* 'Southern Science Record,' ii. (1882) pp. 285–9.

Nature,—her painting of marvellous beauty,—her sculpturing of unrivalled forms,—than in turning over the prints of man, or spending time examining and collecting his effigies; surely as reasonable as counting the pips on a card, as cannoning ivory balls, or bouncing indiarubber ones over a net. We will not, then, push out of existence the playing microscopist, for my own part I have for him a very tender regard, being perhaps myself but little removed, if at all, from this species. In your name I will welcome all such to our gatherings, assuring them that they will find here much to amuse them if they do not care to learn; but we will hope that in consorting with higher forms they will imperceptibly, perhaps, yet surely, by the force of association, put on new features, lose obsolete and useless organs, and develop into higher and higher forms, and this not in descendants yet to be, but in a conscious life-history. Again I say we are delighted to find, and would gladly have more in our midst of, *M. delectata*.

We advance next to *M. evocationes* (*sic*), or the collecting microscopist. This is only one of the somewhat despised forms:—'Only a collector,' with an elevated head and a righteous shrug, is a phrase often heard. But in great economical systems 'mere collectors' play a most important part. This solid world, with its fertile plains, is just a vast collection gathered together by collectors, organic and inorganic. And collectors provide the material for others to work on and work up. The higher workers not infrequently have neither the time nor the opportunity to collect, and, so far as the preparation of microscopic mounts is concerned, have often not the manual skill and delicacy of touch to be successful. Such must depend for their mental pabulum in its raw state on others. And there is work of immense importance to be done by the 'mere collector.' If such cannot add to our knowledge by their own investigations, if from their brains can come no world-shaking theories that shall make their name and our Society's name familiar as household words, they can add to the treasures of our cabinet, their quick-seeing eye can pick out new forms, their diligent feet can take them to unexplored parts, and their delicate hands can mount their finds in such a way that the true investigator will be able to read with his glass, as in a glass, natural riddles, adding to the world's store of knowledge. Our Society cannot afford to despise the collector. Far from it; we will thankfully receive from any quarter, and ardently welcome, genuine specimens of *M. evocationes*.

M. tabernarius, or the tradesman microscopist. A large and growing species, every day producing novel varieties, and one that in these days must be treated with no little respect. Utilitarianism has invaded the old halls of science, and in these modern days not one but many a philosopher's stone has been found in the crucible of the chemist and the jar of the electrician; and mean homes have turned palaces, and common delf silver-plated, at least, through fortunate discovery. Yes, gold in abundance has followed in the track of the scientists. All this is but *vero verius*, nothing more true. In saying the scientific plaything of yesterday is the mighty

machine of to-day—the toy of an enthusiast one day, the necessity of life to thousands the next—it would be but a work of supererogation to remind you of the giant strides made in the development of electric science and practice. In our own line we can perhaps look for no startling discoveries that shall revolutionize the world of daily life, but there is yet room for the *Microscopista tabernarius*. I do not mean the man who makes the instruments, for him there undoubtedly is ample room, and almost every month we have to hail improvements that make our work more easy. But the Microscope is a tool of trade for some. We have heard that the intricate and charming markings of diatoms and Foraminifera have been used by pattern designers, and in some trades the Microscope is daily used. About a year ago I was at the Italian National Exhibition at Milan. Among the most interesting of the exhibits was the process of silk producing and manufacture. At that exhibition the results were not merely shown, but all the details from the beginning to the end, and a row of microscopists with persistent care examined the silkworm eggs, picking out and rejecting every egg that showed any symptom of disease. But why go to Milan? Has not the *greatest* of your legislators declared that by the aid of a powerful Microscope he was enabled to determine on the spot the magnificent character and splendid suitability of the Stawell stone for our new halls of legislature? In this Society it would be of thrilling interest to hear what was the powerful instrument he used—how he used it in the trying circumstances of the Parliamentary picnic—what he learned—and how he learned it by looking at a lump of sandstone? But this is perhaps too much to expect; let us be content that the value of your instrument has been acknowledged in those halls of wit and wisdom. I think I must place this new-caught specimen in a unique sub-species of his own, and label him *M. ludificatio*. I hardly dare translate this title, but its English synonym is not far off 'humbug.'

Under *M. tabernarius*, as a sub-species, we will place *M. detergitata* (*sic*), or the detective microscopist. Here we come to a class directly useful to mankind. By the aid of the Microscope we discover largely what it is that we eat and drink, how sometimes very widely the real differs from the apparent, and how true it is that "things are not what they seem"—a wide field, that has hitherto not been taken up to any extent by our Society. Under this species I had intended to have ranged myself during the past year, and to have done something worthy of your attention for this meeting: but, alas, it has been but a good resolution, and gone, I fear, where many other good resolutions have gone before it. This I have done: prepared a series of test starches for comparison, some eighteen or twenty slides of which I had the pleasure of placing in the Society's cabinet. I have also made a preliminary examination of some of our ordinary articles of food, not sufficiently exact to go into detail, but enough to give to you a hint as to what may be done, and to indicate a useful line of work. For example, I have found arrowroot adulterated with sago, and arrowroot, tapioca, and sago all showing more or less of the well-known form of potato-starch. Cocoa has exhibited potato-starch, sago-starch, in one case

the beautiful grain of *tous-les-mois*, besides sugar crystals and inorganic matter, that may be colouring matter, or may be dirt—in one case, I suspect, plaster-of-paris. Mustard showed pea-flour, potato-starch, and wheat-flour, as well as inorganic matter, probably plaster-of-paris. Oatmeal showed wheat-flour, and maizena potato-starch.

I give these just as examples of what is and of what may be done. It is not our province to do with legislative action, yet we have, I think, a right to know what it is that we eat and drink. Many of the adulterations are in themselves harmless to the public health, though not to the public morals. This species of microscopist is much needed, and I regret that, so far as our Society goes, we have no member that has given himself up to this work in a systematic and careful manner; but certain it is that such a work needs doing, and doing well. I can only bid you hope that our energetic Secretary will secure for us numerous specimens of *M. detergitata*.

M. medicus is the medical microscopist. Our learned and much honoured President comes, of course, under this title. One would say that specimens of this species would be found in abundance about our rooms, making themselves heard above the more subdued voices of other species; for surely the Microscope must be a necessity for medical men, and one would certainly have predicated that our Society's literature would have been enriched by their contributions many and learned; but, with the one exception of our President, I do not think that for years a solitary specimen of the *M. medicus* has been heard in our gatherings. I cannot altogether account for this: I do not know if the class is an exceptionally shy one—shrinking from publicity—in no case courting profane gaze, and with a modest dislike to uttering opinions in gas-light, and never on any occasion advancing thoughts that are not well matured and tested. It may be the *M. medicus* has a difficulty in consorting with other species of the same genus, and prefers buzzing only where his more immediate kin are found. I do not know what bait must be prepared to catch this remarkable shy form: possibly our President may give our Secretary a few hints on the subject.

My last species is the *M. germanus*, a true genuine microscopist. Of this species we have some admirable examples, men who patiently and perseveringly take up some section of the wide world of science, and work on and on till they have worked out some beautiful system, or worked up the whole life-history of a race. It is those men who add to the sum of the world's knowledge, and so add to the sum of its happiness. The discovery of truth in any one line cannot but be beneficial, for every discovery of truth helps in the discovery of other truth, and sometimes in lines remote enough from the first. The story of the world of science is full of instances of this. And every man who lays a stone may know that he is doing something for the completion of that grand temple of truth that shall fill the world with its radiance.

Gentlemen, we exist that we may bring together these various classes, all interested, though in different ways, with microscopy. Men of kindred pursuits naturally desire to meet each other, or should do

so, that there may be mutual help and the interchange of ideas, and that by such help knowledge may 'grow from more to more.'

I think I have shown that we have a right to exist, that by our existence we may not only amuse and profit each other, but do good in the community in which we are placed, and perchance do something to help in the advance of knowledge in the mighty world of science.

May I trust that next year will be far more prosperous than any preceding ones have been?"

Ady, J. E.—The Methods of Microscopical Research. Part I. Introduction. Part II. On Instruments and their Uses. Chapter I. The Microscope, pp. i.–vi. 8vo, London, 1883.

Aylward's (H. P.) Camera Lucida.

["Very cheap camera lucida which can be used with the eye-pieces of any maker without requiring an adapter. The reflecting surface is a thin cover-glass, which is made adjustable in order that the instrument may be used with either deep or shallow eye-pieces."]

Micr. News, III. (1883) p. 208.

Bausch's (E.) New Binocular. [*Supra*, p. 548.]

Amer. Mon. Micr. Journ., IV. (1883) p. 97.

The Microscope, III. (1883) p. 89 (from *Odontographic Journal*).

Behrens, W.—Bericht über einige, während des Jahres 1882 publicirte Verbesserungen etc. von Mikroskopen und mikroskopischen Apparaten. (Report on improvements, &c., in Microscopes and Microscopical Apparatus published during 1882.) [Abstracted from this Journal.]

["Wir wenigstens glauben nicht, dass ein deutscher Mikroskopiker je zu 'Wenham's universal inclining and rotating Microscope' greifen wird. (Sollten dieses und ähnliche englische Instrumente sich nicht noch dahin vervollkommnen lassen, dass der Beobachter auf dem Kopfe stehend hindurch sehen kann?)"]

Bot. Centralbl., XIV. (1883) pp. 253–5, 350–1 (5 figs.).

Bizzozero, G.—Manuel de Microscopie Clinique avec des instructions sur l'emploi du Microscope en Médecine légale, &c. (Manual of Clinical Microscopy with instructions for the employment of the Microscope in medical jurisprudence.) Translated from the 2nd Italian edition with notes and several additional chapters, by Dr. C. Firket (*infra*, p. 613). xii. and 359 pp., 45 figs. and 7 pls. 8vo, Bruxelles, 1883.

[Chap. I. Description and Use of the Microscope, pp. 1–19 (3 figs.).]

Bles, E. J.—Germination of Fungus Spores under the Microscope.

[Describes Dallinger's Damp Chamber and the author's device.]

Sci.-Gossip, 1883, p. 137.

Bradbury, W.—The Achromatic Object Glass, XX., XXI., XXII., XXIII., XXIV., XXV.

Engl. Mech., XXXVII. (1883) pp. 305–6, 329–30, 356–7, 377–8, 405, 451.

Cohen, E., and J. Grimm.—Sammlung von Mikrophotographien zur Veranschaulichung der mikroskopischen Structur von Mineralien und Gesteinen. (Collection of microphotographs for the demonstration of the microscopical structure of minerals and rocks.) Part VIII., 8 microphotographs. 4to, Stuttgart, 1883.

Curties' (T.) Nose-piece Adapter. [*Supra*, p. 572.]

Engl. Mech., XXXVII. (1883) pp. 333, 365, 385.

Curtis, R. J.—The Clinical Use of the Microscope.

[Considers that "the following list will comprise a battery of objectives which will most satisfactorily cover the whole ground of microscopy:—3 in. 10°, 1 in. 25°, 1-2 in. 45°, 1-8 in. 180°," with a set of eye-pieces of 2 in., 1 in., 1-2 in., 1-3 in., 1-5 in.]

The Microscope, III. (1883) pp. 71–6, from *Peoria Medical Monthly*.

Davis, G. E.—Penetration in Objectives. [*Supra*, p. 579.]

Micr. News, III. (1883) pp. 172–6.

Davis, G. E.—"To our Subscribers."—"Our Free List."
Micr. News, III. (1883) p. 182.

Glazebrook, R. T.—On Polarizing Prisms. [*Supra*, p. 579.]
Proc. Phys. Soc. Lond., V. (1883), pp. 204–16 (6 figs.).

Govi.—Intorno allo scopritore di una singolare illusione ottica. (On the discoverer of a singular optical illusion.) [*Post.*]
[With remarks by Sig. Respighi.]
Atti R. Accad. Linc. Trans., VII. (1883) pp. 183–8.

Grattarola, G.—Su un possibile errore nelle misurazioni micropetrografiche. (On a possible error in micropetrographic measurements.)
[In measuring, by means of the fine adjustment screw, the vertical dimensions of an object inclosed in a transparent medium, such as a microlith in quartz or felspar, or the vertical distances between two points in such a medium—in short differences of level—the true difference is equal to that shown by the direct reading of the screw multiplied by the refractive index of the medium.]
Atti Soc. Tosc. Sci. Nat., Proc. Verb., III. (1883) pp. 244–6 (1 fig.).

Grimm, J.—See Cohen, E.

Hailes, H. F.—Adapters for Microscopes.
[Note on letter of J. A. Ollard *infra* as to Nelson's and Curties' Adapters.]
Engl. Mech., XXXVII. (1883) p. 385.

Hardy, J. D.—Gas lamp for microscopic use.
[Exhibition — An adaptation of the albo-carbon burner to a table lamp-stand.] *Journ. Quek. Micr. Club*, I. (1883) p. 197.

Hitchcock, R.—Instructions in Dry-plate Photography (in part).
["The object of these articles is to enable the reader to make good photographs with the Microscope, and to prepare lantern-transparencies for use in illustrating articles read before Societies or public lectures," with "full instructions for developing and finishing negatives, glass positives, and paper prints."]
Amer. Mon. Micr. Journ., IV. (1883) pp. 84–8, 106–9.

Homogeneous-immersion Lenses.
[The cement of Möller's slides shows no signs of deterioration from cedar oil. Hollis' glue appears to be quite proof against the oil. Ward's brown cement seems to be equally efficacious.]
Micr. News, III. (1883) p. 208.

Jadanza, N.—Sopra alcuni sistemi diottrici composti di due lenti. (On some dioptric systems composed of two lenses.)
Atti R. Accad. Sci. Torino, XVIII. (1883) pp. 601–18 (5 figs.).

Johnson, G. C.—Photo-micrography.
["Since the introduction of rapid gelatine dry plates he showed that good pictures might be obtained by the use of objectives of high power, such as the 1-16th in., even with ordinary gaslight."]
Rep. and Proc. Manch. Sci. Stud. Assoc. for 1882, p. 17.

Jung, H.—Neuer Zeichenapparat (Embryograph) für schwache Vergrösserungen. (New Drawing Apparatus—Embryograph—for low amplifications.) [*Post.*]
Zeitschr. f. Instrumentenk., III. (1883) pp. 165–7 (2 figs.).

M'Intosh, D.—United States Patent for a Microscope, No. 273752, 18th June, 1882 (title only). *Zeitschr. f. Instrumentenk.*, III. (1883) Mai, Wrapper.

Manufacturers, Hints to.
[Recommendation to "make stands that are adapted to the wants of students rather than to attempt to reform or educate the Harvard Medical College professors"—where Hartnack Microscopes are almost universally employed—"up to an appreciation of the excellency of American stands and costly objectives."]
Amer. Mon. Micr. Journ., IV. (1883) pp. 97–8.

Monoyer.—Formules générales des systèmes dioptriques centrés. (General formulæ for centred dioptric systems.)
[Intended to show that for the formulæ of analytical geometry employed by Gauss those of elementary algebra may be substituted without at all diminishing the exactness of the results.]
Comptes Rendus, XCVII. (1883) pp. 88–91.

MOORE, A. Y.—*Amphipleura pellucida* by central light.

[Considers the real explanation of the resolution when the mirror is central to be that the edge of the front cell of the objective radiates the light, and all light reaching the bottom of the slide at a greater incidence than the critical angle is reflected upwards, and enters the lens after having passed through the diatom.]

The Microscope, III. (1883) pp. 49–51 (1 fig.).

NELSON, E. M.—On a quick-acting Adapter for Microscopical Objectives. [*Ante*, p. 858.]

Journ. Quek. Micr. Club, I. (1883) pp. 152–3.

„ „ New Nose-piece Adapter. [*Supra*, p. 572.]

Engl. Mech., XXXVII. (1883) pp. 333, 365, 385.

OLLARD, J. A.—Adapters for Microscopes.

[Note on Nelson's and Curties', *supra*, p. 572.]

Engl. Mech., XXXVII. (1883) p. 365.

Ottawa Microscopical Society.

[Note on the formation of the Society and their offer of exchange of microscopic material.]

Sci.-Gossip, 1883, p. 138. See also *Amer. Mon. Micr. Journ.*, IV. (1883) p. 99.

[PEASE'S] "Facility" Nose-piece. [*Ante*, p. 425.]

Amer. Mon. Micr. Journ., IV. (1883) p. 103 (1 fig.).

PERAGALLO, H.—Considérations élémentaires sur l'ouverture des objectifs microscopiques et les moyens de la mesurer. (Elementary considerations on the aperture of microscopic objectives and the methods of measuring it.)

Journ. de Microgr., VII. (1883) pp. 326–36 (7 figs.), from *Bull. Soc. d'Hist. Nat. Toulouse.*

PRADO, P.—United States Patent for a Photo-micrographic Camera, No. 274515, 18th October, 1882. [Title only.]

Zeitschr. f. Instrumentenk., III. (1883) Mai, Wrapper.

"Prismatique."—Object-glass working, VI., VII.

Engl. Mech., XXXVII. (1883) pp. 283 (1 fig.), 473–4.

Prisms *v.* Mirrors.

["It has long been an opinion among microscopists that the best and strongest light for the illumination of microscopic objects is obtained by substituting a prism for the ordinary mirror. The advantages offered by the prism are more theoretical than practical, while the quantity of light reflected by a silvered mirror is far greater than can be obtained from a prism of equal size. The only advantage of the prism is the reflection from the single plane surface, while the mirror gives a reflection from both the outer and inner surfaces of the glass. But practically this is of absolutely no consequence. A well-silvered mirror reflects 95 per cent. of the light incident upon it. We will soon give a process for silvering glass which yields perfect results and is readily applied by any person."]

Amer. Mon. Micr. Journ., IV. (1883) p. 119.

[QUEEN & Co.'s] "Acme" No. 3 Improved [Microscope].

Amer. Mon. Micr. Journ., IV. (1883) pp. 110–1 (1 fig.).

RESPIGHI.—See Govi.

RINDFLEISCH.—[Impromptu Condenser. *Supra*, p. 574.]

Berliner Klinische Wochenschrift, 1883, p. 183.

RYDER, J. A.—The Holman Lantern Microscope. [*Supra*, p. 552.]

Journ. Franklin Institute, CXVI. (1883) pp. 67–9 (1 fig.).

SCHRENCK.—Exhibition (New York Microscopical Society) of a new form of Microscope-table.

["The particular feature of the table was a revolving centre upon which the Microscope is intended to be placed."]

Amer. Mon. Micr. Journ., IV. (1883) p. 100.

SMITH, G.—Apparatus for Photomicrography. [*Post.*]

Amer. Mon. Micr. Journ., IV. (1883) p. 118. from *British Journal of Photography.*

STOWELL, C. H.—Projecting Lanterns. [*Post.*]

The Microscope, III. (1883) pp. 51–3.

Stowell, C. H.—Microscopy in the University of Michigan.
[Description of the nature and extent of the microscopical work in the University.]
The Microscope, III. (1883) pp. 63–8.
„ „ and L. R.—[Suggestions for early publication of the proceedings of the American Society of Microscopists.] *The Microscope*, III. (1883) p. 69.
Thomas, C.—A new form of "Life-slide" ("Thomas's Vivarium").
[See Vol. II. (1882) p. 688.] *Trans. Essex Field Club*, III., pp. xlix.–l. (2 figs.).
Van Heurck, H.—La Lumière électrique appliquée aux recherches de la Micrographie. (The electric light applied to microscopical researches.)
[I. Production of Electricity (Méritens' and Reynier's Dynamos; Tommasi and Reynier's Batteries.) II. Storage (Kabath's and Tommasi's Accumulators.) III. Lamps (Reynier, Swan, and Stearn.) IV. Illumination of the Microscope (Stearn's method, *ante*, p. 29.) V. Photo-micrography. Additional Note (Reynier's new Accumulators).]
Journ. de Microgr., VII. (1883) pp. 244–60 (13 figs.).
Watson's New Microscope-stand. [*Supra*, p. 555.] *Micr. News*, III. (1883) p. 205.
Wright, L.—Optical Combinations of Crystalline Films.
[Describes easily-made combinations of mica-films put together with canada balsam dissolved in benzol. Contains also a reference to an apparatus made by Swift and Son by which all the preparations and crystals requiring highly convergent light can be shown on the stage of any Microscope provided with a draw-tube.]
Proc. Phys. Soc. Lond., V. (1883) pp. 186–95 (1 pl.).
Zeiss, C.—On the method of using Abbe's test-plate.
[The directions issued by Dr. Zeiss with the test-plates and printed *ante*, p. 281.]
Journ. Quek. Micr. Club, I. (1883) pp. 154–6.
„ „ Dissecting Microscope.
[Exhibition and discussion; also on Stephenson's Binocular.]
Journ. Quek. Micr. Club, I. (1883) pp. 200–1.
Zenger, K. W.—Berechnung des Endomersions-Objectives für Fernrohr- und Mikroskopobjective. (Computation of the Endomersion Objective for Telescope and Microscope Objectives.) [*Post.*]
SB. K. Böhm. Gescll. Wiss. Prag, 1881 (1882) pp. 467–79.
„ „ Dioptrische Studien. (Dioptric Studies.)
[On "Endomersion objectives." *Post.*]
SB. K. Böhm. Gesell. Wiss. Prag, pp. 479–92.

β. Collecting, Mounting and Examining Objects, &c.

Water Collecting-Apparatus.*—Mr. C. F. George has used the following in searching for Hydrachnidæ, and has found no other piece of apparatus so efficient:—

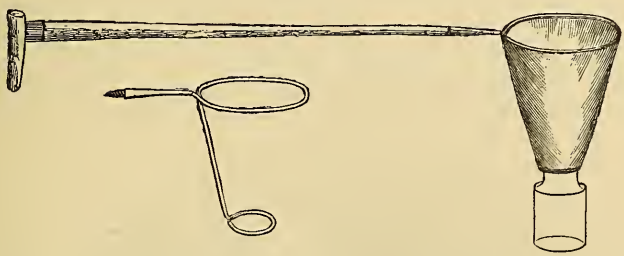
A piece of thick brass wire (fig. 117), is bent at about 6 in. from one end into a ring 4 or 5 in. in diameter. After connecting with some finer wire the two extremities of the ring, bend the stout wire at right angles to the ring, and continue it for about 4 in. Then make another ring about 1½ in. in diameter, and there terminate the wire, leaving the small ring, however, not quite complete. The two rings will thus be parallel to each other. On the upper ring stitch a piece of tape, and to this sew a piece of muslin, made to the shape of a conical bag, and having its wider end affixed to the tape. Into the lower opening of this bag a small, wide-mouthed glass bottle, of about two ounces capacity, should be fastened by a piece of thread or fine string, and the lower ring is then sprung round the neck of the bottle. The other end of the brass wire, which was left

* Journ. Post. Micr. Soc., i. (1882) pp. 158–9 (1 fig.).

projecting for about 6 in., is now to be firmly lashed to a light cane or stick, and the apparatus is complete.

In order to use the apparatus, move it gently backwards and forwards on the surface of the water, under the surface, or just above the bottom of the pond, and among the weeds; the muslin will allow the water to pass through it, whilst any living organisms will be retained by the bottle. This can from time to time be examined with

Fig. 117.



a pocket lens, and when it is found to contain anything, the lower ring of wire can be slipped off, and the neck of the bottle pushed up through the upper ring, inverting the net. The contents may thus be poured off into another bottle, and after rearranging the apparatus, fishing may go on again. The object of the piece of wire connecting the two ends of the net is to keep all stiff, so that the bottle can be turned in any direction, and yet both the upper and lower mouths of the net will remain open.

Preparations of Coal.*—P. F. Reinsch's preparations of coal from the carboniferous strata, the Dyas and Trias (the material being very difficult to reduce to thin and sufficiently transparent sections), are made by using the finest emery employed in polishing mirrors. Powdered chalk obtained by levigation, and carbonate of lime precipitated from lime-water by soda, are also used. A small piece of cork serves as a rubber. During the process the preparation is moistened with glycerine.

Cathcart's Ether Microtome.†— C. W. Cathcart's object in venturing to add another to the many forms of freezing microtome was:—(1) to obtain a simple ether spray-producer which would not allow any ether to escape unevaporated; (2) to have an efficient microtome for use with the ether spray, which would be so simple in its mechanism as to admit of manufacture and production at a comparatively low cost. The microtome can be sold at 17*s.* 6*d.*, including the spray-producer, and it freezes 1-4th in. of tissue in 1½ or 2 minutes, using in the process about 2 drachms of ether, which cost something less than a farthing.

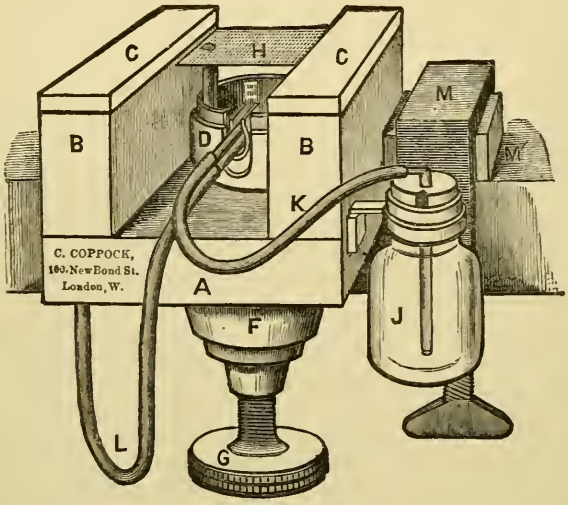
The instrument is thus described by the author:—"The spray-producer works on the same principle as the scent sprays which have

* Bull. Soc. Belg. Micr., ix. (1883) pp. 87–8.

† Journ. Anat. and Physiol., xvii. (1883) pp. 401–3 (2 figs.).

been in use for a long time, where a jet of air playing across the top of a tube draws up the fluid from its interior by tending to make a vacuum in it. The bellows used are the ordinary hand ones sold for carbolic and other spray-producers, these being as cheap and efficient as any that can be got. In working at the spray points, I began by selecting the size of air-hole that these bellows could easily feed with a continuous blast of air, and then, experimenting with various sizes of vaccine tubes, I found at last, that with the smallest size I could produce a spray which, at about 1-2 in. distance from any object, contained just as much ether as the given blast of air could evaporate. There was then of course no running of the ether to waste, while at the same time an intense cold was very rapidly produced. The method of adapting the spray points to one another is a modification of the ordinary one, and is adopted from a German model. It is as

Fig. 118.



follows:—Two fine brass tubes are taken—one is brought to the requisitely fine point for the ether, and the other, being closed at the end, has the air-hole bored at the side a little below the closure. The point of the ether tube is then placed over the middle of the air-hole, and the tubes, laid one over the other, are soldered together in this position; the free ends of the tubes are then connected with the air bellows and the ether bottle respectively by means of indiarubber tubing, and this part of the apparatus is complete.

The microtome (fig. 118) consists of the framework, and the mechanism for raising the section. The framework is of 1-2 in. mahogany, and is in the form of a base with two upright parallel pieces screwed on to it. The base A, which is about $2\frac{1}{2}$ by 4 in., is bored to allow the tubes for raising the section to pass up between the parallel pieces, and has a projecting part at one side to allow of

its being clamped to the table M'. The two parallel parts BB, which are of the same 1-2 in. mahogany, stand about $1\frac{1}{4}$ in. apart; they are 4 in. long, and, rising to 1 in. high, each carries on the upper surface a piece of quarter-in. plate glass CC, of the same length and breadth as itself. This is to support and steady the knife as it is pushed across the tissue to be cut, while the fact of the tissue coming up between the plates allows that part of the knife which is to cut the specimen to be kept free of contact until it touches the tissue.

The method of raising the section plate H is as follows:—About 2 in. of accurately fitting double brass tubing are taken, and into the outer one D the nut F of a fine screw is firmly soldered at what is to be its lower end. The inner tube E has the section plate fixed to its upper end by two screws, with, however, two small pieces of vulcanite intervening between the plate and the tube, so as to disconnect them as much as possible, and into the lower end of the inner tube a transverse bar is fitted, against which the screw coming through the outer tube presses when it is desired to raise the section plate to which the inner tube is attached. By means of a small screw-nail fixing the outer screw to the bar in question, the inner tube can be withdrawn, as well as pushed up whenever that movement is required. A milled head G has been substituted for the ordinary capstan arms, for turning the main screw round.

The spray points are introduced at the requisite distance below the section plate by cutting a narrow slot through both tubes, and fixing to the inner one a piece of bent brass, into which the spray points can be pushed and held firmly, while a small shoulder on the latter prevents them from passing beyond the centre of the under surface of the plate.

Finally, the ether bottle J (with the tubes K and L) is fastened to the side of one of the upright pieces of the framework by a simple hook and eye, the hook being fixed to a collar round the neck of the ether bottle, and the eye to the side of the framework in question. It will be seen, I think, from this description, that with the exception of the fine screw for raising the tissue, the details of the mechanism are very simple, hence the low price at which it can be sold; and in practice it has been found to work admirably."

The instrument is to be obtained from Mr. C. Coppock.

Glycerine Mounting.*—For vegetable sections glycerine is one of the best preservatives, but the difficulty of confining it within the cell has been deemed insuperable. A method invented by Professor Hillhouse enables this end, it is said, to be perfectly attained. The mode of operation is as follows:—

No cell is used, the object being merely placed in a drop of glycerine of sufficient size to reach the edge of the cover-glass when it is dropped in. Canada balsam, dissolved in turpentine, is then applied round the edge so as to close the cell, by means of a small glass rod drawn out to a point, but terminating in a little knob. If a little of the glycerine should exude beyond the cover-glass, it need not be

* Midl. Natural., vi. (1883) p. 166.

removed; it can be covered with the Canada balsam as easily as if it were under the cover-glass, and without interfering with the security of the cell. The Canada balsam is, of course, best if of such a consistence as not easily to become hard and brittle. Professor Hill-house mentions as one of the advantages of this method, that if the section should slip from beneath the cover-glass on the application of pressure, as the thinnest and therefore best sections are apt to do, they would still be visible through the transparent balsam, if its upper surface were made parallel to the slide. It was jocularly suggested at the meeting at which the process was explained that the next step in advance would be to dispense with the cover-glass altogether, and encase the object in a layer of glycerine, protected by a horizontal film of balsam.

Mounting Sections in Series.*—Referring to Dr. J. Frenzel's method of mounting,† Mr. R. Threlfall says that it was pointed out to him by Mr. W. H. Caldwell that the use of hot absolute alcohol in the method has many practical disadvantages. He therefore made some experiments in order to find a better solvent, and after a little consideration came to the conclusion that paraffin of low boiling point would probably dissolve the paraffin in which the sections are imbedded more quickly than the guttapercha film to which they are attached. This proved to be the case to a certain extent; the guttapercha was, however, appreciably soluble. He therefore tried a solution of raw caoutchouc in benzine, instead of guttapercha, with perfectly satisfactory results.

A thin solution of caoutchouc in benzine or chloroform is prepared and poured over the slide so as to form a film in the same way that collodion is poured on a photographic plate. When the film is dry the sections are arranged on it, and the temperature of the slide raised to the melting point of the paraffin; the sections then fall on to the indiarubber film which has become sufficiently sticky to adhere to them perfectly. When the slide is cold it is treated with naphtha or any light paraffin oil, the solvent action being the more rapid the lower the boiling point of the oil used. Absolute alcohol is readily miscible with the naphtha or light paraffin, so that the solvent is readily removed. The slide can now be placed in successive alcohols, stained and returned to absolute alcohol. It is now to be cleared with kreasote or oil of cloves and mounted in the ordinary way. Apart from the great advantage of being able to stain on the slide, this indiarubber method seems to possess some points of superiority over the shellac method of Giesbrecht. This depends on the fact that sections can be mounted in balsam direct from the naphtha. The following are some of the advantages over Giesbrecht's method:—

1. The indiarubber is more uniform and therefore safer for small objects.

2. The indiarubber is dry and thus allows a more minute arrangement of the sections on the slide.

* Zool. Anzeig., vi. (1883) pp. 300–7.

† See this Journal, *ante*, p. 307.

3. The naphtha solves the solid paraffin quicker than turpentine does.

4. No traces of indiarubber are visible after mounting, since indiarubber becomes perfectly transparent in balsam.

These methods have been put to a rigorous test by Mr. Caldwell and are now in use in the Morphological Laboratory of Cambridge University.

Sealing up Preparations.*—Dr. C. Nörner, of the Veterinary Institute of Vienna, describes a method adopted there by Prof. Csokor for the above purpose.

Take the ordinary commercial resinous turpentine, break it into small pieces, and dissolve them in a water-bath, then pour the liquid into another vessel and let it cool. A hard, dark-brown, brittle mass is thus formed upon which the pressure of the finger makes no impression. A little of the resinated oil of turpentine may be added to the liquid, but the whole must be heated for several hours in the water-bath in order to obtain the requisite degree of hardness on cooling.

The turpentine thus prepared is placed on the cover-glass by means of a heated knitting-needle (fixed on a piece of wood), the other end being bent at right angles for about 15–18 mm. to correspond with the width of the cover-glass. The bent end being pressed into the turpentine and withdrawn, the turpentine adhering to it is spread out on the margin of the cover-glass, and this repeated until it is completely surrounded with turpentine, which is finally drawn a little over the edge. Care, however, must be taken not to overheat the needle so that the glass cracks. If the cover-glass should not be sufficiently firm, or if any glycerine still remains on the edge, a combination of gold size and turpentine may be used. The gold size has the advantage of agreeing well with the glycerine, so that it is not necessary to remove the latter completely. When the gold size is dry a second layer of turpentine may be put on. The author generally uses this combination to inclose worms, when the cover-glass cannot be completely closed on all sides in consequence of the thickness of the object. The ring of turpentine may be laid over the gold size without detriment.

The method of sealing glycerine preparations by turpentine has, the author says, the great advantage of extraordinary durability. The object so prepared can also be cleaned at any time with a piece of wash-leather without the fear of injuring it by too much pressure. An additional layer of varnish, which is absolutely necessary for gold-size and other preparations, is dispensed with by this method of treating glycerine preparations with turpentine. It has the disadvantage of being more tedious than in the case of gold size, but practice soon brings dexterity.

Opaque Dry Mounts.†—Mr. J. E. Fawcett prepares opaque dry mounts by building up on the turntable a cell with hot wax partly on

* Arch. f. Mikr. Anat., xxi. (1882) pp. 351–4.

† Micr. News., iii. (1883) pp. 153–4.

the disk of black paper forming the background, and partly on the glass slide. There is thus no untidiness of the paper not fitting the bottom of the ordinary vulcanite cell, or if it is placed on the under side of it, being scratched off. Then again, if the background is put at the back of the glass slip, it is invariably bright, instead of dull. When the slide is dry and ready for sealing up, all that is necessary is to place the cover on it and put it once more on the turntable, when one turn, with the application of the wax-brush, is sufficient to make it a permanent mount. It can then be finished with the usual varnishes. The wax must be kept very hot, and the brush should be left in it when not in use.

Mr. Fawcett also commends cells built up with wax for transparent dry mounts, and the use of wax to help to fill up the sides of balsam cell mounts, between the closing cement and the finishing varnish, though for the latter purpose shellac in spirit would be much more convenient. Wax is also a remedy, he considers, for the running in of the cement used for sealing, and for dampness in the case of "dry" preparations, but as to this see the discussion on the subject in vols. iii. (1880) and i. (1881) of this Journal.

Examining Live Aphides.*—Mr. H. J. Slack says that when we want live aphides to examine under the Microscope in a vigorous condition, we must handle them with extreme gentleness, or their soft and delicate bodies will be injured and the creature killed. Their slightness of structure is, however, accompanied with great endurance of conditions that would be quickly fatal to many stouter organisms. Most insects would be rapidly killed by immersion in paraffin oil; but young and vigorous aphides will often live for some time, and occasionally for hours in this fluid, such as is burnt in lamps. If two or three of the insects are very carefully placed in a little cork cell,† filled with paraffin oil, and covered with thin glass, they are in a handy condition for examination. The result of numerous experiments made with the best American petroleum oil, commonly called crystal oil in the lamp-shops, is that the survivals are very uncertain, but sufficiently frequent for the process to be well worth trying. They keep pretty quiet in the fluid, and it enables higher powers to be used with convenience. A 1-2 inch objective, magnifying about 100 linear, with a full-sized instrument, is very handy. The illumination should be varied; but one of the best ways is to use both an achromatic condenser and a lieberkuhn, or little silver reflector, at the end of the objective. The largest hole and central stop of the condenser will give a fine dark-ground illumination. When used in combination with the lieberkuhn, it lights up the inside of the object, while the less transparent parts receive reflected rays from the silver surface. The student will find a great many cases in which this mode of treating a refractive and reflective object produces the best results. The eyes of the *Aphis* seen in this way are like half mulberries, and the little eye

* Knowledge, iii. (1883) p. 246.

† A phial cork 5-8ths inch in diameter cut across so as to make a disk 1-16th inch thick with an oblong hole in the centre and gummed on a slide. The gum is not dissolved by paraffin oil.

projecting from the corner of the larger group is well displayed. Where the view of the compound eyes is a full-face one, the darker pigment is seen so strongly that its true position is concealed. A profile view shows the little lenses to be clear, like glass, and the pigment to be behind them.

Microscopical Examinations of Articles of Commerce.*—A. Tomaschek points out the value of microscopical examination in the determination of the purity of many articles of commerce, and gives the following illustrations:—

Tea-leaves are readily recognized by their peculiar idioblasts.

Barley-meal is very well characterized by the beautiful tabular cells with thick wavy margins belonging to the paleæ which are always found in the meal in consequence of the close adherence of the paleæ to the fruit. The following method is recommended for their detection:—A drop of concentrated hydrochloric acid is thrown on to the meal and rolled in it. A piece of the dough thus obtained is placed on the slide, and another drop of hydrochloric acid run on to it before covering with the cover-glass, and the cover-glass then pushed lightly backwards and forwards. The tabular cells are not only not attacked by the acid, but are coloured by it a bright sulphur-yellow colour. They may be detected even after the baking of the barley-meal.

The microscopical appearance of wheat-meal is distinguished by the peculiar properties of the paste, which can be best demonstrated in the following way:—A thin layer of meal is placed on the slide, carefully covered with a cover-glass, and then moistened by a drop of water placed on its margin. The cover-glass is then lightly pressed, and pushed backwards and forwards, the gelatinous substance being thus separated from the starch-grains, and appearing in the form of dense clouds. If glycerin is used it solidifies into bluntly angular granules, averaging 0·08–0·01 mm. in length. In order to obtain the iodine reaction characteristic of a nitrogenous substance, a comparatively large quantity of the reagent must be used, as the golden-yellow reaction of the proteinaceous substance does not appear until the starch-grains have absorbed what iodine they require. This gelatinous substance is especially well recognized by its reaction with cochineal. If cochineal-powder is scattered over the wheat-meal, and moistened merely by breathing on it, the proteinaceous masses at once take a beautiful carmine-red colour, the starch-grains remaining quite colourless.

Microscopical Separation of Wheat- and Rye-Meal.†—L. Wittmack records the following observations on the microscopical distinctions between wheat-meal and rye-meal. The amount of starch gives no certain character, and the size of the starch-grains is not in itself sufficient; the maximum size of the starch-grains of rye is 42–52 μ;

* Verhandl. Naturf. Ver. Brünn, xix. (1881) p. 15. See Bot. Centralbl., xi. (1882) p. 318.

† SB. Bot. Ver. Prov. Brandenburg, xxiv. (1882). See Bot. Centralbl., xiii. (1883) p. 91.

of wheat 28–35 μ. Better characters are obtained from the grains themselves.

The denseness of the pitting in the transverse cells of wheat gives them a chaplet-like appearance. The shell or pericarp is often difficult to meet with in the finer kinds of meal.

	Wheat.	Rye.
	μ	μ
Skin, average thickness	43–50	31–40
Epidermal cells of the skin or pericarp—length	116–160	136–400
,, ,, ,, breadth	20–28	26–62
,, ,, porous pitting	very close	less close
Sub-epidermal transverse-cells—length	114–192	72–90
,, ,, breadth	14–17	11–14
,, ,, thickness of walls	5·8–8·7	3·3–5·0
,, ,, pitting ..	very dense and conspicuous	less dense, inconspicuous
Starch-cells—average larger diameter	56–72	40–64
,, shorter diameter	32–40	24–40
Iso-diametrical starch-cells—diameter	40–48	32–36

Good characters are also obtained from the hairs. Before grinding, both ends are removed from the grain; the embryo-end on account of the oil which it contains; the opposite apex on account of its hairs; but a few hairs are still to be found in the meal, which give the following characteristics:—

	Wheat.	Rye.
	μ	μ
Length of hairs	120–742	50–420
Diameter of the largest	15–21	9–17
,, at the bulbous base ..	28	23
,, of the smallest	9–10	8
,, at the bulbous base ..	14	11–14
Thickness of wall of the hair ..	7	3–4
Breadth of cell-cavity	1·4–2 (rarely 5)	7

Wheat has therefore thick-walled hairs with narrow cell-cavity; rye thin-walled hairs with wide cell-cavity.

V. Berthold * confirms in the main Wittmack's statement. He finds the gum-cells of wheat to be decidedly larger than those of rye; the former measuring 3, the latter 1·5–2 μ. The thickness of the wall of the hairs of wheat he states at 5–8, of rye 3–6 μ; the diameter of the cavity of the former 1·5–4, of the latter 4–12 μ.

Hunting for Lost Glaciers with a Microscope.†—Considerable work has been done in this direction in Germany and elsewhere by various observers, work with which geologists are more or less

* Zeitschr. f. Landwirthsch. Gew., &c., 1883, pp. 1–3. See Bot. Centralbl., xiv. (1883) p. 247.

† Nova Acta Acad. Leop.-Carol., xlv. p. 35. See Science, i. (1883) p. 177.

familiar, and Dr. E. Geinitz gives the results of an extended study of the plagioclase rocks and phonolites of the Mecklenburg drift.

The method consists in examining thin sections of the rocks found in the drift, and comparing them with the descriptions given by the Scandinavian lithologists of rocks known *in situ* in that peninsula. In this way various basalts, diabases, gabbros, diorites, and phonolites are referred to certain localities in Sweden, whence they are supposed to have been derived. Interesting results can be obtained by such methods; but they are often uncertain, since it cannot be predicated that rocks of the same character do not exist, or have not existed, in the intermediate drift or water-covered areas.

Microscopical Analysis of the Structure of Iron and Steel.*—The first step, writes Mr. J. C. Bayles, to be taken in practical microscopy is the training of the eye to observe what may be seen without the aid of a lens. This is accomplished by the patient examination of characteristic fractures, and noting similarities and differences. After the naked eye has become familiarized with all it can see, the student should continue his investigations assisted by a hand lens with a power of from two to three diameters, and absolutely achromatic. Specimens to be studied with a view to determining their internal structures should be surfaced in a planer, and smoothed by draw-filing in the direction of the fibre. The surface thus obtained is treated with slightly diluted nitric acid, which gives a rapid and wide development of the structure, which may be studied with advantage while it lasts, and will prepare the student for finer work. For fine development more care and time are needed. After planing, the surface of the metal is ground with fine emery or under a metallic mirror-grinder. It is then treated with acid. A thorough development with weak acid requires from twenty-four hours to six days, according to the composition of the metal. Small specimens are prepared by planing down from the back to a thickness of 1-32nd to 1-16 in. The planed face is then ground and surfaced on a fine whetstone, developed with weak acid, and mounted between glasses with Canada balsam. In selecting a Microscope, care should be taken that the lenses give a good definition, that there is no "shake" or lateral motion in the adjustments for focus, and then the table should admit of inclination at any angle found most convenient for observation.

Concerning the results to be expected from the microscopical analysis of metals, Mr. Bayles expresses the belief that it opens a vast field of knowledge not yet reached by either chemical analysis or physical test. There are many conditions, the result of changes produced by mechanical treatment, to which chemical analysis gives no clue and which are detected, but not explained, by the test of the physical laboratory. The Microscope will, no doubt, explain many of the mysterious changes which occur in metals of given chemical composition under different conditions, and will give the metallurgist an opportunity of studying the anatomy and physiology of iron and steel, which, in a most important sense, will supplement

* Science, i. (1883) p. 101.

analysis and mechanical test, which have thus far, to some extent, run in parallel lines. When, between the report of analysis and the fracture of the broken test-piece, we can place a polished longitudinal or cross-section of the material, its internal structure developed by acid and admitting of careful microscopical study, we are furnished with the missing link in the chain of evidence required for a correct conclusion as to the nature of the material under investigation.

Microchemical Reaction Methods.*—A. Tschirch describes the great advantages of the Microscope in technical chemistry, especially in the examination of foods, and expresses regret that many chemists consider their laboratories complete without such an instrument: he enumerates many examples of its usefulness, such as starches, textile materials, &c.; even in the domain of pure chemistry, its application is necessary in the hæmatin reaction for the detection of blood-stains, the composition of urinary deposits, the search for strychnine, atropine, &c.

These advantages led to its more extensive employment in pure chemistry, and the name of microchemistry was given to it by Döbereiner. The author thinks that microchemistry must always be distinguished by a series of colour reactions, that in the same manner as the changes of colour, &c., in experiments on the large scale are examined in the test-tube, so must they be similarly observed on the slide of the Microscope. The actual process is simple; the objects to be examined must be either in thin sections, fine powder, or as fibres; a drop of the reagent is placed on a slide and allowed to flow slowly towards the object, the operator observing through the instrument: many physical as well as chemical changes may be thus detected; expansion or contraction, refractive changes, commencement of coloration, evolution of gas bubbles, solution, &c. The iodine starch reaction of Stromeyer was the first to be employed with the Microscope; from it is learned the topography and division of starch in plants, the way it is stored up, and the process of its conversion; this reaction has also taught the difference between pure cellulose and woody fibre, and the nature of intercellular substance. The reactions with zinc chloride and iodine, and with sulphuric acid and iodine, are also striking instances of the value of microchemistry, affording an easy method of distinguishing vegetable from animal fibres, the first colouring pure cellulose violet, and the second dissolving it with an intensely blue colour, the lignin incrusting the fibres having been previously moved by maceration in nitric acid, alkalis, or Schultze's maceration fluid. Thus sulphuric acid and iodine stain cork dark yellow, thereby affording a trustworthy test for all membranes or sections containing suberin. The solubility of pure cellulose in "cuoxam," discovered by Schweitzer, is also credited to microchemistry: the reagent may be prepared by digesting copper turnings in concentrated ammonia, or by decomposing a concentrated solution of copper sulphate with ammonia until the precipitated hydroxide is redissolved.

* Arch. Pharm., xx. (1882) pp. 801–12. See Journ. Chem. Soc.—Abstr., xliii. (1882) pp. 376–8.

The maceration process of Schultze is a valuable aid to operations in microchemistry; the substance is treated with nitric acid and potassium chlorate either in the cold, or in cases of obstinate samples, is boiled for a short time, when the cells are isolated by the solution of the intermediate lamellæ. Amongst the instances given of its utility in food analysis is the separation of those peculiar cells of radiating branchial form which exist in the tea-leaf, and are not found in other leaves used for its adulteration (they are, however, found in some of the *Camellia* family).

This treatment has also the advantage of dissolving the coloured incrustations of cinnamon, roasted coffee, &c., and leaving the substances ready for further examination. Potash plays an important part in microchemistry, as it renders many objects transparent which are not made so by other reagents; it was by successive treatment with potash solution, acetic acid, and iodine that Böhm was able to perceive in chlorophyll the small particles of starch which had hitherto escaped observation. The most striking success in the science is that of Sachs with Trommer's sugar-test, which, with slight modifications, enables the microscopist to identify, and even estimate quantitatively, cane- and grape-sugar, dextrin, gums, and albuminous substances in single cells.

