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.

Edited by

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genera also they are not invariably present, and always in *Pleurotœnium*, *Penium*, and *Tetmemorus*, but were absent from all the specimens examined of *Staurastrum*, *Desmidium*, and *Hyalotheca*. They appear to be entirely confined to the Desmidieæ, other fresh-water algæ containing calcium oxalate, especially species of *Spirogyra*, but not calcium sulphate.

The absence of crystals of calcium sulphate, either occasionally or regularly, does not, in the opinion of the author, imply the absence of the salt; since, from its solubility in water, it may be present in the cell-sap. The zygospores of *Closterium* were always found to contain crystals. Calcium sulphate is an excretory product in the process of metastasis, corresponding to the production of calcium oxalate in the higher plants; and the quantity excreted determines whether it shall remain entirely dissolved in the cell-sap, or whether a portion of it shall separate in the form of crystals.

MICROSCOPY.

a. Instruments, Accessories, &c.

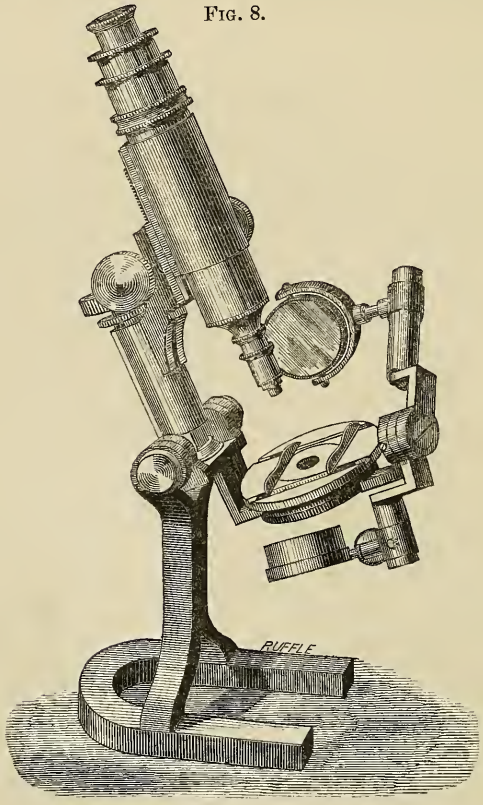
"**Giant Electric Microscope.**"—One of the attractions at the Crystal Palace is what is advertised as "Les Invisibles in the Giant Electric Microscope." We take the following description from a daily paper,* no other description being forthcoming. "A number of gentlemen assembled at the exhibition court of the Crystal Palace on Saturday, by invitation of the directors, to witness the first representation in England of 'Les Invisibles,' an exhibition of natural objects magnified and displayed by means of the great electric Microscope. The apparatus used in the exhibition is the invention of Messrs. Bauer and Co., and 'Les Invisibles' has quite recently attracted a good many visitors to the old Comédie Parisienne, where, as well as at the Athenæum at Nice, a series of representations has been given. The invention may be described in a few words as being the application of electric light to the Microscope, and the result, so far as the spectacle is concerned, is a sort of improved and enlarged magic lantern. Every one is familiar with the former exhibitions at the Polytechnic and elsewhere of the animalculæ (*sic*) in a drop of water, magnified and thrown, by the aid of the lime-light, on to a white screen. Precisely the same sort of effect was produced on Saturday by Mr. F. Link, the London agent for Messrs. Bauer and Co., with this difference, that the magnifying power was enormously in excess of that attained in the old magic lantern entertainments. The electric Microscope has, in fact, made it possible to exhibit in a most attractive form, the appearances presented by minute natural objects when placed under the most powerful magnifying glass. Indeed, the difficulty with which Mr. Link had to contend on

* 'Morning Post,' 5th Jan., 1884.

Saturday was the smallness of the screen upon which his pictures were thrown. For instance, only a small section of a butterfly's wing could be shown at a time, although the screen was as large as the size of the entertainment court would permit, whilst the living organisms in a spot of water and the mites in a small piece of cheese were enlarged until they presented a perfectly appalling spectacle to a timid mind. The capabilities of the apparatus may be imagined from the fact that the eye of a fly was presented in a form no less than four million times its natural size. The electric Microscope, which is worked by an ordinary primary battery, may be said to have extended almost indefinitely the possibilities of presenting in an attractive and instructive manner the wonderful facts of natural science."

Aylward's Rotating and Swinging Tail-piece Microscope.—Mr. H. P. Aylward has added a new movement to the radial swinging

Fig. 8.



tail-piece. Not only do the mirror and the substage swing on separate tail-pieces, either above or below the stage, but they can also

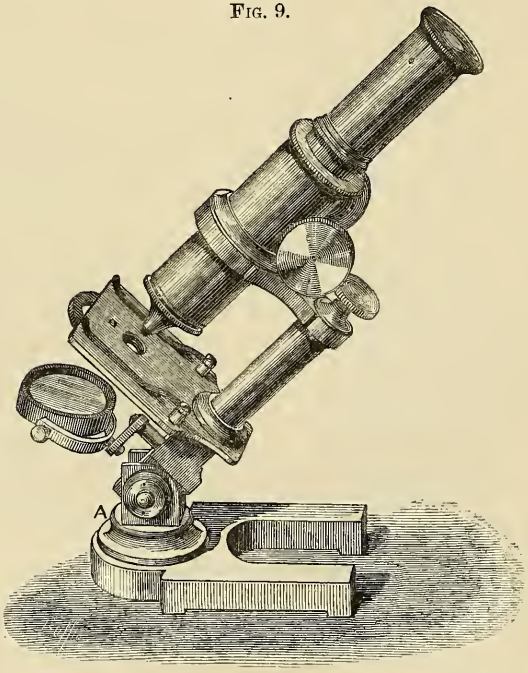
be rotated completely round the stage, so that the direction of the illumination in azimuth can be more readily varied than is the case with Zentmayer's form of tail-piece.

The stage consists of a fixed ring attached to the limb by an angle-plate of brass; this ring carries above it the rotating object-stage, and beneath a rotating collar is fitted, which has a shoulder attachment at right angles carrying the two tail-pieces on an axis slightly above the plane of the object-stage, and allowing of their rotation round the optic axis. The angle-plate, by which the stage-ring is fixed to the limb, is so arranged that the shoulder carrying the tail-pieces will pass behind it, and there is therefore no obstruction to complete rotation.

This plan of suspending the tail-pieces is far more convenient than that devised by L. Jaubert,* or that of J. Mackenzie.†

McLaren's Microscope with Rotating Foot.—Mr. A. McLaren has devised a simple plan of giving greater stability to Microscopes

Fig. 9.



mounted on a pillar support on a horse-shoe foot, which are very liable to be overturned when much inclined from the perpendicular. The plan consists in making the foot rotate at its junction (fig. 9, A)

* See this Journal, i. (1881) pp. 514–5.
† Ibid., pp. 825–7.

with the pillar support, so that when the Microscope is required to be used much inclined the horse-shoe base can be turned round as shown in the fig. This increases the stability of the Microscope, and adds so little to the original cost that the makers of these inexpensive forms may profitably adopt the suggestion.

Mr. McLaren also uses a system of fine adjustment applied at the nose-piece (shown in the fig.), consisting of a ring fitting in the lower end of the body-tube, in which the nose-piece proper, carrying the objective, is screwed by means of a very fine screw, 200 threads to the inch. The focusing is effected by turning the nose-piece either way, by which the objective is raised or depressed very slowly owing to the fine pitch of the screw. By this system, which is also applied to some old forms in our possession, the objective is made to rotate with every movement of focusing, which cannot be commended.

Schieck's Revolver School and Drawing-room Microscope.—Winter's and Harris's Revolver Microscopes.—F. W. Schieck has just issued the Microscope shown in fig. 10 A and B, intended for school and drawing-room demonstration. The peculiarities of the instrument are fully set forth by Herr Schieck himself in the following statement (translated), which also includes some very original directions for preparing objects:—

"The management of a Microscope of the ordinary construction, with fixed stage, movable tube, different eye-pieces, objectives, &c., offers, in most cases, so many kinds of difficulties to the lay public, especially to young students, in the inspection of the preparations accompanying the Microscope, and in the adjustment of the image, but especially in the self-preparation of objects, that this important and interesting instrument has not yet attained that position either among our intelligent youth, or in our drawing-rooms, as an object of instructive entertainment, which befits its high ethical importance. The management of the Microscope has even been found so intricate, that in consequence (as I have had the opportunity of seeing on numberless occasions) it has been very soon put aside again, after a short trial.

My new Microscope entirely removes this disadvantage. It is of such simple construction, and its management so thoroughly easy, that any one, even without any previous acquaintance with the use of a Microscope, is able to observe with it, as well as to make for himself beautiful microscopical preparations.

The new Revolver Microscope has, instead of a stage, a vertical drum, turning on its axis (like the chambers of a revolver), in which twenty different very beautiful and instructive preparations, from the three natural kingdoms, are arranged, which, on turning the drum, are brought successively into the field of view of the Microscope. The movable mirror is in the centre of the drum, and is easily and conveniently adjusted.

The Microscope is provided with a hinge for inclining the stand, so as to be able to observe conveniently whilst sitting.

The twenty preparations are numbered, and an explanation of them accompanies each Microscope.

As the Microscope has only one objective, and one eye-piece, and therefore only admits of a fixed magnifying power, a special focusing arrangement is not necessary. The tube of the Microscope is so fixed, that the image of the preparation is always in the field of view of the eye-piece, and only in the case of differences in the eyes of observers is a small shifting of the tube, amounting to a few millimetres, requisite. For this purpose the body-tube is easily pushed with the hand up or down, guided by a pin working in the

Fig. 10 a.