The author alludes to the tinctorial methods which are employed in the examination of microbes, but which do not come under the strict domain of chemistry; he urges more extensive use of the Microscope, together with the micropolariscope and spectroscope, and the study of botany and physics among chemists.

Dr. T. Schuchardt, of Görlitz (Silesia), has issued a special list of chemical reagents supplied by him for the use of botanical-physiological Institutes, arranged after Poulsen's 'Botanische Microchemie.'

Microscopical Examination of Dyed Silks.*—In an article by M. Marius Moyret, it is pointed out that if the silk fibre is seen lengthwise, it appears uniformly dyed; but in transverse sections it is found that the dye forms a concentric ring, the depth of which ordinarily diminishes gradually from the circumference towards the centre.

The observations made by M. Lembert establish, also, that if we dye silk with a simple colour, such as cochineal, the colour penetrates in time more and more towards the centre of the silk, becoming at the same time deeper and deeper; so that, if we take successive specimens from a lot of yarn during dyeing, they will exhibit under the Microscope rings of colour which become broader and broader, until they reach the centre.

If a silk dyed a light shade of one colour is plunged into a bath of a second colour, and dyed to saturation, the section will show under the Microscope an outer ring, the colour of which is a result of the two dyes employed, and an inner part having the pure tone of the second dye. Or if we plunge a silk dyed to saturation with one

* Chem. Review, xi. (1882) p. 203, from 'Teinturier Pratique.'

colour into a second colour, but without saturating it, with the Microscope we see an outer ring, which is the result of the two colours, and a central part of the primitive shades.

Apparent Motions of Objects.*—Prof. F. C. Van Dyck considers that the familiar fact that objects viewed through the Microscope seem to move when the position of the mirror is slightly changed, has not been discussed in its optical bearings.

"The phenomenon is easily observed by using nearly parallel rays to illuminate the object, and placing the mirror approximately central under the stage. If daylight is used, set the Microscope at a considerable distance from the window, and use the plane mirror. If lamplight is used, set the lamp at the focus of the concave mirror, or use a lens to make the rays parallel and reflect them from the plane mirror.

If the object be so thin as to be sensibly in one plane, it will maintain its location in the field whatever change be made in the position of the mirror, so long as it is accurately focussed. But if the tube of the Microscope be raised or lowered, so as to throw the object slightly out of focus, a shifting of the mirror on its bearings will cause an apparent motion of the object to one side or the other.

If an object of considerable thickness be used and the focus obtained for a central plane, rocking the mirror will cause the lower parts of the object to move to one side, while the upper parts move to the other side. I have an insect's foot with claws, which, treated in this way, seems to work the claws like scissors. Minute details of an object may be made to disappear under spots on the cover-glass, and various similar effects can be produced.

Let us suppose that the illumination is received from the left of the observer, and that a micrometer is inserted in the eye-piece to facilitate observation. Take three points A, B, and C, in the optical axis, A beyond the focus of the objective, B at the focus, and C a little above the focal plane. Suppose a pencil sent from the mirror along the axis, passing A, B, and C, and the centre of the objective. The images of A, B, and C, will fall with their centres on the axis. If the edge of the mirror toward the observer's right be tilted up, the point A, beyond the focus, will appear to be displaced toward the right of the field of view, the point B will remain stationary, and C which is above the plane focussed upon, will move toward the left. Now it can be shown that if the spherical aberration of an objective could be corrected for a series of points and their images, all the images must remain stationary.

The necessity for correction consists essentially in the fact that the margins of lenses with spherical surfaces are too strong relatively to their centres. Hence, with an uncorrected lens, the image of the point B, made by the central portion of the lens, would fall on the axis; but an image of the same point, produced by rays entering the left-hand margin, would fall to the left of the axis, as well as nearer to the lens. The essence of correction is to relatively weaken the

* Amer. Mon. Micr. Journ., iii. (1882) pp. 72-3.

action of the margin, so that the image shall fall on the axis and at the same distance from the lens as the image formed by its central portion. Suppose this correction to be made for the point B. Let the mirror be tilted as described, so that a pencil of rays passes through A to the left margin of the objective. This pencil makes a smaller angle with the front surface than a pencil coming from B and entering at the same place. Hence, the pencil from A will reach the back surface of the lens at a point nearer the axis than would be reached by the pencil from B. If then the pencil from B comes to a focus on the axis, the pencil from A would cross the axis before coming to a focus. This explains the displacement of the image *a* to the right under the conditions given above. The image *b* of the point B will not be affected, because the objective is corrected for a cone of rays from B, and any pencil passing through B must coincide with some element of the cone. It is not necessary to discuss the image *c*, for it will be seen that it must be formed on the side of the axis opposite to *a*."

Phenomena of Motion.*—C. Nägeli and S. Schwendener deal with this subject as follows:—

"The observation of the phenomena of motion under the Microscope has led to many false views as to the nature of these movements. If, for instance, swarm-spores are seen to traverse the field of view in one second, it might be thought that they race through the water at the speed of an arrow, whereas they in reality traverse in that time only a third part of a millimetre, which is somewhat more than a metre in an hour. It must not, therefore, be forgotten that the rapidity of motion of microscopical objects is only an apparent one, and that its accurate estimation is only possible by taking as our standard the actual ratio between time and space. If we wish, for the sake of exact comparison, to estimate the magnitude of the moving bodies, we may always do so; the ascertainment of the real rapidity remains, however, with each successive motion, the principal matter.

If a screw-shaped spiral object, of slight thickness, revolves on its axis in the focal plane, at the same time moving forward, it presents the deceptive appearance of a serpentine motion. Thus it is that the horizontal projections of an object of this kind, corresponding to the successive moments of time, appear exactly as if the movement were a true serpentine one. As an example of an appearance of this nature we may mention the alleged serpentine motion of *Spirillum* and *Vibrio*.

Similar illusions are also produced by swarm-spores and spermatozoa; they appear to describe serpentine lines, while in reality they move in a spiral. It was formerly thought that a number of different appearances of motion must be distinguished, whereas modern observers have recognized most of them as consisting of a forward movement combined with rotation, where the revolution takes place sometimes round a central, and sometimes round an eccentric, axis.†

* 'Das Mikroskop,' English translation (in the press) pp. 258–60 (1 fig.).

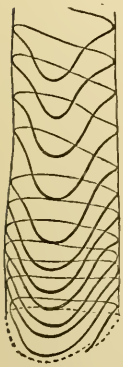
† Cf. on this point Nägeli, 'Beiträge,' ii. p. 88.

To this category belong, for instance, the supposed oscillations of the *Oscillarieæ*, whose changes of level, when thus in motion, were formerly unnoticed.

In addition to these characteristics of a spiral motion it must, of course, be ascertained whether it is right- or left-handed. To distinguish this in spherical or cylindrical bodies which revolve round a central axis is by no means easy, and in many cases, if the object is very small and the contents homogeneous, it is quite impossible. The slight variations from cylindrical or spherical form, as they occur in each cell, are therefore just sufficient to admit of our perceiving whether any rotation does take place. The discovery of the *direction* of the rotation is only possible when fixed points, whose position to the axis of the spiral is known, can be followed in their motion round the axis. The same holds good also, *mutatis mutandis*, of spirally wound threads, spiral vessels, &c.; we must be able to distinguish clearly which are the sides of the windings turned towards or turned away from us.

If the course of the windings is very irregular, as in fig. 119, a little practice and care is needed to distinguish a spiral line, as such, in small objects. The microscopical image might easily lead us to the conclusion that we were examining a cylindrical body composed of bells or funnels inserted one in another. The spirally thickened threads, for instance, as they originate from the epidermis cells of many seeds, were thus interpreted, although here and there by the side of the irregular spirals, quite regular ones are also observed.

Fig. 119.



Moreover, it must not be forgotten that in the microscopical image a spiral line always appears wound in the same manner as when seen with the naked eye, while in a mirror (the inversion being only a half one) a right-handed screw is obviously represented as left-handed, and conversely. If, therefore, the microscopical image is observed in a mirror, as in drawing with the Sömmerring mirror, or if the image-forming pencils are anywhere turned aside by a single reflection, a similar inversion takes place from right-handed to left-handed, and this inversion is again cancelled by a second reflection, as in Oberhäuser's camera lucida, and in many multocular Microscopes. All this is, of course, well known, and to the practised observer self-evident; nevertheless, many microscopists have shown that they are still entirely in the dark about matters of this kind."

Brownian or Pedetic Motion.*—The skipping motion of extremely small particles has been for long a subject of curiosity, but in the view of Prof. Ramsay has as yet remained without explanation. The following is an attempt on his part to ascertain its cause.

1. It is not dependent on the life of the particle. This would

* Proc. Bristol Naturalists' Soc., iii. (1882) pp. 299-302.

seem an absurd notion, but it was a theory first advanced to account for the phenomenon. And as it was first observed by Robert Brown, when examining the pollen of plants, he had some ground for his supposition. Buffon attributed it to this cause, and Spallanzani termed the dancing particles "animaletti d'ultimo ordine." It occurs, however, with particles strictly mineral in their constitution, such as quartz, cinnabar, finely divided gold, &c.

2. Nor does it depend on the material of which the particles are composed, for all substances, if in a sufficiently fine state of division, manifest this motion. (*a*) They may be conductors, e. g. gold, silver, platinum. (*b*) They may be non-conductors, e. g. sulphur, gamboge, quartz. (*c*) They may be absolutely insoluble in water. (*d*) They may be slowly attacked by water, e. g. quartz, silicates, barium sulphate. (*e*) They may be good conductors of heat, e. g. the metals above mentioned. (*f*) Or bad conductors, e. g. sulphur, gamboge. (*g*) They may be transparent, or (*h*) opaque.

3. The motion does not depend on the form of the particles. The question of pedesis is very closely connected with that of the settling of finely divided powders in different menstrua. In a paper communicated to the Geological Society of London in 1876, on the settling of mud, the author showed: (1) that finely divided matter does not quickly settle in pure water. (2) That it settles more quickly in hot than in cold water. (2) That the rate of settling does not depend on the density of the solution, for mud settles more quickly in strong than in weak solutions. (4) It does not depend on the chemical action of the liquid on the solid, for sulphur follows the same rule as other substances. (5) It follows the same order as the absorption of heat, when the salt is dissolved, in the solution of which the suspended particles settle. (6) It depends on the agglomeration of the particles: when the particles acquire sufficient size to have no motion, or a very slow one, they settle quickly. This phenomenon is evidently closely allied to pedetic motion, and is to be explained by it.

Pedetic motion depends on, that is, is affected by:—

1. *The size of the particles.* Particles more than 1-5000th of an inch in diameter do not jerk about suddenly, but are sometimes seen to oscillate slightly.

2. *The specific gravity of the particles.* Metals, or particles of vermilion, of similar size to particles of silica or gamboge, move much more slowly and less frequently.

3. *The nature of the liquid.* No liquid stops pedesis; but liquids which have a chemical action on the substance do. This action may be very slow, still it tends to agglomerate the particles. For instance, barium sulphate, when precipitated from the cold solution, takes a long time to settle; whereas, when warm and in presence of hydrochloric acid, agglomeration soon occurs. Iron precipitated as hydrate in presence of salts of ammonium, and mud in salt water, are other instances. The motion does not cease, but the particles adhere together and move very slowly.

The moving particles may be either liquid or solid; but the

motion of one liquid in another has a character of its own. Thus if a little olive oil be shaken to an emulsion with a large quantity of water, the minute drops move, but slowly and not with a jerky motion. Similarly a few drops of water mixed with a large volume of oil, display the same character of motion.

This motion cannot be attributed to currents in the liquid, for its nature is such as to preclude this explanation. It is in no sense regular, or in one direction.

The author thought it worth while to compare the relative size of such particles with those estimated for molecules, and likewise the amplitude of their motion with that of molecular vibration.

The diameter of a molecule, according to Sir W. Thomson, lies between the millionth and ten-millionth of a millimetre. The diameter of an active particle is about or below the two-thousandth of a millimetre. With this size the pedetic motion is slow and infrequent. If we take the larger diameter for the molecule, then the diameter of the molecule is greater than that of the particle as 1 is to 500, and the mass, supposing them to be of equal specific gravity, as 1 to 125 millions.

If molecules do not coalesce and move as a whole, then they would appear to have no possible power of giving motion to a mass so much larger than themselves, but that molecules have arrangement is probable, owing to the power which some liquids possess of rotating the plane of polarized light.

Clerk-Maxwell supposed for some time that the attraction of two molecules varies inversely as the fifth power of the distance. If attraction at distance 2 is 1, attraction at distance 1 would be 64. Why do not all molecules therefore coalesce? probably, because their own proper motion, of which heat represents the high harmonies, causes them to fly apart again. The wave-length of that motion is not so minute, and although we have no means of ascertaining the amplitude of such vibrations, still their rate is so prodigious as to give rise to an almost incredibly forcible impact.

Ady, J. E.—Exhibition of some Microscopical Preparations of Bone.
Proc. Zool. Soc. Lond., 1883, p. 74.

Bell, F. J.—Exhibition of and remarks upon some Microscopical Preparations obtained from the Zoological Station at Naples.
Proc. Zool. Soc. Lond., 1883, p. 47.

Calderon y Arana.—Nota sobre la extraccion y coleccion de las conchas microscópicas de moluscos y foraminiferos. (Note on the extraction and collection of the microscopic shells of mollusca and foraminifera.) In part.
An. Soc. Esp. Hist. Nat., XII. (1883), Actas, pp. 33–6.

Carter, H. J.—On the Microscopic Structure of thin slices of Fossil Calcispongiæ.
[Contains directions for grinding down a slice of a calcareous fossil. *Post.*]
Ann. & Mag. Nat. Hist., XII. (1883) pp. 26–30.

Cathcart, C. W.—New form of Ether Microtome. [*Supra*, p. 597.]
Journ. Anat. & Physiol., XVII. (1883) pp. 401–3.

Chabry, L.—Note sur quelques propriétés du Bleu de Prusse. (Note on some properties of prussian blue.)
Journ. de l'Anat. et de la Physiol., XVIII. (1882) pp. 503–9.

MICROSCOPY.

a. Instruments, Accessories, &c.

Bailey's Portable Microscope.—The possible variations in the form of portable Microscopes might be supposed to be pretty well exhausted, but Mr. J. W. Bailey has been able to adapt to the instru-

FIG. 120.

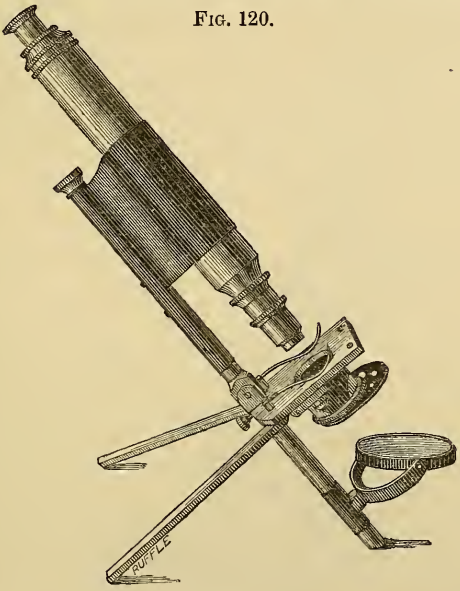
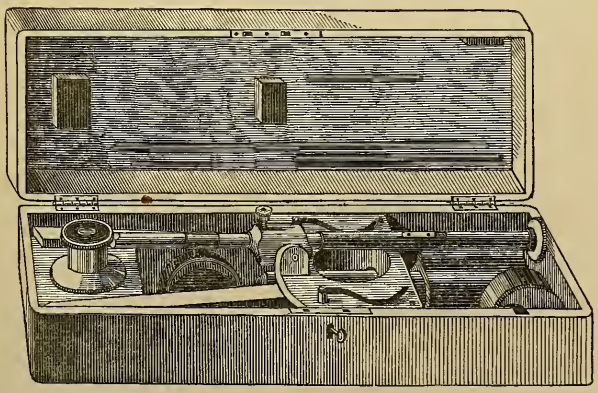


FIG. 121.



ment shown in figs. 120 and 121 some ingenious points of novelty which make it very portable and at the same time steady.

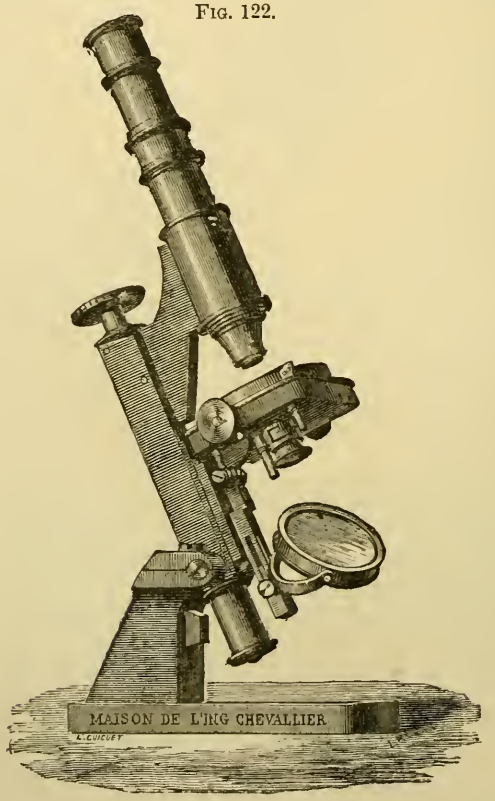
The instrument, when inclined, is shown in fig. 120. To put it

into its case (fig. 121) the stage is turned upwards on a cradle joint against the limb, the two legs, which move with it, then being also parallel with the limb. On closing together the legs (which turn on pivots fixed underneath the stage) and sliding the body-tube down, the instrument is reduced to $11\frac{1}{2}$ in. by 3 in. by $2\frac{1}{2}$ in. A milled head behind the stage secures it if desired.

The instrument can be used in a vertical position by bringing forward the legs on their hinge joints, so that they project in front of the stage and mirror.

Chevallier's Inclining Microscope (large model).—We give a figure of this somewhat peculiar Microscope (fig. 122) in illustration

Fig. 122.

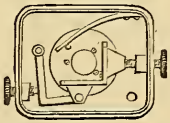


of one of the various designs adopted in the evolution of the modern instrument. The base is solid, and forms one piece with the upright. The limb is suspended in a peculiar manner, being attached to a trunnion axis very near the lower end—much too near to give stability to the inclination. The coarse adjustment is by sliding-tube. The

fine focusing screw is at the top of the limb, but acts not on the tube but on the stage, causing this to slide up or down. The mirror-bar is of somewhat uncommon form, having a hinge-joint close beneath

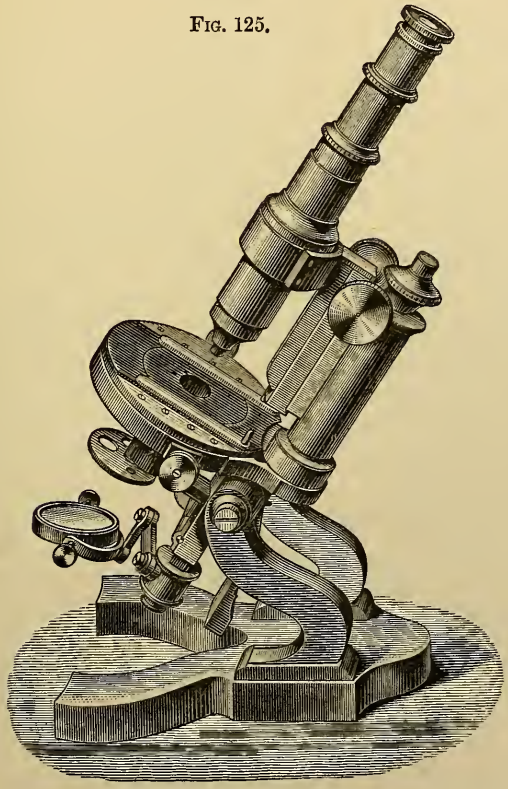
Fig. 123.

Fig. 124.



the stage on which it can be swung considerably forward for oblique illumination; the mirror also slides in a slot to focus the light on the object.

Fig. 125.



A mechanical stage can be applied on the ordinary stage; the mechanism is shown in fig. 123 (upper side) and fig. 124 (lower side). This construction has been largely adopted (with more or less

modification) on the Continent, and was originally devised by M. Nachet, Senr. The rotating movement has the disadvantage, common to the older forms of movable stage, of being acted upon by the rectangular movements, so that the centering in the optic axis is disturbed whenever these movements are used, their utility being thereby seriously reduced.

The Microscopes now issued by the firm of Chevallier are on a more modern type: their large stand is shown in fig. 125.

Hirschwald's Microscope-Goniometer.*—J. Hirschwald has devised a Microscope-goniometer for measuring the angles of crystals not having reflecting surfaces, the principle of which consists in employing the sensibility of a Microscope in the accurate focusing of a plane surface. The instrument (fig. 126) consists essentially of three parts—(1) a Wollaston goniometer, (2) a Microscope, and (3) a telescope.

The goniometer is firmly attached to a horizontal base-plate C. The circle M is divided into half-degrees, and by means of a vernier N reads to single minutes. The lens L allows of a still closer estimation. By the milled head O^1 the object can be turned without the circle, the movement of the latter simultaneously with the object being effected by turning the larger milled head O^2. By screwing down P the turning of O^2 is prevented, and the circle with the object can then only be moved by the screw Q, which presses against the end of the lever J attached to the axis, giving a very slow movement to the circle.

The crystal is attached to the holder R, which, besides rotating on the goniometer axis, allows of four other motions, viz. two rectangular movements in a plane at right angles to the axis, and two similar movements, but in segments of a sphere.

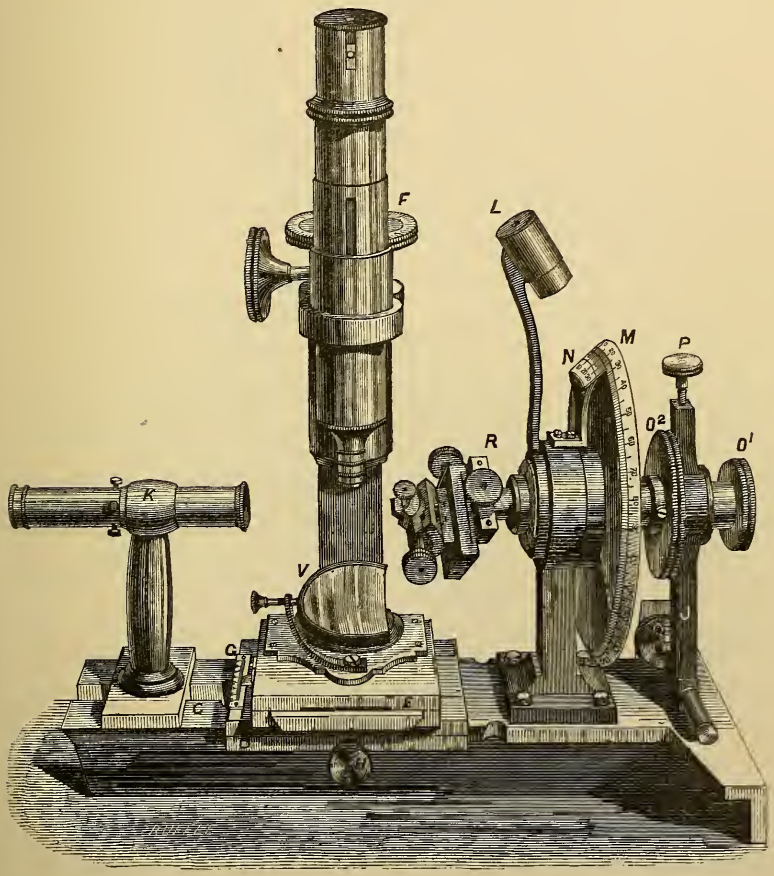
The Microscope rests on a double slide D E, by means of which it can be moved either parallel or at right angles to the axis of the goniometer, so that the entire surface of a crystal can be examined. The slide E has an index mark, which indicates the extent of movement upon a scale G in half-millimetres. The slide D can be fixed to the base-plate by clamping the screw H. The micrometer-screw F of the Microscope has a pitch of 0·4 mm., and is graduated so that the raising or depression of the Microscope can be read to 0·004 mm. The eye-piece has cross-threads, one parallel and the other at right angles to the axis of the goniometer-circle. The former will lie in the vertical plane of the axis when the Microscope is adjusted so that the index mark is at the zero of the scale G. The Microscope with the three lenses of the dividing objective has a magnifying power of 500 times, a focal distance of 0·76 mm., and a sensitiveness of focus of 0·0015 mm. Without the lower objective the figures are 350, 1·2 mm., and 0·004 mm. respectively; and on

* Neues Jahrb. f. Mineral. Geol. u. Palaeontologie, 1879, pp. 301 (1 pl.) and 539; 1880, p. 136.

removing the lower and middle lenses the power is reduced to 200, with a focal distance of 6 mm. and a sensitiveness of 0·008 mm. For the illumination of transparent objects there is a mirror V, a condensing lens on a separate stand being used for opaque ones.

The centering telescope K has cross-threads (movable by four

Fig. 126.

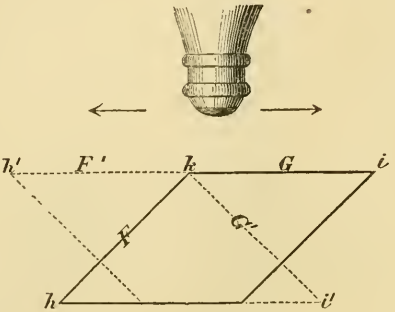


small screws), adjusted exactly in the axis of the goniometer. It moves in a groove in the base-plate in the direction of the axis.

The method of measuring is briefly as follows:—(1) the edge of the surfaces to be measured is placed parallel to the goniometer-axis by means of the thread in the eye-piece; on turning the

crystal the edge and the thread must remain parallel. (2) The edge is so centered that it appears in the middle of the cross-threads of the telescope, and remains in this position on turning the crystal. (3) The screw H is turned to fix the lower slide of the Microscope, so that the latter can only be moved at right angles to the goniometer-axis. The Microscope is focused on one of the two surfaces F G (fig. 127), forming the edge k to be measured, and having focused the

Fig. 127.



part next to k, the Microscope is passed over the surface G, and the crystal slightly moved until the part next i is in focus. When G has been adjusted exactly horizontal, the crystal is then turned, and the surface F similarly adjusted. The angle indicated on the goniometer through which the crystal is turned in order that the second surface F may occupy the position of the first, G, is the complementary angle of the edge measured.

The degree of exactness of the measurements for a diameter of the crystal surface of x mm., and for a defect in the focusing of the Microscope of u mm., will be given by the formula $\tan \alpha = 2\frac{u}{x}$. Therefore for

$$\begin{aligned} x &= 10 \text{ mm. and } u = 0{\cdot}004 \text{ mm.}, & \alpha &= 2'\,45'' \\ &= 5 & &= 5'\,30'' \\ x &= 10 \text{ mm. and } u = 0{\cdot}008 \text{ mm.}, & \alpha &= 5'\,30'' \\ &= 5 & &= 11'\,0'' \end{aligned}$$

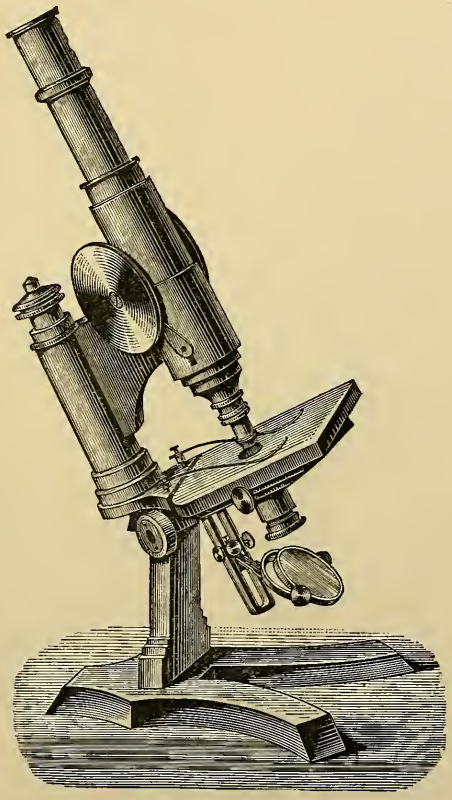
These figures, however, involve extreme assumptions: by careful repetition of the measurements exactness to $1'$ and less can be secured.

It is recommended to dust the surface of transparent crystals with very fine lime-wood charcoal, the focus not, however, being adjusted to the grains of charcoal, but upon the surface on which they rest. For opaque objects fine gum arabic is best.

Plössl's Large Stand.—This instrument (fig. 128) has a coarse adjustment of unusual construction, which is claimed to be eminently simple and to work very smoothly and surely, much better than rack and pinion.

Each of the two milled heads, 48 mm. in diameter, has near its

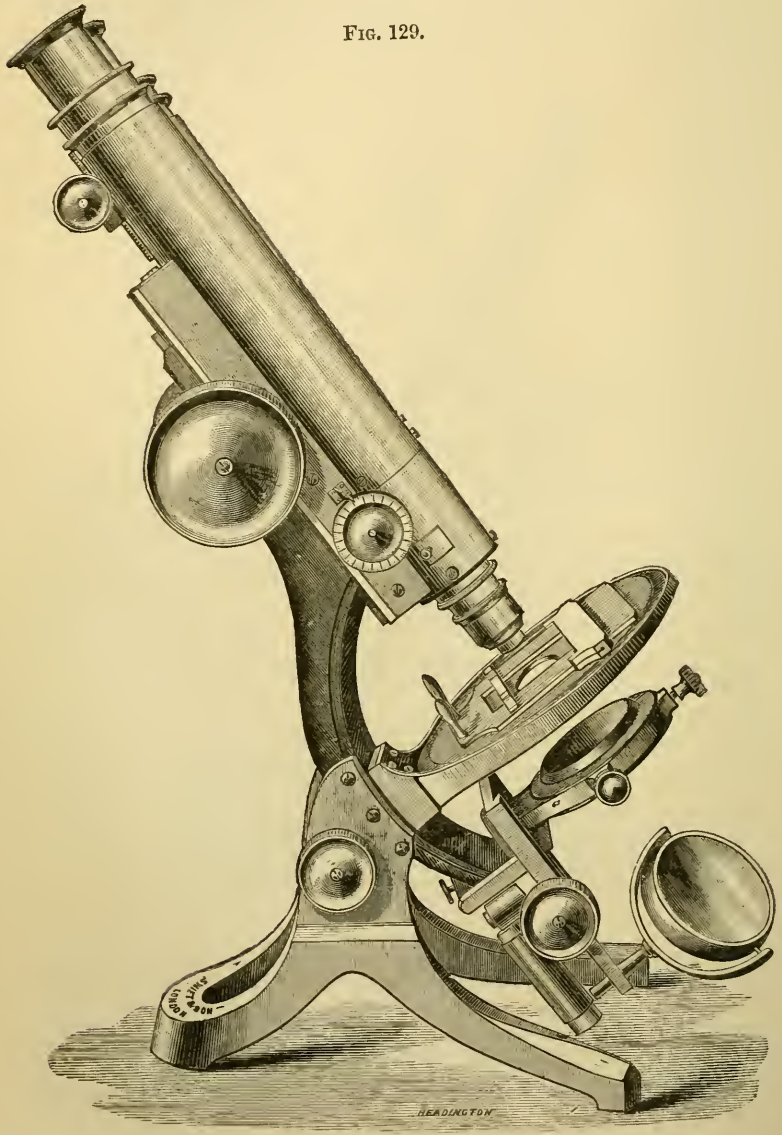
FIG. 128.



periphery a steel pin, to which is attached, so as to be movable, one end of a short rod. The latter is similarly movable at its other end on a pin on the body-tube, which moves in a rectangular slot 35 mm. long, cut parallel to the optic axis in the outer tube, lined with cloth, in which the body-tube slides. The result of the arrangement is, that on turning the milled heads the body-tube is correspondingly raised or depressed.

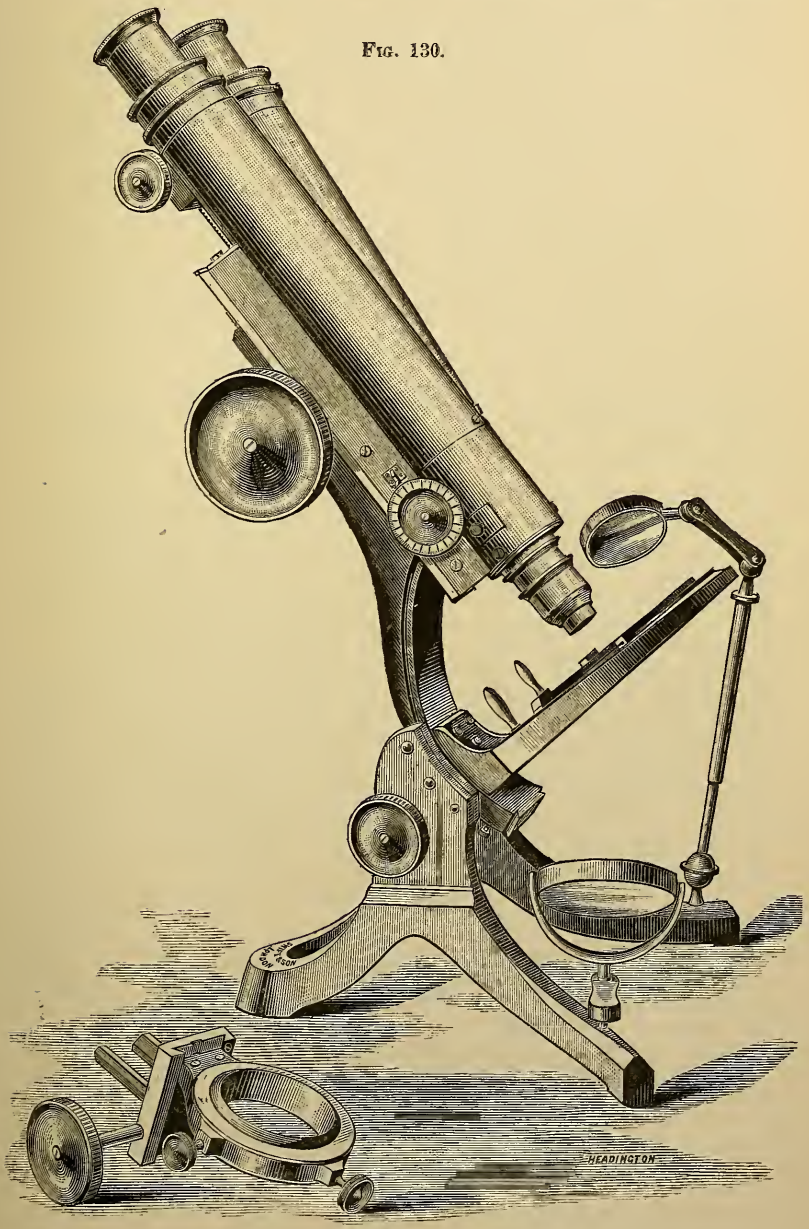
Swift and Son's Radial Inclining Microscope. — Figs. 129 and 130 show a new Microscope, made by Messrs. Swift and Son, which is an improvement of Wale's Working Microscope. The improvement

Fig. 129.



consists essentially in making the movement of inclination radial with the object on the stage, so that a beam of light from a fixed source directed upon the object remains on it during any inclination given

Fig. 130.



to the Microscope. Thus, suppose the light from the mirror to be directed as in fig. 130, then if the limb is inclined to the horizontal the light will still be upon the object, the incidence being, however, greatly increased in obliquity.

This result is obtained by making a sector-groove on either side of the limb radial with the object on the stage. The top of the tripod is provided with jaw-pieces fitting in the sector-grooves, and a clamp-screw causes them to grip the limb at any position of inclination.

The under face of the stage is flat, so as to present the least obstacle to oblique illumination, and the required strength in the attachment to the limb is obtained by thickening the rim on the upper edge as it approaches the limb, as devised by Mr. Tolles.* Friction-stage movements carry the object. The substage fits on the lower end of the limb by a dove-tail slide, which appears to be a convenient arrangement for rapidly attaching or removing it. The mirror can be used as shown in fig. 130, or on the tail-piece as in fig. 129. A telescope rod carries a bull's-eye lens or prism with ball-and-socket joints, as shown in fig. 130. The fine adjustment is on the system applied to Messrs. Swift's previous model.†

The new Microscope is extremely steady in all positions of inclination, in this feature meriting the favourable opinion of Wale's original model expressed by Dr. Carpenter.‡

Projecting Lanterns.§—Prof. C. H. Stowell describes his experience with a Marcy's lime-light sciopticon with one of Zentmayer's microscopic attachments, using ordinary Microscope objectives (1½ and 3-4ths in.), although the field is flatter and lighter if objectives are used especially for this kind of work. To work nicely the gases should be under heavy pressure. When the pressure in the cylinders is down to 60 or 70 pounds, such good results are not obtained.

With this simple outfit the Professor illustrates his lectures on histology. A transverse section of the spinal cord of a pig can be enlarged to 10 ft. in diameter on the screen. To show the nerve-cells a power of 500 diameters is very easily obtained. The cells will show so clearly that their poles can be counted and their nuclei clearly discerned. Sections of injected kidney, liver, intestine, &c., show very clearly and beautifully as well. Sections of cancer will show the stroma and cells. Pneumonia lung will show air-cells 6 in. in diameter more or less filled with the exudate.

One of Dr. A. Y. Moore's double-stained blood slides will show the individual corpuscles and their nuclei at a distance of 20 ft. from the screen very clearly, and this with a disk 6 ft. in diameter. The striæ and sarcolemma of muscle can be exhibited also. The circulation of the blood can be exhibited, using the tongue of the frog, on a disk 12 ft. in diameter.

By a simple device opaque specimens are thrown upon the screen. A frog is pithed, the thoracic walls removed, and the heart beating

* See this Journal, i. (1881) p. 944. † Ibid., p. 297.
‡ Ibid., iii. (1880) p. 1086.
§ The Microscope, iii. (1883) pp. 51–3.

in situ exhibited. The heart will appear about a foot in length, and will powerfully contract, stimulated by the heat. The heart may be removed from the body, pinned to a card, and this thrown on the screen, still there is vigorous motion. Again, the heart may be halved and quartered, yet still the pieces will be seen to contract.

No complex or wonderful apparatus is required. "Two hundred dollars and a little patience and ingenuity will go farther than some fifteen hundred dollar outfits."

Mr. R. Hitchcock,* on the other hand, considers that taking facts as they are at present, it is certainly much better to use photographs of microscopic objects, taken either from the objects themselves by aid of the Microscope, or else from good woodcuts—which is often the better plan—than to grapple with the difficulty of using the projecting Microscope. "We regard the latter as a useful instrument for popular demonstrations, and no doubt it has a limited sphere of usefulness in more strictly scientific work, but until it is greatly improved in several respects, it cannot be of very great value to lecturers upon scientific subjects."

Assyrian Lens. — Sir A. Henry Layard, in his 'Nineveh and Babylon,' describes a lens which he found in the course of his excavations, and which is now in the British Museum. By the kind permission of Dr. Birch, the Keeper of Oriental Antiquities, we have been enabled to figure it here (figs. 131 and 132).

Fig. 131.

Fig. 132.

The lens is thus referred to by Sir A. H. Layard †:—"With the glass bowls was discovered a rock-crystal lens, with opposite convex and plane faces. Its properties could scarcely have been unknown to the Assyrians, and we have consequently the earliest specimen of a magnifying and burning glass. It was buried beneath a heap of fragments of beautiful blue opaque glass, apparently the enamel of some object in ivory or wood, which had perished.

I am indebted to Sir David Brewster, who examined the lens, for the following note:—'This lens is plano-convex, and of a slightly oval form, its length being $1\frac{6}{10}$ in., and its breadth $1\frac{4}{10}$ in. It is about 1-4th ‡ of an inch thick, and a little thicker one side than the other. Its plane surface is pretty even, though ill polished and scratched. Its convex

* Amer. Mon. Micr. Journ., iv. (1883) pp. 125-6.

† 'Nineveh and Babylon,' pp. 197-8. 8vo, London, 1853.

‡ "9-10ths" in original.

surface has not been ground or polished on a spherical concave disk, but has been fashioned on a lapidary's wheel, or by some method equally rude. The convex side is tolerably well polished, and though uneven from the mode in which it has been ground, it gives a tolerably distinct focus, at the distance of $4\frac{1}{2}$ in. from the plane side. There are about twelve cavities in the lens, that have been opened during the process of grinding it: these cavities doubtless contained either naphtha, or the same fluid which is discovered in topaz, quartz, and other minerals. As the lens does not show the polarized rays at great obliquities, its plane surface must be greatly inclined to the axis of the hexagonal prism of quartz, from which it must have been taken. It is obvious, from the shape and rude cutting of the lens, that it could not have been intended as an ornament; we are entitled, therefore, to consider it as intended to be used as a lens, either for magnifying, or for concentrating the rays of the sun, which it does, however, very imperfectly.' " *

Lindsay's Microscope.†—This is represented in figs. 133 and 134. *a* is the lens fixed in a concave speculum; *b* the object-holder; *c* is a handle to which a longer arm can be screwed, and which can be turned up beneath the Microscope; at *d* is a graduated scale for roughly focusing the various lenses belonging to the instrument; *e*, *f*, *g* is a lever on which the observer can place the forefinger at *e*, and the thumb at *f*. Since the lever turns on *h*, whilst *i* moves in a slit in the plate of the object-holder, the latter by this means is adjusted at the required distance from the lens.

Fig. 133.

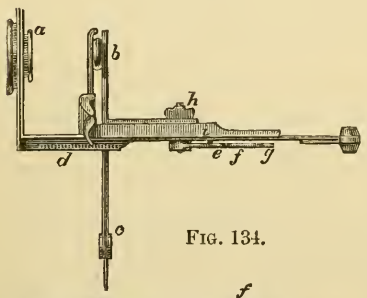
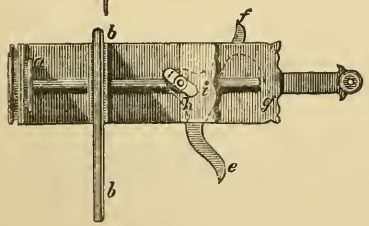


Fig. 134.



Janssen's Microscope.‡—Professor P. Harting, in the course of an examination of some old optical instruments found in Middelburg in 1866,§ and attributed to Janssen, discovered a compound Microscope, of which a section is represented in fig. 135 (1-4th natural size). The two tubes holding the lenses *a* and *b* are of tin roughly soldered together, and sliding in a somewhat wider

* The shading of fig. 131 representing internal striæ, is too strong, suggesting more opacity than really exists.

† Bericht über die wissenschaftlichen Apparate auf der Londoner Internat. Ausstellung im Jahre 1876 (Achenbach und Falk), 1878, Part 1, pp. 52-3 (2 figs.).

‡ Ibid., p. 50 (1 fig.). See also p. 46. § Album der Natur, 1867, p. 261.

third tube. *c* is a diaphragm and *d* an annular support upon which, on inverting the instrument, the lens *a* falls, whilst *b* is held in the usual way by a wire ring. Why the lens *a* is left loose is not apparent. The magnifying power obtainable with the instrument is not great. If the tubes containing the lenses are drawn out as far as possible it magnifies nine times, the object being at a distance of 14 cm. The instrument was presented by Mr. J. Snyder to the "Zeeuwsch Genootschap der Wetenschappen," and from that time its existence was so unknown, even in Holland, that it is not mentioned in such a complete history of the Microscope as that of Harting. It had been long in the possession of the Snyder family, but there are no authentic documents concerning it. Harting came to the conclusion, after examining it, that it was really made by Janssen.

Fig. 135.

Messrs. Beck made several facsimiles of the Microscope from the original in the South Kensington Loan Collection.

"Contribution to the History of the Compound Microscope."* —Professor Heschl, of Vienna, describes nine compound Microscopes found in Austria. The one shown in fig. 136 was made by G. F. Brander, of Augsburg, between the years 1760-90. It is 32 cm. high, has a massive foot *a*, of brass, with a standard *b*, into which fits a prolongation *c*, which carries a square brass box *f*, open at the sides. Into the lower plate of this is screwed the tube *g*, carrying a bi-convex lens *m*, acting as a condenser, and into the upper (at *i*) the objectives, together with the double tube (of brass below and wood and paper above) carrying the Ramsden eye-piece *n*. In the box are two movable plates *h*, forming the "stage," and between which the slider containing the objects is placed. The upper plate is pressed down to the lower by a spiral spring *l*, while the lower plate can be raised or lowered by screwing in or out the tube *g*. The mirror *d* is attached to an arm *e*, so that it can be used excentrically if desired.

There are seven objectives, two of them with Lieberkuhns. The five without Lieberkuhns can be used as simple magnifiers when the tube is removed and the lower part of the stand only employed. The two former could not, however, be then attached to the instrument, and an arm is accordingly supplied to take them (and also the others), which fits into the top of *f*, and projects laterally over the slide on the right. The tube with the eye-piece also fits on this arm, so that the instrument can be used as simple or compound in this position also. The mirror can be brought under the object in the altered position of the objectives by means of its arm above referred to.

A second form, shown in fig. 137, has no maker's name, and its date is doubtful, probably about 1800–10. It is inclosed in a

* Arch. f. Mikr. Anat., xviii. (1880) pp. 391–402 (1 pl.).

wooden case 21 cm. high (with a glass cover), the front of which is removed when in use, and it can be set at any angle on its horizontal axis by the screw *a*. The speciality of the construction is the large stage, 12 cm. by 9 cm., consisting of a lower plate *c c*

Fig. 136.

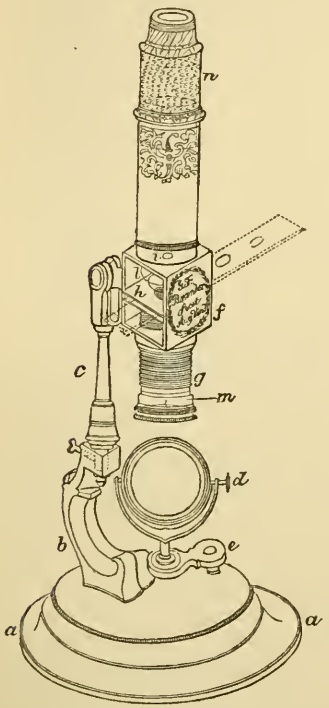
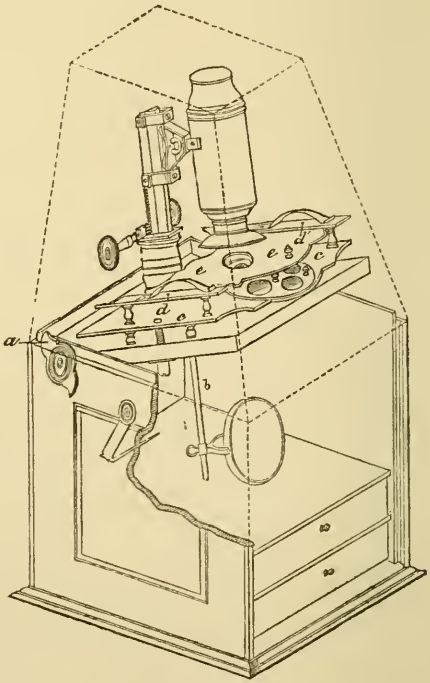


Fig. 137.



carrying a wheel of diaphragms, and an upper plate *e e* sliding between two pieces *d d'* (with spring clips) supported on four short uprights.