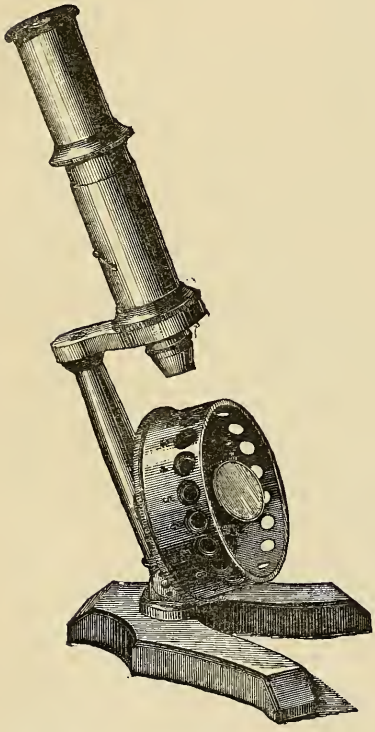
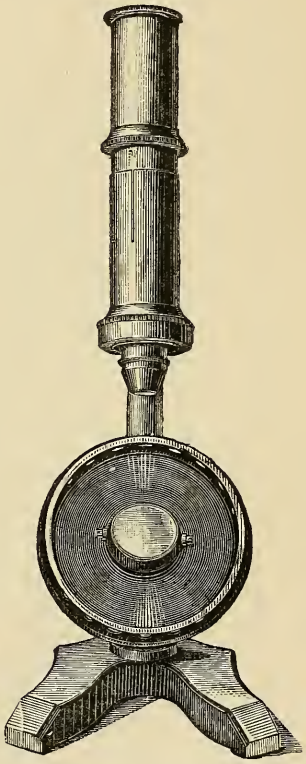


Fig. 10 b.



small slit in its sheath, without ever thereby losing sight of the image of the preparation, as happens with other Microscopes.

The magnifying power is such that most popular objects can be seen distinctly and perfectly. The images are of unsurpassed sharpness and clearness.

The field of view is very large, and all preparations which are not more than 4 mm. in diameter can be seen entire at one view.

An entirely special advantage of this new Microscope is the uncommonly simple manner in which the teacher or student is enabled

by its means to prepare by himself a new series of twenty preparations at pleasure. The hitherto general practice of laying the object to be inspected on large glass slides, and fastening over them the thin, round or square, cover-glasses, presented so many difficulties that a preparation seldom succeeded well, especially if it were put up for any length of time.

With each of my new revolver Microscopes is given a second stage-drum, with twenty empty apertures, and a sufficient number of small round glasses and spring-rings for firmly fixing the preparations. The stage-drum with the preparations already attached to the Microscope is unscrewed from the milled disk, and the second empty drum put in its place.

The insertion of a new object is so exceedingly simple, that directions for it seem, properly speaking, superfluous. In the first place a small round glass is washed clean, and with the forceps belonging to the Microscope, is laid in one of the apertures, then the object to be examined is laid in the middle of this glass, either dry or with mounting liquid (glycerine, gelatine, Canada balsam, or in cases where only a rapid observation of an object is required, even water, spirit, &c.), and covered with a second previously cleaned glass, fastened down with a spring-ring which goes into a small groove made for it, and the preparation is ready. (!) It must, however, be here observed that all hard objects (especially insects) must, in order to succeed well, be previously heated for a few seconds in a small reagent glass, with caustic potash over a spirit flame, by which means the preparations become soft and quite transparent.

The preparations are perfectly protected from dust by a pasteboard cover, and care must be taken always to replace the cover over the stage-drum, after using the Microscope. If, in spite of this, dust should after a time fall upon the preparations, it must be carefully brushed away from both sides by the soft hair brush accompanying each Microscope; any other cleaning of the preparations is never necessary.

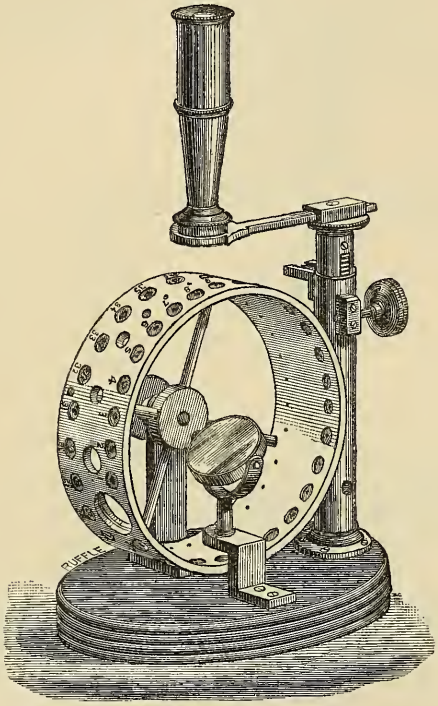
If desired these Microscopes can be supplied with special objects previously given me to prepare, and for the requirements of schools the stage-drum can be fitted with botanical, zoological, or mineralogical preparations. Price according to agreement.

This entirely new, and in every respect original and practical Microscope offers to every one such a fund of entertaining and instructive matter, and will prove to the teacher as well as the student such an inexhaustible source of suggestive occupation, by which to pass the leisure hours usefully and pleasantly, that there is scarcely anything better fitted for a present, always gladly seen, especially by the ripening student. The price is fixed as low as possible, and considering the prices ruling here may be called very cheap."

Herr Schieck intended, we have no doubt, to be strictly accurate when he announced his instrument as "entirely new" (*ganz neu*) and "in every respect original." But it was in fact anticipated by two now in Mr. Crisp's collection, which were made more than fifty years ago, by T. Winter (simple) and Harris and Son (compound, fig. 11).

They are in principle identical with that of Schieck. The revolving object-holder is, however, made of ivory, and is much larger, being $4\frac{1}{2}$ in. in diameter and $1\frac{1}{2}$ in. wide. There is also a double row of apertures for the objects—one row for transparent, and the other for

Fig. 11.



opaque—so that, instead of 20, it holds 44 objects. There is also at one point of the circumference an intermediate set of apertures, apparently for inserting further objects on disks, corks, &c. (In Winter's there is a complete row of 19 of these apertures, 10 with corks).

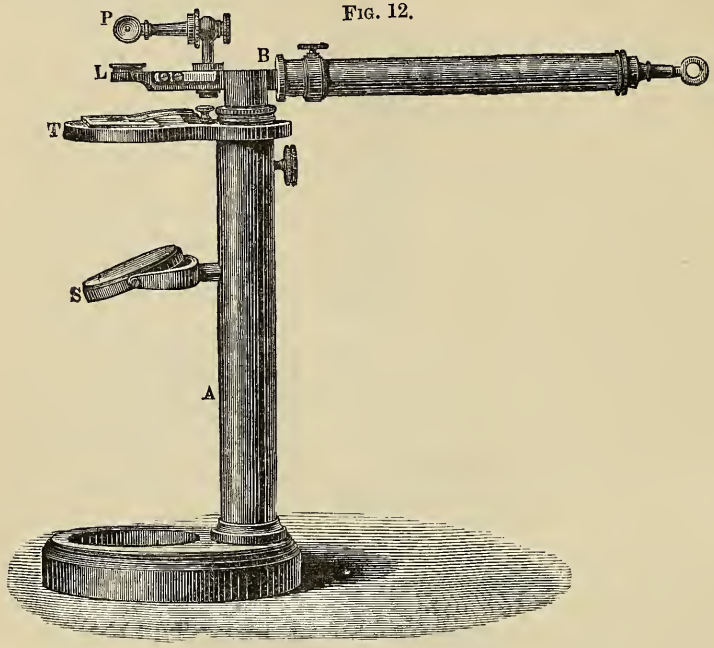
Winkel's Large Drawing Apparatus.* — This (fig. 12) is intended for drawing objects under a low power, and also without any magnification. On the side of the standard A, and above the stage T and mirror S, is a cross-arm B carrying a lens L, and over it a small right-angled prism P, which acts as a camera.† On the other side there is a longer arm, also with a prism for drawing objects in

* Dippel's 'Das Mikroskop,' 1882, pp. 632–3 (1 fig.).

† The text states P to be a prism (protected by a ring) though the fig. hardly agrees.

natural size. The arms can be raised and lowered by the sliding within A of the support to which they are attached, the screw on the right clamping it.

Fig. 12.



Jung's New Drawing Apparatus (Embryograph) for Low Powers.*—H. Jung was induced, by the inconvenient or ineffective performance of other drawing apparatus, to construct a new one (fig. 13) in accordance with the friendly advice of Professor v. Koch, giving powers of about 1 to 20 or 4 to 30 in continuous succession.

Upon the heavy square iron foot rests (besides the column and the bar P, movable by rack and pinion) a concave mirror to illuminate transparent objects. The latter is 80 mm. in diameter, and consists of a plano-convex lens silvered at the back. It is supported on a hinge-joint, which is attached to a short rod fitting into a spring-tube *h*, and this is screwed to a carrier T having a longitudinal slot. The carrier rests on the foot to insure greater stability, and on loosening the screw S which clamps it, it can be moved so as to obtain any desired position of the mirror, either by turning it round the screw as a pivot, or by sliding it along the slot.

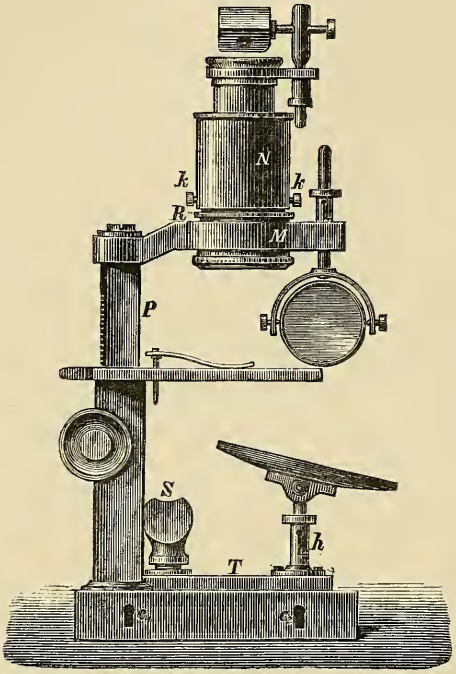
Upon the column is a stage 75 mm. deep, and 108 mm. wide. The stage, instead of a round aperture in the centre has a horseshoe

* Zeitschr. f. Instrumentenk., iii. (1883) pp. 165–7 (2 figs.).

aperture 40 mm. wide, which can be wholly or partially covered by two sliding plates.

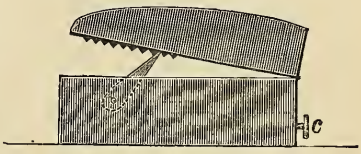
A special Brücke magnifier (with variable power) screws on the arm M. The arm has also a spring-tube into which a smaller mirror

Fig. 13.



can be inserted. This is for illuminating opaque objects, and receives its light from the larger mirror below. The focus of both mirrors is so regulated that with high powers the theoretically possible maximum of illumination can always be nearly attained. For very weak illumination there is on one side a plate of opal glass. "The mirror has the great advantage over ordinary illuminating lenses that the field of view is always somewhat faintly and evenly illuminated, which extraordinarily facilitates the visibility of many natural objects which have not sharp outlines." The upper mirror can be placed in any position with regard to the axis of the lower, and can besides, for special objects, be put in the spring-tube of the lower mirror.

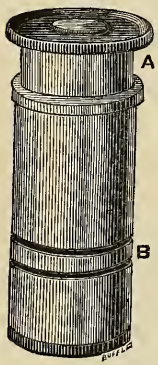
Fig. 14.



The Brücke lens consists of two achromatic objective lenses and a concave eye-lens. The objective lenses can be moved apart or brought nearer to one another by turning the ring R. In the same way the eye-lens can be placed at various distances from the objective by pushing the tube N up or down. This tube is so sprung in the inner fastening that by a somewhat firm pressing together of the two knobs *k*, the friction of the two tubes is lessened and an easy and smooth movement is obtained. For very low powers the lower objective lens can be removed. By this combination and also two stronger eye-pieces all gradations of power, in the given limits, can be obtained. The extent of the field of view is in inverse ratio to the power within the limits of 65 to 7 mm.

For convenient drawing a camera lucida is attached, which like Zeiss's allows the drawing surface to be inclined about 22° to the table. On turning the ring R, or on moving the tube to alter the power the camera always remains in the same position with regard to the ocular and the drawing surface, which is claimed to be "an advantage not to be undervalued, and not considered in many instruments."

Fig. 15.



In order to use the instrument for dissecting there are hand-rests, made to be easily removed. They consist of two hollow boxes (fig. 14) about 2/3 the height of the stage. They are attached by the button-headed screws *c* to the foot of the instrument, being inserted in the holes c_1 and c_2 (fig. 13) and the hinged tops can be set at different inclinations by the support and rack.

Zeiss's Micrometer Eye-piece.—This (fig. 15) is noticeable for the manner in which the micrometer disk is inserted. The eye-piece divides a little below the middle of its length, and has an additional piece between the upper and lower portions to which they are screwed. In this the micrometer disk is placed. The eye-lens is also in a sliding tube for adjustment to different sights.

Bulloch's Objective Attachment.—Mr. W. H. Bulloch has devised the objective-attachment shown in figs. 16 and 17. A is the nose-piece adapter to screw on the Microscope, and B is the ring, provided with three wedge-shaped studs, to be screwed on the objective. Three slots are cut in the body of the lower cylinder of the nose-piece A, and three similar slots in the inward projecting rim of a rotating collar. When the two sets of slots correspond, the ring B, with the objective attached, can be slid into the nose-piece, and then the studs are locked firmly by a slight turn of the rotating collar, which causes its projecting rim to slide over the outer halves of the studs. By reason of the wedge form given to the studs, the collar can be made to press down upon them with more or less force. The objective cannot be removed from the nose-piece until the rotating collar is turned back to the normal position, releasing the studs.

With this device both hands must be used either in attaching or removing the objective, and no provision is made to insure accuracy of centering. In the apparatus from which the above description was

Fig. 16.

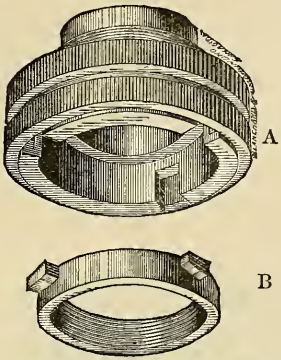
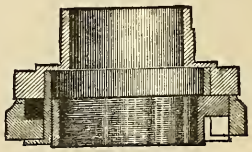


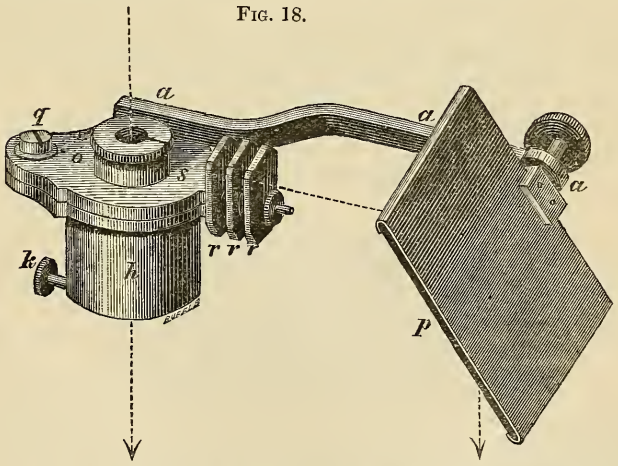
Fig. 17.



made the objective had a lateral play at the shoulder of about 1/50 in. when the collar was secured with moderate force. Such loose fitting would be found very inconvenient in the registration of the positions of small objects with high powers. Altogether, we cannot but think that the apparatus is more complicated than is at all necessary. Whilst it has the studs of Nelson's form it lacks the simplicity of the turn of the objective with the same hand that holds it, and whilst it has the rotating collar of the Watson-Matthews form (amply sufficient to hold the objective) it has the additional complication of studs in place of a simple conical fitting.

Abbe's Camera Lucida.*—G. Kohl gives the annexed fig., 18, of

Fig. 18.



what he terms "Boecker's new drawing apparatus after Dippel," but which is in reality Professor Abbe's Camera Lucida.†

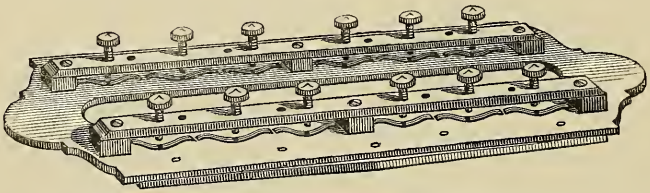
* Bot. Centralbl., xvi. (1883) pp. 385-6 (1 fig.).
† See this Journal, iii. (1883) p. 278.

The novelty consists in the introduction of the tinted glass plates * *r r r* in the path of the rays from the mirror. Also the upper part of the apparatus (mirror *p*, its arm *a*, the glasses *r r r*, and the plate *o s*) is movable on the pivot *q* upon the lower plate, which forms part of the tube *h* fixed to the eye-piece by *k*.

Millar's Multiple Stage-plate.—The object of this stage-plate (fig. 19) is to facilitate the exhibition of a series of slides so that they may be observed successively without having to remove and replace each object separately.

The base-plate slides on the stage after the upper stage-plate is taken off, and it holds six slides. Each of these is fixed by two small

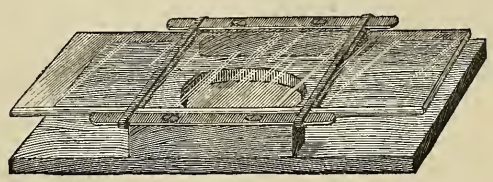
Fig. 19.



screws (passing through the two longitudinal bars) which press the slide against springs attached to the base-plate, there being six springs beneath each bar. The base-plate can be readily pushed in either direction by the hand when it is desired to examine a different object. The mechanical movements of the stage will bring various parts of an object into the field, but it is easy to adjust each slide on the plate in the first instance so that the object shall be central with the optic axis, there being sufficient spare room to move the slide both laterally and vertically.

Stewart's Safety Stage-plate.—This very simple device (fig. 20) was designed by Mr. C. Stewart to provide an economical but

Fig. 20.



effective arrangement for protecting slides from breakage when being exhibited under high powers to large classes of students.

It consists of a wooden slip the length of an ordinary slide and

* See this Journal, iii. (1883) p. 119.

rather wider, with a central aperture and two side pieces ($\frac{1}{4}$ in. high), capped with thin strips of brass projecting at either end of the uprights as shown in the fig. Across the projecting ends two small indiarubber rings are stretched and the slide is passed through these rings and thus suspended. If now the objective is brought down on the slide the latter sinks on the least pressure and ample warning is given to the observer.

Parsons' Current-Slide.—Mr. P. B. Parsons has devised the new form of current-slide shown in figs. 21 (section) and 22 (perspective), which he describes as follows :—

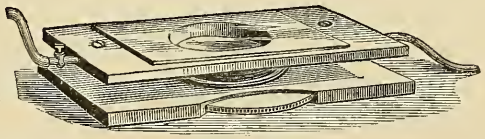
"The slide consists of two plates, pierced with central apertures

Fig. 21.

surrounded by tubular projections, and fitting together like a live-box. The top one is raised or lowered by a milled head fixed to the lower one and working in a thread cut on the tube of the upper. Two pins prevent the plates from coming apart or turning on each other.

The top plate has a hole at one end for the water supply and a

Fig. 22.



similar hole on the other for the waste, a piece of movable brass tube fitting into each.

The supply tube has a valve for regulating the quantity of water admitted, and beyond this is an indiarubber pipe connected with the water-vessel. A double-necked bottle is very convenient, so that a fresh supply of any fluid can be introduced without disturbing anything.