The eye-piece is Huyghenian, without any diaphragm, and the (concave) mirror is of metal attached to the bar *b*.

The third Microscope figured is one given by Franz I., in 1815, to the Vienna Technical High School, resembling most that of Tiedemann described by Harting.* It is engraved with the name of an unknown maker, "Otteny," with "Mecha. Fe. in K.K. Phis. Kabin." added.†

The remaining six are not figured. One is a Cuff instrument,‡

* Harting, P., 'Das Mikroskop,' iii. p. 126.
† In the plate "Schis. Kab."
‡ Harting, P., 'Das Mikroskop,' iii. p. 114.

dating from about 1750. A second is in the form of a square turret of wood with an opening in front for light to reach the mirror within, and two lateral slits for the insertion of the slide. In the upper end is a double (sliding) tube of wood and paper carrying the objective and eye-piece. It was probably made in Nuremberg in the last century. The other four have no special history, and date from 1817 (then bought of Voigtlander for the Vienna University), 1811–20? (by Utzschneider, Reichenbach, and Fraunhofer), 1820–6 (Utzschneider and Fraunhofer), and probably before 1830 (Chevallier).

Standard Eye-pieces.*—Dr. Blackham, on behalf of the committee on Eye-pieces, presented the following report to the Chicago Meeting of the American Society of Microscopists: "Your committee on nomenclature and sizes of oculars would unanimously report:—

1. In favour of naming oculars, like objectives, by their equivalent focal lengths in English inches. We believe this method to be the best adapted to practical use, sufficiently precise for its object, and capable of general introduction with less inconvenience, opposition, or delay than any other rational system. Assuming that 1 in. indicates an amplification of ten diameters, 5 in. of two diameters, 1-5th in. of fifty diameters, &c., as actually obtained by a compound Microscope with a 10 in. tube (from the diaphragm of the ocular to the front lens of the objective), the image being measured by the camera lucida at a distance of ten inches from the camera, and that the amplifying power in use can be approximately determined by multiplying together the powers thus implied in the names of the objective and ocular, an extremely simple and comprehensive system is obtained, whose practical benefits are believed to greatly exceed its technical or theoretical faults, and whose adoption would add much to the definiteness and intelligence of the microscopical work. A table showing the simplicity and scope of this system is given in the Journal of the Royal Microscopical Society for 1882, page 105.

2. In favour of adopting one or more standard sizes for the tubes of oculars. That uniformity in this respect would be a great convenience to students, and, to say the least, no disadvantage to manufacturers, we do not doubt; but the difficulties in the way of adopting such a policy at the present time are evidently great, far beyond comparison with those encountered in the introduction of the 'Society screw.' Furthermore, the great variety of tastes among both makers and buyers as to sizes, styles, and pieces of stands seems to call for not less than two or three standard diameters of tube. As an important step toward uniformity we would gladly recommend the adoption of the sizes recently proposed by the Royal Microscopical Society, 0·92 and 1·35 in., were they adapted to the conditions existing in this country. But 0·92 is a smaller size than we are willing to recommend for any purpose, being much too little, in our judgment, for even the small, compact stands of the 'Continental' model. On the other hand, we would have preferred 1·40 for the

* 'Chicago Times,' 9th August, 1883, in advance of Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883.

large tube, but do not regard the difference as sufficiently important to justify the naming of still another size. There remains, however, a very large variety of medium-sized stands, a class believed to be rapidly increasing in numbers and importance, which cannot, without a total change of character, be raised to 1·35, and which should not, in our opinion, be reduced even to 1. We therefore propose a standard medium size, 1·25, which we believe well adapted to a great majority of purposes, with the alternatives of 1 and 1·35 for those who wish smaller or larger tubes. Suitable adapters would harmonize apparatus previously made with these sizes, and these sizes with each other. We would also suggest the great convenience of uniform diameter in the upper tube of the ocular for the easy interchange of camera-lucidas, analyzers, &c. There seems to be no serious disadvantage in having this tube of uniform diameter in stands of various styles and sizes; and we would recommend that 0·75 in., or some smaller size, be made a standard. We would also recommend that the diameter 1·50, recommended by the Royal Microscopical Society for substage tubes, is in very general use and well adapted to both large and reasonably small stands, and we recommend its adoption to this Society.

3. The following resolutions are therefore submitted to the consideration of the Society:—

Resolved, That this Society recommends that oculars be named by their equivalent focal distances on the basis of 1 in. focus corresponding to 10 diameters of amplification at 10 in. distance, and that this nomenclature be employed in the Proceedings of this Society.

Resolved, That this Society recommends the adoption of the diameter 1·25 in. outside measure as a standard size of ocular tubes, with a preference for 1 and 1·35 where smaller or larger sizes are required, and recommend 0·75 outside measure for ocular cap tubes, and 1·50 in. measure for substage tubes.—R. H. Ward; A. L. Smith; J. D. Hyatt; George E. Blackham."

Mr. W. H. Bulloch objected to the report on the ground that the committee appeared to have followed the English system, which has 1·35 for the largest piece. The system is not well adapted for America, he said, because there are no instruments there that are made according to the English system. No changes in the parts of an instrument can be made. The amplifying power of the eye-piece ought to be the basis of the standard, and not the focal size. There is no make of instruments that correspond to the standard the committee recommends. He also spoke of variations that the density of the glass will cause in the magnifying powers of eye-pieces that are made according to the same formula.

Dr. G. E. Blackham thought the report should be postponed till next year.

Mr. J. D. Cox thought it questionable if the standards should be so confined as the report recommended, "because different grades are required even by the profession."

The Society in the result ordered the report to be published in the

Proceedings, referred back to the committee with instructions to continue its investigations, and the matter considered at the next annual meeting.

Grunow's Camera Lucida.*—Mr. J. Grunow has modified his camera lucida by a slight change in the opening through which the image of the object on the stage is seen. By reducing the opening to a diameter of ·05 inch, he states that the pencil point is still more clearly seen, while sufficient light comes from the object to show the details.

Standard Body-tube for Microscopes.†—Mr. G. E. Davis sees "no other way of bringing about a standard gauge than by publishing the diameters of all stands now in the market, and advising purchasers to choose the larger bore. A small eye-piece will fit a *large tube*, and can be centralized and kept tight by a paper adapter or collar made by the microscopist himself; but a small tube will only take a small ocular, and no other, so that the diameter of the body-tube of the Microscope should always be taken into consideration on the purchase of an instrument."

A table of thirteen English and three foreign stands is given with the diameters of the oculars, both the body and the neck over which the camera lucida usually fits.

Sliding Body-tubes.‡—Dr. J. Edwards Smith thinks that there are some advantages in a sliding body, that are not to be obtained by the use of the rack and pinion.

For example: supposing we are working over wet preparations, and unfortunately the front of the objective becomes immersed in the liquid, a misfortune liable to occur daily. It is then, in such cases, a *positive convenience* to be able to pull the body-tube out of the jacket, clean the objective, and return to its place. All this can be done in much less time than would be required, were the instrument furnished with rack and pinion, to unscrew the lens, clean, and screw in place again.

McCalla's Nose-piece.§—Prof. A. McCalla refers to a form of nose-piece which he considers to have some advantages over Pease's "Facility" nose-piece and that of Nelson. "It is simply a form of bayonet catch which would dispense entirely with the screw, and hold the objective perfectly secure against sagging on one side or working loose when the adjustment collar was in use."

Smith's Rotating Stage.‖—Dr. J. E. Smith describes "the stage which he has had in daily use for years, and one that has to a considerable extent been copied by his friends."

Provide a sheet of well-hammered brass, heavy enough, so that when planed or turned down the stage shall be 1-16th of an inch in

* Amer. Mon. Micr. Journ., iv. (1883) p. 138.
† Micr. News, iii. (1883) pp. 219–20.
‡ 'How to See with the Microscope,' 1880, pp. 44–5.
§ 'Chicago Times,' 8th August, 1883.
‖ 'How to See with the Microscope,' 1880, pp. 27–8.

thickness, with both faces truly parallel. Cut the circle which is to form the stage as large as the instrument will permit, and in accordance with the following directions.

Cut the well-hole 1-16th inch larger than the well-hole of the stage; make a collar, or short tube, out of the same material used for the stage; turn the outside to proper dimensions, so as to fit the well-hole of the new stage, the upper edges of both being "flush," and solder in position.

Next turn accurately the under and projecting part of the short collar, or tube, so that it will *exactly* fit the well-hole of the main stage; place it thereon, and cut off any portion of the collar that may project beneath the stage.

In the stage thus far towards completion, if the collar projects 1-16th inch, this will be found ample for its support.

All that remains to be done is to fit the new stage with plain spring-clips, which can be done in a few moments out of a piece of watch-spring; or, if there is room enough, an object-carrier can be provided on Zentmayer's principle. As to rotation in the optic axis, the author says that if it did so rotate with one objective, it would be pretty sure to fail with another. The compensation must be supplied by finger manipulations easily acquired and as easily practised. "A grand good thing about this improvised stage is, that it can be placed in position or removed therefrom in a moment's time."

Bausch and Lomb Optical Co.'s Compressors.—The first of these (fig. 138) is simply a modification of the Optical Co.'s Trichinoscope,* made, however, shorter and broader. Besides its use as a compressor, it forms with the addition of the lens a convenient pocket Microscope for field use in collecting Infusoria, Algæ, &c.

Fig. 138.

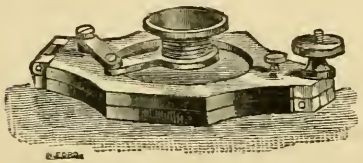
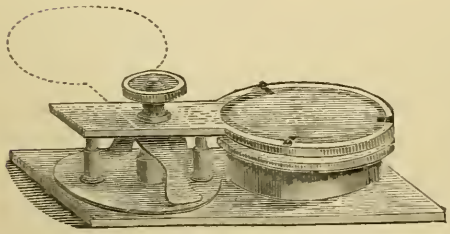


Fig. 139.



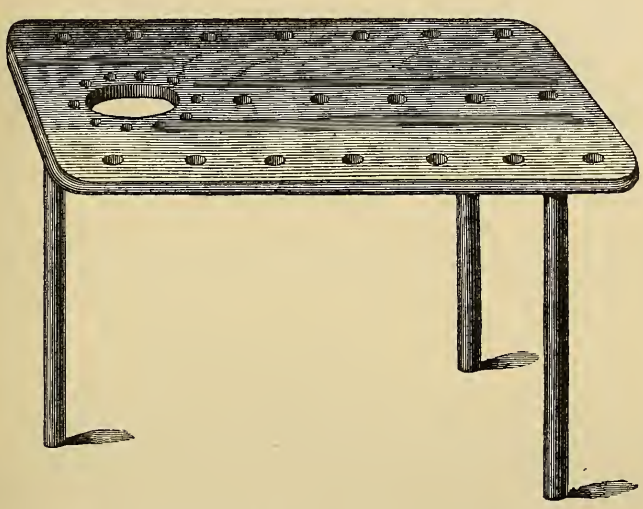
The other form (fig. 139) is a parallel compressor. Parallelism is obtained by attaching a spring and two pins on the under side of the arm carrying the upper plate. The pins slide in two sockets and when the milled head is screwed down the upper plate is pressed on the lower, the pins descending into the sockets. On releasing the screw, the spring forces back the arm. In order that the upper plate may be turned on one side as shown by

* See this Journal, ii. (1882) p. 258.

the dotted lines the sockets are not attached to the lower plate, but to a disk which rotates with the arm.

Frog-plate.—The form shown in fig. 140 differs from the frog-plates usually supplied by opticians for observing the circulation in the web of the frog in that it is of ebonite and not of brass, that it is not intended to be laid upon the stage but to stand on its own supports

Fig. 140.



just over it, and that it can also be used for the study of the tongue. For the latter purpose half of a ring of cork must be fixed with brass pins round the large aperture, on the side next the end of the plate, and to this cork the cornua of the tongue may be attached. The large aperture is of course to be arranged over that of the stage.*

Apparatus for Examining the Circulation in the Lung and Mesentery of the Frog.—One of the best objects for observing the capillary circulation is the lung of the frog. The first difficulty in its use is, however, that it is often emptied by the frog and is then useless for observation. On the other hand, when it is swelled up it is so convex that it cannot be covered with a cover-glass, and the use of high powers is prevented. Holmgren, by an ingenious apparatus (figs. 141, 142, and 143), has surmounted these difficulties.†

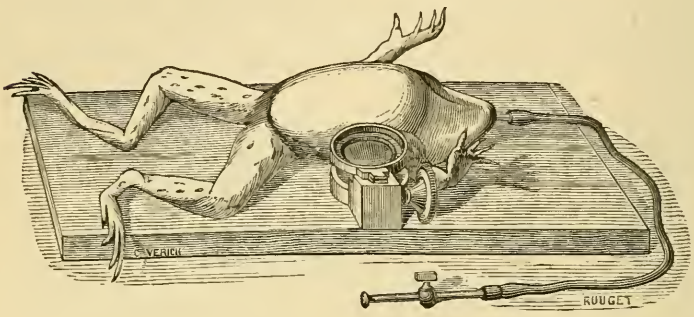
The frog is first immobilized by the subcutaneous injection of curare, and to regulate the state of repletion of the lung, a tube with a tap at the free end (fig. 141) is introduced into the glottis: the

* Cf. Dr. Klein in 'Handbook for the Physiological Laboratory,' 1873, p. 42 (1 fig.).

† Ranvier's 'Traité technique d'Histologie,' 1878, pp. 600–3 (3 figs.).

pulmonary sacs can then be distended at pleasure and the distension maintained by closing the tap. To prevent the air returning

Fig. 141.



through the lips of the glottis, that end of the tube (fig. 142) is provided with a membranous bag *m* (formed of a piece of frog's

Fig. 142.

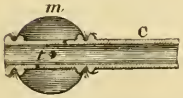
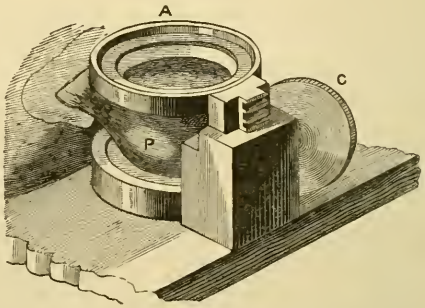
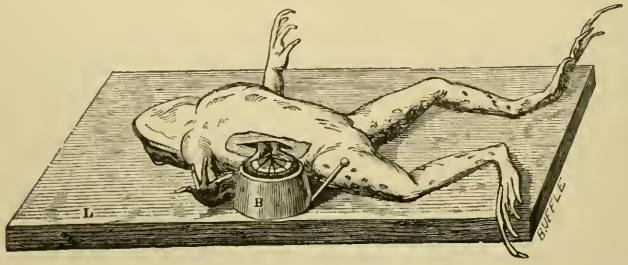


Fig. 143.



intestine tied round the end communicating with the tube *c* by three holes *t*. When the tube is filled with air this bag dilates and

Fig. 144.

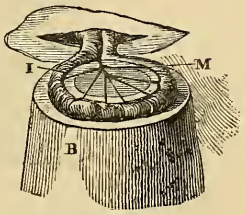


closes the mouth of the glottis against any return of the air from the lung.

The lung P being dissected out is placed as shown in figs. 141 and 143, and is covered by a cover-glass held in a ring A which can be raised or lowered by the rack and pinion C, and the surface can be reduced to a plane.

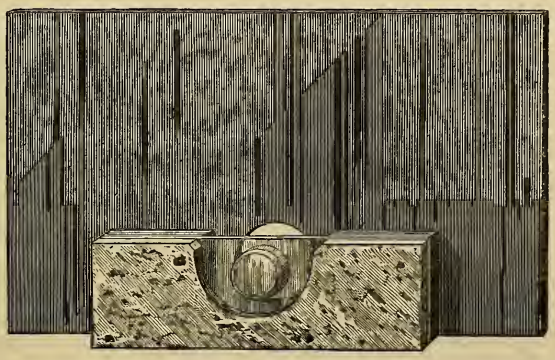
Ranvier's apparatus for the mesentery,* shown in figs. 144 and 145, consists simply of a plate L with an aperture, over which is attached a cork disk B, having a hole drilled through the centre so as to allow light to be transmitted from the mirror. The intestine is dissected out and attached to the disk as shown in the figure. If it is not thus elevated above the level of the wound, blood and lymph will run out and hinder observation. To fix the intestine and mesentery, the disk B has its upper surface cut away so as to leave an annular projection in the centre, on which the mesentery M rests and round which the intestine I is placed.

Fig. 145.



Another arrangement † is shown in fig. 146. A wooden or ebonite plate, to carry the frog, has a circular aperture, over which a glass slide is supported on two corks or pieces of ebonite about 1-6th in.

Fig. 146.



deep. The slide is covered with cork 1-8th in. thick, having a semicircular piece cut out in the centre. In the middle of this, and just over the aperture in the bottom plate is a glass disk, 1-8th in. thick, on which the mesentery lies, the space between it and the cork forming a trough for the reception of the coil of intestine.

A simpler form of apparatus is shown ‡ in fig. 147, where a glass plate A has attached to it two pieces of wax C C, which support and

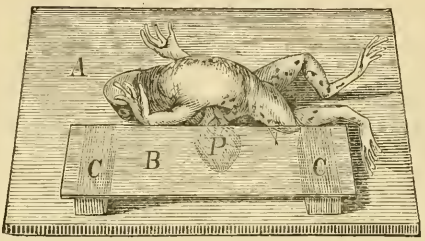
* Ranvier's 'Traité technique d'Histologie,' 1878, pp. 603–5 (2 figs.).

† Cf. Dr. E. Klein in 'Handbook for the Physiological Laboratory,' 1873, pp. 108-9 (1 fig.).

‡ Thanhoffer, L., 'Das Mikroskop,' 1880, p. 152 (1 fig.).

firmly retain a slide B by which the lung P is pressed flat. If high powers are used, the wax supports must be closer together, and cover-glass used.

Fig. 147.



Madan's Modification of Darker's Selenite-Holder.—H. G. Madan has devised a modified form of selenite-holder, which he finds preferable to the holder usually made.

"The ordinary form of Darker's selenite substage fitting is well known; three films of selenite, giving retardations of $\frac{1}{4}$ wave, $\frac{3}{4}$ wave, and $\frac{5}{4}$ wave, respectively, are mounted in circular brass cells, which rotate in rings attached to a side-arm, and can be thrown in and out of the field as required. This arrangement is perfectly effective, but it has two inconveniences: (1) that no means is provided for changing the films for others, such as Ackland's neutral-tint film, or Klein's plate; (2) that when the selenites are in position for use it is difficult to see, and impossible to tell by feeling, the exact azimuth of that direction in the crystal-film, which is usually marked by opticians P↑A; i. e. the direction in which the retardation of one of the two rays behind the other is greatest, and which lies, of course, at an angle of 45° with the acute bisectrix, or 'median line.'

The arrangement described below is intended to avoid both these inconveniences.

The selenite films are mounted in cells of the shape shown in fig. 148; a groove being cut in the edge of the cell before the handle A is soldered into its place. The holder is in the form of a ring, about 3-7ths of which are cut away, as shown in fig. 149; the remaining part being quite sufficient to retain the cell in position, and yet allow it to rotate freely when it is 'sprung' into its place.

Three of these holders are jointed to a side-arm, so that they can be thrown in and out of use, as in the usual Darker's stage.

The handle A is made of such a breadth as to allow the selenite an angular movement in azimuth of exactly 90°; which is, of course, sufficient for all modifications which it is capable of producing in a polarized ray.

Thus the various combinations of the films are obtained by merely moving the projecting handle 45° on either side of its central position, motions as simple and easy as those of a signalman in throwing over his levers for altering points and signals. In my own case, I have mounted the films in such a position that the acute bisectrix is in a

line with the centre of the handle (fig. 150). Hence, the plane of polarization of the light being supposed vertical (i. e. at right angles to the length of a slide placed on the stage): (1) When the handles of the selenite holders are also vertical, the ray passes through the films

Fig. 148.

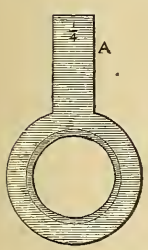
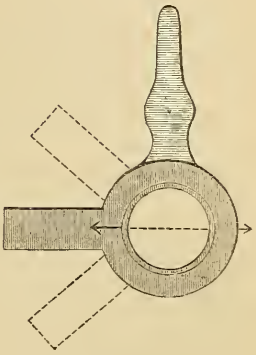


Fig. 149.

Fig. 150.



without change; (2) When the handles are thrown 45° to the right hand, the maximum retardation due to the sum of the thicknesses of the films is produced; (3) When any one of the handles is thrown 45° to the left hand of its central position, the retardation due to that film is subtracted from that of the others.

Thus it is easy to obtain any given retardation within the range of the series of films without removing the eye from the Microscope. So again, to obtain right-handed circular polarized light, the two thicker films are either thrown out of the field, or placed in the median position, and the handle of the $\frac{1}{4}$ wave film is thrown 45° to the right. To obtain left-handed polarized light it is thrown 45° to the left.

In my analyser-cap a holder of somewhat similar construction is fitted for a single $\frac{1}{4}$ wave film, so that it is easy to analyse the light circularly, when desired. If, for special purposes, an entire rotation of a film is desirable, it is only necessary to omit the handle, and mill the edges of the cell on either side of the central groove—in fact, I have several cells thus made. But I prefer the handle from its convenience in showing the exact optical position of the film.

I should like also just to call attention to the ease with which almost any microscope-stand can be made to serve as a Nörremberg's polariscope for examining crystals under strongly convergent polarized light, in order to see the rings, &c., round the optic axis. All that is required is, to remove the nose of the main body, and screw into its place the usual system of converging lenses (which answers much better than any microscopic objective), the fourth lens of the system being fitted into the draw-tube. A similar system of lenses is then fitted below the stage, in place of the condenser, and the crystal to be examined is placed on the stage; or, preferably, supported in a holder like Beck's opaque object-holder, which allows it to be rotated.

Microscopes which, like Ross's newest pattern, have the fine adjustment separate from the main tube, and in which the stage can be swung to any angle, or removed altogether by simply loosening a screw, are especially adapted for the above fitting, since the upper lens-system can be as large in diameter as the main tube.

The lenses I used were the ordinary 'spectacle' lenses, including a pair of hemispheres, and the field is nearly as great as that of Hoffmann's instrument, just taking in the two axes of Brazilian topaz.

With such an arrangement, combined with the selenite stage, nearly or quite all the beautiful experiments given in Dr. Spottiswoode's little treatise on 'Polarized Light,' can be made.

It is more than a dozen years since I made the above addition to my Microscope; and I am surprised that Nörremberg's lenses are not included among the usual 'accessories' of (at any rate) first-class Microscopes."

Sternberg's 'Photomicrographs and how to make them.'—Dr. G. M. Sternberg, Surgeon-Major U.S.A., has just published a work entitled 'Photomicrographs and how to make them,' with illustrations of microscopic subjects, printed by the Boston Heliotype Printing Company from his original negatives.

The subject is dealt with carefully, and the prints afford evidence of the value of the method employed, which differs somewhat from that generally used in this country. He largely advocates for low powers the use of light reflected from a blue sky, and giving long exposures, the apparatus being a little elevated from the usual horizontal position. With high powers, Dr. Sternberg advises direct sunlight, the employment of a heliostat, ammonio-sulphate of copper cell, long focus condensing lens, and substage achromatic condenser. His arrangement for these, and the position of the focusing screen, when using a room as a camera, are not quite the same as are commonly adopted. Some of the figures clearly show that, with a proper selection of objects and this mode of taking the negatives, photomicrography can render very useful service to the microscopist. There is one plate, No. xii. (the fourth square of one of Möller's type-plates of the Diatomaceæ), which is a marvel of excellence, considering the difficulty of the subject, the photograph being made by a Powell and Lealand's 1-2 in. objective. There is also an admirable figure, pl. xvi., of *Navicula lyra*, taken with a Zeiss 1-6th dry objective, and Tolles' amplifier, the heliostat being used. Full directions are given for the use of the apparatus and development of the plates. Dr. Sternberg, to render the work more useful, has selected a series of objects, and has given explanations, so as to carry the student forward in his studies by what may be called "elementary lessons in biology," passing from *Amœba* to bacteria, unicellular algæ, epithelium and other scales, blood-globules, pollen, epidermis, hairs and woody tissue of plants, diatoms, adipose tissue, sarcoma and insect parasites, &c. One figure is given illustrating the great difference in the appearance of the print from a negative of a diatom illuminated by direct light, and by the use of the "spot-lens," much greater solidity being given by the latter, though unfortunately with less detail. There is also a

figure of the stellate hairs of *Deutzia scabra*, as imaged by reflected light. Some of the plates when compared with silver prints rather lack their brilliancy, yet still show the value of the method adopted.

The book will, we have no doubt, prove very useful to the student, especially now that photomicrography appears to be coming into favour for illustrations.

Photomicrography by Lamplight.—Dr. C. Kiaer, although his process is nearly the same as that described by Mr. G. M. Giles,* thinks it may be useful to describe the advantages and defects which lamplight, according to his experience, has in comparison with sunlight. Dry bromsilver-gelatine plates were used. He formerly tried to use lamplight on wet collodion-plates but without satisfactory result, even with the lowest objectives. The feeble light necessarily demands a much longer time for exposure than sunlight. The wet collodion plates are too little sensitive for lamplight and dry up before the necessary time has expired. The bromsilver-gelatine plates are much more sensitive, so that the time for exposure may be shortened to one-third or one-eighth of the time necessary for the wet plates.

To develope the negative he uses a mixture of a solution of neutral oxalate of potassium with a solution of protosulphate of iron with a few drops of sulphuric acid.

The lamp was a petroleum lamp, with a "sun-burner." The round wick has a diameter of 25 mm., and the centre of the flame is elevated about 22 cm. over the base of the apparatus. The lamp is placed close to the (Nachet) Microscope, the latter being in an oblique position about 30° from the vertical. This is preferable because the focusing of the Microscope is more convenient, and because the horizontal position would not permit the use of the concave mirror of the Microscope. The distance between the flame and the mirror is 16 cm., and between the two is a biconvex lens of 8-9 cm. focus, and 5½ cm. diameter. The distance of the object from the ground glass was always ½ m. With Nachet objectives No. 0 and No. 1, the plane mirror should be used, and with No. 5 the concave mirror.

As the lamp produces a light of constant intensity it is easy after a few trials to fix the exact time of exposure for each objective. For objective No. 0 the proper time for exposure (without lens and with plane mirror) is 9 minutes; for objective No. 1., with lens and plane mirror, 3½ minutes for more transparent, and 7 to 10 minutes for yellow to brown coloured objects; for objective No. 5, with only concave mirror, 30 minutes; with lens and concave mirror, according to the transparency of the object, from 7 to 15 minutes.

During exposure, the whole apparatus must stand entirely unmoved. Incautious walking in the room or the shaking produced by a passing vehicle is deleterious. To make the apparatus more steady the coarse adjustment should be screwed down.

It was formerly very difficult to photograph *yellow and brown coloured objects* by sunlight with collodion plates, because these colours act very slowly upon the plates. But when the bromsilver plates are exposed (for double the time) the result is very satisfactory.

* Mon. Micr. Journ., xv. (1876).

As to *visual* and *chemical* foci, Dr. Kiaer found, by lamplight, no difference either with low or high powers. Lamplight has very few actinic rays, which probably are united at the same plane as the visual ones.

By sunlight, moreover, it is often difficult to avoid *interference* effects, whereby the margins of the image are surrounded by dark lines, while by lamplight this inconvenience is avoided.

Another advantage of lamplight is its not being injurious to the preparation, whereas the warmth of the sun may liquefy and blister the gelatine-glycerine, in which the objects may be mounted.

Focusing the Image in Photomicrography.*—"Every operator," writes Mr. G. E. Davis, "has at one time or another of his experience had great difficulty in satisfying himself of the necessary sharpness of the image on the ground glass. Veterans of the art are known to have constructed appliances by means of which many of the difficulties may be bridged over; but the tyro is, as a rule, unacquainted with these so-called 'little dodges,' and therefore we purpose devoting a little of our space to the description of several methods for getting the exact focus of microscopic objects on the ground glass.

Dealing with low powers is not so troublesome as with high ones, as there is always sufficient light to enable a tolerably good focus to be obtained; but with high powers, and consequent loss of light, it requires all the skill at the operator's command to obtain even a passable picture in focusing by means of the ground glass alone. It has been the practice with some to use the finest ground glass obtainable, and to oil this over with olive oil, whilst others have discarded the use of ground glass as a focusing medium, and have thrown the pictures upon fine Bristol cardboard placed in exactly the same plane subsequently occupied by the sensitive surface of the plate.

There is no doubt that the oiled ground glass enables the picture to be more accurately focused than when an unprepared surface is employed, but the want of light in the case of high powers is a difficulty not dealt with by this method.

Some years ago, Mr. J. B. Dancer described to us his method, which is as follows:—Draw two lines over the roughened surface of the ground glass from corner to corner, with a writing diamond, and in the centre, where the lines cross, cement a thin cover-glass, three-quarters of an inch in diameter, with balsam and benzol. This produces a transparent circle, and as aids other circles of a similar character may be dotted over the plate in the portion usually occupied by the picture.

Upon throwing the enlarged image upon a ground glass prepared as above, a little effort will enable the operator to distinguish the details of the picture upon the transparent portion, and in many cases, without any further aid, an exceedingly sharp focus may be obtained. In many cases, however, it is better to use an auxiliary Microscope to examine this image on the transparent circle. Such an auxiliary Microscope may be easily constructed: a piece of brass tube to hold the A ocular at its upper end, while the lower end is

* Micr. News, iii. (1883) pp. 233-4 (1 fig.).

fitted with the Society thread to allow a 2 in. objective to be screwed in. This combination is made to slide in another tube furnished with a set-screw, in order that the inner tube carrying the optical portion may be fixed in any required position.

In use, the outer tube is placed in contact with the glass, and the inner tube carrying the ocular and objective withdrawn until the cross lines on the glass, made with the diamond, are exactly in focus. When the focus is accurately obtained the set-screw is tightened, and it follows that when the lower end of the outer tube is placed over the transparent circles, the sharpest image must be in the same plane as the diamond scratches, when its details are best seen with the auxiliary Microscope.

We can scarcely imagine a simpler or more accurate method than the foregoing, nevertheless, some may object to it on the ground that an auxiliary Microscope is required, and therefore another method is given, which, if not so handy or so accurate as that already described, has the merit at least of being inexpensive. A focusing slide is used, in addition to the ground glass prepared as before described, and this slide is pierced with a series of holes to take an ordinary ocular, the A preferably. The first step is to secure the best focus on the transparent circle, *to the unaided eye*, and the proboscis of the blow-fly will be the best object to work with. When this is obtained, set the eye-piece in the position of sharpest focus in the focusing slide, and always use it in that position, which can be insured by a collar of sufficient depth fitting up to the shoulder."

Aylward's (H. P.) Camera Lucida.

[*Ante*, p. 593. "Mr. Aylward has made a further improvement in this important accessory, and it is certainly not the least of its advantages that it will fit any ocular of English pattern. It can be made to fit foreign stands also."]

Micr. News, III. (1883) pp. 237–8.

Banqueting a Microscopist.

[At a banquet at Charlestown to Professor J. Leidy, a great delicacy was served—tails of fishes having a tumour-like excrescence—this the Professor found contained a tape-worm.]

The Microscope, III. (1883) pp. 128–9, from *The Bistoury*.

Bausch, E.—Microscopical Illumination. Title only of U.S.A Patent 277869 of 24th June, 1882. (Taken from Zeitschr. f. Instrumentenk., July 1883, wrapper.)

Binghamton, N.Y., New Microscopical Society.

Amer. Mon. Micr. Journ., IV. (1883) p. 140.

Bradbury, W.—The Achromatic Object-glass, XXVI.–XXVIII.

Engl. Mech., XXXVII. (1883) pp. 498–9 (1 fig.), 521–2 (1 fig.), and 591–2 (1 fig.).

Bussereau, B.—Nachet's Black-ground Illuminator.

Micr. News, III. (1883) p. 236, transl. from *Journ. de Phot. et Micr.*

Crowther, H. See Harris, W. H.

Davis, G. E.—A Standard Body-tube for Microscopes. [*Supra*, p. 713.]

Micr. News, III. (1883) pp. 219–20, 264.

„ „ Focusing the Image in Photomicrography. [*Supra*, p. 722.]

Micr. News, III. (1883) pp. 233–4 (1 fig.).

Dippel, L.—Das Mikroskop und seine Anwendung. (The Microscope and its use.) Part I. Handbuch der allgemeinen Mikroskopie. (Handbook of General Microscopy.) Sec. 3. 2nd ed. 8vo, Braunschweig, 1883, pp. 737–1030, ix.-xviii. (figs. 507–79).

GRUNOW'S (J.) Camera Lucida. [*Supra*, p. 713.]
Amer. Mon. Micr. Journ., IV. (1883) p. 138.

HARRIS, W. H., and H. CROWTHER.—Suggestions for an Exchange Club.
["Something after the style of the Postal Microscopical Society, but with less routine, which might be put briefly thus:—No fees, no secretary, no journal, no annual meeting."]
Sci.-Gossip, 1883, pp. 209–10.

HITCHCOCK, R.—Instructions in Dry-plate Photography. (*Concluded.*)
Amer. Mon. Micr. Journ., IV. (1883) pp. 124–6.

„ „ Notes from abroad.
[Describes a visit to E. M. Nelson's studio and his methods of illumination —Fisheries Exhibition — Fresh-water medusa at the Quekett Club— Möller's 1600 type-slide—Watson's new Microscope—Photomicrographs.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 129–32.

„ „ The Aperture Shutter.
["An examination of the subject with Mr. Davis to make the demonstration has fully satisfied us that the aperture shutter does greatly increase the penetration of a low-power objective. We mean by this an objective of not more than 1-2 in. focal length."]
Amer. Mon. Micr. Journ., IV. (1883) pp. 134–5.

„ „ The American Society of Microscopists. [Reminder of the Chicago Meeting.] *Amer. Mon. Micr. Journ.*, IV. (1883) pp. 135 and 140.

„ „ Oculars.
[Many oculars show objects greatly distorted. "This is mainly owing to the fact that makers have departed from the proper formula for placing the lenses in relation to their respective focal lengths."]
Amer. Mon. Micr. Journ., IV. (1883) p. 136.

„ „ A "Scientific Evening."
[Describes the Scientific Evening of the Royal Microscopical Society on 2nd May.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 136–7.

„ „ Resolution of *Amphipleura pellucida* by central light.—Oblique light for resolution.
["Mr. E. M. Nelson . . . states that any of the homogeneous-immersion objectives in use will resolve the lines with central artificial light. . . . Nevertheless, the ease and distinctness with which the resolution was made by Prof. Forbes (by sunlight) is surprising."—"Mr. Nelson does not approve of oblique light for resolution. He prefers to use central light in the study of markings on diatoms because oblique light often shows lines when central light shows dots—hence oblique light is misleading. One need not look far to discover a fallacy in the argument thus suggested."]
Amer. Mon. Micr. Journ., IV. (1883) pp. 137–8.

„ „ Mr. W. Teasdale's Spot-lens.
["A good-sized glass fish-eye . . . mounted in a piece of cork makes a very satisfactory spot-lens indeed."]
Amer. Mon. Micr. Journ., IV. (1883) p. 138.

„ „ Zeiss's Catalogue.
["Zeiss now makes a corrective-adjustment for his homogeneous-immersion lenses, but the object of the adjustment is to correct for the varying length of tube and not for different thicknesses of cover-glasses."]
Amer. Mon. Micr. Journ., IV. (1883) pp. 138 and 139.

„ „ Homogeneous-immersion Objectives.
[Satirical account of their condemnation by an English microscopist.]
Amer. Mon. Micr. Journ., IV. (1883) p. 139.

„ „ "New Wenham Binocular Prism."
["Ross and Co. have at last succeeded in reducing the cost . . . so that they are able to introduce it."]
Amer. Mon. Micr. Journ., IV. (1883) p. 139.

HITCHCOCK, R.—Messrs. Rogers' Microscopic Scissors.
[Twelve pairs of perfect scissors which are overbalanced by a half-grain weight.]
Amer. Mon. Micr. Journ., IV. (1883) p. 139.
„ „ The American Association for the Advancement of Science.—Meeting at Minneapolis. *Amer. Mon. Micr. Journ.*, IV. (1883) p. 140.
„ „ Notes from Abroad.
[Visit to E. Ward—Quekett Club Gossip Meeting—Fresh-water Medusa.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 147–9.

HOBSON, B.—The Electric Light applied to the Microscope.
[Describes his experience of the Stearn-Swan lamps, with description of his simple apparatus for applying it. "I am perfectly satisfied with the electric light, it is quite steady, very convenient, can be used close to the object, and shows colours like daylight. I believe that it is perfectly adapted for photography. The Rev. W. H. Dallinger, F.R.S., tells me better light for the Microscope can be obtained in other ways, but I like it more than anything I have seen."]
Sci.-Gossip, 1883, pp. 171–2 (1 fig.).
„ „ On Drawing Microscopic Objects.
[Description of a "micrographic camera" made from a tin biscuit canister.—C. G. Leland's receipt for making tracing paper which can be reconverted into ordinary opaque drawing-paper.—J. C. Leake's dark tent, and miscellaneous remarks.]
Sci.-Gossip, 1883, pp. 193–6.

International Bureau of Weights and Measures.
[Describes the "Comparateurs" for lengths with two Microscopes and micrometers.] (In part.)
Nature, XXVIII. (1883) pp. 464–6 (2 figs.), from *La Nature*.

[JAUBERT'S] Institut populaire du Progrès—Section de Micrographie—Laboratoire et École populaires de Micrographie.
[Announcement of the section having been definitively constituted, and statement of its objects, &c.]
Les Sciences, I. (1883) pp. 31, 45, and 46; see also p. 3.

JUNG, H.—Neuer beweglicher Objectträger für Mikroskope. (New movable Stage for Microscopes.) [*Post.*]
Zeitschr. f. Instrumentenk., III. (1883) pp. 246–7 (1 fig.).

LEITZ Oil-immersion Objectives.
[Notice of 1-15th in. and 1-18th in. (or 1-20th in.) of 1·26 N.A.—the working distance of the latter ·01 in.]
Micr. News, III. (1883) p. 265.

LOWE, C. A.—A Substitute for a Revolving Table.
["Board set on rollers and carrying the Microscope and lamp round a house table by revolving on a centre through the medium of an arm on stalk. . . . As a screw put into a mahogany table would be objectionable," a centre is made of two disks of wood between which the stalk revolves freely on a screw, a 10 lb. weight on the uppermost disk preventing the centre from slipping about the table.]
Sci.-Gossip, 1883, pp. 208–9 (1 fig.).

MIQUEL, P.—Atmospheric Dust and Germs.
[Extract from his paper communicated to the Faculty of Medicine, Paris, with figures of Apparatus—*Post.*]
The Microscope, III. (1883) pp. 111–19 (11 figs.), from the *Scientific American*, from *Le Génie Civil*.

MOORE, A. Y.—The Measurement of Numerical Aperture.
[Describes the method suggested by Prof. Abbe, Vol. I. (1881) p. 400, of measuring the diameter of the emergent pencil with an auxiliary Microscope.]
The Microscope, III. (1883) pp. 97–9.

ONDERDONK, C.—American and German Objectives.
[Complaint of the high price of the former.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 159–60.

Rezner (W. B.), death of—Memorial Resolutions passed by Cleveland Microscopical Society. *Amer. Mon. Micr. Journ.*, IV. (1883) pp. 158–9.

Royal Microscopical Society, Foreign Fellows, proposed increase of subscription. *Engl. Mech.*, XXXVII. (1883) p. 550.

Schröder's New Analysing Prism. [*Post.*] *Amer. Mon. Micr. Journ.*, IV. (1883) p. 157.

„ New Ocular. [*Post.*] „ „ „ p. 157.

Stowell, C. H.—Gleanings from the Journal of the Royal Microscopical Society for June. *The Microscope*, III. (1883) pp. 104–6.

Stowell, C. H., and L. R.—Extreme Minuteness.

["There is a question . . . that remains unanswered, which is whether any object may become so attenuated that it cannot be made visible by any means. . . . The limit of angle of aperture having been reached—no opportunity remaining of increasing capacity in that direction—is it not reasonable to suppose that with present appliances no greater skill in manufacture can be expected?"]

The Microscope, III. (1883) p. 136.

Suffolk, W. T.—Microscopic Vision.

[Report of "Demonstration" illustrating and explaining Prof. Abbe's discoveries.]

Journ. Quek. Micr. Club, I. (1883) pp. 248–52.

Swift, J.—The Microscope and Accessory Apparatus: Notes on the Construction, Selection, and Use. 8vo, London, 1883, viii. and 83 pp., and 61 figs.

Comments on same, see *Engl. Mech.*, XXXVIII. (1883) pp. 50–1.

T. T. T.—Lighton's Dark-field Illuminator.

[See Vol. I. (1878) p. 347. "Its work is so surprising and new that I would suggest that you give to the microscopists of the country . . . a reprint of the drawing and description."]

Amer. Mon. Micr. Journ., IV. (1883) p. 140.

Voit, C. v.—Verwendung der elektrischen Beleuchtung bei anatomischen, mikroskopischen und spektroskopischen Arbeiten. (Use of the electric light for anatomical, microscopical, and spectroscopical researches.) [*Post.*]

Centr.-Ztg. f. Opt. u. Mech., IV. (1883) p. 206.

(Aus Die Elektro-Medecin in der Internat. Elektr.-Ausst. zu München im Jahre 1882, von Dr. R. Stintzing.)

Walmsley, W. H.—Illustrated description and price list of Walmsley's Photomicrographic Apparatus [*ante*, p. 556], and directions for use. 8vo, Philadelphia, 1883, 11 pp. and 2 figs.

Ward, J. W.—Presidential Address to the 8th Annual Meeting of the Buffalo Microscopical Club. pp. 4–15. 8vo, Buffalo, 1883, 17 pp. (with Secretary's Report and List of Officers and Members).

Watson's Student's Microscope.

[Description of Microscope, *ante*, p. 554 "We would suggest to Messrs. Watson the advisability of applying a clamp-screw to the tailpieces so that they may be fixed rigidly in the normal position when axial light is being used. We also think it would facilitate the manipulations of the substage and mirror if the pillar support were taller so as to permit the tailpieces to be longer. At present the tailpieces are so short that there is some difficulty in adjusting the illumination beneath the stage, especially when the Microscope is vertical."]

Engl. Mech., XXXVIII. (1883) pp. 52–3 (1 fig.).

Wenham's New Fine-Adjustment. [*Post.*] *Amer. Mon. Micr. Journ.*, IV. (1883) p. 136.

„ Radial Microscope. [Vol. II. (1882) p. 255.] *Amer. Mon. Micr. Journ.*, IV. (1883) pp. 145–7 (3 figs.).

Western Microscopical Club. [Note as to its position.] *Sci.-Gossip*, 1883, p. 210.

White, T. C.—Photomicrography. [Report of "Demonstration"—*post.*] *Journ. Quek. Micr. Club*, I. (1883) pp. 229–31.

β. Collecting, Mounting and Examining Objects, &c.

Collecting, Cultivating, and Displaying Microscopic Aquatic Life.*—Mr. J. Levick, in his presidential address to the Birmingham Natural History and Microscopical Society, recommends for collecting, "a ring net, made of fine French canvas—a material used by ladies, I am told, for the purpose of wool-work—a still finer net of muslin, which will slip over it easily, making the one screwed ring do for both, and being of great use when the specimens sought are too small for the coarser net. A cutting hook, also, to screw to the stick; a small grapnel or four-pronged hook made of soft copper wire, about as thick as a straw (or No. 9 B.W.G.) cast together by means of lead or soft solder), with a few inches of brass chain attached, weighing about 18 ounces altogether. Then a plaited flaxen or cotton line, which will not gnarl when wet, of 50 or 60 yards in length, and sufficiently strong to stand a considerable pull, enough even to straighten the soft hook, and so to set it free should it meet with wood or any hard substance in the water which renders it fast.

A little practice with this apparatus will enable one with a fairly strong arm to throw, or rather sling, it out and gather aquatic plants from a large area, 50 or 60 yards even from any favourable spot for "paying" out the line, where it will meet with no obstacles when running out.

How much importance I attach to the use of proper apparatus may be gathered from the fact that I attribute the non-discovery of *Leptodora* before 1879, not to its non-existence in our locality, but to the want of a suitable net properly used, these creatures escaping through a net too rough, and being unnoticeable, owing to their extreme delicacy on the one hand, and the quantity of alga they are usually taken with on the other, when a net too fine in the mesh is used.

It is quite true that the first one I obtained from Olton Reservoir was taken by dipping an inverted bottle to a considerable depth, and then by a quick turn allowing the water to rush in; but I have often repeated the experiment where these creatures are fairly abundant, and have usually failed to capture a single individual, when a few sweeps with a suitable net would make a good gathering."

Mr. Levick, in dealing with the question of choice of localities, refers to "that elysium of microscopic life, the reservoir at Barnt Green, which, until a large area had been scoured by means of the before-mentioned hook and line, had been considered barren of anything of special interest. It is certain that, when the bottle only was dipped in near the side, nothing of more than ordinary character was found; and when the hook was sent flying through the air, and a good bundle of weeds (*Polygonum amphibium*, I believe), was brought to shore from a distance of 30 or 40 yards and carefully examined, living treasures were found in perplexing abundance. I need scarcely

* Report and Trans. Birmingham Nat. Hist. and Micr. Soc. for 1882, pp. iii.–xxv.

remind our members of the many splendid creatures which that locality yielded. . . . Now I do not think it too much to say that this, like many other localities, had never been thoroughly searched before, and am quite sure that some of our neighbours who regard their districts as unfavourable for pond life may find riches within their reach quite as great if they will only adopt the same vigorous means of seeking them."

On a country road, in a small patch of water not more than three inches deep in the wheel-ruts or holes made by the feet of cattle, Mr. Levick found *Pandorina morum*, and another rotifer *Notommata brachionus*. The latter was traced to a pond from which sheep drank, and "here was a ready solution to the problem as to how the rotifers had got to the puddle on the roadside. These unintentional distributors of microscopic life would go to the pond and paddle in the water, and then readily carry either the eggs or the rotifers themselves upon their feet, and possibly leave some behind in the first puddle they passed through on their way."

On the question of cultivating microscopic fresh-water life, Mr. Levick says that in indoor aquaria animals and plants also are stimulated into such rapid changes, that sooner or later they come to grief, and he "most earnestly commends all lovers of the study to acquire a garden pond." His "is a brick structure of about 8 feet outside diameter, and about 2 feet 6 inches in depth, measured from the top edge to the base; the inside is made to slope at a good angle, which is very important. It stands about 18 inches above the level of the surrounding ground, making nice sloping banks for about half its circumference, the inside being asphalted, which renders the whole perfectly water-tight. It has an outlet and temporary means of supplying water, but the former is never required, and with the bountiful supply of rain we have had during the past few years, it has rarely been necessary to add any water whatever, occasionally just a little to keep up the level during any warm and dry period we may have happened to have, few of which have troubled us for a long time past. The bottom and sides have a good layer of sandstone rubble, with a little clay, furnishing innumerable nooks and crevices where plants may root and animals may hide, no attempt whatever being made at architectural ornamentation. The rubble, however, is carried to and over the edge of the brickwork, which it completely hides, and is continued down the outside, making just a bit of ordinary garden rock-work, planted in the usual way with ferns, saxifrages, &c., forming in summer-time a perfect maze of plant life, shading the water from some of the sun's rays, and affording shelter for the numerous reptiles which also find a home in or about the pond."