The advantages of this arrangement are :—

1. The depth of the cell is easily adjusted while on the stage, and the object can be brought within reach of fairly high powers by simply reducing the depth of water to a thin film. When not under examination with such powers the cell can be deepened, giving plenty of space with a constant current of fresh water, and yet enabling the observer to keep the object in view with a lower power.

2. The diameter of the cell, while large enough for all ordinary

purposes, admits of the use of very thin cover-glasses, ·005 or ·004 in., and when the cell is screwed up an 1/8 in., 1/10 in., or even 1/12 in. might be used if required.

3. The water supply is perfectly under control, and as there is at the same time no filtering action, the object can be supplied with water containing anything necessary to the life of the object.

4. The current is not interfered with by reducing the depth of the cell.

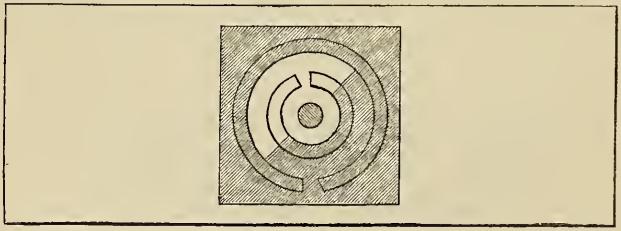
5. Objects can be easily put in, taken out, or manipulated in any way by stopping the supply and sliding the glass cover (which by preference should be square) downwards till the opening is large enough to do what is required. To replace the cover, slide it up till there is the least possible opening left and then fill up any air-space in the cell with water from a fine syringe before pushing it quite over the edge. If the under side of the cover-glass be slightly greased at the corners there will be no risk of it floating off.

This slide is manufactured by Messrs. Swift and Son, and can be made of varying depth and diameter to suit special purposes."

Stokes's Growing-cell.*—Dr. A. C. Stokes cements to a slide a disk and two rings made from cover-glass,† the rings having a small piece broken away from each and arranged as shown in fig.

To use, place on the central disk a small drop of the water con-

Fig. 23.



taining the organisms to be kept alive, and over it arrange a large square cover, taking pains to prevent the water from overflowing into the inner annular space. With a camel's hair pencil carefully, and in small quantities, add fresh water at the top or side of the square, until the space covered by the latter and bounded by the outer ring is filled. It will be found that this water will flow between the square and the upper surface of the exterior ring, will enter through the break in the latter, partially filling the outer annular space, and by capillary attraction will occupy a part of the vacancy between the cover and the interior ring, as shown by the diagonal lines in fig. 23, but unless too much water is used, or is supplied in too great quantities at a time, it will not pass the opening in the inner ring, thus leaving

* Sci.-Gossip, 1884, pp. 8–9 (1 fig.).

† These can be punched out by the method described by Dr. Beale, 'How to Work with the Microscope,' 5th ed., 1880, p. 73.

an abundance of air to supply the animal life under observation. The imprisoned air at once becomes saturated with moisture, as evidenced by the fogginess of the cover; the central drop cannot evaporate, and the external water will not come in contact with it if care is taken in filling and in adding that lost by evaporation. When not in use, the slide is placed across a small vessel of water, a double and twisted thread arranged in contact with the edge of the square cover, and the whole left for another examination at some future time.

Nunn's Pillar and other Slides. *—Dr. R. J. Nunn, under the heading of "*The Pillar-Slide—a new slide for the Microscope*," writes, "Every microscopist knows the difficulty of estimating exactly the amount of fluid which will completely fill the space between a cover and the slide, and consequently a bibulant must be applied to absorb the excess almost always present. This takes a little time, which, to one who has many examinations to make, and who is otherwise pressed, is a matter of some importance.

The following is a description of a slide intended to obviate this difficulty:—

Take a small thick cover (round or square, as desired) and cement it on the centre of a slide with Canada balsam. Let this harden thoroughly so that the cover will not slip during warm weather, and also to prevent water insinuating itself between the glasses during the frequent washing to which it will be subjected. Of course it would be better to have these little pillars ground upon the slides, but with care in using them the cemented ones will answer every purpose.

A drop of the fluid to be examined is placed upon the pillar just described, a cover larger than the pillar is placed upon it, when it will be seen that the excess of fluid flows into the annular space surrounding the pillar. Not the least advantage of this new form of slide is that evaporation takes place from the fluid in this annular space, and may go on for a long time without affecting the stratum under examination.

If desired, the annular space may be filled with oil, and evaporation thus be entirely prevented."

Under the heading of "*Chemical—new slide for the Microscope*," is the following:—"For the application of chemical tests to fluids under microscopical examination, the 'pillar slide' presents many advantages. The method usual in such cases is to place a drop of the reagent at one edge of the cover and a bit of blotting-paper at the opposite edge, with or without a hair inserted between the cover and the slide to facilitate the inflow of the reagent.

If the circular pillar-slide be used, then the cover must be pushed so that all the space is on one side; there will thus be formed a crescentic instead of an annular space. It is evident that in the latter, if the space is filled with reagent it will affect the film, but slowly, because evaporation takes place from the reagent itself, and there is nothing to draw it between the cover and the pillar. In the round

* Sep. repr. from Trans. Med. Assoc. Georgia, 1883, pp. 21–4.

pillar this is best corrected by having the diameter of the cover smaller than that of the pillar, and pushing it to one side so as to project a little beyond the pillar, the lunate space thus formed is filled with reagent, while the rest of the edge of cover is evaporating and drawing upon the reagent to supply the deficiency thus created, or, to hasten the reaction, a bit of blotting-paper may be applied in the usual way.

Another good way is to use a square cover: let one of the corners project beyond the pillar, and under this corner put the drop of reagent, in this way nearly the whole of the edge of the cover will be left free for evaporation, and the rapidity of the reaction will of course be proportionately great. If desired, a different reagent may be placed under each of the four projecting corners of the square cover.

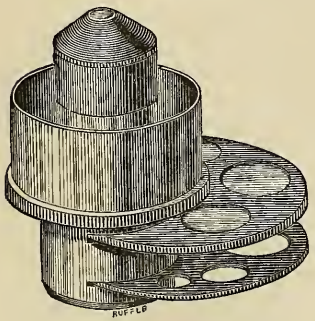
The 'square pillar-slide' seems, however, best adapted to this class of work, with a cover the same size or smaller than the pillar, and projecting a little beyond it; the reagent will then occupy one side of the square and evaporation go on from the other three sides. If an oblong cover is used which projects on opposite sides of the pillar, then the same or different reagents may be placed on opposite sides of the same specimen, without danger of mixing with each other."

Under "*Slides with hollows for chemical reactions*" Dr. Nunn says "Many of the advantages of the pillar slides for the observation of chemical reactions may be obtained by using polished glass slides with one or more hollows.

In using these the drop of fluid to be examined is placed by the side of the hollow, or between them, if there be two or more, and the cover is allowed to project over the hollow or hollows a little distance; under this projecting edge the drop of reagent is placed, and the bit of blotting-paper may be used as usual upon the slide if desired."

Beck's Condenser with two Diaphragm-plates.—Fig. 24 shows the condenser which accompanies Messrs. Beck's Pathological Microscope (Vol. III. 1883, p. 894). The peculiarity of its construction is that it has two rotating diaphragm-plates, one with the usual series of (7) apertures of different sizes, and the other with one clear aperture and three others filled with blue glass of varying tints, for moderating the light. The former is placed at a distance below the lenses sufficient for accurate centering of the condenser.

Fig. 24.

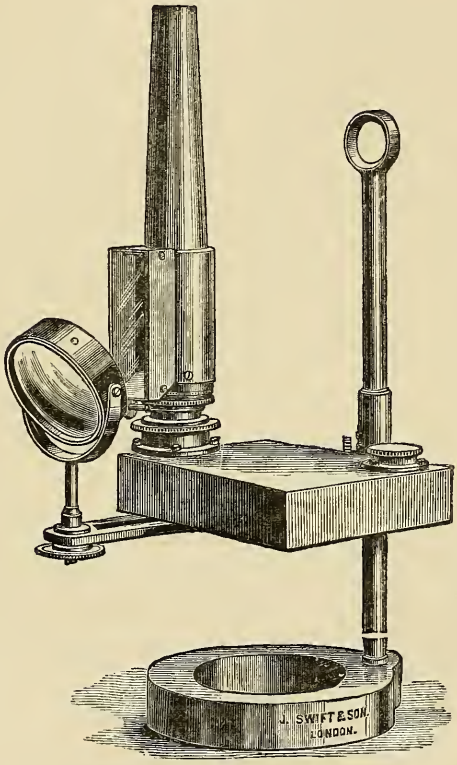


As shown in fig. 24, the condenser is for use with the smaller stands, but by reversing the optical combination and screwing it on the opposite side it is available for large stands.

By the removal of the sliding cap which carries the highest power lens of the three of which the optical combination is composed, the condenser is suitable for use with low-power objectives.

Nelson's Microscope Lamp.—Mr. E. M. Nelson some time ago devised the lamp shown in fig. 25; but no description or figure of it has been issued till now. The principal points in the design are (1) that the flame (using either the edge or the broadside) can be brought much nearer to the surface of the table than usual, which is secured by making the oil-well very shallow, large enough however to hold

Fig. 25.



sufficient for eight or nine hours' work, and with means for replenishing the supply of oil without touching the flame; (2) the metal chimney is arranged to cut off all the light except that required for actual use with the Microscope, and the only glass required is an ordinary 3 × 1 slip which slides in a groove about an inch in front of the flame and can be readily removed for cleaning; (3) the condensing lens is of the compound Herschellian form, by which a clearer disk of light can be obtained than with the usual bull's-eye, and is provided with means of adjustment in all directions. The lamp was constructed by Messrs. Swift and Son.

Developing Photo-micrographs.*—The microscopist who occasionally photographs his specimens finds that his developing solutions deteriorate by keeping, and often when he comes to use them, after standing untouched for some time, they do not act properly. Especially is this true of developers containing pyrogallic acid, which, as ordinarily made, soon lose their strength. It is customary to make up the solutions and keep them ready for use, but owing to the circumstances above mentioned, this plan is not a good one for microscopists who only use them occasionally.

Mr. R. Hitchcock has adopted the following plan for developing, which enables fresh solutions to be readily made without loss of time. There should be always at hand citric acid and pyrogallic acid in powder, strong ammonia (·880), and a solution of potassium bromide, 50 grains to the ounce of water. When about to develop the plates, dissolve 1·5 grains of citric acid in 8 ounces of water. In practice it is not necessary to weigh out the exact quantity, as it can be measured on the point of a knife, after a little experience. Then take half a drachm of ammonia and mix it with 8 ounces of water. Go into the dark room with the solutions, put the exposed plate into the developing dish, and proceed as follows: for a 4 × 5 plate take 1 ounce of citric acid solution and add to it 2 grains of the pyrogallic acid in powder, measuring that quantity in the hand, or on a spatula. It dissolves almost instantly. Then add one ounce of the ammonia solution and a drop or two of the bromide, and flow the whole over the plate. The development proceeds slowly, and may be controlled in the usual manner by adding more bromide, or a few drops of dilute ammonia, as the case may require.

Action of a Diamond in Ruling Lines upon Glass.†—Prof. W. A. Rogers writes, "In offering a communication upon the subject indicated by the title of this paper, I am not unmindful of the fact that I enter a field in which I acknowledge a master. Since the death of the incomparable Nobert, Mr. Fasoldt, of Albany, stands easily first in the art of fine ruling. I desire to repeat here the reply which for the past three years I have invariably made to inquiries for test-plates from my own machine—viz. that with Mr. Fasoldt's special facilities for this class of work he can, I have no doubt, produce far better results than it would be possible for me to obtain by chance efforts. I have thought it better to confine my attention to another equally important problem—viz. an attempt to obtain copies of the imperial yard and of the *mètre des archives*, at the temperature at which they are standard, to subdivide these units into aliquot parts and then to obtain a microscopical unit whose subdivisions should be so nearly equal that the Microscope would fail to reveal the difference. The first part of this work has been mainly completed. Two independently obtained copies of the imperial yard yield nearly identical values for the length of this standard unit. Three independent comparisons with the *mètre des archives* agree within very narrow limits in defining the absolute length of the metric unit, both

* Amer. Mon. Micr. Journ., iv. (1883) p. 198.

† Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 149-65.

of 32 and 62 degrees Fahrenheit. The subdivision of these units into aliquot parts—the yard into inches and the metre into centimetres—has been so far completed that any errors which may remain will not affect the microscopical unit sought. With regard to the exact subdivision of these units, I can only report progress.

Notwithstanding this abandonment of attempts to produce test-bands of the Nobert pattern, I have recently taken up the subject again, somewhat with the view of testing the claim of Mr. Fasoldt that he has succeeded in ruling lines one million to the inch, and especially by the claim that the existence of a spectrum in the bands is an evidence of the reality of the separate lines. The latter claim does not appear to be well founded. Aside from being at variance with theory, it can easily be disproved experimentally.

Before proceeding further with this investigation, I beg to refer to a theory proposed by the writer in a paper presented to the American Academy of Arts and Sciences, in relation to the method which Nobert may possibly have employed in the production of his test-plates. Briefly stated, this theory is that the lines composing Nobert's bands are produced by a single crystal of the ruling diamond, whose ruling qualities improve with use. In the light of subsequent experience this theory may be stated in the following way: When a diamond is ground to a knife-edge, this edge is still made up of separate crystals, though we may not be able to see them, and a perfect line is obtained only when the ruling is done by a single crystal. When a good knife-edge has been obtained the preparation for ruling consists in finding a good crystal. Occasionally excellent ruling crystals are obtained by splitting a diamond in the direction of one or more of the twenty-four cleavage planes which are found in a perfectly formed crystal. A ruling point formed in this way is, however, very easily broken, and soon wears out. Experience has shown that the best results are obtained by choosing a crystal having one glazed surface and splitting off the opposite face. By grinding this split face, a knife-edge is formed against the natural face of the diamond, which will remain in good condition for a long time. When a ruling crystal has been found which will produce moderately heavy lines of the finest quality, it is at first generally too sharp for ruling lines finer than 20,000 or 30,000 to the inch, even with the lightest possible pressure of the surface of the glass. But gradually the edges of this cutting crystal wear away by use until at last this particular crystal takes the form of a true knife-edge, which is parallel with the line of motion of the ruling slide. In other words, when a diamond has been so adjusted as to yield lines of the best character its ruling qualities improve with use. If Nobert had any so-called 'secret,' I believe this to have been its substance.

The problem of fine ruling consists of two parts—first, in tracing lines of varying degrees of fineness; and, second, in making the interlinear spaces equal. The latter part of the problem is purely mechanical, and presents no difficulties which cannot be overcome by mechanical skill.

It will be the aim of the present paper to describe the more

marked characteristics of lines of good quality ruled upon glass, and to illustrate these characteristics by corresponding specimens. To one who is familiar with Nobert's bands a perfect line need not be described. It is densely black, with at least one edge sharply defined. Both edges are perfectly smooth. Add to these characteristics a rich black gloss, and you have a picture of the coarser lines of a perfect Nobert plate. How are those lines produced? In the study of the action of a diamond in producing a breaking fracture in glass the Microscope seems to be of little service, but we can call it to our aid in the study of its action in ruling smooth lines. One would naturally suppose that a line of the best quality would be produced by the stoppage of the light under which it is viewed by the opaque groove which is cut by the ruling diamond. Without doubt this is the way in which lines are generally formed. But it is not the only way in which they can be produced. An examination under the Microscope will reveal the fact that in some instances at least, a portion of the glass is actually removed from the groove cut by the diamond; and that the minute particles of glass thus removed are sometimes laid up in a windrow beside the real line, as a plough turns up a furrow of soil. On the finest plate I have ever produced every line remained in perfect form for about two months. I then first noticed a tendency on the part of some of the single lines to disintegrate, while the lines ruled in closer bands seemed to retain their good qualities. This disintegration finally became so marked that, as an experiment, I removed the cover and cleaned one-half of the surface of the glass by rubbing with chamois skin. The difference in the appearance of the two halves is now very marked. Above, the dense black lines remain. Below, a ragged abrasion of the surface of the glass has taken place. Above, the furrowed lines as originally formed are preserved; below, there is a coarse scratch. It may be said that the action in this case is accidental and abnormal. In reply, I can say I have prepared plates which show that the particles of glass removed take four characteristic forms. (*a*) They appear as chips scattered over the surface of the glass. (*b*) They appear as particles so minute that when laid upon a windrow and forming an apparent line, they cannot be separated under the Microscope. (*c*) They take the form of filaments when the glass is sufficiently tough for them to be maintained unbroken. (*d*) They take a circular form.

I regret that three of the most striking specimens were broken in mounting. In one a perfect line about 1/30,000 of an inch in width was formed with a clear space between it and the groove cut by the diamond. There was not a single break in these filaments from beginning to end, but at nearly equal intervals of about 1/100 of an inch half-knots were formed similar to those formed in a partially twisted cord. By rubbing the surface of one end these filaments were broken up. For the most part they assumed a semicircular form, but some of them maintained their thread-like form and became twisted together in the most intricate fashion.

In the third specimen, which was broken in mounting, the glass removed took a spiral form like the spiral chips from steel when

turned in a lathe. A projecting crystal of the diamond caught these spirals and carried them unbroken to the end of each line, leaving them a tangled mass of threads. Even after they were protected by a cover-glass cemented to the surface, many of these spirals remained intact. Judging by the difference in focus of the various parts, the height of the mass, before the plate was covered, must have been 1/500 of an inch.

The same ruling crystal may produce smooth lines or either chips or threads, according to the motion of the diamond, as may be seen by examination of the accompanying rulings In these plates one-half of the lines of the bands are ruled by a forward motion and one-half by a backward motion of the diamond. Chips may be formed in ruling bands of very fine lines, as illustrated in the bands of lines 24,000 to the inch.

It must not, however, be supposed that lines of the best quality always present the appearance described above. While it is exceedingly rare that lines appear as well after the surface of the glass has been rubbed as before, many instances have occurred within my experience in which the difference, especially in fine lines, was not particularly noticeable. According to the limited evidence at hand, the coarser lines of Nobert's bands present some of the characteristics which I have described. I have restored two of these plates, in which the lines had become nearly obliterated by some kind of condensation under the cover-glass. In one the quality of the lines was not much affected by the operation of cleaning, but in the other the dark gloss which characterizes the heavy lines of nearly all of Nobert's plates was entirely destroyed. The finer lines, however, were much less affected than the coarse ones.

Lines of the character thus far described are evidently unsuited to the ordinary work of the microscopist. It is my experience that lines which are the most symmetrical in form and the most beautiful in appearance are produced indirectly rather than by the direct action of the diamond in cutting a groove in the glass. They can be protected to a certain extent by a cover-glass, but they are liable to undergo changes which will affect their original structure. Except for purposes of investigation, therefore, there is no advantage to be gained by ruling lines of this character. Three conditions must be fulfilled in the production of lines having a permanently good character :—

1. The glass must be tough. There is a marked difference in the character of the filaments produced, and, to a certain extent, of the lines themselves, yet the conditions under which the lines in the series of plates illustrating this paper were ruled were the same in nearly all of the plates—i. e. the same diamond was used, its setting remained unchanged, and there was no change in the pressure of the diamond upon the surface of the glass. I may add also, that I have in my collection several other plates which were ruled especially to test the question of the requisite quality of the glass. They all agree in giving evidence that glass of a given quality will always yield lines of nearly the same quality—the ruling crystal remaining the same and in the same position.