In the remaining part of the address, relating to the examination or rather "display" of objects, *Volvox* and *Amœbæ* are more particularly referred to.

Mr. A. D. Michael, at one of the "Demonstrations" of the Quekett Microscopical Club, gave an admirably practical account of sea-side

collecting,* which we regret not to be able to print *in extenso*. He deals with "where to go," outfit, hints on shore collecting and climbing, the best collecting places, and the period for work, preparing hydrozoa and polyzoa with extended tentacles with osmic acid; also notes on getting insects, acari, &c., in the best condition to mount, and on mounting insects, &c., in balsam.

Collecting and Preparing Infusoria.†—Dr. H. Fol, in a fourth contribution to the knowledge of the family Tintinnodea, says that in the natural sciences method plays a principal part, but it is nowhere of greater importance than in microscopical researches: here the fitness of the investigator consists much less in any particular perspicuity than in the art of bringing into view the points that he wishes to know. Hence, the employment of a new method has enabled him to see clearly many things which he had previously been unable to see, or which he had seen imperfectly and misunderstood.

The collection of the Tintinnodea in the sea is an easy matter. There is no danger of damaging them at the moment of their capture, seeing that their test, into which they withdraw at the smallest sign of danger, sufficiently protects them. They are pretty robust and swim briskly about in the bottles several hours after their capture, and at a time when many delicate animals are already dead or disfigured. It is not, however, at the surface of the sea or under a bright sun that we find them in the greatest abundance. In cloudy weather they rise to the surface more readily than in bright weather; and in the daytime they are found chiefly at a depth of several fathoms.

For their capture he employed a net of fine muslin of a conical form attached to a ring about 50 cm. in diameter. The bottom of the net presents a contracted opening like that of a "weel," which opens at the middle of a much smaller net made of silken sieve-cloth with very fine meshes. This latter is attached to a ring equilibrated by a fragment of cork. This net of silken gauze does not injure the animals at all, and it captures at least twice as many as the glass bottle which some naturalists substitute for it. It is easy to understand in fact, that the impermeable walls of the bottle compel the water to turn in its interior, and cause eddies which carry out a considerable proportion of the captured animals.

With creatures so active and so difficult to observe alive under a high power, it is of great importance to have a process which enables them to be fixed instantaneously in their natural attitude before they have had time to withdraw into their test, and which preserves faithfully the details of their structure.

Dr. Fol tried the various reagents most in vogue without attaining his purpose. With weak osmic acid, he did not succeed in preserving the cilia of the peristome; and with a stronger dose the body became absolutely opaque: in both cases there was always a strong contraction.

* Journ. Quek. Micr. Club, i. (1883) pp. 233-43.

† Arch. Sci. Phys. et Nat., ix. (1883) p. 554. Ann. and Mag. Nat. Hist., xii. (1883) pp. 13-88 (1 pl.).

Acetic acid, chromic acid, and picrosulphuric acid only gave him a fixation which was too slow, so that the animal died contracted in the bottom of its test. Finally he "succeeded with a reagent which is not employed in histology, perchloride of iron"; by its means he has obtained a considerable number of specimens of various species fixed in a state of full expansion. These subjects, washed with alcohol and treated with gallic acid, present a brown coloration which is especially localized upon the nuclei and renders them very visible; the other parts of the animal acquire a light brown tint, which renders them easy to see.

The specimens thus treated may be mounted in Canada balsam, which produces permanent preparations; but they are much more distinct and more instructive if simply placed in glycerine.

By treating in the manner just indicated the whole produce of a capture, we can afterwards, on returning home, seek at leisure for the infusoria, a more or less considerable number of which will be fixed in a state of full extension of the body and peristome, with the cilia and the vibratile palettes preserved in perfection.

Tests slightly tinged with gallic acid and mounted in balsam in glycerine are especially instructive.

Potassic Iodide for Preserving Infusoria.*—Mr. W. S. Kent has found potassic iodide to act in a manner almost identical with osmic acid, and in some instances even more efficiently. The medium possesses the additional advantage of yielding no deleterious exhalations, which have to be carefully guarded against in the use of osmic acid. The formula for preparation is as follows:—Prepare a saturated solution of potassic iodide in distilled water. Saturate this solution with iodine, filter, and dilute to a brown sherry colour.

A very small portion only of the fluid is to be added to that containing the Infusoria.

Preparing Insects and Spiders.†—Mr. S. Green formerly found great difficulty in arranging insects and spiders in proper position. Legs would double up and wings would not remained expanded. It is only very recently that he has overcome the difficulty, and as the method may also be novel to other amateur mounters, he describes it in full.

On capturing an insect, consign it at once to the poison bottle if convenient, and there let it remain until it is quite dead. Do not let it lie in the bottle for longer than half an hour. Ten minutes is generally sufficient. The action of the cyanide of potash would in a few hours injure materially the muscular structure of the insect, and spoil it as a microscopical object. You should remove the insect before its legs and wings become rigid; but first have ready a small piece of glass, on the surface of which spread a thin film of rather stiff Canada balsam. Then place the fly, or any other insect you may be

* Kent, W. S., 'Manual of the Infusoria,' 1880–1, p. 114.
† Journ. Quek. Micr. Club, I. (1883) pp. 224–6 and 253–4.

operating on, lightly upon the Canada balsam film in the position you desire. If a dorsal view is required, and a winged insect the subject, place it back upwards, then with a fine needle or pin arrange its legs and wings. The legs may be made to adhere their entire length to the balsam, but it is desirable that only the tips of the wings be held down by the balsam. In this position the insect should remain for two or three hours to allow the balsam to become harder and the limbs of the insect stiffer. Then place the piece of glass with the insect adhering to it in spirits of wine, where it should be allowed to remain for two or three days. It is not unlikely that in the course of a few hours the action of the spirits may cause the film of balsam to become detached from the glass. This will not matter, for the hardened film will be found sufficiently dense and strong to keep the legs and wings of the insect in the position they were originally placed in by the setting needle. Should, however, the film not become detached when it is time to withdraw the piece of glass from the spirits, it is easy to remove the insect by placing the piece of glass in spirits of turpentine, which will dissolve the hardened balsam. If, as mentioned before, the film has become detached from the glass, a few hours after its first immersion in the spirits, it should remain undisturbed in the spirits for some days, and then it can be treated with turpentine. It should be kept in clear spirits of turpentine until it has become sufficiently transparent for mounting in Canada balsam.

There are some species of spiders that will crumple up their legs unless pinned out. The pinning out is not at all a difficult process; it merely takes a little more time. Fasten with fine tin wire a thin cutting of cork to a piece of glass, then spread a thin film of Canada balsam on the cork. Lay the spider in position on the balsam, and having previously cut the points of a number of fine pins, take the points up with a pair of light forceps and stick them into the cork against the inner side of the legs of the spider. One point, if properly placed, will be sufficient for each leg. The palpi and mandibles may also be kept in position in the same way. After this has been accomplished put the whole in spirits of wine and follow out the treatment described for flies. The piece of glass must, of course, be sufficiently heavy to sink the cork in the spirits. Care should be taken in withdrawing the pin-points when the spider is ready for transfer to spirits of turpentine. The hardened balsam must first be dissolved, then the pin-points taken out and the spider carefully removed from the cork. When quite clean place it on another piece of cork or glass, and pin out as before and put it into the turpentine bath, where it should remain until it is fit for mounting in balsam. The pins should be about one-quarter of an inch long and tolerably fine. In setting ants on the film of Canada balsam their jaws will not always remain open. To prevent their closing a small splinter of wood may be placed between the points of them, which, if carefully done, keeps them well open. The precaution is not necessary while they are in the turpentine bath.

If it is desirable to keep insects for any length of time before mounting them in Canada balsam, or if they have to be sent to a dis-

tance by post, the preparation of them should be stopped after they have been in spirits of wine on the film of Canada balsam. The film, with the insect on it, can be detached from the piece of glass by cutting the former with the point of a fine needle drawn round the insect. Remove the detached piece of film and place it in a small glass bottle full of clean spirits of wine. The hardened balsam can at any time be dissolved away from the insects by spirits of turpentine. It is sometimes easier to set small insects in position by placing them on their backs upon the film of balsam. Their legs can be arranged in that position with greater facility.

Fluid for Preserving Delicate Crustacea and Cœlenterates.*—Dr. F. C. Noll has found a fluid which is very suitable for permanent preparations of delicate crustacea and their larvæ, preventing their shrinking or becoming too transparent.

It is a mixture of equal volumes of Farrant's medium and Meyer's fluid No. II. It is never cloudy nor entirely dry, although it has such a consistency that air-bubbles scarcely ever occur. The preparation is sealed with asphalte or some other varnish. In order to prevent cracks arising in the asphalte varnish, it is better after a time to pass over it a layer of transparent shellac.†

Hydroids, small medusæ, and other cœlenterates which have been hardened in alcohol and then stained, may, the author says, be splendidly preserved in the above fluid.

Hertwigs' Macerating Fluid.‡—For the isolation of tissues in the Cœlenterates, O. and R. Hertwig recommend the following mixture:—Acetic acid, 1 part; osmic acid, 1-5th part; sea water, 1000 parts.

By means of this fluid not only the nerve-cells, muscle-cells, &c., can be isolated so that the exact form of the individual cells may be easily recognized, but also the tissues in the form of thin lamellæ may be separated and studied as a whole. Pieces of tissue or whole animals are left in the mixture five to ten minutes, and then washed for several hours in 1-5th per cent. acetic acid. The macerated parts can be further prepared, and afterwards coloured on the slide; or they can be coloured at once before preparation with needles. In the first case picrocarmine is used, in the second Beale's carmine, because it does not harden the tissues, but assists rather the process of maceration. Pieces of tissue may be preserved a long time in glycerine diluted with an equal volume of water, provided a few drops of carbolic acid have been added to secure against mould and Bacteria.

To obtain preparations of single cell-elements of *Actiniæ*, the macerated portion must be carefully divided up into smaller parts by needles, and one or more of these parts placed under the cover-glass. Light blows on the cover-glass with a needle will cause the cells to

* Zool. Anzeig., vi. (1883) p. 472.

† "Mit einer Lage des durchsichtigen Schutzleisten-(Schellack-)Kitts, wie ihn die Hirsch-apotheke in Frankfurt a. M. liefert."

‡ Jen. Zeitschr. f. Naturwiss., xiii. (1879) p. 462. Cf. Amer. Natural., xvii. (1883) pp. 806-7.

separate. Care should be taken to support one side of the cover by a hair, which is removed quite gradually, after the object has been reduced to very small cell-masses. Sliding of the cover may be avoided by placing wax feet under its corners.

Dr. Mark has employed this method, and obtained excellent results with it. As he remarks, the great merit of this fluid is, that it separates the cell-elements and hardens them at the same time. The *dissociative* and the *preservative* agent are combined in such proportions, that the action of the former is confined within desired limits by that of the latter.

Blue Stain.*—T. F. Hazelwood, using the carmine stain of Dr. Seiler, but not satisfied with the differentiation of the single stain, found a blue stain composed of rosanilin, anilin oil, and sulphuric acid, which gives the finest demonstration of tissues he has ever seen, for while the carmine gives the nuclei, the blue will give the outlines of the cells, fibrillæ of muscles and nerves, connective tissue fibres, &c. Several tongues of frogs, which had been stained with carmine and mounted in glycerine and acetic acid, after Beale, and left for nearly two years sealed up in glycerine, were taken out of their cells and put through the blue stain, and then mounted, each tongue in a series of slides, with glycerine as the medium. A magnificent demonstration of simple and compound papillæ was the result, with the branched muscle-fibres and delicate nerves *in situ*, also nerve-trunks and ganglion cells.

The skin of the frog has, by the use of this same double stain, furnished another means of studying the arrangement of the nerves. Even the most delicate nerve-fibres are thus brought out with great distinctness. In vertical sections of nerve-trunks, by this treatment, the outline of the individual sheaths is distinctly seen, with the axis-cylinder in the centre. So great is the change wrought by this blue stain that the author has dismounted many of his slides and put them through this process, and then remounted in balsam or glycerine at pleasure.

The stain gives equally surprising results in differentiating the tissues of insects. Nerves and tracheæ and cell-walls are finely coloured. The fine network of muscles and nerves on the stomach and intestines and on the glands is thus brought out with stereoscopic effect.

In the case of the muscles of the Lampyridæ the accessory disks of Engelmann can be distinctly seen. The nerves and ganglia in the thin membrane of the bat's wing are also well brought out.

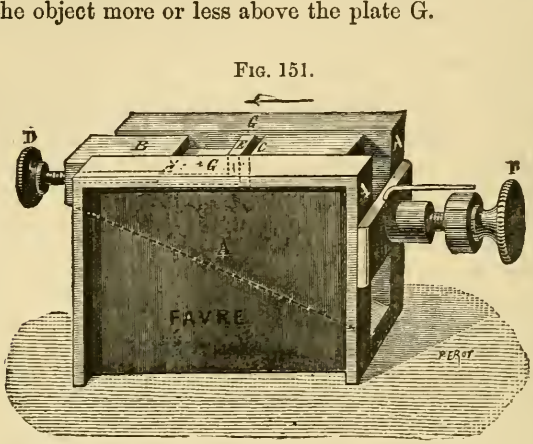
Lelong's Microtome.†—M. Lelong's apparatus, fig. 151, consists of two vertical plates A, having a space between them partly occupied by an inclined plane on which slides a piece B containing the object to be cut, which is put in the cavity C, where it is kept in place by the screw D, which by pushing forward or withdrawing the piece E,

* Amer. Mon. Micr. Journ., iv. (1883) pp. 109–10.

† Latteux, P., 'Manuel de technique microscopique,' 2nd ed., 1883, p. 41 (1 fig.).

allows the cavity C to be made larger or smaller; on the other side the screw F pushes the inclined plane in the direction of the arrow, and elevates the object more or less above the plate G.

Fig. 151.



Dr. P. Latteux recommends the instrument more particularly for hairs.

Cutting Sections of Hairs.*—Dr. P. Latteux has found that transverse sections of hairs are very difficult to obtain by the methods indicated in text-books, the section not being made at right angles to the direction of the hair, so that instead of being round it is oval. He has therefore been driven to devise the following process which enables excellent preparations to be made.

A small piece of wax is placed at one end of a piece of glass, and the hair which it is desired to cut is fixed in the wax by making a hole for it with a hot needle. A second and a third hair are fixed in the same way by the side of the first.

A small piece of diachylon plaster of the width of the glass is then applied at the other end. It will readily adhere to the glass on being simply pressed with the finger. A small quantity of wax is then placed on the plaster, and taking the hairs one by one they are fixed by their free ends so that they are all parallel and arranged like the strings of a violin.

The point now is to fix them in a medium sufficiently solid to keep them in their place, and so that they may not spring back and become sinuous. For this purpose nothing is so useful as collodion. A layer of this is to be spread between the two points where the wax has been placed, and when the ether has evaporated the hairs will be imbedded in a layer of the substance. It sometimes happens that at this moment the hairs relax. The strip of diachylon plaster is then to be carefully detached and fixed a little further off, stretching the hairs gently. Another layer of collodion is then to be poured on and this repeated

* Latteux, P., 'Manuel de Technique microscopique,' 2nd ed., 1883, pp. 263–6.

until we have a membrane of about 1 mm. thick. The hairs are thus fixed so that they cannot move whatever may be done with the layer of collodion.

When dry the sections are cut in the Lelong microtome (*supra*, p. 733). All that is necessary is to cut out of the plate of collodion a square of about 1 cm., and to inclose it between a small piece of soft wood and some elder-pith. We thus obtain small plates of collodion containing sections of the hairs absolutely perpendicular to their greater axis, and these can be mounted in glycerine or better in Canada balsam, but in the latter case, oil of cloves must be avoided, which would dissolve the collodion and free the sections, allowing them to lose their horizontal position.

By this process the author has been able to demonstrate in the clearest manner the torsion of the hairs of the negro. The hairs being fixed in the collodion a small piece of cork cut in the form of a rectangular triangle is fixed to the slide and the sections are made by cutting both the cork and the collodion. It is thus possible to orient them all in the directions which they took originally. The great axis of a section is first observed, and a little afterwards we come upon one whose direction is at right angles to the former, which demonstrates the torsion. From the examination of a great number of sections the author has been able to establish how much the forms vary with the different races and he thinks it will perhaps be possible by the measurement of different diameters to establish a special classification.

Fixing Sections.*—Dr. J. Frenzel, referring to his former paper † and that of Mr. R. Threlfall ‡ recommending caoutchouc instead of guttapercha, says that the former substance has certainly the advantage of giving more quickly a serviceable solution with the solvents used (chloroform or benzine), and the layer spread on the glass dries more quickly than guttapercha; but the latter has the more important advantages, (1) of adhering better, as it never quite dries and softens with heat; and (2) of dissolving less quickly in the common solvents, especially in naphtha, and is therefore considerably more resisting than caoutchouc.

A remarkably good guttapercha solution (1 : 100) can be obtained of Beyrich of Berlin. To prepare the solution oneself, the filtrate must be left to stand from two to three weeks, frequently well shaken, and finally filtered from the deposit. The solvent suggested by Threlfall—naphtha or paraffin oil—is on the contrary, Dr. Frenzel considers, very useful and satisfactory in every respect, at least as far as regards the former, which alone he has tried. Threlfall has, however, he considers, described the mode of operation so insufficiently that few will succeed in obtaining a good result with this method. Dr. Frenzel therefore gives his method.

After the sections are arranged on the *dry* adhesive layer, the slide is warmed for a short time to (at the most) 50° or 55° C., for which a few seconds are sufficient and even a considerably lower tempera-

* Zool. Anzeig., vi. (1883) pp. 422-4.
† See this Journal, *ante*, p. 307. ‡ Ibid., p. 600.

ture. After cooling an *abundant* quantity of naphtha oil is poured over the preparation, and the liquid allowed to run off *quickly until the sections appear almost dry.* Then, without any danger, the preparation can be placed in absolute alcohol, staining fluid, water, &c., in order to stain the sections and treat them further. Only when they are very small is there danger of their being washed away. In order to prevent this, spread over them, after the naphtha oil is almost all evaporated, a few drops of guttapercha solution, allow it to dry, and then place in alcohol, &c. The staining succeeds perfectly in this case also, as the guttapercha has not time to penetrate into the tissues but only covers the sections, without hindering the entrance of other liquids.

If, for any reason, the methods here given are not applicable, or should the sections become detached, Dr. Frenzel uses another method which, although longer than the preceding, has been of great service to him. After the sections have been fixed according to Giesbrecht's method, or with gum arabic, and the paraffin has been removed with oil of turpentine, the latter is allowed to evaporate as much as possible, or is washed out with chloroform; then a few drops of guttapercha solution are put upon the section, the fixing substance is allowed to dry somewhat, and the preparation then placed in alcohol, &c. This latter method is an absolutely certain one, although considerably more lengthy than the previous one.

The end of the process is the same in all cases, being that previously recommended by the author and later by Threlfall.

Fixing and Staining Sections on the Slide.*—H. Schällibaum, finding that Giesbrecht's method will not allow of the staining of the sections on the slide, at least when they are to be afterwards mounted in balsam, suggests the use of a solution of nitro-cellulose in oil of cloves. One part of collodion is mixed (according to its consistence) with 3–4 volumes of oil of cloves or lavender oil, and well shaken. The clear solution is spread with a brush over the slide in a thin layer, which at ordinary temperatures remains fluid for a long time, and adheres well. After the sections have been arranged, the oil of cloves is evaporated by gentle heat over a water bath, which takes 5–10 minutes. The sections thus fixed can be treated for days with oil of turpentine, chloroform, alcohol, and water, without losing their adhesion. The subsequent staining is accomplished in the ordinary manner.

Sections from all imbedding masses known to the author can be fixed in this way, and afterwards mounted in balsam or in glycerine. Cloudiness may appear between the sections, through the solution having been too concentrated and laid on too thick; this may be removed by passing a brush wetted with oil of cloves several times between the sections.

Freeing Objects from Air.†—A writer, whose name is not given, describes the following very simple but efficient process for freeing

* Arch. f. Mikr. Anat., xxii. (1883) pp. 689–90.
† Nature, xxviii. (1883) p. 322.

objects from air before mounting in glycerine jelly, depending on the great solubility of air in water:—

A wide-mouthed bottle, of about four ounces capacity, with a closely fitting *solid* stopper, is completely filled with water, which at the time is, and for half an hour previously has been, boiling in order to expel all traces of dissolved air. The stopper being then inserted without inclosing a single air-bubble, the bottle is set aside until cool enough to receive the sections which are then to be put into it. A few drops of boiling water are then to be added to make good the inevitable loss in removing the stopper; the bottle is to be again closed, wiped dry, and securely sealed with melted paraffin. After twelve hours it may be opened, and the whole contents turned into a white porcelain shallow dish. The sections can then be easily seen, and picked out with a section-lifter, and should be soaked for half an hour in a 50 per cent. solution of glycerine before mounting.

Making Cells of Thin Glass.*—Dr. H. T. Whittell considers that Dr. Beale's plan of making rings by fastening a cover-glass on a metal ring with melted marine glue, and afterwards knocking out the centre with the end of a file, remelting the glue to loosen the ring, and afterwards clearing it off, is a troublesome, time-taking process, and, after experiment, finds that thick gum mucilage may be substituted for the marine glue, and that the cells can then be made with great ease.

Take any number of the thicker glass rings or squares used for making microscopical cells, fasten on each a piece of cover-glass by means of gum mucilage, let them stand in a warm place for 24 to 48 hours till the gum is firmly set. After this break out the centres as in Dr. Beale's method; the part of the thin glass fastened to the rings will remain intact. It is well, as a precaution, to scratch round the inside of the ring with a writing diamond before knocking out the centre. If desired, the inside edge of the ring may now be smoothed with a fine file; but he believes the ragged edges are an advantage in giving greater firmness to the adhesion of the glass in its after uses. The centres being cleared, the whole are thrown into water and left there for a few hours, after which, the gum being dissolved, the thin glass rings will be found loose, clean, and ready for use. The beginner will probably break a few pieces before he acquires the knack of clearing the centres, but after a little practice nine out of twelve will remain perfect. Thick rings with broad edges will be found best to commence with.

Dry Mounting.†—Prof. A. H. Chester, at the Chicago meeting of the American Society of Microscopists, read the following paper:—

"The great difficulty in successfully mounting objects dry has been the deposit on the under side of the cover-glass which is apt to appear sooner or later, and which often so obscures the view of the specimen as to render it comparatively useless. At the Montreal meeting of the American Association for the Advancement of Science, last year,

* Journ. Quek. Micr. Club, i. (1883) p. 193.

† 'Chicago Times,' 9th August, 1883, in advance of Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883.

Prof. W. A. Rogers suggested a plan for overcoming this difficulty by means of a cover-glass held in place by a wire ring, using a perforated brass plate instead of the usual glass slip. While this may answer for his expensive rulings, it clearly will not be convenient for ordinary mountings; but from his suggestions I have worked out the following method. The object is fastened to the glass slip in the usual way, and a cell built up around it by means of one or more tin rings. When the cell is high enough so that the cover-glass laid on top will not touch the object, a tin ring having a little larger hole is cemented on, thus forming a ledge on which the cover-glass may rest, with room above it for the wire ring, which holds it in so firmly that there is no danger of its being jarred out. The tin cells are made as described at the Elmira meeting last year, by punching rings from thick tinfoil, and afterwards stringing the rough rings on a mandril that just fits the hole, clamping them fast and turning them down until they are just the right size outside. After considerable experiment I have adopted the following sizes in the various parts of this work, using a 5-8ths in. cover-glass. For the cell rings a No. 29 punch is used, having a diameter of 0·543 of an inch. For the top rings the punch is No. 22, with a diameter of 0·505 of an inch. This cuts a little larger than its inner diameter, and will just admit the 5-8ths cover-glass. For the outer rim of both a No. 11 punch may be used, 0·751 of an inch in diameter, and making the rings large enough to allow for turning down. The tinfoil for the upper ring should have a thickness of about 0·032 of an inch, No. 21 of the Birmingham wire gauge. Made with a gun-wad punch, the rings will have a bevel on the inside, and being set with the smaller hole uppermost, the bevel will help to hold the brass ring in place. The wire rings are made from No. 24 spring brass wire, 0·022 of an inch in diameter. These rings are easily made by winding a wire on a spindle about 0·4 of an inch in diameter, forming a spiral spring, every coil of which, when cut open, makes a ring. The exact size of this spindle is not important, for the size of the spiral can be varied by putting more or less strain on the wire, or by the rate at which the spindle is revolved. The rings should be a trifle larger than the opening in the cells, so that small pieces must be cut out to make them fit exactly when sprung into place. They can then be taken out and the cover-glass removed with the greatest ease. The cover-glasses should not be more than 1-100th of an inch thick, and several thicknesses of tinfoil may conveniently be used for the lower cells. The thinnest I use is 0·005 of an inch. For objects requiring less than that I simply turn a cement ring on the glass, and then put the top cell on that.

The advantages claimed for this method of mounting are many, some of which I will mention. In the first place, no deposit will collect on the under side of the cover-glass, or, if it does, the glass can be cleaned or replaced by another. Next, there will be no running in of cement, for there will be no partial vacuum, as is often the case when cells are hermetically sealed. If the object becomes dislodged, as often happens when comparatively heavy pieces are mounted dry,

they can easily be fastened in place again. I also find this a quicker method of mounting, it not being necessary to take so much pains to avoid running in. If the cover-glass is broken by accident, it is, of course, easily replaced, which is another decided advantage. But the greatest gain is in the fact that the object can be examined uncovered. In working with metallic crystals and the binocular I have often experienced great difficulty from the interference caused by the cover, and find it a great advantage to remove it altogether when studying. Such are the advantages of the new method. If it has any disadvantages I have failed to find them, after a year's trial."

Glycerine Mounting.*—Referring to Prof. Hillhouse's method, *ante*, p. 599, Mr. J. W. Neville, from practical experience, suggests the sealing of the cover-glass with pale copal varnish instead of dilute balsam. It can be obtained of as light a colour, is much tougher, and not likely to get so brittle as that medium. He has preparations that have been put up in this way for seven years or more, and several of his friends have used it as long a time, preferring it to glycerine jelly, as it does not show such a disposition to leak. Practical microscopists will be glad to learn that after this space of time the objects show no signs of deterioration, but rather wear an improved appearance.

Mr. G. E. Davis also writes:†—"Much has been said against glycerine mounts and their leaky propensities after a lapse of time. We have lately seen some glycerine preparations put up ten years ago, and they are to-day as tight as when first mounted. The only varnish used for cell and cement was white zinc varnish. We have many glycerine mounts in our cabinet, and have come to the conclusion long ago that if every care were taken to clean away the superfluous glycerine there would be no more complaints of leakage. No cement will adhere where there is even the slightest film of glycerine."

Dr. H. T. Whittell ‡ has tried, with limited success, all the plans and cements that he has seen recommended for mounting objects lying under the cover-glass floating in a drop of water or glycerine, with some of the same fluid outside the cover-glass so as to preserve the object in the exact condition in which it has been found, but has obtained much more satisfactory results by the following simple plan:—

As much glycerine as possible is first removed from the slide by the usual plan of wiping, and absorbing with bibulous paper round the edges of the cover. A little gold-size—that sold to artists is best—is rubbed up with a little whiting that has been previously well dried in an oven, and this is poured into a bottle for use. Some of the whiting settles to the bottom, but a quantity is held in suspension, and a larger proportion can always be obtained by shaking up the bottle. By means of a fine brush a little of this chalk cement is passed along the edges, and just outside the cover-glass, taking care to fill up the angle between the slide and cover. To prevent moving the preparation, it is better in this stage to imitate what the artists call "stippling," that

* Midl. Natural., vi. (1883) p. 190.
† Micr. News, iii. (1883) p. 238.
‡ Journ. Quek. Micr. Club, i. (1883) pp. 191–3.

is, to take the brush along in one sweep. The cement falls from the brush as one proceeds, and it is easy to see when enough has been applied. While taking care to have sufficient cement to fill up the angles, the aim should be to have as narrow a line as possible around the edges of the preparation. The slide is now set aside for twelve or twenty-four hours, when the layer of cement will have become tough, and will be found to hold the cover effectively in its place. The slide is now put into water, to wash off all trace of glycerine, and is afterwards set on end to drain and dry. A ring of gold-size or other cement may afterwards be applied in successive layers, and in due time, when all is firmly set, a finishing layer of white cement or of asphalt.

Mounting Objects "Opaque" in Balsam.*—Mr. E. Ward calls attention to the fact that there are some few objects which, although too opaque for transmitted light, are yet more beautiful, if mounted in balsam, than when dry. This is most apparent in the various parts of some diamond beetles, such as the genera of *Entimus* and *Cyphus*. In the old days, when paper-covered slides were much in vogue, this kind of preparation was readily made, it being only necessary to paint the slide at the back with black varnish, which was protected by the covering paper; but when it was seen how much better appearance the slides presented if uncovered, but neatly ringed, it was found a more difficult matter to get this same opacity for balsam mounts, as if the opaque varnish was placed inside the cell it was frequently dissolved by the balsam, and if painted on the under side, it almost always became unsightly through being rubbed, offending those who care for the neatness of finish of their slides.

Mr. Ward has succeeded in producing a black which can be used with safety under the cell, and which he has given plenty of trial; the process being moderately easy, and the materials to the hands of almost every worker.

Having affixed to the glass slip, by means of the brown cement originally introduced by the author, a metal cell of sufficient depth (and it is absolutely necessary that it be quite as deep as the object to be mounted, or the after process will be more difficult), allow this to dry, and then paint the inside of the cell on the glass with a black varnish made by adding lamp-black to brown cement. This black varnish should only be made as required, and for a small quantity it is only necessary to put a few drops of brown cement into a watch-glass, and stir in with a camel-hair brush a small quantity of the black; this brush will also do for the painting of the cell.

The varnish having been painted in, the cell will dry in an hour or so, particularly if put in a moderately warm place; and though the surface will be very granular, this granulation will not interfere with the after result.

The elytron, or other object, may now be fastened down to the cell-button with gum or brown cement, and when dry, the cell should be filled with benzole, which will penetrate every crevice and nook.

* Micr. News, iii. (1883) pp. 197–8.

Before the benzole has quite evaporated, fill up the cell with balsam and benzole until it appears heaped up above the top of the cell.

The slide should now be put on one side, covered with something, such as a wine-glass or chip-box, to keep off the dust until the benzole has evaporated, which will leave the balsam nearly hard in the cell. It will however be found that, even with care, some dust will have settled upon the surface of the balsam. This can be removed by a camel-hair brush dipped in benzole, and drawn across the surface. If this surface is still higher than the cell, the slide is now ready for the last process, and only needs a cover-glass, which should be warmed and pressed upon the surface, and held down by a spring clip until the existing balsam has become hard, when it can be cleaned off, and the slide subjected to the usual process of ringing.

Styrax and Liquidambar as Substitutes for Canada Balsam.*—Dr. H. Van Heurck, desiring to obtain a fluid of high refractive index which would not be open to the inconveniences of monobromide of naphthaline as regards the difficulty of sealing up and the disagreeable odour, found that styrax from *Liquidambar styraciflora* and liquidambar from *L. orientalis* were excellent media for the purpose, and much less alterable than Canada balsam. Styrax is supplied by Gehe and Co., of Dresden. It contains a granular substance, which is got rid of by dissolving it in chloroform and filtering the solution, which is used for mounting. Liquidambar is preferable as being very pale yellow instead of a brownish yellow, but it does not appear to be obtainable from European druggists.

The index of refraction is not given. *Amphipleura pellucida* is said to show the striæ in a "perfect manner," and the author "believes that the use of the above products will rapidly spread, and by reason of their great advantages will completely supplant Canada balsam."

Practical Processes in Vegetable Histology.†—L. Olivier writes as follows:—

In studying the structure of a living organism, it is not sufficient to examine under the Microscope the form and relations of its elements. We must, in addition, determine the chemical nature of each. In this physiology is as much concerned as general anatomy, physiological functions being the resultant not merely of the molecular composition but also of the arrangement of the organic structures.

The endeavour has therefore been to find for histology reagents capable of discovering in the interior of the cells the presence of the analysed substances.

Two methods have been adopted. The older and more general consists in examining, under the Microscope, different preparations of the same organ, before and after the successive action of certain

* Bull. Soc. Belg. Micr., ix. (1883) pp. 134–6.

† Rev. Sci. Nat., i. (1882) pp. 436–54; ii. (1882) pp. 71–91. We have been unable to verify the footnotes so as to print them in the form usual in this Journal, and they are therefore given for the most part as in the original.—Ed.

agents on it. Note is taken of what this complex treatment eliminates, precipitates, or colours. This result is compared with that obtained by a different treatment of the same organ, or by the similar treatment of a different organ, thence deducing the chemical characters of the tissues experimented on. Thus pieces of wood, in which the Microscope reveals the existence of cells, vessels, and fibres, no longer show cells after being subjected to the influence of certain substances. Another series of reagents causes them to lose their fibres without destroying their vessels, whilst the former resist the treatment which dissolves the walls of the vessels.

It is to this kind of analysis that we have been so long limited. The increasing perfection of practical microscopy now enables us to substitute for it a more certain and productive method, that of microchemical reactions.

When an organ is acted upon by a whole series of acids, bases, or salts, and then examined under the Microscope, it is difficult to distinguish clearly the histological elements, and still more to pronounce upon the nature of the changes to which a given treatment has subjected them. Given several kind of elements, it is impossible to decide what action they may exercise one upon the other in a mixture. Besides, all the elements being more or less disintegrated by the chemical treatment, we are rarely in a position to pronounce upon the histological nature of those which have not been completely dissolved. If, on the contrary, they are all observed in *the same preparation*, in a thin section where they are only juxtaposed, all the phases of the reaction can be followed under the Microscope, and there is no longer any risk of being mistaken as to the localisation of the phenomena.

In animal histology this method is already very advanced. In vegetable histology it is still very rudimentary, the sparse data which science possesses on the matter not having been yet collected into a systematic method in botanical treatises.*

Let us first call attention to the fact that the same reagent does not always produce identical modifications in all those elements whose fundamental composition is the same. In order to produce the same effects in all the organs in which the elements are found it must often be employed in *different degrees of concentration*. Sometimes even its action must be preceded by that of another agent, which eliminates from the element to be discovered the substances masking the phenomena. It is therefore important to note, in the case of the majority of the reactions which will be indicated, in which special cases they have given good results.

The operator ought not, moreover, to be content with a single reaction, *the accuracy of a determination resting entirely on the concordance of numerous observations*. Hence the many series of manipulations intended to render the preparations transparent, to fix the microscopical forms, to contract the structures, to precipitate or dissolve certain substances, and to colour and finally to preserve them.

* V. A. Poulsen published at Copenhagen a very excellent little book on this subject, translated into German ('Botanische Microchemie,' Cassel, 1881) by C. Müller, from which, as will be seen, we shall borrow largely.

I. Clarification.

1. Generally the tissues are made transparent at the same time that thin sections are prepared. For this purpose recourse is had to the alkalies (ammonia or potash), to glycerin, and to chromic, acetic, carbolic, and nitric acids.

Ammonia.—Prof. Dippel * uses ammonia to give transparency to delicate sections of plants whose tissues would be lacerated by too long immersion in concentrated alkali. The ammoniacal gas, being rapidly disengaged in the open air, the action which it exercises on the tissues in an evaporating dish is weakened in proportion to the thinness of the sections.

Potash.—This substance is of more general use than ammonia. It especially thins cell-walls of cellulose membranes. Poulsen,† Nägeli,‡ Dippel, § Wiesner, || and Sachs ¶ have tried it in very different researches, and are unanimous in recommending its use for thinning the cell-walls and making them clearer.

In a weak solution it also renders protoplasm transparent.

It is dissolved in water or alcohol.

The solution is made to act either on the preparations themselves or upon the organs before they are cut. In this case the alcoholic solution is the best. Russow ** has made a good preparation of it by pouring into alcohol of 85 or 90 per cent. a concentrated aqueous solution of potash in such quantity that after twenty-four hours there will be a deposit at the bottom of the vessel. It is then sufficient to decant the liquor to obtain it in the requisite condition.

Hanstein †† has made use of it to study the root-cap and the embryo. Sections of stems, leaves, or roots immersed in it acquire great distinctness. Hanstein leaves them in it for several hours, then washes them in very dilute hydrochloric acid or weak acetic acid, so as to neutralize the alkali. Sometimes the latter treatment darkens the cells; the preparations are then exposed to the action of ammonia and washed in distilled water before placing them in glycerin, which further clears them.

Glycerin.—This liquid only clears thin objects preserved in it *after a considerable time.* This property is strengthened by the addition of acetic acid to the glycerin.

Acetic acid.—The effect of this acid is very perceptible when care is taken to wash the preparations in distilled water before submitting them to its action. It assists the examination of the nuclei, which it

* 'Das Mikroskop,' i. (1867) p. 279.

† Loc. cit.

‡ 'Das Mikroskop,' 1877, pp. 472 and 525.

§ 'Das Mikroskop,' i. (1867) p. 278.

|| 'Technische Mikroskopie,' 1867, passim.

¶ "Ueber die Stoffe welche das Material der Zellhäute liefern," in Pringsh. Jahrb., iii. 1863.

** Mém. Acad. St. Petersburg, xix. p. 15.

†† "Die Entwickelung des Keimes der Monocotyl. und Dicotyl." in Hanstein's Bot. Abhandl., Bonn, 1870.

renders more visible, chiefly by effect of contrast, rendering the protoplasm which surrounds them soluble in the water.

Carbolic acid.—E. Warming, whose interesting work on bacteria and monads is well known, has found in carbolic acid a valuable agent for rendering these little organisms transparent.

Alcohol and Nitric acid.—We have obtained preparations of *extreme thinness and of the greatest transparency* * in the following manner:—Place in a watch-glass the objects to be thinned (sections of stems or roots); add to them alcohol of 36°, into which pour, drop by drop, concentrated nitric acid until the red vapours of hyponitric acid are disengaged. If the preparations are violently attacked, cover the watch-glass with a small bell-glass, observing through it what takes place in the liquid; as soon as the preparations rise to the surface of the mixture, raise the cover, and by means of two *wooden* needles push them to the bottom of the glass.

When there is no disengagement of red vapour at the normal temperature, set fire to the alcohol in order to concentrate it further, and warm the watch-glass on a piece of wire-gauze over a gas-burner.

Under these conditions, the cell-walls undergo a considerable thinning, but all their contents disappear. They become so delicate that the difficulty is to remove them from the water in the evaporating dish (into which the watch-glass has been emptied) to transfer them into the glycerin of the slide. We attain this object by adding to the still warm alcohol a little chloroform; this treatment hardens the preparations, which can then be transferred by means of little *wooden* spatula into the glycerin, where they soon recover the same flexibility as in the watch-glass.

We have obtained better photographs of vegetable sections thus prepared than with those obtained by other processes.

Chromic acid.—According to Hohnel † this acid gives transparency to tissues of a corky nature, such as cells of cork, epidermis, cuticles, and the envelopes of pollen-grains, to the extent of making details perfectly visible, which, without the aid of reagents, could not have been seen.

The solution of chromic acid admits of very different degrees of concentration, the important point being that it should be free from sulphuric acid.

Calcium chloride.—When it is desired to give transparency to the preparation without thinning it, it may be very useful, especially if the tissues are young, to have recourse to the process employed by Treub,‡ and afterwards by Flahaut, § which consists, as described by the latter author, "in placing the sections in a watch-glass or in a small porcelain capsule with one or two drops of water; the drop is covered with a little dry calcium chloride in powder, and slowly

* 'Recherches sur l'appareil tégumentaire des racines' (8 pls. and 50 microphotographs). Paris, 1881.

† "Ueber Kork," SB. Wiener Akad., 1877, 1 Abth.

‡ 'Le méristème primitif de la racine des monocotylédones.' Leyde, 1876.

§ "Recherches sur l'accroissement terminal de la racine chez les Phanérogames," Ann. Sci. Nat., vi. (1878) p. 24.

warmed over a small flame until the desiccation is nearly complete. The sections are withdrawn directly from the action of the flame, and a few drops of water added, which dissolve the calcium chloride. The sections immediately float in the water; they need only be collected and placed in the glycerin, in which they attain sufficient transparency after a few hours. This treatment results, not in dissolving all that the cells contain, but in darkening their contents by slightly thickening the originally very thin walls; these walls become at the same time clear and brilliant. The opacity of the cell-contents obstructs the study of several layers of cells at the same time.

II. Fixation of Forms.

The ternary parts of the plant being generally tolerably rigid, it is only necessary to fix the proteid matters (protoplasm, nuclei, vibratile cilia, &c.). The following agents are employed for this purpose.

Absolute alcohol.—When absolute, alcohol fixes the protoplasm without contracting it. It can be made to act directly on the preparations to be examined, or upon the organs before making sections. Strasburger has studied in the latter mode the formation of the cells in *Iris pumila.* By immersing *Spirogyra orthospira* in absolute alcohol at different hours of the night he succeeded in fixing the different phases of the division of the nucleus in this alga, which it then became very easy to study by daylight (without its changing) the day after and the following days. The same observer succeeded in retarding division until the morning by placing the *Spirogyra* in a room without heat in November. He was thus able to follow under the Microscope all the phenomena of the division, and to fix them at the most suitable moment by immersing the plant in absolute alcohol.

Chromic acid.—L. Guignard has successfully employed chromic acid to fix the nuclei in the embryo-sac in the Mimosæ.* The good results he obtained with it mark this reagent as one of the most valuable in vegetable microchemistry.

Osmic acid.—Osmic acid, whilst fixing the form, has the advantage of giving transparency to the protoplasm and the cell-walls, but has also the inconvenience of destroying the protoplasm after some hours. Strasburger has nevertheless used it in his observations on the division of nuclei. He placed the plants in water containing 1-500th of sugar, and added one or two drops of a 1 per cent. solution of osmic acid.

Vignal † and Certes ‡ have called the attention of naturalists to the good results obtained with osmic acid for fixing instantaneously the forms of the lower organisms (*Noctilucæ*, infusoria, algæ, zoospores, microbes of virulent diseases, &c.). Generally it is sufficient

* Bull. Soc. Bot., 25th June, 1880.

† "Recherches histologiques et physiologiques sur les Noctiluques," Arch. de Physiol., 1878.

‡ "Sur une méthode de conservation des infusoires," Comptes Rendus, 3rd March, 1879.

to expose the organisms on the slide for five minutes to the vapours of a 1 per cent. solution of osmic acid. But if they are very contractile it is preferable to treat them directly with the liquid acid after all disturbance of the slide has ceased.

Certes * has succeeded in doing away with the corrosive action of osmic acid. He places the organisms to be examined in a test-tube containing 30 c.cm. of distilled water or a few drops of the water of which he intends to make a microscopical analysis. He adds to it 1 c.cm. of half per cent. osmic acid. In a few minutes he fills up the test-tube with water, and allows it to rest for twenty-four or even forty-eight hours. All the algæ, spores, bacteria, monads, vibriones, amœbæ, and infusoria which originally swarm in the water are then deposited at the bottom of the test-tube. They are collected by means of a pipette, after the greater portion of the liquid has been decanted.

For eleven months we have preserved, in the same test-tube in which they were killed, some specimens of *Monas* which, during life, were very active. Their form has hitherto undergone no alteration. It is exactly the same as at the moment when they were attacked by the osmic acid.

Taking our stand on the fixative properties of this agent, we have attempted to make use of it to determine the parts of an organism endowed with spontaneous motility. We had to decide whether the long caudal filaments, the existence of which we had recognized in the *Bacterium rubescens* of Ray Lankester, are contractile, and whether they are active or passive in locomotion.

With this object we poured into two watch-glasses some distilled water, and a few drops of the water in which they were multiplying abundantly. We added to the contents of one of the two watch-glasses a drop of osmic acid properly diluted, and then added to it distilled water.

When, after a rest of twenty-four hours, we coloured the organisms in the latter glass by means of reagents, of which we shall speak later, we succeeded in showing the long filaments. This was, on the contrary, impossible with the organisms in the other glass; a phenomenon which we attribute to a contraction of the filament in the latter case, and to an absence of contraction in the case of fixation by osmic acid.†

Alcoholic solution of corrosive sublimate.—The effect of this solution employed as a fixative is rapid, but of very short duration. It is used with advantage in studying aleurone.

III. Contraction.

It is known that protoplasm, either free like the plasmodia of the Myxomycetes, or surrounded by a ternary membrane, as in multicellular plants, has at its periphery a hyaline layer, which remains in perfect continuity with the rest of the protoplasm, though dis-

* "Sur l'analyse micrographique des eaux," Comptes Rendus, 14th June, 1880.
† Bull. Soc. Bot., iii., 22nd July, 1881. See this Journal, ii. (1882) p. 640.

tinguished from it by its hyaline appearance and a greater refrangibility. In the interior of the protoplasm a border of the same nature surrounds the vacuoles when there are any. It is this membranous layer which regulates the osmotic phenomena of the cell. It is very permeable to water, but very little so to the salts which are dissolved in it, so that on placing the cell in pure water or in water charged with salts, the capacity of the vacuoles is increased or diminished, the protoplasm is dilated or contracted.

Amongst the substances which produce the latter effect must be mentioned solution of sugar, weak aqueous solution of chlorate of potash, *dilute* alcohol, glycerin, and sulphuric acid. These agents contract the protoplasm to the extent of detaching it from the cell-membrane. At the same time they give it a consistency which enables it to be better distinguished.

Solution of sugar, introduced gradually into the preparations, contracts the vacuoles without killing the protoplasm; when the cell-sap is abundant, as in old cells of *Spirogyra* and *Œdogonium*, it may happen that the volume of the protoplasm will be reduced one-half.*

Alcohol always kills the protoplasm. It contracts it only when dilute, the slower its action the more marked is its effect. Contracted by this agent, the protoplasmic substance becomes hard and resisting.

Glycerin produces an analogous result, with this difference however, that the protoplasm does not become so rigid.

Sulphuric acid acts in the same way, with more energy and rapidity. It is important therefore to suspend the action as soon as the contraction has taken place. It would destroy the protoplasm if the action were prolonged.

Mineral acids generally behave in a similar way.

These different substances, frequently employed in the examination of the protoplasm of the higher plants, can also be applied to the study of the lower cryptogams which the simplicity of their structure places at the confines of the two organic kingdoms. Dilute alcohol, glycerin, and the mineral acids, by absorbing water, reduce the bulk of the protoplasmic masses not surrounded by cell-walls and destitute of vacuoles. We have used them successfully to determine the general contraction of the body of *Monas Okenii* Ehr., and to show by that that this microbe, absolutely destitute of ternary envelope, must be removed from the bacteria and associated with the nudo-flagellate organisms.

Knowing the means of rendering the tissues transparent, of contracting the organisms, and of fixing them in their forms, we must now consider what kinds of histological elements or products of the vegetable economy are capable of being revealed by means of crystallization, destruction, or colouring. In each of these three cases we shall follow the inverse order to that which we have hitherto adopted; instead of indicating, for each reagent, the different substances for

* P. Van Tieghem, 'Traité de Botanique,' p. 473. Paris, 1882.

the determination of which it is appropriate, we shall examine the different substances, and for each one point out the microchemical operations which belong to it.