2. The greatest difficulty encountered in setting a ruling crystal is to obtain one which will rule lines of the required quality which will retain their form after the surface of the glass is rubbed. The crystal with which nearly all the plates of this series were ruled was only obtained after a search continued at intervals through several weeks. Sometimes a diamond which will rule good light lines will not produce good heavy lines, and *vice versâ*. According to my experience it is better to have a special diamond for each class of line desired, though the diamond with which the present series of plates was ruled seems well adapted to every kind of work required, except, perhaps, the production of the finest bands. An examination of plates illustrates the wide difference in the character of lines ruled with the same diamond, after the edges of the ruling crystal have been worn smooth. In one there are two sets of lines, side by side, in one of which the surface has been rubbed, and in the other of which the lines have been left undisturbed. The difference is very marked. It may be said here that the surface of a ruled plate should always be cleaned by rubbing in the direction of the lines only, never at right angles to the lines. It will often happen after sharp rubbing that the lines appear ragged, when the difficulty is that the chips have not all been removed from the grooves. Rubbing with Vienna lime, moistened with alcohol, will usually complete the cleaning satisfactorily.

3. After a crystal has been found which will fulfil the conditions of producing a line which will bear cleaning, there still remains a difficulty which will only be revealed after the lapse of considerable time. This is well illustrated in one plate in which the lines were as perfect as could be desired for several days after they were ruled. The lines of the band are now completely broken up. Evidently they were in a state of strain, which finally became so great that resistance to rupture became impossible. This, however, is an extreme case. Generally the lines simply enlarge at certain points. Usually the termination of the enlargement occurs at irregular distances along the lines, and it is nearly always very sharply defined. The most curious action of this kind which has ever come under my notice is where the lines have broken up into a form something like the strand of a heavy rope.

The process of setting a diamond is as follows: The holder has the means of adjustment in three planes: (*a*) an adjustment in a horizontal plane; (*b*) an adjustment in a vertical plane; (*c*) an adjustment in a plane at right angles to the ruled lines. It is my practice to begin by giving the knife-edge of the diamond considerable inclination to the line of motion of the ruling slide. I then rule a series of single lines at different known angles of inclination, care being taken to pass the line of parallelism. An examination of the character of the lines thus ruled will enable one to determine within narrow limits near which one the knife-edge is set parallel with the slide. After a fair line has been obtained in this way a sharp crystal is generally found by tilting the diamond in a vertical plane, though it will often be found necessary to make the third adjustment men-

tioned. Sometimes the cutting crystal is lost after ruling a few lines, but generally good results can be obtained after a constant service of weeks, and even months. A crystal is lost either by being broken off or by being worn out. When a crystal has been lost it need not be concluded that the diamond needs sharpening. It is only necessary to find a new crystal, an operation requiring patience rather than skill.

It should be stated, that while this theory of individual cutting-crystals seems to be the true one, I have never been able to detect them by an examination with the Microscope. It is only by their behaviour that their existence can be recognized.

One of the most severe tests of the ruling qualities of a crystal consists in producing, without fracture, heavy lines which cross each other at a small angle of inclination, and which will receive graphite without interruption of continuity at the intersection. Lines ruled at right angles and forming small squares afford a better test than parallel lines. In one plate presented the curved lines formed by the intersection of straight lines are nearly perfect in form, and they hold the graphite quite as well as the original lines. In another plate I have attempted a representation of the nucleus of a comet. The filling is not quite as perfect as in the other plate, but this is due to the quality of the glass. Attention is called to the granular structure under a moderately high power. I have found rulings of this form to be an excellent test of the quality of the glass required for receiving the best lines. In general, the first filling of the lines is the most perfect. One plate affords an illustration, exceedingly rare, of lines which receive the lines equally well after repeated fillings. Lines as fine as 50,000 to the inch very readily receive the graphite. The limit beyond which it seems impossible to go may be placed at about 100,000 to the inch.

A few words may properly be added here with regard to the protection of ruled lines. When lines are formed by a true groove in the glass, it is better that they should remain unprotected. But when the lines are formed in the manner illustrated by the plates of this series, the quality of the lines in the end is pretty sure to deteriorate whenever there is an actual contact of the cover-glass with the slide. I have made serious efforts to overcome this difficulty, but with only partial success. Slides mounted with gutta-percha rings generally remain in good condition for a long time, especially if, after expelling the air as far as possible by heat, a ring of white wax cements the rim of the cover-glass to the slide. But even with this precaution there is no certainty of final preservation. If it should be found that the brass slides of this series are convenient in manipulation, their adoption can be recommended, since they entirely obviate this difficulty. They are made in the following way:—A hole having been made in the centre, a flange is left 1/200 in. in thickness. The cover-glass is then cemented to the surface of the brass, and the rulings are made on the under side. The protection is made by dropping upon the ledge of brass a rather thick circle of cover-glass, which is held in position by a circular brass wire.

After this digression, I return to the consideration of the credibility of Mr. Fasoldt's claim that he has succeeded in ruling lines 1,000,000 to the inch. At this point it is only fair to say that until recently I have shared in the general incredulity with which Mr. Fasoldt's claim has been regarded. Indeed, I still think he has placed the limit just a trifle too high. But if the limit is reduced one-half, I am by no means sure but that it may be reached. Possibly it may have been already reached. But what evidence have we that it is possible to see single lines of this degree of fineness, granting that it is possible to produce them? The answer to this question involves another inquiry, viz. has the Microscope reached its highest visual possibilities? Here again it is necessary to draw a sharp distinction between visibility and resolution. In the matter of limit of resolution it must be admitted that little or no progress has been made since the resolution of Nobert's nineteenth band. The distinguishing feature of Nobert's lines is a certain boldness which enables them to be photographed, and it is to photography, supplemented by the statement of the maker, that we owe the certainty of the resolution of the nineteenth band. But all attempts to go beyond this band, even with Nobert's later plates, have proved failures. I cannot learn that any one has yet succeeded in photographing a Fasoldt plate as high as 100,000 to the inch. Certainly various attempts which have been made with bands of my own ruling higher than about 70,000 have not been successful. There are several Nobert plates of the new pattern in this country. They run as high as 240,000 lines to the inch,* but who has gone beyond the number of lines in the nineteenth band? † With great respect for the honest belief of several microscopists who claim to have resolved Fasoldt's bands as high as 152,000 to the inch, I must yet hold to the opinion that in no case has the resolution been proved by a test which will be generally accepted by microscopists. There is one test, and only one, which is absolutely decisive—viz. the one originally proposed by Nobert, that of ruling a definite number of lines in a band of given fineness, and keeping the number secret until the microscopist could give the correct count, not merely in one instance but in several. Even here we must depend upon the honesty of the maker in revealing the correct count. Has the correct count been made in any Fasoldt plate as high as 100,000 to the inch? I think not. Has it been done with any band of my own ruling of the same degree of fineness? No. Let us marshal the evidence pro and con, offered by experience.

(*a*) Mr. Fasoldt's finest bands present a perfectly smooth and uniform surface. They have well-defined limits, and the width of the bands is what it should be by the number of lines claimed to be ruled.

(*b*) According to present experience single lines can be ruled

* The highest is 1/20,000 of a Paris line, i. e. 224,000 to the English inch.—Ed. J.R.M.S.

† Mr. E. M. Nelson claims to have resolved the next finest band to the 19th, viz. the 11th band of the latest 20 band plate, the lines of which are at the rate of about 123,000 to the inch.—Ed. J.R.M.S.

several degrees finer than I have been able to detect under the Microscope. About four years since I sent to Prof. J. Edwards Smith a ruled plate with a statement of the number of bands, accompanied with a description of the same. Soon after I received a letter from Prof. Smith, saying there must be some mistake in the description, as he was unable to find two of the bands. I replied that the bands were certainly ruled, and that I thought I could convince him of that fact. I therefore requested him to re-examine the plate with the greatest care, and if he was still unable to find the bands to return the plate to me. After a vain endeavour to discover them the plate was sent to me. I removed the cover, filled the lines with graphite, remounted the slide, and returned it to Prof. Smith. Not only had the invisible bands become visible, but the separate lines, with an interlinear space of 1/80,000 in., were easily seen. Now when Prof. J. Edwards Smith, an acknowledged expert in the manipulation of the Microscope, is unable to find lines which are really in the centre of the field of the Microscope, I suspect that other observers may find a similar difficulty. Among the plates presented is one series which were ruled to illustrate the possibility of producing lines which really exist, but which are invisible under the Microscope. On one plate there are two sets of lines, one set on the slide and the other on the under side of the cover. Between the bands, 10,000 and 24,000 to the inch, the entire intervening space is filled with a continuous series of bands, 24,000 to the inch. I have not been able to see the lines of the last band. In another plate there are a series of bands containing twenty-one lines each, the entire linear space being 1/2000 in. The first eleven lines are ruled with a forward motion of the diamond, and the second ten lines are ruled with a backward motion. The last two bands are preceded by heavy finding lines. Each of the last three bands is followed by bands 24,000 to the inch. I think it will be found difficult to see the lines of the last two bands under any illumination at present in use, and yet I am confident that the lines exist. I found my belief upon two bits of evidence: First, the pressure of the diamond upon the glass was sufficient to produce the lines. With considerable less pressure there would still have been a constant contact between the diamond and the glass. Second, I saw them ruled through the sense of hearing. When a diamond does its very best work it produces a sharp, singing tone, which is audible at a distance as great as twelve inches. This singing tone I distinctly heard for every line ruled. It is even more marked in ruling the finest lines than in coarse ones. I have two singing diamonds, or rather two diamonds with singing crystals, and these two are the ones with which I have done my best work.