IV. Precipitation, Crystallization.

The substances whose precipitation or crystallization is produced in the interior of the cells are asparagin, inulin, and the saccharoses. Their deposition can be incited by a solution which contains principles different from those that are being sought for or even (according to the method originated by Borodin *) saturated with the substance itself which it is proposed to discover.

Asparagin.—Asparagin crystallizes in this way in cells when treated with a saturated solution of asparagin. It is even the best means of showing its presence. It is obtained in greater quantity by immersing the tissues in absolute alcohol, which on subsequent evaporation leaves the asparagin in crystals. But as the alcohol also takes up other substances capable of crystallizing, in order to recognize it, we treat all the crystals with a concentrated solution of asparagin, in which this substance alone remains crystallized.

It should be observed that the tissue in which it is to be studied ought to be in active life, since asparagin, which is an acid of bimalate of ammonia, constitutes a product of secretion, as it were the urea of plants.

Inulin.—Solid inulin can be obtained in the cells in two different conditions; in the amorphous or the crystalline. Desiccation causes the precipitation of this substance, which previously existed dissolved in the cell-sap; it is most frequently amorphous. Nevertheless, when desiccation is very slow, it crystallizes.

Prolonged maceration of the organs which contain the reserve-materials in alcohol causes the formation of sphero-crystals of inulin. When sections are made of the tissue thus prepared, a little acetic acid is added, and they are put in glycerin.

The alcohol used must be diluted with water. It is advantageous to reduce imperceptibly, by evaporation, the quantity of water added to the alcohol, and to keep up the level of the liquid in the vessel by adding to it gradually absolute alcohol.

When there is not time to allow the organs to remain in the alcohol before making sections, the sections themselves can be subjected to the action of either absolute alcohol or ether. In this case a deposit of amorphous inulin is obtained.

Saccharose.—The saccharoses are insoluble in absolute alcohol. It is therefore sufficient to treat the saccharine cells by this agent in order to produce the crystallization of the saccharose. Bonnier † has often had recourse to this process in the examination he has made of the nectaries. By way of verification, he treated the soluble portion of the tissue with 80 per cent. alcohol and with ether; he then saw crystals of the same form appear in the liquid.

* Bot. Ztg., 1878, p. 804.

† "Les Nectaires," Ann. Sci. Nat., 1879. See this Journal, ii. (1879) p. 748.

Sections made transversely to the saccharine tissues can also be allowed to dry. In evaporating, the cell-sap leaves the saccharoses in the form of stellate crystals, the crystallographic system of which it then becomes possible to recognize.

Aleurone.—This is the place to point out the means of preserving from solution in water the proteid part of the aleurone grains. It is known that in several plants, the peony for instance, this portion of the grain is very soluble in water. It is rendered insoluble by first subjecting it to the action of an alcoholic solution of bichloride of mercury. It is on this very phenomenon that Pfeffer relies to establish the presence of a quaternary nitrogenous substance in the aleurone grain.*

V. Dissolution and Destruction.

We dissolve certain substances either with the object of discovering what they are, or more frequently the better to see the elements which they hide. Thus it is not uncommon to destroy the protoplasm in order to make the nucleus more visible.

Protoplasm.—In order to display the nucleus, the tissue is treated with acetic acid, which renders the protoplasm transparent, and then dissolves it. A concentrated solution of potash destroys it, but that attacks the nucleus as well. It is only employed to obtain a membranous skeleton of the tissue.

Aleurone.—Sulphuric acid entirely destroys the grains of aleurone.

Oily Matters.—The oily matters have a special refrangibility under the Microscope, which distinguishes them from other substances inclosed in the tissues. Their most general solvents are ether and the essential oils; alcohol, chloroform, and benzine are also often used for this purpose.

The oily matters which exist in the solid state in plants, and which are known by the name of *vegetable butters* (cocoa-nut butter, cocoa butter, nutmeg butter, Japanese wax, palm-oil, laurel-oil, &c.), may be dissolved, like oily liquids, in ether and essential oils.

The use of alcohol is often recommended to remove the oil from sections of the albumen, the embryo, or the cotyledons of oleaginous seeds; we ought to call attention to the fact that ether acts more rapidly, and that moreover several oils are only partly soluble in alcohol, such as linseed-oil, hempseed-oil, poppy-oil, croton-oil, and nut-oil.

Essential Oils.—These oils are very unequally soluble in alcohol or ether; they are all soluble in the fixed oils. They exist in the tissues in the condition of balsams or oleo-resins. The non-volatile oils, in which the resinous substances are insoluble, allow of their extraction.

But as the use of the fixed oils is inconvenient, because of the difficulty of getting rid of them from the preparations which have been impregnated by them, we point out, according to Planchon,† the

* Pfeffer, Jahrb. f. Wiss. Botanik, viii. (1872).

† Planchon, 'Traité pratique de la détermination des drogues simples d'origine végétale,' ii.

solubility and density of several essential oils, which it is useful to know, in order to free the sections from them.

A. Essential oils denser than water:—Bitter almonds, cloves, mustard, cinnamon.

B. Essential oils less dense than water:—

Camphor.

Essence of roses, soluble in sulphuric acid.

Essential oil of aniseed: when sulphuric acid is added to it in sufficient quantity, the solution separates into two layers, of which only one is fluid.

Essential oils of conifers, only soluble in several times their volume of alcohol.

Essential oil of lavender, soluble in one volume of alcohol.

Essential oil of rosemary, mint, and thyme, very soluble in alcohol.

Resins.—When examining the oleo-resinous ducts of plants, especially in the Coniferæ, Cycadeæ, Aroideæ, Umbelliferæ, Araliaceæ, Compositæ, and Clusiaceæ, in which they are very much developed, we must eliminate the resins which accumulate in the passages where they were originally united with the essential oils, as has been done by Sachs,* Trécul,† N. J. C. Müller,‡ and Ph. van Tieghem.§ It is the same with the *resins* properly so called (betulin, colophane, jalap, lac, &c.), the *balsams* (tolu, benzoin, &c.), the *gum-resins* (gamboge, &c.). These substances, abundant in the sections of old tissues, generally prevent the study of the oleaginous cells. They can be completely dissolved in the fixed oils by heat. But it is generally preferable to treat them with essential oils, ether, or alcohol, which at ordinary temperatures dissolve the greater portion of them. The little which remains in the passages does not injure the examination of the preparation, and moreover this imperfect solution of the resin, joined to its other characters, helps in its recognition.

Waxy matters.—The waxy matters of the cuticles are but slightly soluble in cold alcohol, but they dissolve very quickly in boiling alcohol or slightly warmed ether. It is the sections themselves which are subjected to the action of these liquids in order to obtain perfectly pure cuticles, or to recognize the waxy nature of the substances developed at the surface of these membranes.

Latex.—In making sections of organs provided with latex, care must be taken to keep the razor and the preparations continually wet with ether. Without this precaution the latex blackens the razor, and consequently the tissues which are being cut, so that it becomes impossible to examine them.

Caoutchouc is composed of the corpuscles of the latex of certain plants. These corpuscles can be recognized under the Microscope by their swelling in the volatile oils, and dissolving in benzin, chloroform, and bisulphide of carbon.

* Bot. Ztg., 1859, pp. 177–85.

† Journ. de l'Institut, 6th Aug., 1862. Ann. Sci. Nat., v. and vii.

‡ 'Untersuchungen über die Vertheilung der Holze,' 1867.

§ "Mém. sur les canaux sécréteurs des plantes," Ann. Sci. Nat., xvi. (1872).

Cellulose.—Cellulose, as it is most frequently present in the cells, that is in the condition of polymerization not exceeding $(C_6H_{10}O_5)_4$, is soluble in Schweizer's ammonio-cupric solution. More condensed (for instance elder pith, the walls of thickened fibres, old vessels, ligneous cells) it is insoluble in the same reagent.

Schweizer's solution alters with time, therefore it ought to be used freshly prepared. It is obtained by pouring ammonia on copper-turnings, in a funnel; the liquid is again poured over the copper until it is coloured deep blue.

As the solution of cellulose can only be effected by a large quantity of nitrite of ammonia, care must be taken to keep a constant current of the liquid passing between the two glasses between which the preparation is compressed. For this purpose pieces of filtering-paper are used, which absorb the liquid at the edge of the cover-glass, whilst some drops of the solvent are placed at the opposite edge. The operation is hastened by disusing the cover-glass where large sections are being treated.

When the preparations are numerous and resisting they can be shaken together in a little flask filled with Schweizer's liquid, and subjected to several washings. This is the most rapid process. But if the preparations are at all delicate the first method alone is practicable; the operator should follow under the Microscope the different stages of the solution. The observation is easy with a low power; but directly it requires more than 200 diameters it becomes troublesome. In this case it is better to increase the power of the eye-piece alone; high-power objectives are inappropriate, the distance of their front lens from the preparation is so small that they risk being wetted by the reagent.

The butyric fermentation offers a slower but more accurate means of isolating in a preparation all the non-cellulose membrane by determining the cellulose. The organs or the sections from which we wish to eliminate the purely cellulose portions are placed in a glass of water, to which are added pieces of radish-roots, haricot-beans, or broad-beans, a *very small* quantity of sugar and powdered carbonate of lime. The mixture is shaken up and left exposed to the air. The fermentation is increased by keeping the vessel in a temperature of about 30° C.

When, carbonate of lime being in excess, there is no further disengagement of gas, the *Bacillus amylobacter* has formed its spore, and the fermentation has ceased; all the cellulose has then been, by a series of successive hydrations, converted into glucose, and the glucose decomposed into carbonic acid and butyric acid. The *rôle* of the carbonate of lime is to allow the formation of butyrate of lime as butyric acid is produced; this acid, free and accumulating in the liquid, would arrest the development of the *Bacillus* long before the destruction of all the cellulose.

Like Schweizer's solution, the butyric ferment does not attack cellulose whose condensation exceeds $(C_6H_{10}O_5)_4$. The action of the microbe is indeed so special that it is only exercised on a certain kind of this compound, although no chemical reagent shows two

varieties of it. Thus cells of *Chara* and *Elodea*, although dissolving in nitrite of ammonia, are not altered by *Bacillus amylobacter*.

Generally this microscopical agent does not affect starch, which is a lower polymere than cellulose. Nevertheless, Van Tieghem has found that in certain plants, contrary to what usually takes place, this microbe subjects the grains of starch to butyric fermentation, without destroying, or before destroying, the walls of the cells into which it has penetrated. This is the case with the root of *Adoxa moschatellina*.*

It is easy, with a *high magnifying power*, to study, under the Microscope, the course of the butyric fermentation. It is only necessary to guard against the preparation drying up and coming in contact with the air, which is fatal to *Bacillus amylobacter*.

Crystals of Carbonate of Lime.—In the condition of cystoliths, or of very small granular crystals, carbonate of lime is not rare in the protoplasm or septa of the cells (for example, plasmodia of the Physareæ, epidermal cells of several Urticaceæ, cell-walls of *Corallina* and *Acetabularia*). Acids, and particularly hydrochloric acid, dissolve it by disengaging, under the form of bubbles, the carbonic acid which it contains. This disengagement, easily observed under the Microscope, is very characteristic.

Crystals of Oxalate of Lime.—These crystals, which are much more frequent than the former, are distinguished from them chemically by being insoluble in acetic acid, and soluble, without disengagement of gas, in hydrochloric acid.

It is useful to apply these reactions in the case of crystals of the quadratic system with six equivalents of water. But for the raphides of the monoclinic system, with two equivalents of water, they are almost always superfluous, their form being sufficient to reveal their nature.

VI. Colouring.

1. Albuminoid substances.

Protoplasm.—It has been believed for a long time that the chemical reactions of living protoplasm are essentially different from those of dead protoplasm.† In 1874 Sachs wrote: "Solutions of different colouring matters, as aqueous solutions of the colours of flowers and the juices of fruits, especially also weak acetic solution of carmine, have no power of colouring living protoplasm; but if it has been previously killed, or if it has lost its vital properties by long-continued action of these reagents, it absorbs a relatively larger quantity of colouring material than of the solvent, and the whole substance assumes a much more intense colour than the reagent. Solutions of iodine in water, alcohol, potassium iodide, or glycerin, act in a similar manner; they all cause a yellow or brown colouring

* Van Tieghem, "Anatomie de la Moschatelline," Bull. Soc. Bot., ii. (1880) p. 282.

† Sachs, 'Text-book of Botany,' 2nd edition, p. 37.

of the protoplasm, which is more intense than that of the solution itself."*

These ideas have been accepted without dispute until the last few years; it may even be said that they are still current in science. A recent work, however, of Pfeffer† seems destined to greatly modify them. Whilst studying the osmotic phenomena in the lower plants, and particularly in the Myxomycetes, he remarked that the membranous layer of the protoplasm is soft enough during life to allow a small crystal or a bacterium to pass through it without leaving a hole. In this condition, on making an opening by means of a needle, the whole protoplasmic mass may be seen immediately to show the colours considered as exclusively characteristic of dead protoplasm. Now it is known, at least amongst a great number of Thallophytes, that a prick does not kill the protoplasm. Pfeffer concludes from this that, whilst living, it is permeable by all the substances which colour it after death; but that the membranous layer, as long as it is entire, prevents the introduction of certain of these substances into the interior of the protoplasmic body. He founds this opinion on the fact, observed by himself, that the peripheral layer becomes hard and brittle as soon as the protoplasm dies. Any slight cause is then sufficient to break through it, and consequently to allow the colouring reagent to penetrate the protoplasm. But this does not take place, in his opinion, when, after infinite precautions, the organism is killed without injury to the membranous layer. Under these conditions, those agents which do not colour living protoplasm will also not colour it when dead.

The possibility of colouring the central protoplasm of the *Amœbæ*, whilst the pseudopodia remain hyaline, seems to contradict the theory of the German botanist; but it must be observed that the pseudopodia of the *Amœbæ*, like the cilia of the Infusoria, are of the same nature as the membranous layer of the protoplasm. It would therefore seem that the latter behaves, in regard to colouring matters, in the same way as with different mineral agents, admitting some and being impermeable by others.

To the first category belong cyanin or quinolein blue, eosin, fuchsin, and anilin-brown. To the second the infusion of logwood or saffron, solution of cochineal in weak acetic acid, and the ammoniacal solution of carmine.

The following is a list of the principal reagents in use for colouring protoplasm:—

Iodine.—It is well known that iodine colours albuminoid substances a dark yellow. Poulsen recommends its use in the following form for colouring protoplasm a pale brown, and showing more easily the bacteria and vibratile cilia of the micro-organisms.

	gr.
Bisublimed iodine	0·05
Iodide of potassium	0·20
Distilled water	15·00

* Sachs, loc. cit., p. 39.

† 'Pflanzenphysiologie,' i. (1881) pp. 31 and 50.

For the same purpose is also used a solution of iodine in water or in alcohol (tincture of iodine), of different strengths, and in glycerin, to which is added a small quantity of iodide of potassium.

Alkalies.—Treated with nitric acid, then with ammonia or potash dissolved in water, the protoplasm is coloured yellow; it assumes a dark violet tint when the action of the alkali has been preceded by that of a concentrated solution of sulphate of copper, followed by washing in water. The colouring can be better judged of by the introduction of the alkali in a slow current between the slide and the cover-glass, the liquid being sucked through by means of filtering-paper.

Hydrochloric acid.—The protoplasm becomes pink or slightly violet when left for a few seconds in boiling hydrochloric acid.

Sulphuric acid and Sugar.—The preparations are treated with sulphuric acid, and then washed in distilled water, so as to free them as much as possible from the acid; then, between the two glasses inclosing the objects, is passed a current of concentrated solution of sugar; all the protoplasm becomes pink or violet. In this operation the difficulty lies in exactly regulating the time of the immersion in the sulphuric acid. When too short, it is useless: when too long, it destroys the whole of the protoplasm. Generally speaking, when English concentrated acid is used, the action must be stopped as soon as the protoplasm becomes very slightly pink.

Acetic acid and Cochineal.—To a solution of cochineal in alcohol at 60° C., 2 per cent. of acetic acid must be added. This reagent gives a pinkish or violet tint to the protoplasm.

Carmine.—The carmine is dissolved in ammonia, and the solution allowed to evaporate in the air, so that it may be as little alkaline as possible. In these conditions it colours the protoplasm red.

Anilin colours.—The use of anilin colours as reagents for protoplasm is of recent date. It gives very good results. Unfortunately the reactions differ according to the origin of the products, which are not identical in all makes. Purple, blue, and yellow are used principally in alcoholic solution. Anilin violet dissolved in alcohol is particularly valuable, because it colours the principal mass of the protoplasm a blue violet, whilst under its influence the nuclei, ternary substances, gums, and amylaceous substances become reddish.*

Koch† made use of anilin-brown and hematoxylin to colour bacteria, and photograph them more easily; these may then be preserved in glycerin with the addition of potassium acetate; in this solution the colouring is preserved. The same precaution must be taken when the bacteria are treated with methyl-violet or violet of Paris.

This reagent in alcoholic solution has been of great use to the author in the study of micro-organisms. When very concentrated, it may be used for the vibratile cilia, which are invisible when they are not coloured, but can be seen very distinctly in this liquid. The fundamental protoplasm being easily stained with this substance, it is

* Poulsen, loc. cit. p. 48.

† Cohn, Beitr. z. Biol. der Pfl., ii. p. 406.

often necessary, at the risk of concealing its inclosed substances, to employ very dilute methyl-violet; one drop of a solution containing 1-10,000th or even only 1-50,000th poured over the preparation is sufficient in many cases.

This solution can be made to act either immediately on the protoplasm or even after treatment with osmic acid. In the latter case there is still a coloration. It may be seen in *Clathrocystis roseo-persicina*, the *Euglenæ*, several nudo-flagellate organisms, and in the cells of the Phanerogams. Certes, who has successfully applied this reagent to the microscopical analysis of water, recommends its application mixed with diluted glycerin. He says*: "Precautions must be taken to make the action of the glycerin very slow, so as to avoid the shrivelling of the tissues. In these conditions the absorption of the colouring matters is better effected; the organisms remain transparent, and if we wish to preserve specimens, the glycerin constitutes a preservative medium, and keeps the organisms from evaporation."

Whilst methyl-violet kills the protoplasm at the same time that it colours it, very weak aqueous solutions of anilin-brown, fuchsin, and eosin, colour the protoplasm without killing it immediately. Organisms have been seen to live many hours after having been coloured by these substances.

Koch has used an alcoholic solution of eosin to kill and colour a reddish pink the protoplasm of *Sarcina*, *Bacterium*, and *Bacillus*.

The aqueous solution of cyanin or quinolein blue, whilst penetrating the living protoplasm, condenses the colouring matter in sufficient quantity for its tint to be perceptible. Certes† was able to show the members of the Zoological Society of France some living infusoria which he had coloured many hours previously by means of cyanin and anilin-brown, also called Bismarck-brown.

These results are important: by taking them into consideration, in the future we may be able to study, on the living subject, the phenomena of conjugation and reproduction in the Algæ and the Infusoria, instead of being, as hitherto, confined to the study of the organisms killed in different stages of their evolution.

Nucleus.—Generally speaking, the substances which colour the protoplasm, iodine, fuchsin, and carmine, also colour the nucleus, which absorbs the colouring matter in greatest quantity. It can be further studied, moreover, by means of particular reagents.

Subjected to the action of osmic acid, the nuclei become black. Iodized glycerin makes them yellow. According to Treub,‡ methyl-green colours very dark green those nuclei which are not in process of division, and pale green those which are dividing, because in reality this reagent only colours the chromatin in the nucleus.

In his researches on the division of cells, Strasburger§ employed the anilin colours with 1 per cent. of acetic acid as reagents for the nuclei. The very deep colouring which they take in these con-

* Comptes Rendus, 14th June, 1880.
† Bull. Soc. Zool., 22nd February, 1881.
‡ Arch. Néerland., xv. (1880).
§ 'Zellbildung und Zelltheilung,' 1880. See this Journal, i. (1881) p. 621.

ditions clearly differentiates them from the other portions of the protoplasm.

For the same object acetic acid and cochineal are used. Strasburger * immerses the preparations in acetic acid, washes them in distilled water, sometimes neutralizing the acid by a weak alkaline solution, and then uses the tincture of cochineal. Guignard † prefers carmine to this reagent for studying the nuclei in the embryo-sac and the suspensor of the Leguminosæ. He dissolves it in a mixture of 1 part of water, 2 parts of absolute alcohol, and 1 part of glycerin containing borax.

Poulsen ‡ gets the solution of carmine for colouring the nuclei by warming 0·6 gr. of carmine in 2 gr. of ammonia until the solution is reduced to half its bulk; he adds to it 60 gr. of water, 60 gr. of glycerin, and 15 gr. of absolute alcohol. The liquid is allowed to stand until clear, and then filtered.

The author has used the carmine to follow the curious phenomenon of the fragmentation of the nuclei in the hypertrophied cells in consequence of wounds.§ He has obtained an excellent result with hæmatoxylin. Although an extract of logwood, this substance only exists in very small quantity in the tincture of logwood.

The method indicated by Poulsen ‖ is to use 0·35 gr. of powdered hæmatoxylin in 10 gr. of water; a few drops of a filtered solution of alum containing 3 gr. of alum to 30 gr. of water are added to it to fix the colour. When the preparations remain for some time in hæmatoxylin thus prepared, the nuclei are coloured a fine blue. Picrocarminate of ammonia (or Ranvier's picrocarmine) is also of great use in the study of nuclei, both in the Phanerogams ¶ and in the Microphytes and Infusoria.** For the latter Certes †† thus prepares the solution of this reagent:—glycerin, 1 part; water, 3 parts; picrocarminate, 1 part.

The colouring is effected either after the fixing by osmic acid or independently of the action of this acid.

These various reagents may be employed (provided their concentration be varied) for studying in the midst of the protoplasm the minute structure of the nucleus, the nucleoli, the mode of distribution of the chromatin, all the phenomena of the division, the formation of the "barrel," of the equatorial plate, and the poles, &c. On this subject may be advantageously consulted the papers of Baranetzki,‡‡ Zacharias,§§ Strasburger,‖‖ Schmitz,¶¶ Treub,*** and Guignard,††† and the *resumé* of their works given by Van Tieghem in his 'Traité de Botanique,' in course of publication.‡‡‡

* 'Studien über Protoplasma,' 1876.
† Ann. Sci. Nat., xii. (1881).
‡ Loc. cit., p. 42.
§ Bull. Soc. Bot., 10th March, 1882.
‖ Loc. cit., p. 46.
¶ Poulsen, loc. cit., p. 46.
** Cf. Ranvier, 'Traité d'Histologie.'
†† Comptes Rendus, 3rd March, 1879.
‡‡ Bot. Ztg., 1880.
§§ "Ueber die chemische Beschaffenheit des Zellkerns," Bot. Ztg., 18th March, 1881. See this Journal, i. (1881) p. 769.
‖‖ Loc. cit., 1880.
¶¶ SB. Naturf. Gesell. zu Halle, 1878 and 1879.
*** Arch. Néerland., xv. (1880).
††† Loc. cit., 1881.
‡‡‡ Paris, 1882. Fasc. 4, pp. 343, &c.

Pigmented bodies.—The influence of chemical agents on the pigment-bodies of protoplasm has been much studied; nevertheless but few reagents are known. Etiolin becomes blue when treated with sulphuric acid or chlorine water; the green substance to which the name of chlorophyll is now appropriated turns yellow under the prolonged action of diluted acids, whilst concentrated hydrochloric and sulphuric acids colour it blue or blue-green. The use of hydrochloric acid or of water at 50° C. is recommended for isolating hypochlorine, and potash for colouring brown anthoxanthin and madder,* and chloride of iron to turn this last substance red or orange. But here ends our knowledge of the reagents for these substances, whose study presents great interest for physiology, agriculture, and manufactures.

Proteid Crystalloids.—The colouring which these bodies take under the influence of certain reagents, helps, independently of other characters, to distinguish them from mineral crystals. "Their substance exhibits," says Sachs, "all the more essential reactions of protoplasm, its power of coagulation and of taking up colouring matters, the yellow reaction with potash after treatment with nitric acid, as well as that with iodine."†

Recourse is also had to these agents to diagnose the crystalloids of protoplasm when they are colourless, like those of the potato, *Lathræa squamaria*, the aleurone grains of oleaginous seeds and of the albumen of castor-oil. In the petals of the pansy (*Viola tricolor*) and the orchids, the fruits of *Solanum americanum* and the sporangiferous filaments of *Pilobolus*, when they are coloured, they may be decolorized by alcohol, and then coloured afresh by the agents just mentioned.

2. Ternary Substances.

Starch.—Iodine is the best reagent for starch. It is generally said in treatises on chemistry that it turns it blue. It is important to know under what conditions this takes place. When the starch-granules of the haricot bean, for instance, are subjected to an aqueous solution of iodine they immediately turn blue. But it must be remarked that:—1st. The colouring disappears under the influence of great heat, and reappears when cold again. 2nd. The blue colour of the granules is only due to a portion of the substance which composes it. The *amylose* can be distinguished in each granule, of which it forms in some degree the skeleton, as also the *granulose* which fills the interstices, and may be extracted by diastase. The former turns yellow, whilst the latter turns a deep blue under the action of iodine. Most frequently they exist together; but there are cases in which they are isolated. The amorphous starch of *Bacillus amylobacter* and of *Spirillum amyliferum* is entirely composed of granulose; iodine colours it blue. In the Florideæ starch exists in the form of grains of pure amylose to which a solution of iodine gives a yellow colour. When, as in the potato, amylose and granulose

* Decaisne, 'Recherches anatomiques et physiologiques sur la Garance,' &c., (10 pls.) 1837.

† Loc. cit., p. 49.

exist together in the starch-granule, the granule can be turned yellow by iodine after the granulose has been extracted.

The reactions of starch are so delicate that they can be recognized in the very small starch-granules contained in the chlorophyll-bodies. The colouring by iodine is distinctly visible when care is taken to render the chlorophyll-body transparent by acetic acid, or to increase its permeability by submitting it to the action of potash.

In the *Euglenæ* there is a variety of starch called paramylon, formed of long cylindrical rods, disks, or ellipsoid bodies; when coloured yellow by iodine it appears exactly similar to amylose.

Certes,* by making use of the iodized serum described by Ranvier,† has demonstrated in several Infusoria an amylaceous substance coloured mahogany-brown or wine-red by this reagent. He considers it as identical with the glycogenous matter, the existence of which was shown by C. Bernard in the liver of the higher animals and of many Invertebrates. It is probable that it exists with these same characters in many plants, the percentage constitution of starch and of the substance called glycogen being the same.

Tannins.—Salts of iron are the reagents for the tannic acids. They generally colour them black or dark blue, sometimes green. Acetate of iron gives a very deep blue colour, and chloride of iron a dark green; chromate of potash, alcoholic solution of anilin-violet and dilute chloriodide of zinc may also be used. The tannins become brownish red in the first case, red in the second, red or violet in the third.

The development of *Penicillium glaucum* and of *Sterigmatocystis nigra* in a solution of tannin exposed to the air separates the tannin into glucose and gallic acid. Perhaps this phenomenon is due to a diastase formed in very small quantities in the cells of the plant. The same division takes place with dilute acids. It is probable that it also takes place in the interior of tanniferous cells by the progress of vegetation, for these cells are sometimes seen gradually to lose their tannin, in proportion as they acquire more and more glucose, a transformation which is particularly evident during the ripening of fruits.‡ This is an interesting subject of study; we can by micro-chemistry exactly determine the localization of the tannin; it would be very important to follow its metamorphoses. The difficulty probably lies in distinctly showing the diastase, for there are many ways by which the sugars may be revealed.

Sugars.—Sulphate of copper, followed by the action of potash after washing, gives a colour to the sugars which enables them to be recognized in the tissues of plants. But the colouring differs according to whether the sugar belongs to the group of saccharoses ($C_{12}H_{22}O_{11}$) or glucoses ($C_6H_{12}O_6$). Poulsen § recommends the following process: Make a tolerably thin section of the tissue; immerse it

* Comptes Rendus, 12th January, 1880.
† 'Traité technique d'Histologie,' p. 158.
‡ Van Tieghem, 'Traité de Botanique,' 1882, p. 512.
§ Loc. cit., p. 33.

from two to ten minutes in a concentrated solution of sulphate of copper, then wash it quickly in distilled water, and submit it to the action of a warm solution of potash. The cells inclosing saccharose then show a pale blue colour, whilst those inclosing glucose assume an orange-red tint.

When the former are treated with warm sulphuric acid or nitrate of potash, they lose their blue colour and become, like the latter, orange-red. Gaston Bonnier,* by using Fehling's solution, has succeeded in determining under the Microscope the localization and the relative abundance of the saccharoses and glucoses in the nectaries of flowers. "A drop of Fehling's liquid, diluted, is put in the preparation, which is then warmed. We observe under the Microscope in which part the yellow or reddish-yellow precipitate is formed; we then invert; add a drop of cupropotassic liquid, and warm again. The precipitate is again examined. If it is much more abundant than at the first examination it is because there is a considerable accumulation of saccharose. There must be, of course, an excess of tartrate in the first operation to cause the precipitation of the glucose."

This method of working is very delicate, requiring great dexterity and numerous precautions. If the liquid is boiled under the cover-glass in such a way as to cause violent movements, the precipitate gets distributed over the preparation; which then assumes a general tint of yellow, from which no conclusion can be drawn. The operation must, moreover, be executed as quickly as possible, without which, the water gradually dissolving the sugars, we should again have a general precipitate. Finally the preparation must not be very thin if we wish to form a correct judgment of the relative intensity of the colours obtained by the reaction. The best conditions for operating are therefore with moderately thin sections. If the result is too much obscured by the dissolving of the sugars in the water of the preparation, the sections must be warmed in a small tube and taken up again with forceps to be examined as soon as the precipitate is formed in the cells. As all these precautions were not taken in the first attempts, this process of research appeared to be impracticable. Since then it has given very good results in many cases; for by comparing the observation of these more or less intense precipitates with the results given by the preceding process in well-marked cases, I have found sufficient agreement.

In fact, the yellow colour produced by Fehling's solution, and the increase of the colour after inversion, are not absolute proofs of the presence of glucoses and saccharoses;† but it is an important character, which, taken with others, may serve to demonstrate the presence of sugars in the cells. If the real presence of the two kinds of sugar has been recognized by testing, this process gives excellent indications of the manner in which they are distributed in the tissues.‡

Oils; Oily matters; Resins.—The general reagent for these sub-

* "Les Nectaires," Ann. Sci. Nat., 1879.

† "As certain gums precipitate the tartrate, the same takes place with certain varieties of dextrine and ordinary dextrine in the presence of acids."

‡ G. Bonnier, loc. cit., p. 83.

stances is the alcoholic tincture of *alkanet*. The colouring matter is extracted from the roots of *Alkanna tinctoria*. The tincture colours red, not the individual drops of oil, but the entire mass composed of these drops and the protoplasm which contains them, when they are in sufficiently large quantity. This is also the case with oleaginous seeds. The reagent shows that the oil is always outside the grains of aleurone.*

Tincture of alkanet also colours the resins red.

Cyanin is also used as a reagent for oily matters. These substances absorb very energetically the colouring matter of the aqueous or alcoholic solution of quinolein blue. The smallest oily particles of the protoplasm thus acquire a great distinctness, as has been shown by the experiments of Certes † on many lower organisms, animal and vegetable.

Gums.—The anilin colours stain deeply the mucilaginous membranes which iodine alone or iodine used after the action of sulphuric acid does not colour blue. Chloriodide of zinc gives them a yellow colour; they assume, according to Solla‡ and Hohnel,§ a fine yellow colour after being immersed for some time in ammonia, to which nitrate of potash has been added.

Cellulose.—The cellulose of the cell-wall has the formula $C_6 H_{10} O_5$; it exists in plants in different stages of condensation.

The polymere $(C_6 H_{10} O_5)_4$, which may be taken as the type of cellulose, is not turned blue by iodine, but shows a fine blue colour after treatment with iodine and sulphuric acid. The polymere $(C_6 H_{10} O_5)_3$, which is rather rare, turns blue directly with iodine like granulose. The same takes place with the paraphyses and the walls of the asci of the lichens and of many fungi.

Good results have been obtained with an iodized solution of the strength of 1 gr. of iodine in 3 gr. of iodide of potassium and 600 gr. of water.||

Sulphuric acid and iodine are used in succession. The iodine may be in an aqueous or alcoholic solution. The sulphuric acid may be replaced by phosphoric acid. Instead of using the two agents, iodine and sulphuric acid successively, a single reagent may be substituted which has the same effect, chloriodide of zinc. It is very important to observe that the chloriodide of zinc cannot be rigorously defined quantitatively; the same reagents not suiting all species of plants equally well. The chloriodide of zinc which may have just given excellent indications on sections of one species, does not act effectively on another species. This is because the vegetable cells contain different substances, which, in many cases may prevent the reaction.

* Poulsen, loc. cit., p. 41.

† Cf. Balbiani, 'Recherches sur les phenomènes sexuels des Infusoires,' note 1, p. 27, 1861. Ranvier. loc. cit., p. 102. Certes, "Sur un procédé de coloration des Infusoires," Comptes Rendus, 8th March, 1881.

‡ "Mittellamelle des Holzelemente u. d. Hoftüpfel Schliessmembran," Bot. Ztg., 1880, No. 26.

§ See Poulsen, loc. cit. p. 61.

|| "Beitr. zur Kenntniss d. chem. und phys. Beschaffenheit der Intercellularsubstanz," Oester. Bot. Zeitschr., 1879.

Therefore the plan should be adopted of washing them well (either in water, alcohol, ether, or chloroform) before subjecting them to the action of the reagents.

The author employs four or five different preparations of chlor-iodide of zinc, and when one does not give any result recourse is had to another. The chloriodide is prepared by adding to an aqueous solution of very concentrated chloride of zinc a variable quantity of iodide of potassium. Sometimes a small quantity of iodine may be added.

By modifying the proportions and by adding or not adding water to the mixtures, a series of four, five, or six is obtained, of which at least one may be useful when the others are not.

Poulsen * recommends the successive use of potash and sulphate of copper to colour the old cellulose membranes deep blue.

Carmine in alum solution colours cellulose membranes deep red. Tangl† prepares the reagent in the following manner. He saturates distilled water with alum, adds to it a small quantity of carmine, allows it to boil for ten minutes and when clear filters it. The solution has the advantage of not colouring either the lignin or suberin.

Lignin or *Lignose.*—Under the influence of chloriodide of zinc employed alone, or of iodine and sulphuric acid employed simultaneously the lignified membranes turn yellow. They turn blue when the action of these substances has been preceded by the immersion of the tissues in an acid, particularly sulphuric, chromic, and nitric acids. These reactions being common to the walls of the ligneous cells, the lignified fibres, and the old vessels, we are justified in concluding that they are composed of the same ligneous substance.

The lignification consists in an impregnation of the primitive cellulose; that is, the polymeric molecule $(C_6 H_{10} O_5)_4$ is decomposed into a lower polymere which becomes coloured and impregnates the other part of the polymere remaining in the state of cellulose. According to Bergmann, the formula of lignose is $C_{18} H_{26} O_{11}$ which for comparison with that of cellulose may be approximately written $C_{12} H_{18} O_7$. The substance which impregnates cellulose is therefore less oxygenated than this latter substance. The action of the acids consists in eliminating the membranes.

Van Tieghem made known in 1863 a reaction of the lignified membranes, on which has since been founded a means of characterizing them. This means consists in the production of a substance which is formed in the presence of acids in the lignified membranes. It originated with Wiesner.‡ Poulsen § operates in the following manner. An aqueous, or better still an alcoholic solution of phloroglucine is made, and a drop is placed on the slide on which is the vegetable tissue, this having been previously immersed in acetic acid; the

* Loc. cit., p. 59.

† "Ueber offene Communication zwischen den Zellen des Endosperms," Pringsh. Jahrb., xii. (1880). See this Journal, i. (1881) p. 70.

‡ SB. Wien. Akad., lxxvii., 1 Abth.

§ Loc. cit., p. 40.

lignified portions soon assume a deep red colour, which they retain for a long time.

Wigan,* Maschki,† and Vogel,‡ following Poulsen,§ have used the aqueous solution of cochineal mixed with acetic acid or alum, to colour the prosenchymatous cells of the liber. The colouring, which is red, becomes very intense after the tissue has remained for a long time in the solution.

Cutin; Suberin.—True suberin is a definite compound, not a mixture. When membranes supposed to be suberized or cutinized turn blue under the influence of chloriodide of zinc, after being treated with a boiling acid, it is because they are only lignified. True suberin turns yellow under the action of this reagent, even after immersion in boiling acids. The reaction is the same when iodine or sulphuric acid is substituted for chloriodide of zinc.

The cutin which behaves in this way seems to be identical with suberin. It may be correctly enough represented by the formula $C_{12}H_{22}O_2$. But cuticles in which the treatment by acids still allows the cellulose to be separated and coloured can only be considered as lignified.

The author has proved that lignin and suberin retain the anilin colours much more persistently than cellulose. Relying on this observation, he has succeeded, by the use of these colours, in well differentiating in microscopical sections of vegetable tissues, the cellulose and non-cellulose portions of the membranes. The sections are put to soak in a solution of fuchsin, half alcoholic and half aqueous, then immersed in absolute alcohol. After this last treatment the cellulose portions are decolorized, whereas the cutinized or suberized portions retain for a very much longer time the red colour of the fuchsin. This process would not be useful for analysis, but it is very convenient in enabling the sections to be rapidly passed in review, and the most prominent differences of their chemical constitution immediately distinguished.

On these micro-chemical reactions of cellulose, lignin, and suberin is partly founded the determination of the nature of the fibres which enter into the manufacture of fabrics. Vetillart‖ has published an important work on this subject, from which the following directions are taken:—

To isolate the fibres of the tissue to be examined, it is boiled for half an hour in a lye containing 10 per cent. of carbonate of potash or soda. The object of this operation is also to swell the cell-walls, and to render them more pervious to the reagents. In cases where it is insufficient (which are very rare), H. Beauregard and V. Galippe¶ recommend the tissue to be soaked for ten minutes in

* Bot. Ztg., 1862, pp. 129, 139.

† Ibid., 1859, p. 22.

‡ "Anat. und Histol. der unterirdischen Theile von *Convolvulus arvensis*," SB. Wien. Akad., xiii. (1863).

§ Loc. cit., p. 42.

‖ 'Etudes sur les fibres végétales textiles employées dans l'industrie,' 1876.

¶ 'Guide de l'élève et du praticien pour les travaux pratiques de micrographie,' 1880.

a concentrated solution of potash or soda. This should be followed by a washing of the tissue in distilled water. When dry, the fibres are separated; a third part is submitted to the action of the reagents.

We must here confine ourselves to pointing out the distinction which iodine and sulphuric acid, or chloriodide of zinc, allow us to establish between the elements which they colour blue and those which they colour yellow. To establish this distinction, Vetillart advises the use of a solution of iodine freshly prepared by saturating with this metalloid 100 gr. of distilled water, to which has been previously added 1 gr. of iodide of potassium. For the sulphuric acid he recommends 2 volumes of concentrated glycerin to be added to 1 volume of distilled water, into which solution is to be introduced little by little 3 volumes of commercial sulphuric acid marking 66° Baumé. The vessel in which this operation is carried out should be surrounded by water.

The fibres which are subjected to the action of these reagents should be as dry as possible; with this view they are exposed to heat. The fibres are placed on the glass slide, and one or two drops of the iodized solution are added. When the fibres are well soaked, the excess of liquid is removed by filtering-paper. The cover-glass is then placed over the fibres, and a current of the solution of sulphuric acid is made to pass beneath the cover-glass. The reactions produced are then observed. Amongst Dicotyledons, jute is coloured yellow; flax, hemp, sunn, and cotton are coloured blue; amongst Monocotyledons, *Phormium tenax* and *Agave americana* turn yellow; alfa and esparto completely blue. Those who are interested in this microchemical examination of textile fabrics may consult with advantage the work of Vetillart, which is full of details for which there is no room here.

VII. Preservation.

The processes for preserving histological preparations being generally well known, there need be but little said on the subject.

Glycerin is the liquid most often used for this purpose. There are, however, many cases in which it is not generally known that it is worthless. It must not be used for the Florideæ, diatoms, or bacteria. The cell-walls of the Florideæ, especially when they have not been previously immersed in absolute alcohol, swell up in glycerin to such an extent that the form of the cells is no longer recognizable. The markings on the diatoms are not shown clearly, and the cell-walls of the bacteria become so transparent in glycerin that it is very difficult to see them.

These algæ, on the contrary, keep very well in glycerin jelly. Nordstett* especially recommends it for the Desmidieæ; he prepares it by mixing *hot* gelatin (pure), 1 part; distilled water, 3 parts; glycerin, 4 parts; which he afterwards decants.

* "Om anwändandet af gelatin-glycerine vid untersökning og preparering af Desmidieer," Bot. Notiser, 1876, No. 2.

We owe another preparation to Kaiser.* He leaves for two hours 1 part by weight of French gelatin in 6 parts of distilled water; he afterwards adds 7 parts of pure glycerin; and into 100 gr. of the mixture he introduces 1 gr. of carbolic acid. He heats and shakes the whole for ten or fifteen minutes, until it becomes fluid and clear, after which he filters it.

This glycerin jelly in a thin film has the clearness and transparency of water. It is useful for all those preparations which, requiring a cover-glass, are yet so delicate that the cover injures them; such as pollen-grains, starch-grains, feculæ, yeast-cells, and spores, especially those of unicellular algæ like Desmidieæ.

The same liquid is excellent for preserving the structure of the protoplasm and the distribution of the chlorophyll-bodies whose form and position have been fixed by absolute alcohol or osmic acid. When the preparation has been thus fixed it is put into dilute glycerin, then into the glycerin jelly. After this liquid has become cold, the cover-glass can be luted.

Canada Balsam, by reason of the difference of the refractive powers, is preferable for the preservation of diatoms; it is liquefied by warming. "The finest striæ on the diatoms are visible in it."

A very concentrated solution of balsam in ether or chloroform can be substituted for pure balsam; this mixture is purer. Delicate objects which contain much water do not keep well in balsam until they have been dried in the air, or treated with absolute alcohol or oil of cloves.

All the preparations, even those in balsam, should be luted.

Rapid Method of Demonstrating the Tubercle Bacillus without the use of Nitric Acid.† — The following method, which Dr. H. Gibbes has used for some time with great success, will, he thinks, prove useful to those requiring the demonstration of the tubercle bacillus for diagnostic purposes in a rapid manner. The great advantage consists in doing away with the use of nitric acid.

The stain is made as follows:—Take of rosanilin hydrochloride two grammes, methyl-blue one gramme; rub them up in a glass mortar. Then dissolve anilin oil 3 c.c. in rectified spirit 15 c.c.; add the spirit slowly to the stains until all is dissolved, then slowly add distilled water 15 c.c.; keep in a stoppered bottle.

To use the stain:—The sputum having been dried on the cover-glass in the usual manner, a few drops of the stain are poured into a test-tube and warmed; as soon as steam rises pour into a watch-glass, and place the cover-glass on the stain. Allow it to remain for four or five minutes, then wash in methylated spirit until no more colour comes away; drain thoroughly and dry, either in the air or over a spirit-lamp. Mount in Canada balsam. The whole process, after the sputum is dried, need not take more than six or seven minutes. This process is also valuable for sections of tissue containing bacilli, as

* Bot. Centralbl., 1880, p. 25. Cf. 'Glycerin-gelatine for Mounting,' this Journal, iii. (1880) p. 502.

† Lancet, i. (1883) p. 771.

they can be doubly stained without the least trouble. Dr. Gibbes has not tried to do this against time, but has merely placed the sections in the stain and allowed them to remain for some hours, and then transferred them to methylated spirit, where they have been left as long as the colour came out. In this way beautiful specimens have been made, without the shrinking which always occurs in the nitric acid process.

Dr. Gibbes subsequently adds :*—"This process gives the most satisfactory results, and the horrible nuisance of the nitric acid is avoided. It brings out the bacilli quite as well as the other process, and it stains all putrefactive bacteria and micrococci very deeply, so that in the field of the Microscope blue micrococci and bacteria may be compared with the red bacilli of tubercle. The stain can be used cold equally well. The cover-glass in that case must be left in the stain for at least half an hour."

Grinding down a Slice of a Calcareous Fossil for Microscopical Examination.†—Mr. H. J. Carter gives the following directions :—

"Take about one part of half-dry Canada balsam, and place it on the centre of a glass slide : heat it until melted over a spirit-lamp with about half an inch vertical flame, moving the slide backwards and forwards to prevent the latter from cracking ; add two parts of shellac ; and when the whole has bubbled up, stir it with the point of a needle so as to mix it well, and spread it altogether over a little more of the glass than the size of the slice to be reduced.

Previous to this, cut off with a watch-spring or very fine saw fixed in an iron bow-frame (all of which may be obtained from an ironmonger at a very small charge) the slice to be ground down ; and if there be much siliceous matter in the fossil, the saw (which is very cheap) may be sacrificed by the addition of emery powder and water to the groove, as this accelerates the cutting. (Of course where a machine with horizontal turning-wheel is possessed, such as is used for cutting siliceous fossils, flints, &c., this is the quickest and most economical way to obtain the 'slice.')

Having thus obtained it, so far prepared, rub one side (viz. that to be examined) down to *scratchless smoothness* on a schoolboy's slate or very fine honestone with level surface, to effect which it is absolutely necessary that all the materials should be entirely freed, by washing, from every particle of emery or siliceous mineral that may happen to be present, otherwise the calcareous surface will become almost irremediably furrowed.

Next dry the slice on a tin or paper tray placed inside the fender by the fire, where it can remain until the next part of the process is completed.

Now remelt the material on the glass slide as before, and when sufficiently fluidified to present a uniformly level surface (but *not burnt*, for this would destroy the tenacity of the cement, and thus give it a crispness which, by cracking, would defeat all attempts at further

* 'Practical Histology and Pathology,' 2nd ed., 1883, p. 142.

† Ann. and Mag. Nat. Hist., xii. (1883) pp. 29–30.

reduction), quickly transfer the warmed slice (which should now be close at hand) to it, while with a little pressure the 'smoothed' surface is brought into direct contact with that of the glass. Thus let it remain on the table where this is done until the glass feels cold to the touch.

After this reduce the slice to the thinness of a wafer over a very fine vertical rotating grinding-stone, or on a copper plate with emery powder and water, horizontally.

Now wash it well in water, and, placing the slide on a piece of buckskin leather spread on the table or on a level surface (to keep it from slipping) with the slice uppermost, continue the reduction in water with a piece of very fine siliceous limestone, that may be obtained from a statuary of convenient form (that is, one which will admit of the surface of the slice coming into direct and continuous contact with that of the limestone), with which it should be horizontally rubbed until reduced to the required thinness, which must be ascertained by repeatedly transferring the slice to the field of the Microscope with a 1 in. object-glass and high ocular. The nearer this thinness is approached the oftener this transfer should be made, washing the slice by dipping the slide into a bowl of water each time that it is examined.

When sufficiently reduced, wash the slide as before, and stand it up to drain until the slice is perfectly dry. Then cover with benzol, followed by balsam and thin glass, for preservation and more deliberate examination.

I make no apology for introducing these remarks, as the 'process,' although open to criticism and improvement, no doubt, answers the purpose; and while inexperienced, I myself should have been very glad of such aid. Dr. Holl suggested to me the use of shellac, which is the most valuable hint that I have received."