The argument against the visibility of single-ruled lines which cannot be seen with the present means at command, even if within the limits of possibility, considered in a physiological sense, is in one respect a sufficient answer to the evidence offered in favour of their existence. This evidence, while not exactly negative in its character, is yet not sufficiently conclusive to be regarded as coming under the head of proof through the medium by which the

existence of any fact is attested, viz. the medium of some one of the senses. But may it not be true that we have not yet reached the fulfilment of the conditions necessary to visibility? It certainly cannot yet be safely asserted that it is impossible to see a material particle which has, in one direction, a magnitude not exceeding 1/500,000 in. Photography offers the evidence, somewhat negative in its character, that the limit of visibility is reached with lines having a width of about 1/200,000 of an inch. Lines of this width are the finest that have ever been photographed. But the most conclusive evidence against the certainty of being able to produce lines as fine as 500,000 to the inch consists in the fact, repeatedly proven in my own experience, that lines which appear to be excessively fine often have a real width two or three times as great as they appear to have, as has been proved conclusively by filling the lines with graphite, which brings out the real limit. This phenomenon will come up again in connection with the subject of resolution.

I have already stated my belief that the limit of resolution has been so nearly reached that, though it is quite possible under a combination of favourable circumstances to obtain a resolution a little beyond 113,000 to the inch, the uncertainty which must always attend observations of this character is so great that the certainty of resolution cannot be safely asserted. In consideration of this uncertainty, and of the fact that so little progress has been made in resolution compared with the recent advance in the construction of objectives, I beg to propose as a test the visibility of single-ruled lines in place of the resolution of these lines in close combination. Instead of bands of lines of the Nobert pattern, I propose a series of bands, each having the same interlinear unit, but with the lines of each successive band finer than those of the preceding band. The space between the lines should not be so great as to interfere with their easy detection, nor so small as to require any effort in resolution. One micron (μ) is a convenient unit. A heavy line should precede the band, in order to facilitate finding it.

According to my own experience there are four facts which must always throw grave doubt upon any reported case of difficult resolution:—

1. It is well known that by the manipulation of the light, every other condition remaining the same, it is possible to vary the apparent number of lines in a given band of coarse rulings. Can any one offer a reason why there should not be the same difference with bands of fine lines closely ruled?

2. I have many times ruled bands of lines with the interlinear spaces distinctly marked, but in which each line was in reality considerably wider than the space between the lines, as I have proved by extending single lines beyond the others and filling them with graphite. The only explanation of this singular fact which I can suggest is that the diamond may possibly cut square down at one edge of the line and for the remainder of the line produce only an abrasion of the surface of the glass, which is so slight as not to interfere with throwing up a furrow upon the remaining portion.

3. Lines of a given depth appear finer when closely ruled in bands than they do in single lines.

4. I add another observation with some hesitation, since I have not been able to prove its truth beyond peradventure. I have often, but not always, found that when single lines, apparently invisible, are placed in close combination in bands, they not only form a visible band, but a band capable of apparent resolution into separate lines. Can any one offer a reason why we can see in combination what we cannot see as separate parts? Of course I shall be at once reminded by the astronomer that it is much easier to pick up a cluster than to see scattered stars of the same magnitude. But when it is once found, the separate stars composing it are no more easily seen than stars of the same magnitude more widely scattered. I offer this observation in a tentative way, since it has, if true, an important bearing upon the question of the ultimate limit of resolution. Among the accompanying plates is one that illustrates the statement here made. This plate consists of a series of bands, 12,000 to 24,000 to the inch, each preceded by a heavy finding line. The lines of each successive band are finer than the preceding. The last two bands were ruled with the same pressure of the diamond as the fourth band preceding. The intervals at which they were ruled are 1/80,000 and 1/200,000 in. I do not by any means vouch for the existence of the separate lines, yet the bands are smooth, and there is a distinct difference in the appearance of the two halves of the 80,000 band, the first having been ruled with a forward and the second with a backward motion of the diamond. The corresponding single lines of the fourth band preceding are wholly invisible. This plate seems to show that the visibility of the lines in bands depends somewhat on the narrowness of the interval between the lines, since the lines of the same degree of fineness with an interval of 1/24,000 in. cannot be seen.

It is obvious that this whole question of resolution needs the most careful consideration and investigation, since it bears an intimate relation to the limit of visibility of single particles of matter. Mr. Hitchcock, in a recent number of his 'Journal,' has made the claim that resolution has to a certain extent ceased to be a test of the quality of an objective. I suspect that this claim will be found to have some foundation in fact. For the last ten years we have only the assertion of resolution, without doubt honestly made, but yet unaccompanied with the proof. It is time that the proof should accompany the assertion. I insist that simple vision does not afford the required proof.

Now we must face this question as honest inquirers after truth. There is a limit which theory places to resolution with objectives of given resolving power, not to visibility, as has been frequently stated. Before we can safely assert that observation has gone beyond theory, we must be prepared to offer evidence which can be placed upon record, can be discussed deliberately, can be weighed impartially in the balance with counter evidence, and can still stand unimpeached. Do you say that this is hardly worth the trouble? I reply that the issue here raised comes to the surface in one form or another at almost

every point in physiological and pathological investigations. It will do no harm to recall the number of times it has at this meeting stood as a sentinel at the entrance to the temple whose mysteries we are seeking to explore. Has not the question so tersely put by Dr. Gleason at the Elmira meeting of this Society, 'Do we see what we see, or don't we see what we see, or do we see what we don't see?' been the stopping place of more than one important issue raised at the meeting? I hope I do not need to say that I have no personal ends to serve in an inquiry in which I happen to be a personal factor. Let us then have a test which will for ever set at rest this vexed question of resolution. I submit for your consideration the following outline of a test which I venture to think will be sufficient and conclusive. Let Mr. Fasoldt rule three plates under as nearly the same conditions as possible, except in the number of lines in the different bands of each plate. Let him label each plate and accompany it with a full description of the number of lines in each band. Let these plates be sent to any gentleman in whom the great body of microscopists have confidence as eminently qualified to conduct an investigation of this sort, such as Prof. H. L. Smith of Geneva, or Col. J. J. Woodward of Washington. Let whoever receives the plates remove the labels of Mr. Fasoldt, and put in their place labels whose signification is known only to himself. Then let the gentlemen who think they have resolved 152,000 lines to the inch take the plates, make their count of the lines in each band, and send in their report. Let the plates also be photographed, and let the number of lines be counted; then let the results of these investigations be published. If all substantially agree in the count, this will end further discussion.

The limit of visibility of single particles of matter under the Microscope bears an intimate relation to the limit of naked-eye visibility. My attention was first called to the smallness of this limit by an accidental circumstance. I had ruled a micrometer upon a thin cover-glass consisting, as I supposed, of moderately coarse lines. After several vain attempts to discover traces of the lines ruled, I chanced while holding the glass at a certain angle with respect to the source of light to breathe upon it. At the instant the film of moisture was passing off, I was surprised to be able to see all the lines which were ruled, 100 to the inch, with the greatest distinctness. I then carefully filled the lines with graphite, when they were, after the closest inspection, found to be as fine as any I have ever ruled. According to the nearest measurement I could make, their width was about 1/6 of a micron. Repeated observations gave in every case satisfactory evidence of visibility. In order to ascertain what effect the thickness of the glass might have upon the visibility, the cover-glass was lightly cemented to a glass slide with guttapercha, when it was found that the lines were by no means as distinctly visible as before. The cover was then removed, when the original observation was easily confirmed. The lines of this plate were readily seen by Professor Pickering, and by several assistants connected with the observatory. Unfortunately the glass was broken in an attempt to mount it upon a brass slide. While it is a simple

matter to rule lines which are easily visible by the unaided eye, especially in sunlight, having a width not exceeding 1/50,000 in., I have never since succeeded in obtaining a plate quite as good as the one described. Clearly the ruling crystal had been broken off before this particular plate was ruled, and, as often happens, a minute and delicate crystal remained, which produced the lines which were really traced.

In the course of subsequent experiments I found that while the visibility was increased by the film of moisture, exceedingly fine lines could be seen without this aid to vision when the proper angles of inclination to the source of light are obtained. To get the best results the ruled surface should have an angle of about 15° with the source of light, and the lines themselves should have nearly the same angle of inclination. Everything depends upon getting the exact angles of inclination required. More striking results are obtained by sunlight than by artificial light. Highly polished metals, especially tempered steel and iridium, yield better results than glass. I will not undertake to say how fine lines traced upon metal can be seen, but I suspect that the limit of naked-eye visibility is far beyond the capacity of ruling. I have a plate of highly polished and nearly pure iridium upon which there are traced a series of lines which are discernible by the eye in sunlight, but which I have never yet been able to see under the Microscope by direct light. Yet these lines are easily seen with a low-power objective under certain conditions.

I do not propose to offer any theory to account for the facts which I have observed, not even the one which would naturally be the one first suggested—viz. that of visibility by reflection. I admit that the apparent width of the lines would be increased if the real and reflected lines could be seen side by side. It can be easily shown that the lines in one of the accompanying plates are visible under conditions in which it is impossible for reflection to take place. For the present I content myself with stating the facts of observation illustrated by the ruled plates by which these observations can be repeated.

I close this paper with the suggestion that the increase in the efficiency of the Microscope will probably come from the better manipulation of the light under which an object is viewed. At present the unaided eye is a not very unequal competitor of the Microscope in the matter of simple vision. In fact, there are certain phenomena connected with this question which can be better studied by the unaided eye than under the Microscope. I believe it to be possible to see under the action of sunlight what cannot be seen under any objective. There has been produced upon my ruling-machine, upon a polished surface of tempered steel, a band of 10,000 lines, covering a space of 4 inches. I have tested the equality of the spacing for aliquot parts of a revolution of the screw in every possible way by direct measurement. Other observers have done the same thing. I can hardly be wrong in the assertion that the spaces indicated by even tenths of a revolution are exactly equal as far as any tests of direct measurement can be applied. Yet, by holding this bar in a certain position with respect to the source of light, the limits of each revolu-

tion of the screw can be distinctly seen. These waves of light and shade indicate an error which can be seen by the unaided eye but which cannot be measured with certainty. Finally, if the visibility of ruled lines is so erroneously increased by the position which they occupy with respect to the source of light, why may not the visibility under the Microscope be increased in nearly the same proportion by some mechanical device which shall enable the observer to find exactly the proper angle of inclination at which the light should be thrown upon the object in order to secure the best possible result?"