Verification of Microscopical Observation.*—This formed the subject of the address of President A. McCalla to the Sixth Annual Meeting (at Chicago) of the American Society of Microscopists.

After remarks on the practical value of the Microscope and microscopical studies, "the world at large not being enough aware how great is the debt it owes to microscopic research," the address referred to the danger of a neglect of the painstaking precautions necessary to insure truth and the necessity for careful and laborious investigation into a thousand minutiæ whose after-importance cannot always be known, the substantiating a phenomenon observed by chance by many a set experiment, the framing an hypothesis to account for the facts observed and testing its truth by a series of observations under many varying conditions. That very popularization of the Microscope which is so encouraging in our day tends to a lack of care in its use.

"When we reflect, then, on the high order of knowledge and of skill which the scientific use of the Microscope demands it is no

* 'Chicago Times,' 8th August, 1883, in advance of Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883.

wonder that, while it is the most perfect and the most fruitful instrument of precise research, its own announced results oft need verifying. It is not strange that theories have been put forth, discoveries proclaimed, by observers young and old, which later and more careful researches have failed to substantiate or have entirely overthrown. How many theories have been advanced in regard to the nature of the diatoms, the structure of their frustules and of their living substances; as to their mode of motion, and even as to their place in the broad classification of biology. Are they animal or vegetable, or alternately one and the other? There is authority and argument for either view. And when we ask as to the real nature of the regular and beautiful systems of markings their valves display, we can find theories in plenty, but all as yet unverified. They have been declared to be ridges, or furrows, rows of knobs, of areolations, or of minute apertures through the glassy wall of the valve. We have been told we see them most perfectly when they show as hexagons or as circles, or as a wicker basket pattern; their size and distance apart have been given a most diverse measure. But now we have learned from Abbe's researches how little reliance is to be placed on any of these appearances, and how easily many of these various images may be made to appear from a given structural detail by proper manipulation of the light and of the focus. . . .

But more particularly does microscopic vision itself need verification. The things seen must not too readily be taken to be the invisible realities. The eye in ordinary vision needs, more than the other senses, to be trained to see aright, and when so trained surpasses all the rest in the fullness of its revelations. So still more does the microscopic vision require careful training that we may be able to safely judge of the reality from the appearances that it affords us.

Permit me then to suggest in brief outline some of the means which we should employ for microscopic verification, and I would name the most obvious :—

1. The Repetition of Observations.—Under varying conditions and by various observations, that which really exists ought still to be seen. It is, of course, not true that every eye can see what the trained adept at the Microscope can easily discover, or that a rare form can be seen again whenever desired. But in general, what man has seen that man can see again, and unsupported discoveries must always be regarded as doubtful till they are verified by repetition. One who has any experience in microscopy can at least see what is in focus beneath the instrument, when his attention has been once called to it, while on the other hand, even the well-trained eye is in danger of projecting the mental preconceptions of the observer into the focal plane of the objective, and seeing in the object under examination, not what is really there, but what some theory demands shall be. Spectral lines seem real to one observer that are easily rejected by another, and images seen under one set of conditions disappear under another, and their presence or absence can be accounted for. One of the greatest benefits of a Society like this, and of the smaller local associations, is that they afford opportunity for this comparison of observa-

tions and correction of our errors of vision, our mistaken or imperfect views, by mutual interchange.

2. The use of the Camera Lucida.—A second means of verification is the use of this instrument, by which we may record in permanent form the fleeting vision of a single observation. Our memory is imperfect even when strongly impressed; we forget the details of what we see, or confuse them with later images. But a drawing preserves the forms we have observed secure against memory's obliteration, and at the same time, by the very act of drawing, our attention is quickened and our recollection made more clear. A drawing thus made serves, too, a double purpose. It preserves for us a transcript of what we saw to compare with our own later studies, and it serves as a ready means of interchange of views with others, outweighing, often, many a page of mere description. The various new and improved forms of the camera lucida which have been brought out in the past year or two are therefore matters of congratulation.

3. The use of Photomicrography.—This is, perhaps, a still more important adjunct for verification. By this beautiful application of the art preservative we have not alone a quick and easy mode of obtaining a record of our observations, for comparison with those of others, or with our own later studies, but we have a record that is almost entirely free from the fallibility inherent in a mere drawing. Photography has errors of its own, but it eliminates the errors of the hand and eye and judgment. The shadowy distortions projected into the microscopic image by our imagination disappear when the light writes down its own impressions of the structure it traverses. And thus the photographic evidence of what can be seen is a verification indeed. The service it wrought in the hands of Dr. J. J. Woodward in first demonstrating the resolution of the finer diatoms and of Nobert's higher bands of ruled lines by American objectives, you all remember. The photograph itself is not free from possible error; it cannot focus itself, it will record diffraction images as well as negative or dioptric ones, and hence its own record needs careful interpretation. As in astronomical work the photographs of the comet or nebula, of the eclipse of the sun, or the transit of Venus, do not give the final truths that are sought after, but need to be carefully collated and measured and studied in many ways, that from them may be deduced the structure of the corona or the comet, the parallax and distance of the planet and the sun—so with the photomicrographs of the objects of our study. They may not be absolute proofs on their face of the real structure under examination, especially in the case of very minute lines or particles near the limit of visibility, but they present a record of that structure, freed from the 'personal equation' of the observer, and they preserve that record for study and comparison in the indefinite future, when details now unthought of, and therefore unnoticed by the eye, shall be seen to be of importance in its interpretation. And may not the photograph do even more than this in microscopic verification? Its achievements in astronomy and in recording the swift motions of the racehorse may yet be duplicated

here. The eye can only see under certain very definite conditions. There must be a definite amount of light in the retinal image or the optic nerves will not be at all affected. Hence a very swiftly-moving object which sends from any one position light for an infinitesimal instant only, is invisible, or is seen only as a blur. So one that is quite at rest may send too little light and be unseen. But the eye whose retina is gelatine and silver bromide, can be made so quickly sensitive that it can catch with ease the swiftest leap of greyhound or racehorse, or the still swifter, though far remote, uprushings of the great fire-clouds of the photosphere; or it can be made so sensitively slow, that it will gather in for hours the dim light that comes from the distant star-depths, and build up by slow degrees an image that the eye alone could never see. So, may not photography compass the same results in microscopic work? In high amplification the loss of light becomes soon a limiting value to the possibility of ocular vision, and all details are lost in dimness, but the gelatine plate can be made to take its time to it, as the eye cannot, and slowly gathers up out of the thick darkness an image for our study, if only we can correct and focus properly. It may not be even swift enough to follow the molecule or atom in its flight; but there are other motions, now in dispute, that it may yet be made to seize, the waving cilia, the yet unseen motile organs of the diatom, the flagella of the bacterium, and still others yet unknown. Still more, it is not impossible that photography may verify exceedingly minute structure in another way—by subjecting the details of the photographic image to further enlargement. To make the process of service in this direction, however, will demand a much greater perfection of manipulation than in other departments of photographic work, where it has been successfully employed, and whether it can ever give a true image of details finer than the limit of visibility is, I think, doubtful, in spite of Prof. Abbe's seeming indorsement of its possibility in the article in 'The Monthly Microscopical Journal' of November, 1875. It is, however, well worth the thorough trial.

4. Media and Reagents.—A wise and careful use of the diverse chemical fluids which have, of late years, been brought into notice, will form the most efficient means of verification. I have already referred to the large part that the preparation of an object has to do with its successful microscopic examination. The different media that have been proposed from time to time for preparing objects, for permanently mounting them, and for various test reactions upon them, are almost endless. But of late years there has been a more intelligent application of chemistry and chemical physics to the aid of microscopic investigation, the principles involved are better understood, and we are now armed as never before, with means of putting nature to the test and verifying our vision of her most intricate minutiæ. Yet many microscopists work on in old ruts, mounting everything in one and the same medium. Some look on staining as only a refinement of dilettantism, a thing of mere looks, like coloured varnish rings and ornamental labels. But these staining fluids, as

this use is now developed, differentiate the various tissues from one another, and are a most invaluable help to exact knowledge. As the presents of sword and spear and shield, offered, along with the jewelry and costly robes, to the daughters of Lycomedes, by the crafty Ulysses, in the old Homeric story, served to discover the young Achilles in spite of his womanly disguise, so do these chemical staining fluids serve to disclose to us by their selective power the different tissues and organs in substances otherwise alike transparent and invisible. The various aniline colours with which chemistry has enriched the world, transforming a waste product from a nuisance to a source of wealth, have given a new and almost inexhaustible apparatus of verification to the microscopist. But perhaps a still more important means of verification is to be found.

5. Improved Lenses and Accessory Apparatus.—Abbe's introduction of the homogeneous immersion system of objectives, and the greatly increased aperture which at once resulted, and the more perfect adjustment by motion of the inner system of lenses of the objective as designed by Tolles, mark an era in the history of the Microscope and afford a new and powerful adjunct to the verification of former discovery. And this is being done. Dr. W. B. Carpenter, in his Montreal address last year, somewhat loftily asserted that we in America were, in the matter of wide aperture, simply going over the track which the English microscopists traversed twenty-five years ago, and have now abandoned. The statement is wide of the mark in its literal meaning. If any English microscopists had dry 4-10ths of 110° or glycerine immersions 1-6th of 130° balsam angle twenty-five years ago they were strangely reticent about them. But in another sense his words are most true. American microscopists are traversing again the ground passed over twenty-five years ago, that the observations made then with inferior lenses may be corrected and verified by the superb glasses of to-day. But Americans are not alone in this. English and Continental scholars are enlisted in the same work, and a London optician leads the world in making lenses of wide aperture. Let me not be understood, however, as claiming all perfection for all uses for the wide-angled lenses. The views of Prof. Abbe in regard to the limitations of wide apertures seem to me eminently just. But not alone in the objective do we find means of more accurately testing our observations. Many improvements in the accessory apparatus are of great value.

6. A Better Knowledge of Optics.—This is perhaps the most important of all means of verification of microscopic observations. Without this all the rest will be in vain. We must elaborate or the simplest apparatus will yield no real gain of knowledge to the world unless the eye be trained to comprehend what it sees, to interpret the appearances that present themselves and discriminate the causes that produce them, and so trace back the effects of the lenses themselves, of the diaphragm, of the obliquity of the light, and the effects due to the real structure of the object under examination. The mathematical reasonings of Helmholtz and still more those of Abbe on the true theory of microscopic vision may not

need to be followed by every one who would use the instrument, but to be acquainted with the main facts of Abbe's theory—to comprehend the doctrines he has propounded and the experiments by which he has made it plain, so as to use it in the interpretation of what the lens reveals, is as necessary for the one who would be a well-skilled observer as for him who would improve the powers of the instrument itself.

The best natural endowments of clear vision and delicate touch, and the greatest attainment of that 'manual dexterity,' which, as Beale says, 'although subordinate to many higher mental qualifications, is essential for the successful prosecution of microscopic observation,' are not enough, unless guided by that clear mental perception of the general principles of optical physics which can help the eye to recognize the origin of the appearances it sees and lead the way to decisive experiment. The studies of Abbe in particular have done more to establish a firm footing for further improvement of the Microscope and a more intelligent use of it in the form we now have, than all the laborious but ill-directed efforts of a host of other workers. As a knowledge of chemical science has led to a great advance in the use of reagents, mounting media, hardening, clearing, and other preparatory fluids, so a knowledge of the laws of light is essential to the proper use of the Microscope in examining the objects prepared. To discriminate between bubbles of air or globules of oil in water, to understand what forms a transparent, solid, or hollow cylinder may appear to take by transmitted or reflected light, and in media of an index more or less varying from its own, have long been recognized as questions the microscopist should exercise himself upon by theory and practice till he cannot be misled. Yet how often still are men misled in these cases? Especially important is it to learn to discriminate between proper and imperfect focusing, and to use the adjustment collar of the higher power lenses to the best effect. 'There is no doubt,' says President Duncan, of the Royal Society, 'that, with very few exceptions, the microscopic work relating to the morphology of the animal and vegetable kingdom has been conducted either without corrected objectives or with those which have an average adjustment,' and, remarking that very minute bodies appear abnormally thick from lack of correction, &c., when highly magnified, goes on to say he has no doubt but that similar abnormalities are constantly recorded as truths. So, too, there is no doubt that lines, fine dots, and beaded structures of various kinds have been constantly misunderstood. Lines have been recorded which have no real existence, or which, if existent, are neither so wide nor so numerous as they appear to be, nor in the direction they appear to lie. A careless use of the diaphragm, a more or less complete employment of the aperture of the objective, or of one part of that aperture rather than another, or error in focusing, may transform elevations into depressions, squares or triangles into circles, or rhomboids, or hexagons, or simple lines, and vice versâ. One of the most interesting questions we are called to meet to-day, as it seems to me, is whether we can discover any sure and satisfactory diagnosis of the real nature of

minute structure near the present limits of vision from the images it gives. At present we can scarcely say more than that a single series of lines will never appear as anything else but lines under an objective of sufficient aperture and with proper amplification, though they may appear doubled or quadrupled in number and fineness. They will not appear more widely spaced than in reality, and will not take on the semblance of dots or hexagons. But dots may appear as lines of varying fineness, or in varying direction, or as dots or bodies of various shapes and sizes, according to the manipulation used, and we are as yet without any sure way of judging of their real nature from their microscopic image. But that these structures can yet be verified and their true nature ascertained I confidently believe, even though Abbe himself has been unable as yet to solve the puzzle, and the inquiry may be long and difficult. Whether the Microscope can ever reveal the existence of any structural detail finer than that which now seems to mark the limit of vision, is another question. Doubtless with other materials than our present crown and flint glass, and with still fuller understanding of the principles involved, objectives transcending the present limits may yet be made and new difficulties of resolution appear. But at present we are not ready for such machines. We have not learned to use correctly what we have. The finer structures now revealed as at present are not understood by us. When we have learned how to verify what we now can see we will be ready for further gifts, for more powerful lenses from our opticians,—objectives of wider aperture, immersed in fluids of refractive index equal to their own—and when we are ready for them they will doubtless be produced. At the present time the Abbe diffraction plate offers itself as a most fruitful field of study, and when we can learn to discriminate without hesitation the various appearances of its squares and rhomboids we can attack anew the mysteries of histology, resolve the diatom frustules in a truer and more perfect sense, investigate the bioplasm theory to a final and satisfactory conclusion, and perhaps discriminate optically between the septic and the pathogenic bacteria, learn the true structure of muscle and the real meaning of its striations, and in a thousand other ways approach a little nearer to an understanding of the mystery of life and the wonderful, beautiful symmetry of the structure of the universe of God."

Examination of the Corpuscles held in Suspension in Water.*— Amongst the essential characters of the potability of water, limpidity, E. Marchand says, ought to be imperiously exacted. The perfect transparency of the liquid can generally be sufficiently ascertained by simple examination, but a more accurate observation can be made by passing a ray of sunlight through the water inclosed in a glass flask surrounded by black paper, in which are two opposite rectangular apertures, through one of which the ray passes while the observer looks through the other. When the liquid is optically pure the light traverses it without obstacle, but however few particles there may be held in suspension, each of these, on being illuminated, is visible

* Comptes Rendus, xcvii. (1883) pp. 49–50.

when otherwise they would remain invisible. There is nothing new in this method of examination; it is an application of the process employed by Prof. Tyndall to prove the optical purity of air, but it does not appear to have been put into practice up to the present. It has led the author to what he considers a conclusion of the very highest interest, viz. the constant presence of certain corpuscles in all the waters of Caux and which he is now certain will be found in the natural waters of all countries.

These corpuscles are hyaline and endowed with a refractive power about equal to that of water. Amongst them are some which present vacuoles filled with water or gas. Others appear under the form of disks, similar to the discoid diatoms. They all have a density greater than that of sea water (1·026) which contains myriads of them, at least at Fécamp. They resist the attacks of dilute mineral acids and also of dilute caustic alkalies. They were found in all the waters which the author has been able to examine hitherto; sea water, spring water, well water, running water, rain water, and even in distilled water which has been for some time exposed to contact with the air, which leads to the belief that they are also dispersed in the atmosphere.

Although about 2 mm. in diameter they are so flexible and plastic that they pass through the finest filters; for a great number of those which are contained in drinking water pass through the kidneys and are found again in the urine.

The germs of *Euglenæ* exist among these corpuscles, and this circumstance explains the profusion with which green substances, especially that bearing the name of Priestley, are developed in all the places exposed to solar light, direct or diffused, and to damp.

Amongst these little organisms there are some which appear to the author to play an eminently active part in the purification of waters charged with organic matters in a state of putrefaction, or capable of entering into putrefaction, when these waters, either running or stagnant, are exposed to contact with the air. We know that the substances in question are then oxidized and are transformed into carbonic acid and ammonia, or into nitric acid. Hitherto it has been admitted that the intervention of the combustive element is manifested by a direct action. The author is now led to believe that this intervention is only the consequence of a phenomenon of nutrition, undergone by some of the corpuscles in question, perhaps even by all. With respect to this he has begun a series of experiments and observations the results of which he intends later on to submit to the Academy. The present communication is chiefly made to establish priority, "but, in any case, the profusion with which these *non-microscopic* little beings are diffused ought, it seems to me, to be considered as a certain sign of the importance of the *rôle* which they are destined to play in nature."

Andres, A., Giesbrecht, W., and Mayer, P.—Neuerungen in der Schneidetechnik. (Novelties in section-cutting.) [*Post.*]
MT. Zool. Stat. Neapel, IV. (1883) pp. 429–36 (2 figs.).

Bennett, R. A. R.—Mounting Insect Organs.—Cement for securing slides.
Sci.-Gossip, 1883, p. 208.

Bolton's (T.) Exhibition of living organisms under the Microscope.—Aquaria, Microscopes, &c., at the Fisheries Exhibition.
Micr. News, III. (1883) pp. 182–3 and 268.

Brun, J.—Préparation des Diatomées. (Preparation of the Diatomaceæ.) 12mo, Genève, 1883, 4 pp.

Capus, G., and Rochebrune, A. T. de.—Guide du Naturaliste préparateur et du voyageur scientifique, ou instructions pour la recherche, la préparation, le transport et la conservation des animaux, végétaux, minéraux, fossiles et organismes vivants et pour les études histologiques et anthropologiques. (Guide for the Naturalist and scientific traveller, or instructions for searching for, preparing, transporting, and preserving animals, plants, minerals, fossils, and living organisms, and for histological and anthropological studies.) 2nd ed. with an introduction by E. Perrier. 18mo, Paris, 1883, xii. and 324 pp. and 223 figs.

Cheshire, F.—Cutting sections of probosces of honey-feeding Insects. [*Post.*]
Proc. Entomol. Soc. Lond., 1883, p. xix.

Cole, A. C.—Popular Microscopical Studies. No. 1. Hebridian Gneiss. Description by Prof. F. Heddle. pp. 1–6 (1 pl. × 25).
[Contains "How to prepare a rock section for the Microscope." *Post.*]
„ „ Studies in Microscopical Science. Vol. II. No. 3. Sect. I. Animal Histology. Chap. I. The Morphology of the Cell *continued*, pp. 3–4.

Davis, G. E.—Glycerine Mounts. [*Supra*, p. 739.]
Micr. News, III. (1883) p. 238.

Evenings with the Microscope. II. Multiple Images. Crystals.
[Describes the preparation (1) of insects' eyes for showing an image in each of the facets, and (2) of crystals.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 126–8.
„ „ „ III. [Mounting of Polycistina.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 143–4.

Frenzel, J.—Neuer Beitrag zur microscopischen Technik. Aufkleben der Schnitte. (Further contribution to microscopical technics. Fixing the sections.) [*Supra*, p. 735.] *Zool. Anzeig.*, VI. (1883) pp. 422–4.

Giesbrecht, W. See Andres, A.

Graff, T. Up de.—A Magnificent Cabinet.
[Dr. L. M. Eastman's, President of the Baltimore Microscopical Society.]
The Microscope, III. (1883) p. 133, from *The Bistoury*.

Green, S.—On an easy Method of Preparing Insects for the Microscope.
[*Supra*, p. 730.]
Journ. Quek. Micr. Club, I. (1883) pp. 224–6 and 253–4.

Haacke, W.—Zur Aufstellungs- und Behandlungsweise von Alcoholpräparaten. (On the putting-up and treatment of alcohol preparations.)
[Additions to the papers of Möbius (*ante*, p. 292), Zietz (*ante*, p. 471), and others. Deals with macroscopic preparations.]
Zool. Anzeig., VI. (1883) pp. 518–20.

Heurck, H. Van.—De l'emploi du styrax et du liquidambar en remplacement du baume de Canada. (On the employment of styrax and liquidambar in place of Canada balsam.) [*Supra*, p. 741.]
Bull. Soc. Belg. Micr., IX. (1883) pp. 133–6.

Hitchcock, R.—Microscopic Objects at the Fisheries Exhibition.
[E. Pott's collection of American fresh-water sponges, &c. (*ante*, p. 616); the author's slides of selected foraminifera and of ova; Mr. Bolton's exhibits.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 128–9.

Jones, T. R.—The importance of minute things of life in past and present times.

[Deals with the following: Important, though minute, things of life in the vegetable world: Nullipores and nullipore-limestone; corallines and coralline shore-sand and raised beaches; Characeæ and chara-limestone; Diatomaceæ and diatomaceous earths; Equisetums and grasses (canes, wheat, hay, &c.); puff-ball, lycopodium, and spore-coal; lichens on rock and the formation of soil. In the animal world: Sponges and spicules and spicular sandstones (chert, &c.); polycistina and polycistine beds (Barbadoes); entomostraca (ostracods), marine and freshwater, ostracodous limestones; Foraminifera, and foraminiferal limestones.]

Trans. Hertfordshire Nat. Hist. Soc., II. (1883) pp. 164–72.

Klein, E.—Elements of Histology. 342 pp. and 168 figs. 8vo, London, 1883.

Knott, J. F.—Sections of Hair-follicles stained.

[Exhibition at Dublin Microscopical Club—Sections perpendicular to long axis of hairs. Stained with picro-carmine and anilin violet, which latter tinges the outer (Henle's) layer of the inner root-sheath. Huxley's layer staining with picrocarmine as well as the outer root-sheath, the various layers of the complex wall of the hair-follicles are extremely well differentiated.]

Ann. & Mag. Nat. Hist., XII. (1883) p. 126.

Levick, J.—Presidential Address to the Birmingham Natural History and Microscopical Society.

[On "the collecting, growing or cultivation, and examination or display of microscopic aquatic life." *Supra*, p. 727 and *post*.]

Report & Trans. Birm. Nat. Hist. & Micr. Soc. for 1882, pp. iii.–xxv.

M'Nab, Dr.—*Protococcus pluvialis* to show nucleus.

[Exhibition to Dublin Microscopical Club of specimens of the ciliated state of *Protococcus* (*Chlamydococcus*) *pluvialis* treated with osmic acid and carmine. The nucleus was most clearly seen in each free cell, and also in others which had divided or were then undergoing division into four or eight new cells.]

Ann. & Mag. Nat. Hist., XII. (1883) p. 124.

Mayer, P. See Andres, A.

Michael, A. D.—On Sea-side Collecting.

[Report of demonstration. *Supra*, p. 729.]

Journ. Quek. Micr. Club, I. (1883) pp. 233–43.

Michigan, University of.—Central Laboratory for Microscopy and general Histology.

[Statement of the subjects in which instruction is given and synopsis of the plan pursued in the principal divisions:—Normal human histology. Vegetable histology. Advanced normal and pathological histology. Embryology and Urinalysis.]

Science, II. (1883) pp. 208–9.

Mounting and Photographing Microscopic Objects.

[Intended to "show how any possessor of a Microscope may make for himself preparations which though they may not equal by many degrees the productions of the best professional mounters, yet have a far higher educational value, as their preparation will afford information which could not be otherwise acquired." Deals with materials and instruments; the objects of mounting; details of mounting a section of deal and a piece of sole's skin (dry); mounting a flea (in balsam); hardening; imbedding; staining; vegetable sections; mineral and rock sections; mounting in glycerine jelly (*supra*, p. 736); photomicrography.]

Nature, XXVIII. (1883) pp. 300–3 (4 figs.), 321–2.

Neville, J. W.—New methods of mounting for the Microscope. [*Supra*, p. 739.]

Midl. Natural., VI. (1883) p. 190.

Newton, E. T.—Some methods of preparing parts of Insects for microscopical examination.

[Report of "Demonstration" showing "how he had been in the habit of preparing a series of sections of . . . the head of a cockroach."]

Journ. Quek. Micr. Club, I. (1883) pp. 245–6.

Noll, F. C.—[Eine Flüssigkeit für Dauerpräparate von zarten Crustaceen und deren Larven.] (A fluid for permanent preparations of delicate Crustacea and their larvæ.) [*Supra*, p. 732.]

Zool. Anzeig., VI. (1883) p. 472.

Perrier, E. See Capus, G.

Quinlan, F. J. B.—Bacillus-mounting.

The Microscope, III. (1883) p. 138, from *Medical and Surgical Reporter*, from *Medical Press*, 28th March, 1883.

Rataboul.—Les Diatomées. Récolte et préparation. (The Diatomaceæ. Collection and preparation.) 39 pp. and 1 pl. 8vo, Toulouse, 1883.

Richter, P.—Zur Manipulation von Süsswasseralgen, für das Herbarium bestimmt. (On the manipulation of Fresh-water Algæ intended for the Herbarium.) *Hedwigia*, XXII. (1883) pp. 97–100.

Rochebrune, A. T. de. See Capus, G.

Rutridge, T.—Tracings for the Lantern.

[Description of the Rev. W. H. Dallinger's plan.]

The Microscope, II. (1883) p. 198.

S., W. J.—Cyclosis.

[As to low powers which will show the phenomenon in *Vallisneria*. The rotation of cell-sap can be seen with a wide-angle 2 in., and better still with a good working 1 in. or 1–2 in., although the 1-4th in. is the glass for it."]

Sci.-Gossip, 1883, p. 209.

Schallibaum, H.—Ueber ein Verfahren mikroskopische Schnitte auf dem Objectträger zu fixiren und daselbst zu färben. (On a process for fixing microscopical sections on the slide and there staining them.) [*Supra*, p. 736.]

Arch. f. Mikr. Anat., XXII. (1883) pp. 689–90.

Schuchardt's (T.) Chemically pure reagents for use in botanical-physiological Institutes. [*Ante*, p. 607.]

Bot. Centralbl., XV. (1883) pp. 158–9.

Slack, H. J.—Pleasant Hours with the Microscope.

[The Proboscis of the fly—Hairs of Plants—Preparing leaves of *Deutzia scabra* and *Pinus austriaca* (*post*)—Pollen.]

Knowledge, IV. (1883) p. 71 (7 figs.), 103-5 (6 figs.), 130–1, 162–3 (4 figs.).

Stowell, C. H.—Laboratory Work.

[Kidney—Liver—Brain.] *The Microscope*, III. (1883) pp. 100–4.

Ward, E.—Microscopical Mounts and Mounting and Micro-crystallization. 8vo, Manchester, 1883, 20 pp.

[Two papers read before the Manchester Science Association and the Manchester Microscopical Society. *Post.*]

XVI.—*On a New Camera Lucida.* By Dr. Hugo Schröder.

(*Read* 10*th October*, 1883.)

In the recent volumes of the Journal of this Society I have met with descriptions and figures of several forms of camera lucida which were new to me. I obtained an example of each, and made a series of trials in comparison with the older forms with which I was already familiar. In all of them I found more or less defects, such as limitation of field, distortion, indistinctness of image or of drawing-point, awkwardness of position, &c. Being engaged later in endeavouring to simplify and perfect the construction and adjustment of Mr. Wenham's high-power binocular prism, I was much interested by the ingenuity of this device, and it occurred to me that that arrangement of prisms might be modified, so as to be available as a camera lucida in which the defects of the forms hitherto made would be considerably reduced if not entirely eliminated.

Assuming a 45° inclination of the Microscope to be the position most generally convenient for drawing, I (in June last) drew on a large scale the system of prisms which appeared to me suitable for a camera lucida. Messrs. Ross undertook to construct the prisms to my drawings, and the apparatus was found upon trial to answer my expectations fully. I am induced to describe it here because it has also met with much approbation from microscopists, who were previously disinclined to believe in the possibility of any new device at the present day, which should be substantially better than the numerous older forms which apparently exhausted the subject!

It is well known that all forms of reflecting prisms acting by means of *one* reflection are extremely sensitive in regard to the position of the mirror in relation to the Microscope, as also in a less degree in relation to the eye; the slightest deviation from the normal position in many cases entirely destroying the effectiveness of the apparatus. For this reason cameræ lucidæ acting by *one* reflection have not found favour, though their apparent simplicity has induced the construction of many such forms.

In order to obviate the difficulties incident to the use of *one* reflection, many devices have been made acting by *two* reflections, and where these have been so contrived as to act like parallel mirrors the reflected image has possessed the advantage peculiar to this principle, of being practically insensitive to slight differences of position relative to the Microscope or to the eye, remaining in fact stationary within a considerable range of adjustment, as in Wollaston's camera lucida.

My device (fig. 152) consists of a combination of a right-angled prism (fig. 153), A B C, and a rhomboidal prism D E F G, so arranged that when adjusted very nearly in contact (i.e. separated by only a thin stratum of air) the faces B C and D E are parallel, and consequently between D E and B E′ they act together as a thick parallel plate of glass through which the drawing-paper is viewed. The rhomboidal prism is so constructed that when the face G F is applied at right angles to the optic axis of the Microscope the axial ray H passes without refraction to I on the internal face E F, whence it is *totally* reflected to J in the face D G. At J a part of the ray is reflected to the eye by *ordinary* reflection in the direction J K, and a part transmitted to J′ on the face A C of the right-angled prism. Of the latter a portion is also reflected to K by ordinary reflection at J′. The hypothenuse face A C is cut at such an angle that the reflection from J′ coincides with that from J at the eye-point K, thus utilizing the secondary reflection to strengthen the luminousness of the image. The angle at G is arranged so that the extreme marginal

Fig. 152.

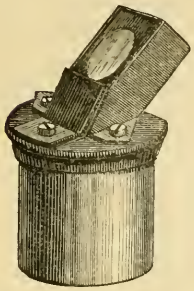
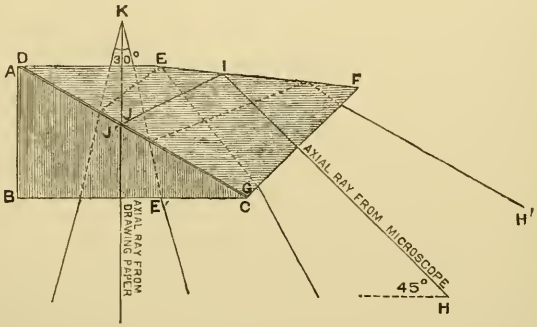


Fig. 153.



ray H′ from the field of the B eye-piece strikes upon D G at a point just beyond the angle of total reflection, the diffraction-bands at the limiting angle being faintly discernible at this edge of the field. This angle gives the greatest amount of light by *ordinary* reflection short of *total* reflection.

By this arrangement the Ramsden circle over the eye-piece comes just above the camera lucida, and the field of view is not in any way reduced; all that can be seen directly through the B eye-piece (say 30° of field) is perfectly depicted in the camera lucida,

whilst the drawing being viewed direct is of course not cut down in field.

In practice the Microscope should be inclined about 45°, and the image accurately focused through the eye-piece as usual. The camera is then slid on the eye-piece and pushed down more or less until the microscopical image is seen distinctly and the illumination of the field is equal throughout. The drawing-paper is placed on the table immediately under the camera. The observer will then see the microscopical image projected on the paper, at the same time viewing the pencil-point directly. The *whole* pupil of the eye is available for both images, the diaphragm on the apparatus being considerably larger than the pupil. It may be necessary to balance the illumination either by subduing the light in the Microscope or by increasing it on the drawing-paper. It will generally be found that when the object is in a luminous field the light on the object (especially with lamplight) may be advantageously subdued by ground glass or similar means. The eye may be removed as often as required from the camera and the work recommenced without the slightest shifting of the image; and with properly balanced illumination, fully shaded drawings can be made with very little practice. The drawing-paper should in every case be placed at the distance of distinct vision, either using spectacles or not. If the vertical position of the Microscope be preferred the drawing-paper may be inclined 45° either in front or at the side of the instrument. For very accurate drawings, in all azimuths, the drawing-paper should of course wholly coincide with the plane of the optical image, as with every other form of camera lucida. A spring clip is provided in which a screen of black paper may be put to shade the eye not in use.

This form of camera lucida can be modified so as to project the image at any desired angle. It can be used with the dissecting Microscope or hand-magnifier, also on a stand for architectural or mechanical drawings.

XVII.—*On "Optical Tube-length"; an Unconsidered Element in the Theory of the Microscope.*

By Frank Crisp, V.P.L.S., Sec. R.M.S.

(*Read 14th November*, 1883.)

It is not a little strange that at this late period in the development of the Microscope, an element of capital importance both from a theoretical and a practical point of view should have been left entirely unconsidered, and indeed unknown; and the fact that it is so, illustrates the disadvantages which English-speaking microscopists have always been under in having no text-book dealing with the theory of the Microscope.

In a letter written more than a year ago in reference to the Table of Magnifying Powers published in the Journal, Professor Abbe called my attention to the erroneous notions which prevailed on the subject of the magnifying power of the Microscope, and which he had been the first to clear up,* and I ought then to have published the explanation now given here, but the pressure of other engagements diverted my attention, and I confined myself to explaining the matter verbally to those who attended the meetings. Finding, however, that the Committee on Eye-pieces of the American Society of Microscopists have been misled by the Table in question, it is obviously desirable not to delay the explanation any longer.

Microscopists have always recognized that the length of the tube of the Microscope is a factor in determining the amplification of the image, that the amplification is generally greater with a 10 in. tube than with one of 6 in.; and that we obtain an increase of power by pulling out the draw-tube. Here, however, all exact notions as to the function of the tube-length have practically stopped, so much so that there has not been any agreement even as to how the length of the tube is to be measured, whether from the front or back lens of the objective to the field lens, the diaphragm, or the eye lens of the eye-piece.

In particular, no view of tube-length has been held which would explain the following apparently paradoxical statements:—

That two objectives of precisely the same focal length used with the same tube and the same eye-piece may nevertheless give different magnifying powers.

That two objectives of different focal lengths used with the same

* Professor Abbe also communicated it to Dr. Dippel, by whom it was embodied in the last edition of 'Das Mikroskop,' 1882.

tube and eye-piece will not give magnifying powers in proportion to their focal lengths; thus a 1-2 in. will not necessarily give double the power of a 1 in.

Conversely, two eye-pieces will not amplify in proportion to their focal lengths, though used with the same tube and objective.

Indeed, the true magnifying powers may differ from the powers which would be obtained on the ordinary assumptions by more than 100 per cent., and Prof. Abbe records the existence of objectives (of somewhat exceptional construction it is true) which exhibit this paradoxical behaviour: that one of longer focal length amplifies much more than one of shorter focal length; that one gives the same amplification with a long and a short tube, and that one gives a higher amplification with a short tube than with a long one.

What then is the explanation of these paradoxes?

The explanation is not to be found in any question of the length of the objective or eye-piece, or the character of their respective settings, but depends upon the fact that hitherto microscopists have regarded the outside only of the tube and have left out of consideration the optical action which goes on within it.

To properly understand the matter it will be necessary to consider the principles on which the action of the Microscope in regard to magnifying power is founded.

The magnifying power of a lens depends of course upon its focal length and varies inversely with it; the ordinary mode of obtaining the power being to divide the distance of distinct vision l (assumed as 10 in.) by the focal length, or expressing it by a formula $N = \frac{l}{f}$. Thus if the focal length f of an objective is 1-8th in. $10 \div \frac{1}{8} = 80$. The same applies to the action of the Microscope as a whole, that is with eye-piece and objective combined; when we have determined its focal length we similarly obtain its magnifying power.*

We have therefore to ascertain the proper mode of determining the focal length f of the entire Microscope, having given the focal length f^1 of the objective and the focal length f^2 of the eye-piece.

The usual assumption hitherto has been that f is determined by multiplying f^1 and f^2 together and dividing by the length of the tube 10 in., or

$$f = \frac{f^1 f^2}{10},$$

* The quotient obtained by dividing 10 in. by the focal length gives the linear amplification of an image—real or virtual—which is projected by an objective to a distance of 10 in. *from its posterior focus*, and not from the objective, as has been so commonly assumed.

so that if we had an objective of 1-8th in. and an eye-piece of 2 in. the focal length of the Microscope

$$f = \frac{\frac{1}{8} \times 2}{10} = \frac{1}{40}.$$

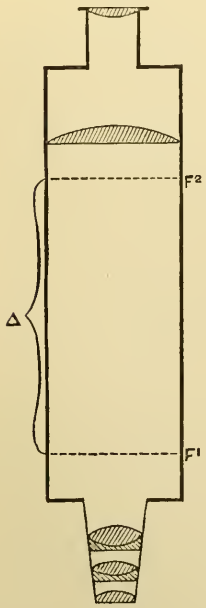
A Microscope of a focal length of 1-40th in. would magnify 400 times, so that if this method of arriving at the focal length of the Microscope were correct, we should only have to multiply the power of the (1-8th in.) objective (80) by that of the (2 in.) eye-piece (5) to have the total magnifying power (400), the brass tube being assumed to be constant at 10 in.

The fallacy of this method lies in the fact that the true formula is not

$$f = \frac{f^1 f^2}{10}, \qquad \text{but} \qquad f = \frac{f^1 f^2}{\Delta},$$

Δ *being the distance between the posterior principal focal plane of the objective, and the anterior principal focal plane of the eye-piece,* or, as Professor Abbe terms it, the rational or *optical tube-length,* in contradistinction to the mechanical or physical length.*

Fig. 154.



The accompanying fig. 154, where F^1 is the posterior focal plane of the objective and F^2 the anterior focal plane of the eye-piece, will illustrate this more clearly.

As Δ is the divisor of the fraction which represents the focal length, the latter is of course larger or smaller according as Δ is smaller or larger, that is, it varies inversely as Δ; and as the magnifying power is inversely to the focal length, the magnifying power varies directly as Δ, which is therefore seen to be a fundamental factor of microscopic amplification.

We can now see how it is that two objectives of the same focal length may yet give different magnifying powers with the same tube and eye-piece. By the different methods of construction adopted by their makers, the focal plane of the one objective may be further off the back lens than is the case with the other. The distance Δ between the focal planes of the objective and eye-piece will be correspondingly

* The principal focal planes are the planes passing through the point on the axis in which parallel rays coming from the *opposite* side of the lens are brought to a focus. "Anterior" and "posterior" are used in reference to the direction in which the rays come to the observer.

diminished, and the focal length of the whole Microscope increased. The magnifying power will therefore be diminished.

Again, take the case of two objectives of say 1-8th in. and 1 in. focal length used with the same eye-piece (2 in.) and tube. If the distance Δ remained constant, say 10 in., the total focal length would vary with that of the objectives,

$$f = \frac{\frac{1}{8} \times 2}{10} = \frac{1}{40}, \qquad \text{or} \qquad f = \frac{1 \times 2}{10} = \frac{1}{5}.$$

But the posterior focal planes of the two objectives, instead of coinciding, may have different positions, every variation producing of course a change in the value of Δ. With the 1-8th in. objective the posterior focal plane may be very near the back lens, and we have a long Δ: with a 1 in. objective its posterior focal plane may be further from the back lens (higher up the tube), and we have a diminished Δ. We might have with the 1-8th in. objective $\Delta = 10$ in., and a power of $(80 \times 10 =)$ 800, but with the 1 in. objective we should not have $(10 \times 10 =)$ 100, or a total power in proportion to the powers of the objectives. Δ might be 8 in. only instead of 10 in., and the total power would be only 80.

The converse case of different eye-pieces with the same objective is similarly explicable. The anterior focal planes of the eye-pieces may be at different points of the tube, and we shall have a varying Δ.

As to the general character of the variations in Δ, it may be noted that the position of the anterior focal plane of the eye-piece does not vary much in the Huyghenian form; a substantial difference is, however, found in this respect between the Ramsden and Huyghenian, the former having its anterior focal plane at some distance below the field lens, and the latter above it. With the objective, however, a very wide range is possible. Its posterior focal plane may be (1) some distance above the last surface of the objective; (2) close to this surface outside or within the objective; or (3)—though a more exceptional case—as a virtual focus below the stage or even below the table. Practically, however, with objectives of ordinary construction, the difference in position of the posterior focal plane is not great with powers higher than 1-2 in., and it is only when we come to the lower powers that the difference is a substantial one.

Greater differences in the power will also be found with short tubes than with long ones. With a 10 in. tube a difference of 2 in. reduces the 10 to 8, but with a 6 in. tube from 6 to 4, quite different percentages of variation.

The process, therefore, of multiplying together the powers of the eye-piece and the objective to obtain the total power of the

Microscope is a fallacious one, as it supposes a constant tube-length; whilst, as we have seen, the true tube-length varies with the different objectives and eye-pieces used.

To determine the power of the Microscope from the powers of the eye-piece and objective, it is necessary, in addition, to know the position of the focal planes of each of the latter. How these may be readily determined must be deferred for a subsequent occasion.

gutter very deep, but closed towards the interior (as other observers admit *) by a fine membrane, the least violence will be sufficient to break the section at this point and give the image of a fissure traversing the thickness of a valve from one part to another. This effect cannot have been produced in the case of the section previously described, because it is supported by the solid portions of the valve farther off, and above all by the hardened balsam which surrounds it. An absolutely solid cement does not present these inconveniences. Balsam is only suitable for giving, to an already consistent rock, greater hardness. It could not be employed to agglutinate diatoms in powder. The other cements which I have used have given me almost negative results. There is, however, one the use of which would, I think, give some advantages; it is the solid matter deposited by certain petrifying waters. The waters of these springs, which are sometimes employed to obtain remarkably delicate copies of medals, bas-reliefs, &c., leave, on evaporating, a hard translucent substance, composed in great part of carbonate of lime. On mixing a certain quantity of the frustules with these mineral waters, we should obtain, by evaporation, a deposit in which very thin and perfectly transparent laminæ could be cut and sections of diatoms obtained. Moreover, the cement could easily be removed by a weak acid, which would enable the sections to be mounted, isolated in a medium more favourable to their study.

It is not even necessary to have recourse to these artifices of preparation. Many sufficiently hard rocks contain diatoms in more or less considerable quantity. Certain varieties of guano, for example, are very hard and give very good sections. Here is a still virgin field which will furnish many an interesting observation to those who will explore it."

MICROSCOPY.

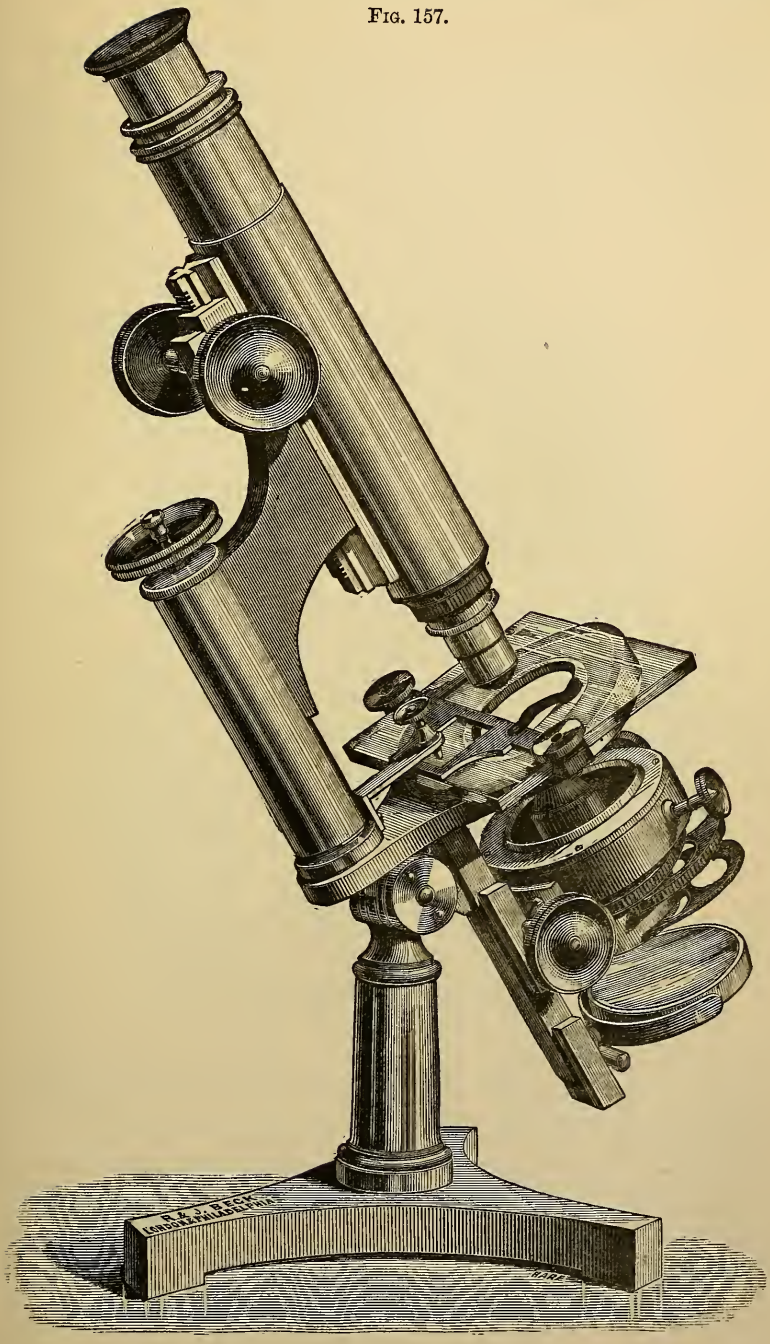
a. Instruments, Accessories, &c.

Beck's Pathological Microscope.—Messrs. Beck have designed this Microscope with a special view to delicate pathological research. The instrument is on the same model as their Economic Stand, but to it has been added a rack-and-pinion substage with centering-screws, which carries an achromatic condenser of an aperture of about 1·4 N.A. It is supplied with two rotating diaphragm-plates, the upper containing a series of blue glasses for moderating the light, the lower a series of openings of different sizes, by which the aperture can be varied to any extent, which are also placed at a distance below the lenses sufficient for accurate centering of the condenser.

Of this arrangement Messrs. Beck say, "This convenient method for rapidly varying the intensity and angle of the cone of light by means of the two diaphragm-plates will, we feel sure, be appreciated by all practical workers on minute pathology. We have made the lenses of large diameter, so that a great flood of light can be used when

* Schmidt, Bot. Ztg., 1872, p. 741.

Fig. 157.

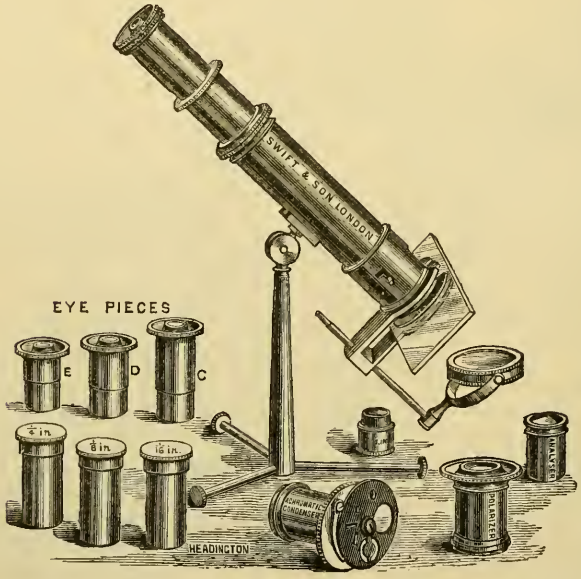


necessary, and the top lens may be taken off when a less convergent cone of light is required for low-power work."

Chevalier's Microscopes.—The Microscope figured at p. 699 (fig. 125) should, we understand, have been described as by the firm of Chevalier, who have no connection with that of Chevallier, the constructors of the instrument fig. 122.

Swift and Son's Pocket Microscope.—Messrs. Swift and Son have added a stand to their (Brown's) Pocket Microscope (figs. 158 and 159), which is one of the smallest Microscopes made having any pretensions to be a serviceable instrument and not a mere toy. As now modified, it appears to be the most complete really "Pocket" instrument yet issued. It is furnished with 1 in., 1-4th, and 1-8th in. dry objectives, and 1-16th in. immersion, three eye-pieces, achromatic

Fig. 158.



condenser with rotating disk having three diaphragms, central stop, and radial slots, together with polarizer, analyser, adjustable concave mirror in gimbal fitting, the whole (with glass slips) packing in a mahogany box $4\frac{3}{4} \times 3\frac{3}{4} \times 1\frac{1}{2}$.

The standard consists of a conical pillar, to the lower end of which three rods are screwed radially, having milled heads at the outer ends and forming a tripod foot; the upper end has a cradle-joint carrying a dovetail slide-socket, in which fits a corresponding slide at the back of the body-tube. The Microscope can be inclined on the cradle-joint as required. The slides, which can be of the usual

size, are held on the stage by a spring cylinder-clip having two lateral projecting pins which slide in right-and-left bayonet slots; the clip can be raised by the pins and keyed in the bayonet slots by a slight lateral turn when the slides are being put in or removed. The coarse adjustment is effected by sliding the tube; the fine adjustment by moving the draw-tube in or out, a plan which is far more convenient in practice than we should have anticipated. We have found no difficulty in focusing the 1-8th objective in this manner

Fig. 159.

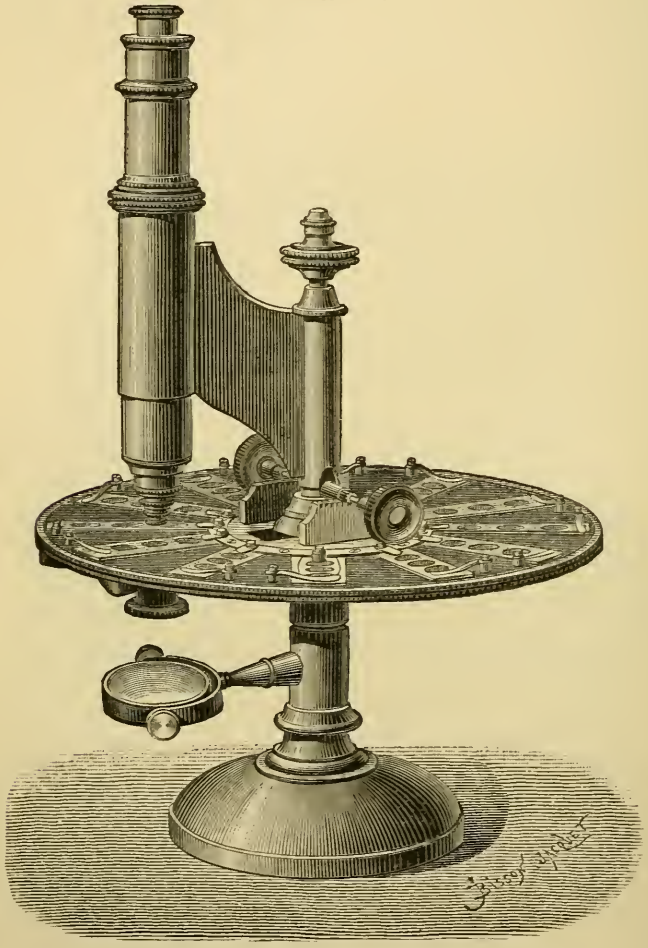
either with the Microscope on its tripod and the light reflected from the mirror, or by pointing the body-tube directly to the sky; and doubtless with a little practice the 1-16th could be used with the like facility. By the addition of adapters the objectives could of course be used on full size Microscopes. The three high powers are provided with correction adjustment. We understand that the Microscope was constructed wholly by Mr. M. Swift (fig. 158 $\frac{1}{2}$ scale, fig. 159 $\frac{2}{3}$ scale).

Mirand's Revolver Microscope.—This Microscope, by J. Mirand, jun., is a further extension of the principle on which Klönne and Müller's instrument was based (Vol. III., 1880, p. 144).

In the latter form the circular stage held eight objects on ordinary slides, which could be successively brought into the field on rotating the stage. In the new form the stage can not only be rotated on its centre, but moved from back to front and *vice versâ*, so that its centre does not coincide with that of the pillar. With this plan each of

the twelve slides carried by the stage can have three different objects mounted upon them. If then the centre object on one of the slides is brought into the field of view, all those which occupy the same relative position on the other slides will pass under the objective

Fig 160.

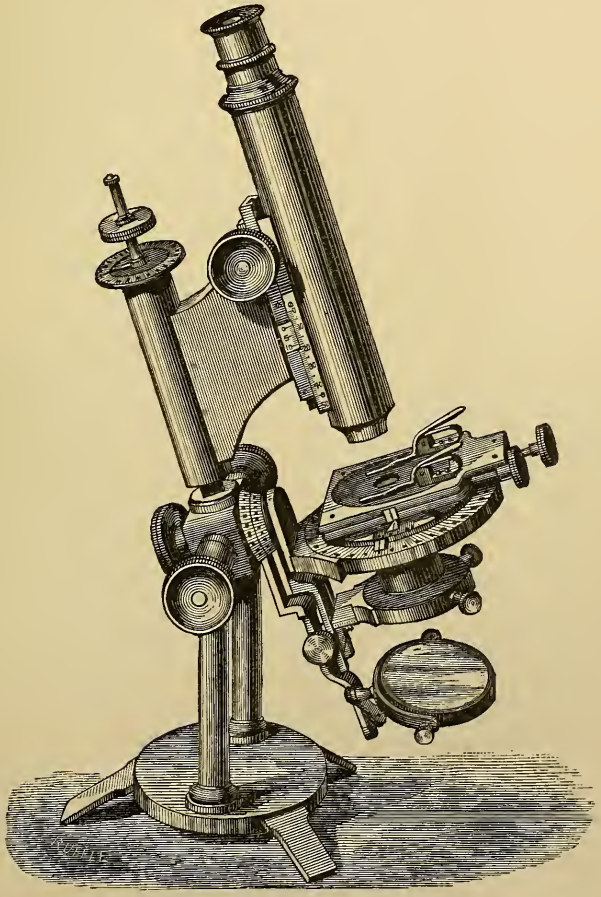


when the stage is rotated. On turning the milled heads above the stage, the pinions connected with which work in rackwork attached to the stage, the latter is moved from back to front or *vice versâ* so that the body-tube will stand over the first or third object on one of the slides. The rotation of the stage will then bring the corre-

spondingly placed objects on each of the other slides under the objective as before.

Pelletan's "Continental" Microscope.—This Microscope (fig. 161) has been issued by Dr. J. Pelletan, of Paris, and claims notice not for any distinctive feature in design, but as a combination of several points which have hitherto been confined to English or American

Fig. 161.



models, together with the focusing arrangements and connection of the body-tube with the pillar generally adopted on the Continent.

The principal novelty (to the Continental public) is the adoption of the swinging tail-pieces to carry the substage and mirror, each moving radially to the object on the stage, after the plan modified

by Bulloch,* of Chicago, from Zentmayer's "Centennial" Microscope.†

The substage with centering movements fits on the first tail-piece behind the stage, and is worked by rack and pinion. The mirror is mounted on a crank arm on the second tail-piece. The tail-pieces swing laterally either together or independently; each is provided with a graduated collar for registering the lateral rotation, and a sprung-pin drops into a corresponding notch, fixing each in the normal position when axial light is required.

The stage is circular, and rotates about 7-8ths of a turn; it has goniometrical divisions near the edge; "finders" are applied to the mechanical rectangular movements. It is attached to the lower end of the inclining column by a conical axis passing through and secured at the back by a large milled nut. This stage can be removed and a glass friction-stage substituted, which can be used reversed for oblique illumination from the mirror, &c. The friction-stage is fitted with a hemispherical lens so that its plane face is flush with the surface of the stage as in Tolles's and other Microscopes.

The focusing arrangements are of the usual Continental type. A scale is applied on the side of the body-tube working against a fixed vernier on the limb for recording focal distances by the coarse adjustment, whilst for finer measurements a graduated disk is fixed on the top of the column carrying the limb, and the fine focusing screw rotates with an index pointer, by which the number of turns and fractions can be registered.

The body-tube is much larger than is usually adopted on the Continent, and will admit an extra draw-tube (supplied with the Microscope) for the Ross gauge of eye-pieces. As arranged in the figure there are two draw-tubes, the larger one sliding in the body-tube and carrying the smaller, in which the Hartnack gauge of eye-pieces is used. The "Society" thread is applied at the nose-piece.

The suspension of the inclining column between the standards appears to have been devised without regard to the balance of the instrument. The trunnion axis is very nearly at the lower end of the column, so that the stability of the position of inclination is entirely dependent on the tension of the clamp-screws on the ends of this axis; if the unwary operator should loosen the clamp-screws without supporting the column the optical part of the Microscope falls forward or backward, in either case striking the table, as no stop-pins are provided either to mark the vertical or the horizontal position.

The Microscope is manufactured by E. Lütz, and appears to us to require thorough revision both in design and construction.

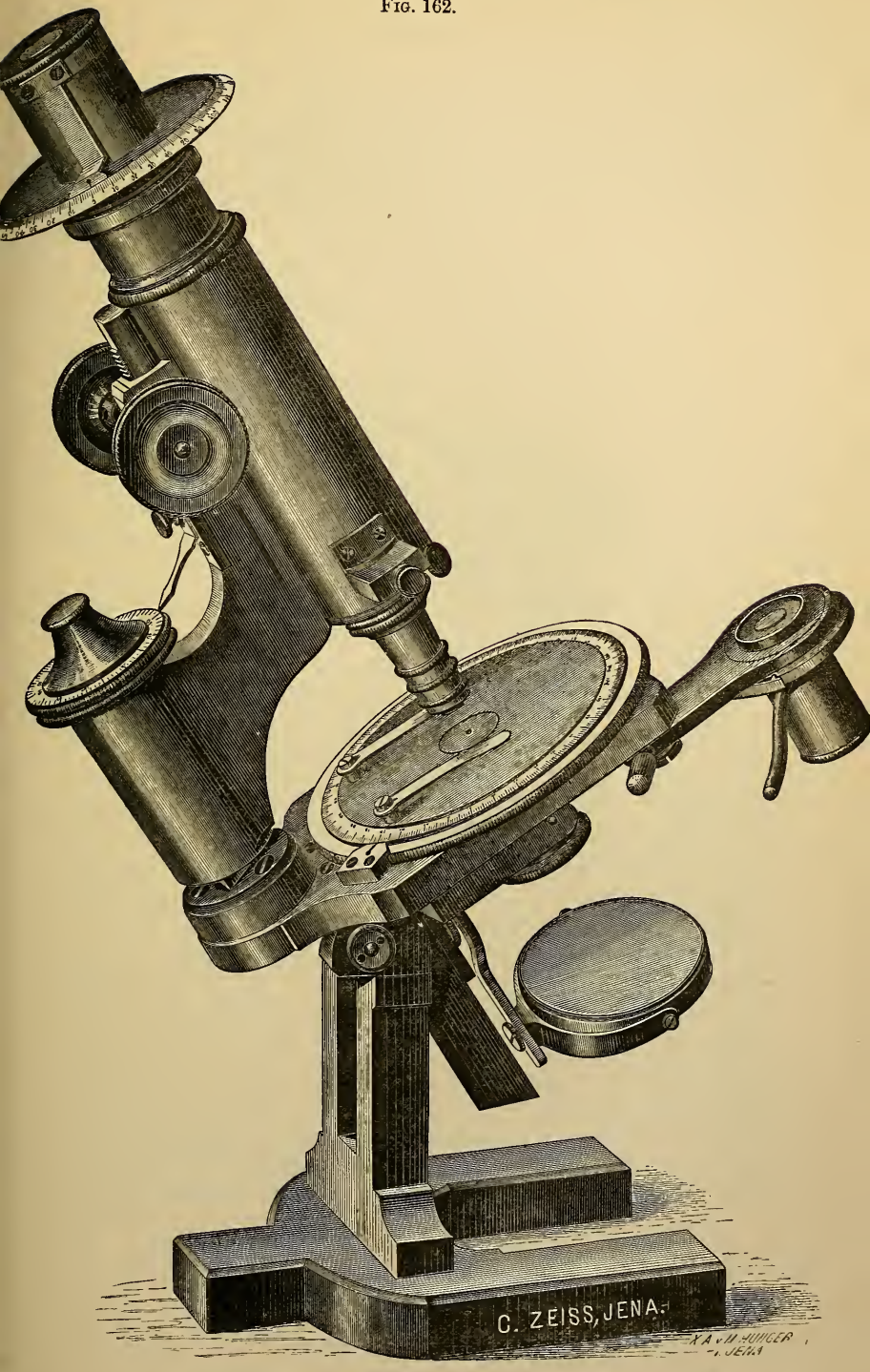
Zeiss's Mineralogical Microscope.—This (fig. 162) is based upon Dr. Zeiss's large Microscope-stand with the addition of a rotating stage, polarizer and analyser, sliding quartz-plate above the objective, and centering nose-piece.

The polarizer turns away from the stage, as shown in the woodcut,

* See this Journal, iii. (1880) pp. 1073–80.

† Ibid., pp. 1067–73.

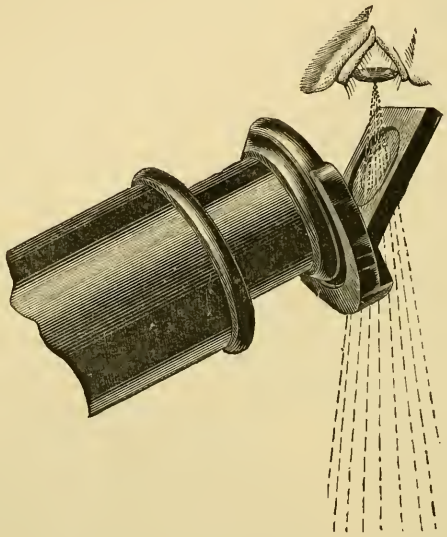
FIG. 162.



the tubular diaphragm-holder also turning in the same way. The arm attached to the polarizer serves to rotate it.

Bausch and Lomb Optical Company's Fitting for Neutral Tint Camera Lucida.—Fig. 163 shows the fitting adopted by the Bausch and Lomb Optical Co. It is made of vulcanite, and the half ring to which

Fig. 163.



the frame holding the neutral tint glass is fixed fits on the cap of the eye-piece. The vulcanite is sufficiently elastic to obtain a good grip of the eye-piece.

Testing the Binocular Arrangement.*—Mr. J. Swift gives the following directions for testing the binocular arrangement of a Microscope.

It is of the first importance that the reflecting surfaces of the Wenham prism should be absolutely flat; as the rays passing through it are twice reflected before they emerge, the slightest error in the surfaces will seriously impair the definition. For testing the quality of the prism the tongue of the blow-fly may be viewed with a 1 in. objective, and should be equally well defined in both fields. In this testing the same eye should be used in viewing each image separately. The image in both fields should focus clear and sharp at the same time, that is to say, after adjusting the focus in the vertical tube, the other tube should not require the focus to be readjusted to make the image as distinct as in the former; this point should be tested with

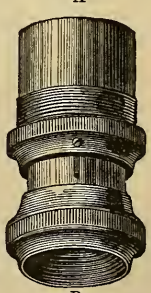
* 'The Microscope and Accessory Apparatus,' 1883, pp. 27–9.

one and the same eye-piece. After adjusting and viewing the image in one field, remove the eye-piece and place it in the other tube; if the definition is then equally good the prism may be considered satisfactory. Repeat the operation with the corresponding eye-piece without altering the focal adjustment, and if the image is not equally well defined, the eye-pieces do not match, that is to say their focal powers differ. It is absolutely essential that each pair of eye-pieces should be of equal power. Next ascertain whether the images in both fields entirely coalesce when an object is viewed through the tubes with both eyes. Place on the stage some round object large enough to nearly fill the field of the eye-piece (a good *Echinus* spine is generally sufficiently round and of the size required), adjust it in the centre of the field of the vertical tube, so as to leave a concentric ring of light around it, and then view the image in the oblique tube with the same eye-piece as before; should the image be equally in the centre of the field, it is satisfactory. If, however, the image in this tube appears a little out of centre towards the *left* of the observer, we should not reject the instrument on that account, as in the opinion of many experienced microscopists a slight lateral deviation of this kind gives an increased stereoscopic effect to the image. But if the image in the oblique tube be out of centre in the opposite direction (viz. towards the *right*), the binocular arrangement is defective. Observations prolonged for even a short time will then cause great pain to the eyes, and if continued would permanently injure even the strongest eyesight.

A reviewer of Mr. Swift's work * is sure that the above instructions "would lead the careful amateur to condemn 50 per cent. of the binocular Microscopes issued by the opticians of this country."

Bausch and Lomb Optical Company's Safety Nose-piece.—This (fig. 164) consists of two tubes; the upper A having the Society screw, and fitting into the end of the body-tube; and the lower B, also with the Society screw, receiving the objective. The lower tube is pushed out by a weak spiral spring which is inside the upper one, but a slight pressure is sufficient to press it in, and so "prevent jamming of the objective into the object." The lower tube is kept from rotating by the slot and pin seen in the figure.

FIG. 164.



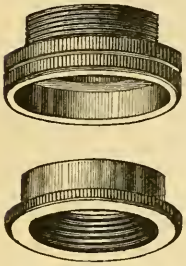
Matthews' Device for Exchanging Objectives.†—Dr. J. Matthews, referring to the fact that the joints of the stomach-pump fit together as cones and that a joint was never known to give way, suggests, as a most simple, inexpensive, and ready method for exchanging objectives, a short adapter in the form of a hollow cone which is screwed into the ordinary nose-piece, with another piece screwing on the objective and coned down exactly to

* Engl. Mech., xxxviii. (1883) p. 50.

† Journ. Quek. Micr. Club., i. (1883) p. 305.

fit inside the first. The only action required is then to push the one into the other, and as they fit accurately there is quite sufficient adherence to keep the objective in its place. The centering of the objectives is likely to be more accurate than if they are screwed on in the usual way. "It was of course just possible that a blow might cause the objective to drop out, but this in practice was hardly likely to happen."

Fig. 165.

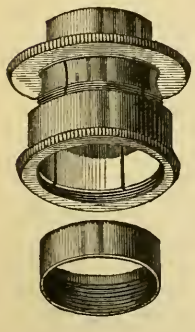


Mr. H. F. Hailes, referring to the analogy between the fitting of an objective and the chucks of a lathe, says that the proprietor of large engineering works informed him that a cone-fitting was the best for lathes that could be used, and that he had done away with screwed nose-pieces in favour of the cone. As to its power of holding, Mr. Hailes saw a 1 in. iron bolt screwed perfectly at one cut with dies held in a chuck so fitted.

Mr. E. M. Nelson, on the same subject, said that he believed the cone "to be the best fitting in the world, and for his own part he should be glad to see the whole system of screws swept away and the cone substituted."

Watson's Adapter Nose-piece.—To avoid the danger of the objective dropping out of the cone-fitting of Matthews' adapter nose-piece, Messrs. Watson have cut four slots in the coned tube of the nose-piece to give it spring, and have applied an outer screw-collar by which the tension of the cone can be increased if required. An adapter, coned externally, screws on the objective, where it may remain, as it presents no obstacle to the use of the ordinary objective-boxes. The screw-collar on the nose-piece can be regulated to give just the required amount of tension to prevent the objective from dropping out; and where additional precaution is thought desirable, a quarter turn of the collar will grip the objective as firmly as required, the reverse movement releasing it.

Fig. 166.



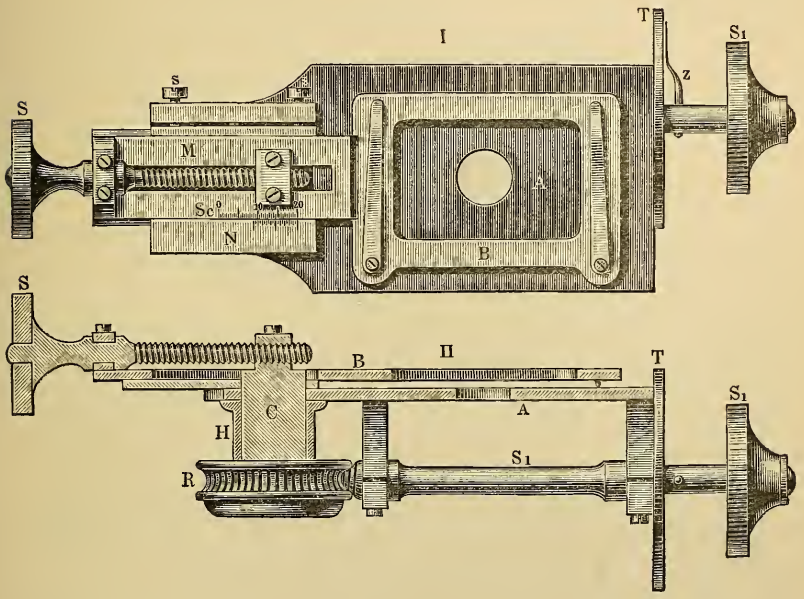
Boecker's Movable Stage.*—This (fig. 167) is yet another contrivance, of German origin, for moving an object on the stage in two directions, described with a freshness and elaboration of detail which carries one back some forty or fifty years in the history of corresponding contrivances for English Microscopes.

The lower plate A is clamped to the stage, and the upper plate B (with clips for the object) is moved by the screw S in a longitudinal direction, M and B being connected. The movement of B from back

* Dippel's 'Das Mikroskop,' 2nd ed., 1882, pp. 649–51 (1 fig.).

to front is effected by S_1, which has an endless screw working in the toothed wheel R on the axis C, which turns in the tube H attached to the fixed plate. C being connected with the movable plate B, the latter will describe an arc of a circle when S_1 is turned.

Fig. 167.



By way of apology for the latter movement not being rectilinear, it is pointed out that "since the lever-arm from the turning-point at C to the centre of the optic axis is very large in comparison with the diameter of the field, so that the arc described is a very flat one, the movement will not appear to be circular, but rectilinear."

A finder is made by graduations at Sc and N for the one movement, and on a disk at T (with an index *z*) for the other. The small screws *s s* serve to regulate the tightness or looseness of the movement of the slide M.

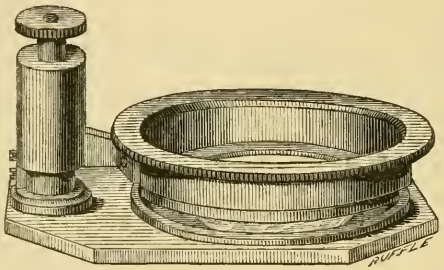
Fol's Compressor.*—Mr. J. A. Ryder writes us that he finds the compressor of Prof. H. Fol the most convenient he has tried; in fact, his studies of the development of living fish ova could not have been accomplished without it.

It consists (fig. 168) of an octagonal base-plate $3\frac{1}{4}$ in. by $2\frac{1}{2}$ in., with a circular aperture closed by glass disk $1\frac{1}{2}$ in. in diameter. A raised rim round the disk gives a depth of 1-6th in. for fluids. Over the aperture is a sprung brass ring attached to an arm, which is moved

* Morph. Jahrb., ii. (1876) pp. 440–4 (1 fig.).

up and down on a pillar by a micrometer-screw by the same action as that of the fine adjustment of Continental Microscopes. In the ring slides a piece of tubing with a thin glass plate cemented to the bottom. By pushing it more or less through the ring, a "coarse adjustment" of the compression is obtained, whilst the micrometer-

Fig. 168.

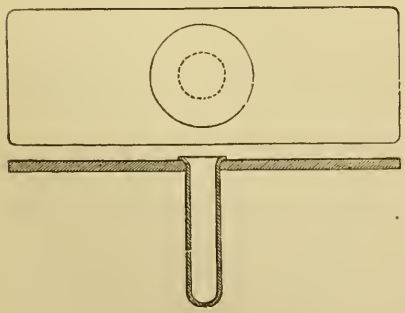


screw furnishes a "fine adjustment." If in place of the adjustable ring two pieces of tubing were used, sliding one within another, uniformity in their movement and the parallelism of the two glass surfaces could only be insured if the height of the tubing were not less than a third of the diameter, which would make large compressors very unwieldy.

Mr. Ryder mentions that the apparatus has the merit of being almost immediately applicable to any sized ovum, by having a supply of metal rings of different thicknesses to confine ova of different sizes between the cover and the glass of the base-plate.

Slack's Tubular Live-box.*—Mr. H. J. Slack has been led to construct a tubular live-box, to facilitate showing the action of the blue-bottle's mouth-organs, and that of similar insects. It does not answer for bees. At this time of the year many large flies are driven indoors by the cold, and this little apparatus may assist in studying some of their interesting peculiarities. When an ordinary live-box is used to hold a blow-fly captive, there is some difficulty in holding him tight enough, with the under side up, and yet not so squeezed as to injure him, or interfere with his comfort. The tube live-box is made with a small tube bottle, such as is used by

Fig. 169.



* Knowledge, iv. (1883) pp. 267–8 (1 fig.).

homœopathic chemists, about 1 in. long and 1-4th in. wide at the mouth. This is inserted into a hole cut in a wooden slide, and its rim prevents its falling through. Another wooden slide has a hole cut through it of rather larger diameter, and on the top side a thin glass cover is fastened with shellac glue. This slide is laid on the other. The glass cover forms a lid, which closes the tube bottle, and is held in its place by an elastic indiarubber band. A little cotton wool is put into the bottom of the tube to shorten the space, to suit the length of the fly, which must be inserted mouth uppermost, and kept moderately near the glass cover, upon which a drop of syrup is placed. Flies will readily feed in this position, and they are sufficiently limited in the power of lateral motion to be easily kept in view with 1½ in. or 1 in. objective.

Wenham's Reflex Illuminator.*—Mr. Wenham devised this apparatus for the illumination of balsamed objects, and also pointed out that, with dry-mounted objects on the cover-glass, specimens are frequently met with which have dropped on the surface of the slide itself, and may be seen "self-luminous" with the reflex illuminator as with the immersion paraboloid; but the direction of the light is limited to one azimuth, which may be varied by rotating the illuminator. Mr. J. Swift "cannot, however, express a favourable opinion of either of these methods of illumination, on the ground (1) that objects such as diatoms, mounted in balsam, are too transparent to be viewed by light reflected from their surface only; and (2) the viewing objects as 'self-luminous' by means of light deflected or scattered within their substance has not led to any useful result, though the method has been known to microscopists since Mr. Wenham's publication of it in 1856. It appears to the author that the reflex illuminator may be used effectively to illuminate balsamed objects by transmitted light of great obliquity—i. e. of obliquity within the balsam, which can only be obtained by immersion or equivalent means; it is then as an oblique illuminator for *transmitted* light that he would recommend its use. This action of the apparatus can be utilized only in conjunction with an immersion objective whose aperture exceeds 82° measured in crown glass."

It should be noted that this action of the reflex illuminator was first utilized by Mr. Samuel Wells, of Boston, U.S.A. So far as our experience goes, the use of the reflex illuminator as an oblique transmitter is a very cumbersome method compared with the admirable simplicity of the oil-immersion condenser, or as compared with the simple hemispherical lens placed in immersion contact with the base of the slide.

Practical Benefits conferred by the Microscope. — Prof. E. Ray Lankester in his Presidential Address to the Section of Biology at the Southport meeting of the British Association for the Advancement of Science, strongly advocated the endowment of research, especially in Biology. Referring to the Microscope he said, "I need hardly remind

* 'The Microscope and Accessory Apparatus,' 1883, pp. 50-2 (1 fig.).

this audience of the almost romantic history of some of the great discoveries which have been made in reference to the nature and history of living things during the past century. The Microscope, which was a drawing-room toy a hundred years ago, has, in the hands of devoted and gifted students of nature, been the means of giving us knowledge which, on the one hand, has saved thousands of surgical patients from terrible pain and death, and, on the other hand, has laid the foundation of that new philosophy with which the name of Darwin will for ever be associated. When Ehrenberg, and later, Dujardin described and figured the various forms of *Monas*, *Vibrio*, *Spirillum*, and *Bacterium* which their Microscopes revealed to them, no one could predict that fifty years later these organisms would be recognized as the cause of that dangerous suppuration of wounds which so often defeated the beneficent efforts of the surgeon, and made an operation in a hospital ward as dangerous to the patient as residence in a plague-stricken city. Yet this is the result which the assiduous studies of the biologists, provided with laboratories and maintenance by Continental States, have in due time brought to light. . . . The amount of death, not to speak of the suffering short of death, which the knowledge of bacteria gained by the Microscope has thus averted is incalculable. . . . One other case I may call to mind in which knowledge of the presence of bacteria as the cause of disease has led to successful curative treatment. A not uncommon affliction is inflammation of the bladder, accompanied by ammoniacal decomposition of the urine. Microscopical investigation has shown that this ammoniacal decomposition is entirely due to the activity of a *Bacterium*. Fortunately this *Bacterium* is at once killed by weak solutions of quinine, which can be injected into the bladder without causing any injury or irritation. This example appears to have great importance, because it is the fact that many kinds of bacteria are not killed by solutions of quinine, but require other and much more irritant poisons to destroy their life, which could not be injected into the bladder without causing disastrous effects. Since some bacteria are killed by one poison and some by another, it becomes a matter of the keenest interest to find out all such poisons, and possibly among them may be some which can be applied so as to kill the bacteria which produce phthisis, erysipelas, glanders, anthrax, and other scourges of humanity, while not acting injuriously upon the body of the victim in which these infinitesimal parasites are doing their deadly work. In such ways as this biology has turned the toy 'magnifying glass' of the last century into a saviour of life and health."

Bale's Eye-piece Micrometer.—Mr. W. M. Bale writes that the following lines should be inserted in his description of a simple eye-piece micrometer, viz. after "central one," in line 27 of p. 571, "but on the other side of it, also two others on opposite sides, each measuring a space of 5-1000ths in. from the central one."

Abraham, P. S. See Hayes, R. A.

Bachmann, O.—Unsere modernen Mikroskope und deren sämtliche Hilfs- und Nebenapparate für wissenschaftliche Forschungen. Ein Handbuch für Histologen, Geologen, Mediziner, Pharmazeuten, Chemiker, Techniker und Studierende. (Our modern Microscopes and their auxiliary and accessory apparatus for scientific researches. A handbook for histologists, geologists, medical men, pharmaceuticists, chemists, technicians, and students). xv. and 344 pp. and 175 figs. 8vo, München and Leipzig, 1883.

Baker's Seaside Microscope.

Amer. Mon. Micr. Journ., IV. (1883) p. 190–1 (1 fig.).

Blackburn, W.—Address to Manchester Microscopical Society on the Annual Soirée of the Mounting Section.

["A few remarks upon the objects and aims of our Society."]

Micr. News, III. (1883) pp. 301–4.

Brass, dead black colour for. *Amer. Mon. Micr. Journ.*, IV. (1883) p. 177.

Brittain, T., presentation of an Address to, by the Manchester Microscopical Society. *Micr. News*, III. (1883) pp. 299-301.

Bulloch's Biological Microscope.

[Quotation of remarks, *ante*, p. 554 last 3 lines, and p. 555 first 2 lines:—"This is praise from high quarters of which Mr. Bulloch may be justly proud."]

Amer. Mon. Micr. Journ., IV. (1883) p. 197.

Curties, T.—Nose-piece Adapter.

[*Ante*, p. 572.] *Journ. Quek. Micr. Club*, I. (1883) pp. 299–300.

Davis, G. E.—Our Verification Department.

[Nos. 115–30.] *Micr. News*, III. (1883) p. 318.

Errera, L.—Rapport sur la participation de la Société [Belge de Microscopie] à l'Exposition internationale de Photographie. (Report on the participation of the Belgian Society of Microscopy in the International Exhibition of Photography.)

[List of 56 photo-micrographs in different branches of natural history, exhibited by the Society, and for which they obtained one of the seven diplomas of honour.]

Bull. Soc. Belg. Micr., IX. (1883) pp. 160–4.

Flögel, J. H. L.—Mein Dunkelkasten. (My Dark Chamber.) [*Post.*]

Zool. Anzeig., VI. (1883) pp. 566–7.

Hayes, R. A.—Four Microphotographs, with Description by P. S. Abraham. 6 pp. and 4 microphot. 8vo, Dublin, 1883.

[Microphotographs of preparations of transplanted teeth by the oxy-hydrogen lamp, the light being by a special arrangement of lenses condensed so as to furnish an evenly illuminated disk of about 1-2 in. in diameter. No eye-piece or correction for difference in visual and chemical foci.]

Sep. repr. from *Trans. Acad. Med. Ireland*, I.

Hitchcock, R.—A Microscopist rambling.

[Description of a visit to New Brighton.]

Amer. Mon. Micr. Journ., IV. (1883) pp. 166–7.

„ „ Divisions of Micrometer Eye-piece.

[Reply to inquiry as to the parts of an inch in which an eye-piece micrometer should be ruled. "On the whole it seems best to adopt some divisions which shall give sufficient accuracy without confusing the mind in counting the lines or in any wise obscuring the view of the object. It is on these grounds that we have ventured to recommend the spacing of 1-100th in."]

Amer. Mon. Micr. Journ., IV. (1883) p. 179.

„ „ Testing Objectives.

[Exhortation to use Prof. Abbe's method, *ante*, p. 120.]

Amer. Mon. Micr. Journ., IV. (1883) p. 194.

„ „ Developing Photo-Micrographs. [*Post.*]

Amer. Mon. Micr. Journ., IV. (1883) p. 198.

International Bureau of Weights and Measures (*concld.*).
Nature, XXVIII. (1883) pp. 592-6 (2 figs.) from *La Nature*.

J., C.—The Microscopic Glasses. (A chapter in advance.)
[Describes the examination of the insectivorous powers of *Drosera* "about the year 1900," with spectacles "of such a power as to enable the wearer at a distance of a few feet to distinguish the minutest object as clearly as with a first-rate Microscope."]
Sci.-Gossip, 1883, pp. 243-4.

Kellicott, D. S.—The American Society of Microscopists.
[Account of the Chicago Meeting.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 172-4, 185-90.
The Microscope, III. (1883) pp. 145-51, 160-1.

Knauer, J.—Das Mikroskop und seine Anwendung. (The Microscope and its use.) *Naturhistoriker*, V. (1883) pp. 409-12.

Koch.—Ueber eine Methode die Mikrometer-schrauben zu prüfen. (On a method of testing micrometer-screws.)
Ber. Verhandl. Naturf. Ges. Freiburg, VIII. (1882) Heft 1.

Lankester, E. R.—Presidential Address to the Section of Biology at the Southport Meeting of the British Association for the Advancement of Science.
[Advocating the endowment of research, especially in Biology. *Supra*, p. 907.]

Lasaulx, A. v.—Ein neues für petrographische und mineralogische Untersuchungen bestimmtes Mikroskop. (A new Microscope intended for petrographical and mineralogical researches.)
[Made by Nachet under E. Bertrand's directions. Apparently the same as *ante*, p. 413.]
Verh. Naturhist. Ver. Preuss. Rheinl. u. Westf., XXXIX. (1882) SB., p. 82.

Lockyer, J. N.—The Movements of the Earth. (In part.)
[Contains "How Optics enables us to read fine verniers.
" " " to replace the vernier by a micrometer."]
Nature, XXVIII. (1883) pp. 598-604 (17 figs.).

Mason, J. J.—Minute structure of the Central Nervous System of certain Reptiles and Batrachians of America. Illustrated with 113 permanent photo-micrographs. Series A, viii. and 32 pp. [*Post.*] 4to, Newport U.S.A., 1879-82.

Matthews, J.—Device for facilitating the exchange of objectives.
[*Supra*, p. 903.] *Journ. Quek. Micr. Club*, I. (1883) pp. 299, 305.

Nelson, E. M.—New method of fixing objectives to the Microscope.
[*Ante*, p. 572.] *Journ. Quek. Micr. Club*, I. (1883) pp. 298-300.

Nunn, R. J.—The Pillar Slide. A new slide for the Microscope. [*Post.*]
Sep. repr. from *Trans. Med. Assoc. Georgia*, 1883, pp. 21-2.
Amer. Mon. Micr. Journ., IV. (1883) p. 178.

" " Chemical.—New slide for the Microscope. [*Post.*]
Sep. repr. from *Trans. Med. Assoc. Georgia*, 1883, pp. 22-4.

" " Slides with hollows for chemical reactions. [*Post.*]
Sep. repr. from *Trans. Med. Assoc. Georgia*, 1883, p. 24.

Officer, W.—Another reading table.
[A piece of board covered on one side with American leather-cloth (for tables with cloth covers), and on the other with green baize (for polished tables).]
Sci.-Gossip, 1883, p. 232.

Ollard, J. A.—Zoophyte Troughs.
[Directions for making.] *Engl. Mech.*, XXXVIII. (1883) p. 224 (1 fig.).

., W. G.—Doublets for the Microscope.
[Deals with the reduction of spherical aberration with 2 lenses.]
Engl. Mech., XXXVIII. (1883) p. 223.

Pippet, W. A.—A substitute for a revolving table.
[Cover of stout oil-cloth to a small table with a round top, drawn underneath the table by strings like the mouth of a bag: the "cover will then revolve with the greatest ease even when it has a considerable weight upon it"].
Sci.-Gossip, 1883, pp. 232-3.

Pumphrey, W.—The Application of Photography to the delineation of microscopic objects.

[Brief directions for photographing microscopic objects, with drawing of a camera.]

Journ. Post. Micr. Soc., II. (1883) pp. 201–6 (1 fig.).

Rogers, W. A.—Studies in Metrology—First paper.

[Contains a description and 7 figs. of the Rogers-Bond Universal Comparator, with two comparing Microscopes, Micrometers, Tolles's opaque illuminator, &c.]

Sep. repr. from *Proc. Amer. Acad. Arts & Sci.*, 1882–3, pp. 287–398 (7 figs.).

Slack, H. J.—Tubular Live-box. [*Supra*, p. 906.]

Knowledge, IV. (1883) pp. 267–8 (1 fig.).

Sloan, J.—A good Objective.

[Spencer's 1-10th hom. imm. 125° B.A. resolves *Amphipleura pellucida* "with daylight above or beneath the stage, with concave mirror alone, in homogeneous fluid or in glycerine. By lamplight and concave mirror with bull's-eye condenser with either fluid. It also resolves them readily by central sunlight."]

Amer. Mon. Micr. Journ., IV. (1883) pp. 198.

Smith, J. Lawrence.—Obituary.

[Inventor of the inverted Microscope.]

Amer. Journ. Sci., XXVI. (1883) pp. 414–5.

Sternberg, G. M.—Photo-micrographs and how to make them. 204 pp. and 47 photo-micrographs (on 20 plates) reproduced by the heliotype process. 8vo, Boston, 1883. [*Ante*, p. 720.]

[Cf. *Amer. Mon. Micr. Journ.*, IV. (1883) p. 197.]

Stowell, C. H.—Gleanings from the Journal of the Royal Microscopical Society for August. *The Microscope*, III. (1883) p. 156.

Stowell, C. H. and L. R.—A new State Microscopical Society.

[Suggestion for a Michigan Society.] *The Microscope*, III. (1883) p. 160.

β. Collecting, Mounting and Examining Objects, &c.

Aylward's Apparatus for Pond-Life Hunting. — Mr. H. P. Aylward has designed a set of apparatus for pond-life hunting, the novel feature of which is that the holder for the bottle is made of steel wire, one end grasping the neck of the bottle, and the other end being a hollow spiral, in which the taper end of any sized walking-stick may be inserted. The hook is similarly attached to a spiral. The dipping-bottle packs in a japanned cylindrical tin box, the upper half of which is composed of very fine copper gauze. When the bottle is emptied into this box, the organisms will be retained in the lower part, and the surplus water escape through the gauze. This operation may be repeated any number of times, and the contents afterwards returned to the bottle. For special gatherings, another japanned box is supplied, containing several large test-tubes. The size of the cylindrical box and its case containing the bottle is 5 in. × 2 in., that of the box with test-tubes, $5\frac{1}{2}$ in. × $3\frac{1}{2}$ in. × 1 in.

Capturing and Breeding Insects, Acari, &c., for Mounting.*— Mr. A. D. Michael, referring to the question of breeding insects, acari, &c., in order to get them in the best condition to mount, says that

* Journ. Quek. Micr. Club, i. (1883) pp. 241–2.

he only occasionally does so. Breeding may be advantageous when pupæ can be obtained in a late stage, or when a rare larva is found. But it is extremely difficult to imitate the whole natural conditions for any length of time; the creature is not strong and vigorous, and though the hairs and setæ are less injured, it does not necessarily make a better mount than a hardier well-developed creature born in a natural state, and perhaps caught only a short time after emerging. His own habit was, therefore, rather to rely upon capture and not breeding.

Treatment of Pelagic Fish Eggs.* — The transparent eggs of various Teleostei found floating on the surface of the sea present unusual difficulties in the way of hardening. Dr. C. O. Whitman has had recourse to all the fluids commonly used for this purpose, and failed to find any satisfactory method of hardening the yolk. Even the germinal disk cannot be well preserved by any of the ordinary hardening agents. Kleinenberg's picro-sulphuric acid, for instance, causes the cells, all through the cleavage stages as well as the later embryonic stages, to swell and in many cases to become completely disorganized. The embryonic stages can be hardened in chromic acid (1 per cent.), but the yolk contracts considerably without becoming well hardened even after three days' immersion.

All sorts of wrinkles and distortions are caused when the ova are transferred from the acid to alcohol. The best results have been obtained with osmic acid and a modified form of Merkel's fluid. This fluid, as used by Dr. Eisig, consists of chromic acid (1-4th per cent.) and platinum chloride (1-4th per cent.) mixed in equal parts. Thus prepared it causes maceration of the embryonic portion of the egg. By using a stronger chromic acid (1 per cent.) and combining it as before with the same quantity of platinum chloride (1-4th per cent.), everything may be well preserved and hardened except the yolk. Before transferring to alcohol, after one to two days' immersion in this fluid, it is necessary to prick the egg membrane in order that the alcohol may reach the egg readily, otherwise the membrane wrinkles badly and often injures the embryo.

For the cleavage stages this fluid cannot be used with success unless the egg has been first killed with another agent, for eggs placed in the fluid continue to live for a considerable time, and may even pass through one or two stages of cleavage. It is therefore necessary to use some agent that kills almost instantly. For this purpose Dr. Whitman has found osmic acid the best reagent. The eggs are placed in a watch-glass with a few drops of sea-water, and then a quantity of osmic acid (one-half per cent.) equal to that of the sea-water is added. After 5–10 minutes the eggs are transferred to the mixture of chromic acid and platinum chloride, and left for twenty-four hours or more. This fluid not only arrests the process of blackening, but actually bleaches the egg.

After this treatment it is an easy matter to separate the blastoderm from the yolk by needles, and the preparations thus obtained

* Amer. Natural., xvii. (1883) pp. 1204-5.

can be mounted *in toto*, or sectioned. As the blastoderm is quite thin during the cleavage stages, a whole series of these stages may be mounted and studied from the surface to advantage. After removal from the acid the preparations may be stained at once, and then treated with alcohol and mounted in balsam.

Water-bath and Moulds for Imbedding.*—A. Andres, W. Giesbrecht, and P. Mayer describe some minor arrangements which they have devised for facilitating imbedding in paraffin.

First a water-bath, the principal advantage of which is that the steam cannot reach the object, and that with a very small consumption of gas or alcohol a constant temperature can be kept up during half the day.† It is made of brass, contains a deep cylindrical and two shallow depressions with cups of brass and several deep holes, in which the glass tubes containing objects in chloroform and paraffin can be put, as well as a thermometer.‡ Difficult objects are placed with their tubes, from which the corks are previously removed, in the water-bath whilst cold, and then gradually warmed; afterwards they are put in shallow saucers, a low temperature being kept up as long as chloroform evaporates; a deeper vessel contains the paraffin for imbedding. On one side is a slit for the insertion of slides to be warmed.

The imbedding is not done in boxes of paper or of tinfoil as recommended by Kossmann, but in moulds with glass bottoms and movable metal sides, so that they can be altered in size at will. At the Zoological Institute at Leipzig they are made of type-metal. The authors have altered them a little, giving them the shape of ⊐⊏, and making them of brass in order to use as little metal as possible, and so obtain a uniform cooling of the whole mass. The metal walls and glass bottom were rubbed each time with glycerine, before being used, to prevent the paraffin adhering. For exactly placing very small objects the boxes are coated with thin collodion (after rubbing with glycerine), and then put into a water-bath for the evaporation of the ether-alcohol, and a box is thus obtained in which paraffin can be kept liquid for hours without running out between the metal and the glass. The imbedding then takes place quietly. The box is put in a small water-bath under the dissecting Microscope, and after the objects are placed in position it is quickly cooled by the emptying of the bath.

Fearnley's Modification of the Groves-Williams Ether Freezing Microtome.—Dr. Fearnley has devised the modification of the Groves-Williams Ether Freezing Microtome § shown in fig. 170. The

* MT. Zool. Stat. Neapel, iv. (1883) pp. 435–6.

† R. Kossmann, Zool. Anzeig., vi. (1883) pp. 19–21, recommends for the same purpose an air-bath which can be kept at 50° with a Kemp-Bunsen gas regulator.

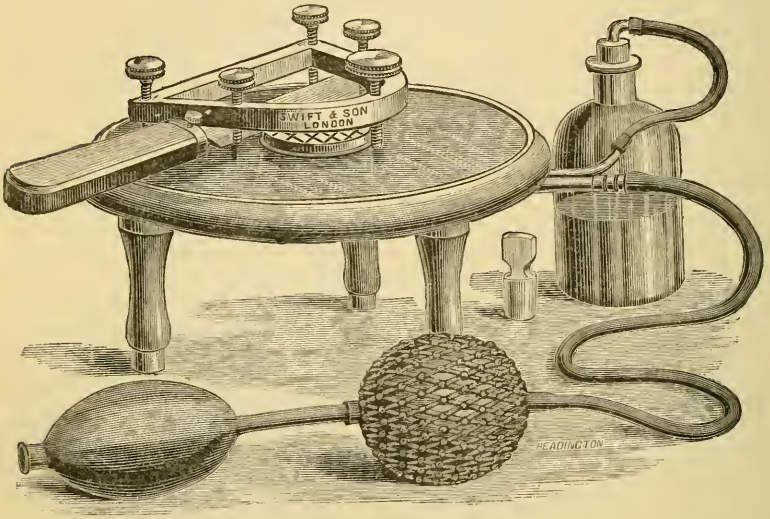
‡ This water-bath has already been described in an original and similar form by C. O. Whitman. Amer. Natural., xvi. (1882) pp. 697–785.

§ See this Journal, ii. (1882) p. 758.

bracket is removed and the glass plate is supported on a tripod, the ether apparatus being applied beneath.

The advantage claimed for the instrument over the older forms is that when only a few sections are required but little ether is

Fig. 170.



expended, as they can be frozen in fifteen seconds; whereas with the Groves-Williams instrument 1 min. to 1½ min. is requisite. The latter, however, has the great advantage of entirely conveying from the room the fumes of the ether, which in many cases cause serious inconvenience to the operator. The instrument is made by Messrs. Swift and Son.

Improvements in the Thoma Microtome.*—A. Andres, W. Giesbrecht, and P. Mayer describe some improvements in the medium size of this instrument.

The "*clicking arrangement*" enables each turn of the micrometer-screw to be recognized by the ear, so that the eye, which is already sufficiently strained by the cutting, rests. This is of importance when working much with the microtome, especially with sections of small objects; the authors, therefore, do not agree with Prof. Thoma when he says† "such complications are useful only for very special conditions." On the author's suggestion Herr Jung has applied this arrangement to the drum of the micrometer-screw, and has further

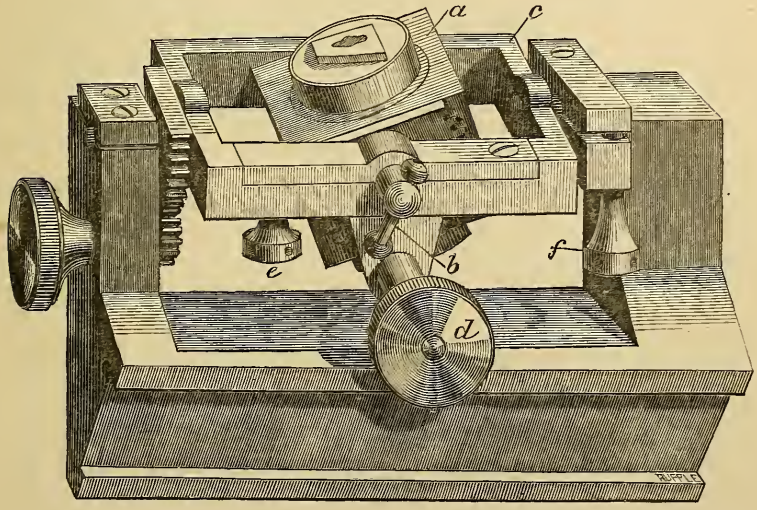
* MT. Zool. Stat. Neapel, iv. (1883) pp. 432–5.

† See this Journal, *ante*, p. 303.

enhanced its usefulness by causing the spring to catch at pleasure either in each of the fifteen divisions of the drum or in a whole or half or 1-3rd turn of the screw.

By an improvement in the *object-holder* the object is now movable in all three directions of space. It is raised in the vertical direction and turned round the vertical axis by the hand; in the two other planes it is moved by rack and pinion, so that changes in direction can be conveniently and accurately made during the cutting. As fig. 171 shows, the piece of paraffin is at the top of a hollow metal

Fig. 171.



cylinder, which is filled inside with paraffin. The cylinder can be pushed up and down in the block *a*, and by means of six holes beneath and a small metal rod can be turned in it. It is held fast in all positions by a clamp *b*. The turning of the block in the frame *c* round the horizontal axis is effected by *d*, and it is fixed by the small screw *e* (the head of which is provided with holes for the small metal rod), which presses one bearing of the block against its axis. In the same way the frame is turned round the long axis by the rack and pinion on the left and fixed by the screw *f*. By the pressure of the bearing on the axis, the position of the object is altered at the most 0·005 mm.

The arrangement is in fact only a modification of the Cardani ring, used with ship lamps, &c. With this microtome alone is it possible to alter the direction of the object at pleasure, without at the same time raising or lowering it much. The latter disadvantage is

present in Spengel's otherwise very good microtome * so that on altering the direction of the section a considerable amount of shifting is necessary. Both axes are therefore passed through the middle of the upper surface of the block, as near as possible to the object. The attachment of the object on a cylinder which is movable in a vertical direction has the great advantage that pieces of more than 2 cm. in length can be cut. At the beginning the cylinder is placed as low as possible, and raised later on as required. Plates from 0·5 to 1 cm. deep can also be used under the knife and afterwards removed.

The latest modification relates to the *points* on which the slides run. These have now been made of ivory, and the sliding surfaces of the so-called bronze. In consequence of this the instrument is no longer subject to rust, and the movement of the knife-carrier, which when very slow, becomes irregular, is now, by the increased friction, quite regular. The durability of this new combination is of course undetermined, it seems, however, as if the wearing away of the bearing surfaces were less than formerly, when metal was used upon metal.

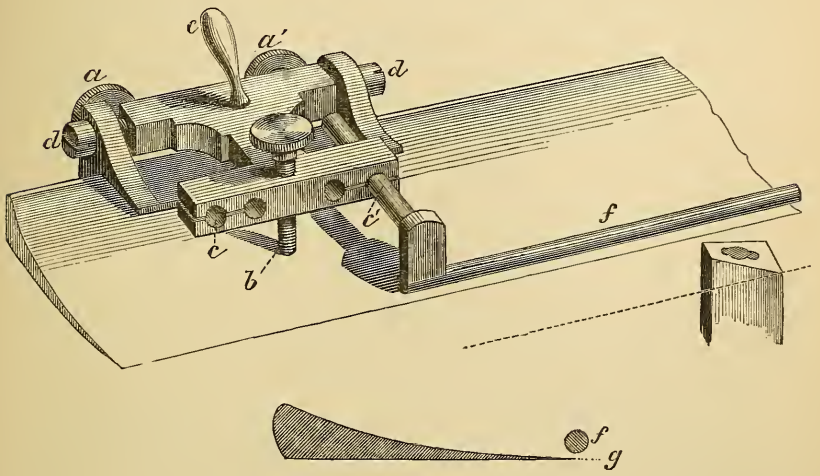
Andres, Giesbrecht, and Mayer's Section-stretcher.†—A. Andres, W. Giesbrecht, and P. Mayer describe a section-stretcher which they consider to be superior to that of F. E. Schultze.‡ The latter, consisting of a small cylinder and a watch-spring, is fixed to the object-slide of the microtome, and as the paraffin diminishes in height, the cylinder exercises a decreased pressure and will not therefore work uniformly during the whole process. Whilst the authors gave up a similar apparatus on account of the above drawback, Schultze on the other hand rejected an instrument similar to theirs in favour of his own.

The apparatus of the authors is attached to the knife itself, and during the cutting maintains the same position with respect to the section which it had in the beginning. It consists (fig. 172) of a cylindrical steel rod *f* which is exactly parallel to the knife-edge, and is just over it, and so that if further depressed the lowest line of its surface would fall exactly on the knife-edge *q*. It thus compels the section to pass between it and the edge. The position of the rod parallel to the edge of the knife in the vertical plane is adjusted by turning its arm in the holes *c* or *c'*; the parallel position in the horizontal plane by the screws *a* and *a'*, which work against the back of the knife; and the vertical distance from the edge, which must be regulated according to the thickness of the section, by the screw *b*. The whole apparatus is held on the knife by two clips pressing on the under surfaces. The hinge *d d* enables the rod and its support to be turned back by means of the handle *c* so that the edge of the knife and the rod *f* can be cleaned if necessary. For sections of great extent a very thick rod is supplied, and for very small sections a thin rod which can be easily attached.

* Zool. Anzeig., ii. (1879) pp. 641–8.
† MT. Zool. Stat. Neapel, iv. (1883) pp. 429–32 (1 fig.).
‡ Cf. this Journal, *ante*, p. 450.

If the apparatus is adjusted in the manner described it will work equally well from the beginning to the end. It cannot be used for friable sections; in such cases a section-stretcher is not applicable. The block of paraffin to be cut is to be so shaped that it presents the section shown in the figure. Some paraffin is left on the side towards

Fig. 172.



the edge of the knife, so that before it reaches the object it may find something to cut, and the opposite side is pared away so that the section (as is shown in the figure by the dotted edge of the knife) may adhere only by the posterior corner and not along the whole margin of the edge of the knife, and can therefore be easily removed by a pincette.

Cutting Sections of Probosces of Honey-feeding Insects.*— F. Cheshire recommends that the insect to be operated upon should be kept fasting for some time and then fed upon honey mixed with gelatine impregnated with some highly coloured dye. The insect should be immediately decapitated and the head rapidly cooled, and then imbedded in gelatine and the section cut by the microtome. The mouth passage is then easily seen from the presence of the dye.

By the use of this method Mr. Cheshire was easily able to make out the structure of the extreme apex ("Reaumur's bouton") of the tongue of the honey-bee, about which so much difference of opinion has existed. He has also found that the tongue is neither a tube through its entire length nor a gutter or trough, but is in reality a trough on the upper side at the apex, and a tube for the rest of its length.

* Proc. Entomol. Soc. Lond., 1883, p. xix.

Staining with Rose Bengale, Iodine Green, and Bleu de Lyon.*—Dr. H. Griesbach describes Rose Bengale as a chlorinated tetriodofluorescin, belonging to the Resorcinphtalein group; it is the bluest of all known eosin compounds and resembles fuchsin in shade. If dissolved in water it is very useful for staining chromic acid preparations, e. g. spinal cord, the grey substance of which is stained a deep bluish red, while the white substance is paler; it is also adapted for muscles and connective of Vertebrata and Invertebrata, but not satisfactorily for glandular tissues or bones.

It is especially suited for double and triple stainings, in conjunction with iodine green, and iodine green and aqueous solution of Bleu de Lyon: the nuclei of the gland cells of the organ of Bojanus, hardened in alcohol, come out emerald green, the protoplasm is unstained; cell-membranes and cilia are stained red. Transverse sections of the edge of the foot of *Anodonta*, from an alcohol specimen, should be washed in distilled water, drawn quickly through a dark solution of Rose Bengale, then washed in pure distilled water and placed for some seconds in iodine green, washed again in distilled water and placed for about five minutes in absolute alcohol, to fix the colour and remove possible excess; the sections are now drawn two or three times through a solution of Bleu de Lyon made with two parts of absolute alcohol and three of distilled water, transferred to absolute alcohol, clarified in oil of aniseed and mounted in dammar-lac; the result is very beautiful.

Carmine Staining.†—"Obersteiner is entitled to the gratitude of all neurologists who, while interested in histological researches, are unable to devote much time to cosmetic experiments. He has made the simple suggestion of heating the staining fluid containing the specimens. Previously, when large sections were to be stained in neutral carmine, one great difficulty encountered had been the fact that specimens hardened for any length of time, however well they might ultimately stain, took the colouring matter up so slowly that many days and even weeks elapsed before the process was complete, and in the meantime the carmine usually precipitated, and the finest specimens were thus rendered valueless. In the laboratory of one of the editors it has been attempted to obviate this by daily changing the staining fluid, which can be done, if proper skill be employed, without injuring the sections. But even with this many failures occur. By subjecting the staining fluid containing the sections to a water-bath heated by a spirit-lamp, the finest staining can be accomplished in from one to two hours, and in the case of hæmatoxylin in even less time. The heating of hardened sections does not injure them in the least when the precaution is used of employing a water-bath."

Stain for Fresh Tissues of Vertebrata.‡—The methods recommended by Prof. S. Mayer are intended exclusively for fresh or recently

* Zool. Anzeig., vi. (1883) pp. 172–4.
† Amer. Journ. Neurology and Psychiatry, ii. (1883) p. 579.
‡ SB. Akad. Wiss. Wien, lxxxv. (1882) pp. 69–82 (2 pls.).

dead tissues and for thin parts capable of ready examination by transmitted light. The stain recommended is Violet B. of Bindschedler and Busch (Bâle) in the proportion of one gramme to 300 c.c. of ½ per cent. salt solution.

The mesentery is very well stained by this reagent, the vascular system being very clearly brought out, while the connective tissue is rendered pale red; this is best seen in one of the *tâches laiteuses* of Ranvier. The piece should be first shaken up in a test-tube with some ½ per cent. solution of common salt, then spread out smooth on a glass plate with a brush, covered with a drop of staining fluid for ten to thirty seconds, then removed with a bristle, washed with salt-solution, and placed on a glass slip in salt-solution for examination. The method is said to be preferable to injection, from the distinctness with which the vessels are brought out, the definition of the structure of their walls, the superior rapidity and simplicity, and the prevention of misleading appearances. Specimens too deeply stained can be made paler by washing in ½ per cent. salt solution; specimens which are quite fresh require a rather lengthy staining, viz. ½ to 1 minute. Another very good object to which to apply the method is the hyaloid membrane of the frog's eye. It is also useful in the study of fat-cells in process of atrophy. Occasionally the contents of the cells are themselves stained. Certain cells, apparently plasmatic or food-cells, are brought prominently into view in the mesentery, omentum, and ligamentum uteri of the rat by this method; the granules may be coloured violet or dark blue.

It is especially useful for exhibiting smooth muscular fibres, as found in tracts in the serous membranes of the pelvis, abdomen, and thorax, and forming a netted layer in the peritoneum surrounding the vas deferens and spermatic vessels; also for elastic tissue, which may thus be well seen in the meso-rectum of the rabbit; also for the grey nerve-fibres of the serous membranes of the frog, and for the larger and smaller lymphatic vessels. No means have at present been devised for rendering permanent preparations made in the above manner. The two plates accompanying the paper contain some beautiful figures of preparations made according to the method.

Series Preparations.*—Almost the same considerations which led Dr. Giesbrecht† to his method of mounting sections in series, gave Dr. J. H. L. Flögel the idea four years ago, of using a substance for fixing in which the imbedding mass is absolutely insoluble. For this purpose he used an aqueous solution of gum arabic for objects imbedded in paraffin.

A filtered solution is prepared of 1 : 20, and, in order to protect it from mould, a dash of alcohol is added. The slide must be so carefully cleaned that it can be evenly wetted all over. The gum solution is poured over the whole surface of the slide and allowed to run off. The process can then be carried on in two ways. Either the glass is placed perpendicularly to dry, protected from dust, the sections arranged on the *dry* surface, and breathed upon so strongly that the

* Zool. Anzeig., vi. (1883) p. 565.

† Ibid., iv. (1881) p. 484. Cf. this Journal, i. (1881) p. 953.

thin layer of gum is again dissolved by the water; or the paraffin sections are laid at once in the *liquid* gum solution and, fixed in their proper place, adhere whilst drying Either modification has its advantages and disadvantages. With extremely delicate and small sections (·003 mm. thick), the dry slide is unconditionally the best; with thicker (·01 mm.) and larger sections the wet process gives the best results.

If only few and small sections are to be mounted the removal of the paraffin after fixing is unnecessary; the balsam dissolves it entirely. But if 50 or 100 sections are wanted together, the paraffin should be removed, before putting on the cover-glass, by benzine, and before it is evaporated balsam is quickly added.

After a while the gum is removed by washing from every part of the slide outside the cover-glass.

Mounting Minute Insects and Acari in Balsam.*—Mr. A. D. Michael describes his process as follows:—He first kills the creatures in hot water or spirit. Hard insects and *Acari* are best killed in hot water which causes them to expand their legs, but water rather injures minute flies, and spirit is better for them. Next wash the objects thoroughly in spirit and clean with a badger's hair, clean mechanically and by washing in spirit. Place the object on a glass slip and arrange it with the hair, leave it in spirit for such a time as experience suggests, tilt the slip so as to drain off the spirit, but not to dry the object, which should never be allowed to dry from the first process to the final mounting. Having drained off the spirit, drop on the object a little oil of cloves, which is better than turpentine; slightly warm the slide and put on a thin cover-glass, which must be supported so as not to touch the object; leave it until thoroughly soaked. If necessary remove to a clean slip for the final mount. It may be necessary to arrange the object more than once. Drain off the oil of cloves and put on a small quantity of Canada balsam, or preferably balsam and benzole. Arrange the creature on the centre of the slide. Let the balsam harden a little, then the object will not float off, as happens sometimes when a quantity of balsam is used at once. Lower the cover straight down on the object; do not try to drive out a wave of balsam as is recommended in the text-books. It is better not to put enough balsam at first to fill the space under the cover, as the balsam supports the cover if it does not reach the edge, but if the balsam reaches the edge of the cover it is apt to draw down the cover and crush delicate objects. A few pieces of thin glass to support the cover are a great protection to the object, or better still, a few tiny glass beads. Finish the slide with a ring, Bell's cement or something of the kind, but that must not be done unless the cover be supported in some way.

Collecting together Scales of Insects and other Minute Objects upon one place on a Slide.†—G. Dimmock puts the scales in a drop

* Journ. Quek. Micr. Club, i. (1883) pp. 241–2.

† Psyche, iv. (1883) p. 71.

of some quickly evaporating substance on the slide—chloroform is best for most purposes. The scales will form a kind of whirlpool, nearly all the scales finally settling down, as the liquid evaporates, in one place on the slide. Rapping the slide gently sometimes aids in the collecting together of the scales, and the tip of the scalpel used to scrape the scales from the insect can be washed in the drop of chloroform, thus saving every scale when they are from a rare specimen from which it is desired to remove only a few scales. By inclining the slide gently the mass of floating scales can be made to settle on the exact centre of the glass. One part of Canada balsam added to several hundred parts of chloroform, will cause the scales to stick firmly to the slide.

Mounting Hydrozoa, Polyzoa, &c., with extended Tentacles.*—Mr. A. D. Michael prefers to use spirit for killing the animals. Osmic acid stains too much. They should be got in good condition, placed in a watch-glass, and syringed freely, and then placed under a low power and watched until the tentacles are well extended. Then with a fine pipette run a small drop of spirit down the *side* of the glass, not on the polype. The creature will probably withdraw its tentacles. If so, leave it alone until they expand again; without disturbing it run another drop down the glass. After doing this once or twice the animal gets dull and heavy, drunk in fact, and then spirit may be added freely, and the polype mounted.

As a medium for mounting, spirit and water gives very good results, possibly the best on the whole, but Goadby's solution preserves the creatures in more natural form and keeps the sarcode harder, presenting a more life-like appearance, but it is open to the objection that it contains corrosive sublimate which produces a certain amount of discoloration of the creature after a time. Another objection is that it has a tendency to cast a sediment. For that reason it should be used weaker than the book strength, adding about three times the quantity of distilled water.

Mounting Leaves of Pinus.†—Mr. H. J. Slack writes that "Amongst the objects which yield beautiful results with [nitric] acid and chlorate of potash treatment, are the needle-shaped leaves of the pine-trees. *Pinus austriaca*, common in shrubberies, is a good one for the purpose. Quite clean leaves should be selected, of fresh growth. They should be cut into short lengths, so as not to require much acid to cover them, and treated exactly as the *Deutzia* leaves,‡ but they want a little more cooking. When finished they are quite white, and in the state of hollow tubes, all their insides being eaten out. To prepare for the Microscope, a piece of the tube must be slit open and flattened out on a slide with fine needles in a drop of water. If it curls up it must be flattened again and kept so by a cover-glass. When quite dry, mount in balsam, and view with a 1-2 inch objective,

* Journ. Quek. Micr. Club, i. (1883) p. 241.

† Knowledge, iv. (1883) pp. 130–1.

‡ The remarks above quoted are preceded by a description of the method of treating the leaves of *Deutzia scabra*.

polarized light, and a selenite film. A hand-magnifier is sufficient to show that fir needles are ornamented with rows of white glistening spots. In these the stomata of the plant are situated. Their action upon polarized light is very beautiful, and the changes obtainable by rotating the prisms very striking. Very elegant patterns that would be popular for ladies' dresses, window-curtains, &c., readily appear. So far as the writer knows, these pine needles have been generally neglected by microscopists."

Cleaning Diatoms.*—J. Y. Bergen, jun., finds the following method works well:

The diatoms are to be freed as far as possible from water, by decanting it off. Then covered with a liberal quantity of pure concentrated sulphuric acid, which is heated to boiling in a good porcelain evaporating dish. Continue the heating till the white fumes of sulphuric acid begin to escape freely, and then, while still over the lamp, add potassium nitrate (saltpetre) in bits the size of a pea, waiting after each addition till the effervescence ceases before adding more. Continue till the whole mass in the dish is white or light yellow. This will not usually take more than five minutes. Then wash the cleaned diatoms with successive portions of distilled water as usual.

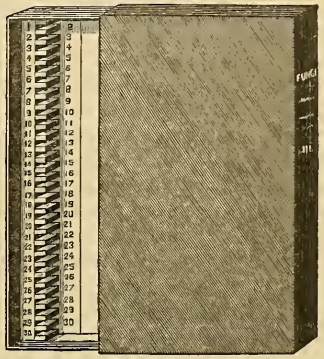
Preparation of Fresh-water Algæ for the Herbarium.†—P. Richter recommends that specimens of fresh-water algæ intended for the herbarium should be first of all placed on thin glass, or better upon mica, taking care that they dry as quickly as possible, in order that decay may not set in. When moistened for observation under the Microscope, as little water as possible should be used, and the excess removed as completely as possible by blotting-paper. They must often also be protected by a second layer of mica, which is preferable either to glass or paper. The mica can be readily split under water, but should not be too thin. To replace waste, which will necessarily take place with each moistening for observation, a quantity of the algæ should also simply be dried upon paper; and for the larger kinds this alone is necessary. Unicellular algæ which float free in the water, require no special treatment; they usually dry quickly on paper. For unicellular or filamentous gelatinous algæ, such as the Oscillatorieæ, it is usual to employ stearin-paper, in order to be able to subject them to slight pressure; but it has the disadvantage of keeping the specimens moist for some days, so that decay sets in. Richter finds the purpose answered better by ordinary yellow straw-paper with either smooth or rough surface; layers of blotting-paper may be placed between the straw-paper to dry it, and the whole subjected to slight pressure; the blotting-paper should be changed as often as possible; the first change may be after half an hour. If the alga sticks to the straw-paper, it can readily be detached by moistening. Chocolate-coloured cellulose-paper answers the same purpose as the straw-paper.

* Amer. Mon. Micr. Journ., iv. (1883) p. 198.

† Hedwigia, xxii. (1883) pp. 97-100.

Brown's Slide-box.—Mr. R. Brown, jun., of Yale College Observatory, U.S.A., has devised a slide-box (fig. 173) to stand on end like a book (and appropriately lettered on the back), the slides remaining horizontal, cover-glasses uppermost. It consists of an inner box of pasteboard, covered with bookbinder's cloth, 7 in. by 4 in. by $1\frac{1}{8}$ in., with a rack on each side 2-3rds in. deep. Both the bottom of the box and the top of one of the racks is numbered from 1 to 30, corresponding to the divisions of the rack, and the loose cover which fits on the inner box (not shown in the fig.) has corresponding numbers, against which the names of the slides can be written. This inner box slides in an outer case. Mr. Brown writes of the box as follows:—

Fig. 173.



"So far as it is an improvement upon the form employed by Prof. H. L. Smith, it is the joint work of Governor J. D. Cox, of Ohio, and myself, and has been in use three years and more, and our satisfactory experience with it seems to be confirmed by the increasing number of inquiries I receive from microscopists to whose attention it has come, without other notice than the exhibition of it before the Section of Microscopy and Histology of the American Association for the Advancement of Science at Cincinnati in 1881.

While it seems to me that the box explains itself, I will say of one or two points which might seem to be superfluous, that it was the outcome of our experience with a very smoky and sooty atmosphere, wherefore the cover to the inner box, which is also made to do duty as a table of contents. This is unattached, because it was thought to be in the way, if hinged, when the box or several of them were in use; as it is, it can lie in, on, or under the box or its cover, without occupying any of the table room. At the corresponding numbers on the index are written in pencil the names of contained objects. The column of numbers in the bottom of the box was so placed at first, but becomes superfluous when the numbers are placed on the top edge of the rack, where a slight deviation from exact conformity with the slide's position is of less consequence. Many kinds of paper were tried to find one which being correctly spaced in printing would not stretch in the process of pasting in the box, and the one which has been found to answer ('plate' paper) when printed in one direction, will stretch from 1-8th to 1-4th in. in the 7, if printed in the rectangular direction, i. e. when wet with paste.

Between the edges of the slides and the movable cover (and, if found necessary, in the bottom of the box) may be put a piece of felt, or cloth, or flannel, for the more effectual exclusion of dust or smoke, and for the greater security of the slides if to be subjected to rough

handling in carriage; but I have known of no breakage, although I have often carried boxes in my pockets without any precaution. The 7-inch racks accommodate 30 slides, except where cells of more than 1-8th in. in depth occur, and then such a slide has the space of two allotted to it. This appeared to be the practical limit of approximation of slides within our own experience, and the height of the box seemed better than if shortened for 25, giving accommodation for the additional 5 without appreciable increase of cost. As a box is seldom presumed to be filled, there is no advantage in one number over another in the way of estimating the number of slides in a collection.

In a system so inexpensive, a good deal of space may be left for estimated accessions, and a scientific classification of slides may be maintained with a minimum of trouble. When the space thus left is filled, it only remains to start a new box, which follows in order on the shelf the one which has become crowded, without any change in the succeeding boxes. Sometimes a part of the contents of the crowded box may be transferred to the new and empty one, to admit of further growth in the former; in this case the index is to be cleaned of the titles of the slides removed.

I have had these boxes (including the movable cover-index and outer case) made, in lots of 200 at a time, for 12 cents (6*d.*) apiece, the racks for 8c. (4*d.*) per pair, and the printing for about 2c. (1*d.*) per box. With smoother finished racks and glazed paper lining I think the boxes could be made for 25c. or 1*s.* apiece, this allowing only the manufacturer's profit. The making (12c.) of the boxes included the gluing-in of the racks and pasting of labels. Made on a proper scale, these ought to cost less in England than here. Of course, where the taste and the means for gratifying it co-exist, the boxes may imitate any quality of binding, and be of any degree of fineness of inside finish."

Cataloguing, Labelling, and Storing Preparations.* — Prof. S. H. Gage, in a paper presented to the Chicago Meeting of the American Society of Microscopists, says:—

"To every one possessing a microscopic slide one or more of the considerations named in the title of this paper appears of importance. All of them are, however, of especial importance to the teacher and investigator. To the investigator his specimens are the most precious of his possessions, for they contain the facts which he tries to interpret, and they remain the same while his knowledge, and hence his power of interpretation, increase. They thus form the basis of further or more correct knowledge; but in order to be safe guides for the student, teacher, or investigator, it seems to the writer that every preparation should possess two things—viz. a label, and a catalogue or history. This catalogue should indicate all that is known of a specimen at the time of its preparation, and all of the processes by which it is treated. It is only by the possession of such a complete

* 'Chicago Times,' 8th August, 1883, in advance of Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883.

knowledge of the entire history of a preparation that one is able to judge with certainty of the comparative excellence of methods, and thus be able to discard or improve those which are defective. The teacher, as well as the investigator, should have this information in an accessible form, so that not only he but his students can obtain at any time all necessary information concerning the preparations which serve him as illustrations and them as examples.

After consulting all the authorities at my disposal, and after profiting by the suggestions of as many investigators and teachers as possible, and after a careful practical test of five years in the anatomical laboratory of Cornell University, the following formula for cataloguing and labelling microscopical preparations is offered, hoping that others may find aid in the suggestions, and in return help the author to eliminate what is needless and correct what is defective:—

Formula for Cataloguing Microscopical Preparations:—	An actual Catalogue Card written according to the Formula:—
1. The general name.	1. Nerve fibres.
2. The number and date of the preparation and the name of the preparator.	2. No. 31 (Drr. 11), March 21, 1880; S. H. G. preparator.
3. The special name of the preparation; the common and scientific name of the object from which it is derived.	3. Isolated medullated nerve-fibres from the sciatic of the cat (*Felis domestica*).
4. The special object of the preparation.	4. This preparation shows well the axis-cylinder and the nodes of Ranvier.
5. The method of hardening, dissociating, &c.	5. Dissociated 24 hours in 25 per cent. alcohol.
6. The special method of preparation for the Microscope, viz. cut into sections, spread, &c.	6. Teased or dissociated on the slide with needles.
7. The staining agent and the time required for staining.	7. Stained over-night in picro-carmine.
8. The clearing agent and the mounting medium.	8. Cleared with turpentine and carbolic acid; mounted in chloroform balsam.
9. The objectives to use in studying the preparation.	9. Use 3-4ths and higher objectives (× 50).
10. Remarks, including references to good figures and descriptions.	10. See for figures and descriptions Quain's Anatomy, vol. ii. p. 141, and Ranvier, 'Traité d'Histologie,' p. 723.

Formula for Labelling Microscopical Preparations:—	Label written according to the Formula:—
1. The number and date of the preparation (No. 2 of catalogue).	1. No. 96; 1880.
2. The general name (No. 1 of catalogue).	2. Nerve-fibres.
3. The name of the object from which the preparation is derived.	3. Cat.

A very practical question arises immediately whether this catalogue shall be kept in a manuscript book or in some other form. The card form of catalogue, like that employed by Prof. Wilder for anatomical and zoological specimens, has been adopted and used during

the last five years. It has proved very satisfactory and convenient. The cards are postal card size, and each preparation has its own card. Such a catalogue has the advantage that it may be arranged alphabetically. As new preparations are made new cards may be added in their proper alphabetical order, while the cards of destroyed or discarded preparations may be removed without in any way marring the catalogue. Finally, the cards may be kept in a neat box which occupies but little more space than a manuscript book, and may be as readily carried from place to place. The ease and certainty with which the history of any preparation may be found is so evident that it hardly needs to be mentioned.

Cabinet.—A microscopical cabinet should possess the following characters:—

1. It should allow the slides to lie flat, and exclude them from dust and light.

2. Each slide should be in a separate compartment. At each end of this compartment should be a groove or bevel, so that upon depressing either end of the slide the other rises sufficiently to be easily grasped. It is also desirable to have the floor of the compartment under the object grooved, so that the slide opposite the preparation will not rest on the wood, and thus become soiled.

3. Each compartment should be numbered, and into each should be put only the slide bearing the corresponding number.

4. The drawers of the cabinet should be independent, but so close together that the slide cannot get out when the cabinet is tipped. On the outside or front of each drawer should be the number of the drawer in roman numerals, and the number of the first and last compartment in the drawer in arabic numerals."

In conclusion, it seemed to the author, both from theory and from practice, that a collection of microscopical objects, catalogued, labelled, and stored as described above, would be at its maximum value, from the ease and certainty of finding objects, while the fulness of the information concerning them would make them guides as well as models for students, and a storehouse of knowledge for the teacher and the investigator.

In the discussion which ensued, the method suggested by Prof. Gage was considered too elaborate for any but a large laboratory. In the matter of personal collections of the preparations which are generally small, "the opinion prevailed that each microscopist should be allowed to indulge his whims and have them arranged to suit his tastes."

Mr. I. C. Thompson also, in an article on the Classification and Labelling of Objects, writes * that with very few exceptions the labels of slides are almost devoid of any further information than the bare scientific or unscientific name of the object, and that often conveyed in so vague a manner as to be hardly intelligible. Slides, as ordinarily labelled, will not admit the insertion of much matter on the label, as the width must necessarily be something less than one inch; but if two labels are affixed, and placed horizontally on the slide instead of

* Sci.-Gossip, 1883, p. 251.

vertically, each can, as a rule, be a full inch or more in width, and may be arranged to contain a vast amount of information, and that of great importance. By horizontal labelling, too, the name of the object can be readily seen while upon the stage of the Microscope; a consummation usually accompanied with considerable chance of neck dislocation, should the slide be labelled in the orthodox manner.

As an experiment for his own cabinet, he recently designed some labels of this description, and has found them to answer very satisfactorily.

The kingdom, whether animal, vegetable, or mineral, heads the top of the left-hand label in bold letters, the labels for animal kingdom being further immediately distinguished by red type, the vegetable by green, and the inorganic by black type. Below the heading, follow in consecutive lines the sub-kingdom, class, order, family, genus and species, a blank line being left for the English or conventional name.

The corresponding label on the right hand gives desirable information respecting the mode of mounting and of viewing the object, naming the part mounted, the medium in which it is mounted, the name of mounter, date, and power required, and other details, concluding with the name of owner, as a corresponding finish to the "kingdom" on the other label.

The amount of information thus conveyed is most valuable, and though necessitating some expenditure of time and research, on the part of the beginner at any rate, the knowledge recorded is stored up, not only in the mind, but upon the slide. As an example, from the animal kingdom, we have, say, a slide of the wood ant.

ANIMAL KINGDOM.		
SubKingd^{m}., *Arthropoda* Class, *Insecta* Order, *Hymenoptera* Family, *Formicidæ* Genus, *Formica* Species, *F. rufa* *WOOD ANT.*		Part, *Entire Insect* Medium, *Balsam* (*dark ground illum.*) Mounter, *F. Enock* Date, 5/83. O.G., 2 *in.* I. C. THOMPSON, LIVERPOOL.

Another from the vegetable kingdom, a section of the female flowers of the yew.

VEGETABLE KINGDOM.		
SubKingd^{m}., *Phanerogamia* Class, *Gymnospermia* Order, *Coniferæ* Family, *Taxineæ* Genus, *Taxus* Species, *T. baccata* *YEW.*		Part, *Female Flowers long. sect. stained* Medium, *Glyc. Jelly* (*see Sachs, fig.* 388) Mounter, *C. V. Smith* Date, 9/82. O.G., $\frac{1}{4}$ *to* 1 *in.* I. C. THOMPSON, LIVERPOOL.

It is a decided advantage to have the labels printed in sheets, with (say) eight or a dozen pairs of labels on each, as being more easy

to write upon than if already cut up, and having a definite space between each the sheet is readily cut up, no trimming being required.

The use of square pieces of card of varying thickness, placed under the labels, forms a valuable protection to the object mounted between, further allowing of the slides being packed together side by side, thus obviating the necessity of rackwork during transit.

Examining Sponges.*—H. J. Carter considers that the "quickest way to examine a sponge is to soak a microscopic fragment of it in distilled water for from twelve to twenty-four hours; then tear it to pieces on a slide, drain, dry, and mount with balsam as usual; but to be *certain* of the exact form of its spicules requires that they should be boiled out with nitric acid, which may also be easily and quickly effected by placing the microscopic fragment on the centre of a glass slide and covering it with a drop or two of nitric acid, then boiling this over a spirit-lamp with low flame till it is nearly dry, after which the same process must be repeated twice or thrice; and, finally, before the last drop of nitric acid is entirely dried up, removing the slide to the table, when, through gradually increased inclination and sufficient but careful edulcoration with distilled water, the residuum may be freed from all remaining acid, drained, dried, and mounted in balsam; or, if desired, another microscopic fragment, prepared as first mentioned, may be added to it previously, when the perfect form of the spicules respectively, together with their position *in situ*, may be seen at once in the same preparation."

Exhibiting Volvox and Amœba.†—Part of Mr. J. Levick's Presidential Address to the Birmingham Natural History and Microscopical Society is occupied with the methods of "displaying" microscopic life, more especially *Volvox globator* and *Amœba*, which he describes as follows:—

"I directed my first attention to what may be called massing or crowding them together, getting them out of dirty into clean water, freeing them from other things which it was undesirable to show at the same time, and several methods succeeded very well.

Let us suppose that we have a jar with a good gathering of *Volvox*, and we wish to get them so thickly together that the whole field of the Microscope may be filled with them, nothing being more beautiful as an object of display. The most natural way to attain this is by filtering them out, and for this purpose I have made some small metallic sieves, the mesh of which is not more than 1-100th of an inch in breadth, such as the one I now have before me. This I place in a small shallow vessel, pouring the water not through, but outside the sieve, and then by means of a small syringe withdraw the water through this fine gauze, continuing the process until I get the *Volvox* at the bottom of the earthenware vessel as thickly together as I like. They may then be picked up by means of the syringe, and placed in any quantity or density upon a slide or compressor, care being taken

* Ann. and Mag. Nat. Hist., xii. (1883) p. 317.

† Report and Trans. Birmingham Nat. Hist. and Micr. Soc. for 1882, pp. xvii.-xxiii.

in showing them to allow only just sufficient depth between the top and bottom glasses to allow them to revolve freely through the water. The same result I have obtained by taking advantage of the effects of heat and cold upon these organisms. If they are freely distributed about the water in which they are stored, it is only necessary to take some ice and lower the temperature of the water to bring most of them to the bottom; or if they are at the bottom, mixed with dirt, as they often are, then to place the jar near the fire, and so stimulate them, and bring all that are living and fresh to the top, when they may be brought to one side of the vessel by directing upon it a bright light.

It is usually regarded as a difficult matter to see the cilia upon *Volvox* by even those familiar with the use of the Microscope; but these may be made so plain that the most inexperienced person may see them without the least trouble, provided that a strong light, with the *yellow* rays unintercepted, be used, and that sufficient obliquity be obtained by means of a paraboloid or other apparatus, using a compressor with a thin glass top and bottom, and just slightly flattening the largest of the spheres. The 1-2 inch is best, but when they are once seen, and all things are properly arranged, there is no real difficulty in watching their flashings with a 1-inch or even a 2-inch object-glass.

Then take another of those perplexing objects, the *Amœbœ*, which is regarded as not only hard to find, but harder still to see, and let me say that the two difficulties resolve themselves into the latter one only, there being no trouble whatever in obtaining specimens. . . . At first they seem particularly difficult to handle and isolate, being usually found so near the mud, or mixed with it; but a little study of the habits of these organisms shows a ready way to get over that difficulty.

Not being swimmers, though doubtless like the *Hydra* they possess the power to rise or fall in the water, and have besides some slight means of free locomotion, they are usually found to attach themselves to anything with which they may come in contact, generally decayed weeds or mud, and it is only necessary to take advantage of this habit to obtain them quite free from everything else.

Take up some mud and water in which they are plentiful and fill a thin trough; lay it nearly or quite flat upon the stage of the Microscope and allow it to remain there a few moments; then quietly empty out the mud and dirty water at one end while you replace it with clean at the other, and the *Amœbœ* will be found attached to the glass as clear as the noonday sun. Care only needs to be taken that the clean water shall replace the dirty without exposing the animals to the air, or they will fall to pieces in countless granules, an experiment worth noting."

Aramburu, F.—Examen Microscopico del Trigo y de la Harina. (Microscopical examination of Wheat and Flour.) 156 pp. and 50 figs., Madrid, 1883.

Aylward's (H. P.) Apparatus for Pond-Life Hunting. [*Supra*, p. 911.]
Journ. Post. Micr. Soc., II. (1883) p. 255.

Bennett, R. A. R.—Mounting Pollen.
[If small and transparent—dry. If opaque, in essential oil of lemon or glycerine.]
Engl. Mech., XXXVIII. (1883) p. 200.

Bergen, J. Y., jun.—Cleaning Diatoms. [*Supra*, p. 922.]
Amer. Mon. Micr. Journ., IV. (1883) p. 198.

Bernheimer, S. See Bizzozero, G.

Bizzozero, G.—Handbuch der Klinischen Mikroskopie. (Handbook of Clinical Microscopy.) Translated into German by Dr. A. Lustig and S. Bernheimer, with a Preface by Dr. H. Nothnagel. 44 figs. and 7 plates. 8vo, Erlangen, 1883.

Blackburn, W.—The Mounting of Pollen as an Opaque Object. [*Post.*]
Micr. News, III. (1883) pp. 297–9.

Braithwaite, R.—The Structure of Mosses.
[Report of "Demonstration." For permanent mounting glycerine jelly is preferable. Rimmington's is very pure and well made. "Immerse the moss in clean water, exactly as it is desired to mount it, quickly transfer to a clean slip, on which is dropped a little jelly sufficiently heated to melt it; place on the cover, and there will be no difficulty in making a good mount, which can be finished off with rings of gold size, and kept as long as desired."]
Journ. Quek. Micr. Club, I. (1883) pp. 290–6.

Calderon y Arana.—Nota sobre la extraccion y coleccion de las conchas microscopicas de moluscos y foraminiferos. (Note on the extraction and collection of the microscopic shells of Mollusca and Foraminifera.)
An. Soc. Esp. Hist. Nat., XII. (1883) *Actas*, p. 37.

Carter, H. J.—Contributions to our Knowledge of the Spongida.
[Contains a note on the quickest way to examine a sponge. *Supra*, p. 928.]
Ann. & Mag. Nat. Hist., XII. (1883) p. 317.

Cole, A. C.—Popular Microscopical Studies. No. 2. pp. 7–10. The Scalp. Plate of Human Scalp. Hor. Sec. × 130. Double stained.

" " Studies in Microscopical Science.
Vol. II. Nos. 3A and 5. Sec. I. Animal Histology. Chap. I. The Morphology of the Cell (*concld.*). The Blood—Blood of Frog. pp. 5–12 (pls. 1 and 2 × 75, pl. 3 × 400).
Nos. 4 and 6. Sec. II. Nos. 2 and 3. Botanical Histology. Chap. I. The Morphology of the Cell (*contd.*), pp. 5–8, 9–12. Plate I. *Frittilaria imperialis*, L.S. of scale leaf × 210. Plate 2. *Pinus sylvestris*, T.S. of stem × 30. Plate 3. *Arachnoidiscus Ehrenbergii* (recent) × 400.

" " The Methods of Microscopical Research.
Part 3. The Human Eye. pp. vii.–xvi., 10 figs. and 1 pl.
Part 4. The preparation of Animal Tissues. pp. xvii.–xxiv.

Davis, G. E.—Water, Water Analysis, and the Microscope. [*Post.*]
Micr. News, III. (1883) pp. 283–8, 309–13 (7 figs.).

Dimmock G.—The Scales of Coleoptera. [*Supra*, p. 920.]
Psyche, IV. (1883) p. 71.

Dippel, L.—Ein neues Einschlussmittel für Diatomeenpräparate. (A new mounting medium for preparations of Diatoms.)
[Abstract of Dr. H. van Heurck's paper, *ante* p. 741, with notes in commendation of Styrax.]
Bot. Centralbl., XVI. (1883) pp. 158–9.

Flögel, J. H. L.—Serienpraeparate. (Series Preparations.) [*Supra*, p. 919.]
Zool. Anzeig., VI. (1883) p. 565.

G., F.—Microscope Mounting.
[Elementary instruction on (1) Slips and micro-covers, (2) Ringing, and (3) Finishing, varnishing, labelling, and cataloguing.]
Engl. Mech., XXXVIII. (1883) pp. 194–5.

Grant, F.—How to Mount for the Microscope. II. Preliminary examination of objects.

[Deals with crystals, with note on the different crystalline forms assumed by the same body, and directions for showing this.]

Engl. Mech., XXXVIII. (1883) pp. 222–3.

,, ,, Microscopic Mounting. III. Resinous and Air Mounting.

[1. Appliances for all mounting. 2. Materials for resinous mounting. 3. Process of resinous mounting.]

Engl. Mech., XXXVIII. (1883) pp. 243–5.

Harris, V., and D'Arcy Power.—Manual for the Physiological Laboratory. 2nd Ed. viii. and 214 pp. 43 figs. 8vo, London, 1882.

Hitchcock, R.—Microscopical Evidence concerning Blood Corpuscles.

[Comments on evidence given at a recent trial that certain spots found upon a coat were produced by human blood. "Granting the strong probability that the Microscope does under favourable circumstances afford a means of positively identifying human blood and distinguishing it from all other blood, we must still hold to the opinion that until experience has shown such evidence to be sure and infallible, no scientific man is warranted in stating that a stain upon cloth is made by human blood from the microscopical examination alone."]

Amer. Mon. Micr. Journ., IV. (1883) pp. 175–6.

Holmes, C. D.—Mounting Insect Organs, &c.

[Soak in liq. pot. for a day, or longer, if large. Wash and lay out upon the slip, arrange, and gently press while in the water with another slip. Remove to weak solution of acetic acid for a few hours. Wash again in clean water, and transfer to slip, and drop on spirits of wine; arrange the object and put over another clean slip; gently press and lightly fasten with thread; place end down in a small quantity of spirits of wine for a few hours. Then remove the thread and gently lift off one slip, the whole still wet with the spirit, when the object will adhere to one of the slips; drop on absolute alcohol and work object into centre of slide. Then apply oil of cloves, and in a few hours the object will be ready for the balsam to finish.]

Sci.-Gossip, 1883, p. 232.

Horn's (J.) method of mounting very minute animals, such as embryonic fishes, in a medium which makes them transparent and causes but very little contraction of the internal parts.

[Composition of medium unknown.]

Amer. Mon. Micr. Journ., IV. (1883) p. 178.

Johnston, C.—Ethyl-Æther of Gallic Acid and a New Mounting Material.

[Media for making solutions out of which the substance should crystallize —glacial acetic acid added to absolute alcohol in the proportion of from 5–20 per cent.: to this was added the ethyl-æther of gallic acid in same proportion dissolved in a test-tube. Media for mounting—boiled balsam copaiba, thickened to the consistency of molasses by best dammar resin.]

Amer. Mon. Micr. Journ., IV. (1883) pp. 192–4.

Koch.—Testing Air, Water, and Earth for Impurities.

Micr. News, III. (1883) pp. 319–20, from *Lancet*, from *Proceedings of Berlin Medical Congress.*

Lovett's (E.) Embryological Slides. [Commendation of them.]

Amer. Mon. Micr. Journ., IV. (1883) p. 197.

Lustig, A. See Bizzozero, G.

Macdonald, J. D.—A Guide to the Microscopical Examination of Drinking-water, with an Appendix on the Microscopical Examination of Air. [*Post.*] 2nd ed. xi. and 83 pp., 25 pls. 8vo, London, 1883.

Markel, J. F.—The Microscope in the Diagnosis of Diseases of the Kidneys.

The Microscope, III. (1883) pp. 163–7.

Merrill (G. P.) has prepared 1550 microscopic slides of building-stones to be used in connection with the investigations of Dr. G. W. Hawes on the building-stones of the United States.

Ann. Rep. Smithsonian Institution for 1881, p. 110.

Nothnagel, H. See Bizzozero, G.

Nunn, R. J.—The Microscope in Medical Gynecology.
Sep. repr. from *Trans. Med. Assoc. Georgia*, 1883, pp. 8–10.

Power, D'Arcy. See Harris, V.

Quinn's (E. P.) Microscopical Labels. *Micr. News*, III. (1883) pp. 294 and 323.

Robinson, I.—Notes on a Microscopical Aquarium.
[Describes the Rotifers, Infusoria, &c., found in a bell-glass aquarium 10 in. × 10 in., kept on a hall-table.]
Trans. Hert. Nat. Hist. Soc., II. (1883) pp. 112–4.

Ryder, J. A.—On Semper's Method of making Dry Preparations.
[Vol. I. (1881) p. 706, with remarks.]
Proc. U.S. Nat. Mus., IV. (1881–2) pp. 224–5.

Slack, H. J.—Pleasant Hours with the Microscope.
[Mouth-organs of Wasps and Bees—Tubular Live-box, *supra*, p. 906.]
Knowledge, IV. (1883) pp. 216–7 (3 figs.), 242–3, 267–8 (3 figs.).

Thompson, I. C.—On the Classification and Labelling of Microscopical Objects. [*Supra*, p. 926.]
Sci.-Gossip, 1883, pp. 249–51. Cf. also *Micr. News*, III. (1883) p. 323.

Whitman, C. O.—Treatment of Pelagic Fish Eggs. [*Supra*, p. 912.]
Amer. Natural., XVII. (1883) 1204–5.

OBITUARY.

No Obituary Notices have been received of Fellows deceased in 1882.

APPENDIX.

The publication of the Appendix referred to at p. 272 of Vol. II. (1882) is unavoidably postponed to the next volume for the sake of greater completeness.