Prof. Rogers, in the discussion on a paper by Dr. G. E. Blackham on the Relation of Aperture to Amplification, also said * "The whole thing depends on the question Can we compute resolving powers? I will not say that we cannot, and I have my doubts if we can. I question the truthfulness of the formula that is used in the computation. My confidence in it was shaken some time ago, when in the measurement of some plates I found errors of 1/40,000 in. I think that the formula is true, so far as it goes, but it does not tell the whole truth. There are conditions that affect it. Take, for instance, Bayard's formula for refractions. It is affected by the atmosphere and temperature. Now, I do not say that the two formulas are analogous; I use Bayard's only as an illustration of what may occur. My position is this: Take what we have as a basis of investigation, and go ahead to ascertain the truth. There is a great sea for exploration in the question."

Test-Diatoms in Phosphorus and Monobromide of Naphthaline.† —Canon E. Carr thinks those who are interested in the resolution of the more finely marked diatoms, and who have seen or heard of the magnificent image of *Surirella gemma*, mounted in phosphorus, shown by Mr. J. W. Stephenson at the Society's meetings and conversazioni, with a Zeiss' oil-immersion 1/8 objective and his own catoptric illuminator, will be glad to learn that Möller now supplies some of the more difficult test-objects mounted in highly refractive media. Having recently purchased a slide of *Amphipleura pellucida* mounted in phosphorus, and one of *Surirella gemma* mounted in monobromide of naphthaline, he gives the result of his examination of them. The resolution of the hemispherules on the latter was not remarkable, being much the same as that obtained on a slide of the object mounted dry. The resolution of the former, however, was all that could be desired with the means at command, and contrasted favourably with anything he had seen before. Previously, with a Powell and Lealand's water-immersion 1/8 objective, and Wenham disk illuminator, he had seen the striæ very faintly shown on a balsam-mounted slide. Much better resolution had been effected on a dry mount by a Powell oil-immersion 1/25 objective, and their achromatic condenser. But even this result was not to be compared with that obtained on the phosphorus mount. Using Powell's oil-immersion 1/12 objective (N.A. 1·43), and their oil-immersion condenser, the striæ came out

* Loc. cit., pp. 227–8.

† Engl. Mech., xxxviii. (1883) p. 280.

remarkably clear and sharp, and, though not distinctly broken up into dots, gave apparent indications of a want of continuity. It would be interesting (he adds) if other observers who possess large-angled object-glasses, and corresponding means of illumination, would give their experience in regard to the new slides of these difficult but fascinating objects.

Microscopic Test-Objects.* — Under the above title Mr. E. M. Nelson replied to Canon Carr as follows :—"Having worked at these objects for some years, and having also kept pace with the times in objectives and apparatus, I will, in answer to Mr. Carr's request, give the results of my experience: 1st, the total abolition of oblique illumination if one wishes to see the true structure of an object; 2nd, object mounted dry on cover.

I use a Powell achromatic condenser, accurately centered to the optic axis. The edge of the flame of a paraffin lamp, with 1/2 in. wick, exactly focused on the object, without bull's-eye or mirror. This illumination, with a Powell oil 1/12, N.A. 1·43, easily resolves *A. pellucida*, dry on cover, *with direct light*—i. e. without slot or stop.

If *S. gemma* is examined by this means, the hemispherule theory is at once exploded, and the true structure (which is far more beautiful) is revealed. It is something like a most delicate skeleton leaf. This, however, is very difficult for a beginner. The *P. formosum* is, perhaps, the best one to try first. Work away at that until the hemispheres, which are so easily seen, give place to a *square* grating! To see this, with a 1/4, N.A. ·74, will severely test the lens and the observer's manipulative skill. A coarse *N. lyra* and a *Tryblionella punctata* both have square apertures, and are very easy. N.B.—If the objective is much out of correction, the square apertures will blur round. The next one to try is *P. angulatum*. In this a fracture should be distinctly seen to pass *through* the apertures. The apertures will take a rose tint if the glass is properly corrected.

It is manifestly absurd to test an objective by a fine diatom seen with oblique light, for only a small portion of a narrow marginal zone of the objective is used. The central, and by far the more important, part of the glass might be stopped out.

By the central illumination, however, the whole of the objective is used; the centre by the dioptric beam, the margin by the diffraction pencils. In former days one used to hear this sort of thing said: 'This 1/12 is a beautiful diatom glass.' 'This 1/10 is splendid on *Podura*, but not good at diatom resolving.' (What a fine thing for the opticians! One had to buy two glasses, one for *Podura* and one for diatoms.) The explanation is very simple: for *Podura* a glass must be good in the centre, and for diatoms, with oblique light (the only light used in those days), good in the marginal zone. So then the 1/10, which was good for *Podura*, and the 1/12 for diatoms, could neither of them have been thoroughly corrected from their centres to their margins. I have a glass in my collection which is very fair on *Podura* when the screw-collar is in one position, and also is a

* Engl. Mech., xxxviii. (1883) p. 324.

good diatom resolver with its collar in another position; but when all its zones are tried at *once*, by the direct illumination, it utterly breaks down.

With regard to *A. pellucida*, the *strongest* resolution is obtained with Powell's vertical illuminator. The long striæ can only be seen by this method. Spurious longitudinal striæ may be easily seen; but the true lines are very difficult, and may be estimated to be 120,000 to the in. at the lowest. The transverse I have counted repeatedly, and find them, in Van Heurck's specimens, very constant at 95,000 per inch. The best picture of the trans-striæ is obtained with oil-immersion 1/12, N.A. 1·43, or oil-immersion 1/25, N.A. 1·38, and Powell's oil-immersion condenser, *used dry*, with single slot, edge of flame direct, valve being dry on cover. The lowest angled glass with which I have seen the transverse striæ, is a water-immersion 1/16, N.A. 1·08, and the lowest power 1/4, N.A. 1·17."

In reply to a letter from "Monachus" * inviting Mr. Nelson to state how he came to recognize that oblique illumination must be entirely abolished in favour of central, and that by so doing we shall see the *true* structure of the object, Mr. Nelson wrote:†—"I began to realize the uselessness of oblique light for the determination of true structure during a lengthened examination of a Nobert's 19-band plate. I was much struck by the appearance of a single line of the first band, when viewed by an oil-immersion N.A. 1·25, illuminated by a large angled cone of direct light. The groove which the diamond had ploughed in the glass was most distinctly seen, and along the sides of the groove there were places where the chips of glass had flown off. With oblique light all this was lost; the line appeared as if it had been painted on the surface of the glass. This showed me that if definition was wanted direct light must be used.

I do not intend for one moment to affirm that a higher band of Nobert can be resolved by direct than by oblique light; but this I do say, that the ultimate structure of a diatom can only be demonstrated by direct light.

No microscopist in the present day would uphold the theory that the ultimate resolution of the *P. angulatum* was six sets of lines or grooves, inclined at an angle of 60° to one another. But a similar view of it was held in Quekett's time, for in the frontispiece of his book there is a beautiful engraving of it, exhibiting diamond-shaped marks all over it; a false conclusion, the result of oblique light. Neither will any one insist that the ultimate resolution of the *N. Rhomboides* is represented by two sets of lines, at right angles to one another, a picture produced by the employment of two beams of oblique light. In the days of Griffith and Henfrey they got beyond that, and dotted the *Rhomboides*.

It is quite natural to expect that with the increase of aperture and the improvement in objectives there should be simultaneously a development in the resolution of the diatoms. One misses, too, with oblique light, all that beautiful tracery inside the hexagonal

* Engl. Mech., xxxviii. (1883) p. 341.
† Ibid., p. 386 (3 figs.).

areolation of the *Coscinodisci*, which can only be seen by direct light; for with oblique light the blur of the hexagonal structure blots out the fine markings. When we come to the very finely-marked diatoms, such as *A. pellucida* and some of the *Nitzschiæ*, we must be content with lines, by oblique light, until we can get sufficient aperture to enable us to see the ultimate structure."

"Monachus" rejoined as follows:*—"I am obliged to Mr. Nelson for his reply to my letter, as it leaves no room for ambiguity as to his views.

It is not of course my object, in occupying your space, to simply engage in a personal controversy with Mr. Nelson, and I therefore leave, for the moment at any rate, many points in his letters in regard to which he is mistaken, such as the statements about the two beams in the case of *N. Rhomboides*, the lines and dots he figures, &c. My object is to prevent your readers being misled on the cardinal statement of Mr. Nelson that he (or any one else) has seen the true structure of *Surirella gemma*, or any similar diatom. When this *is* seen we shall have reached the millennium of microscopical observation—how far we are from that day no one can tell, but it is certain we have not reached it yet; and in representing what he saw as the 'true structure,' Mr. Nelson was but falling into the same error as the old school of microscopists whom he criticizes.

I will first quote Mr. Nelson's statement *verbatim*:—'If *S. gemma* is examined by this means, the hemispherule theory is at once exploded, and the true structure (which is far more beautiful) is revealed. It is something like a most delicate skeleton leaf.'

Why *S. gemma* is beyond the reach of any such determination of its true structure, it is the object of the succeeding paragraphs to show.

When rays emanating from a luminous body are transmitted through any structure, which by its opaque, semi-transparent, or refractive constituents prevents the continuous propagation of the luminous waves, the rays cease to pass through in straight lines, and each pencil is split up into a conical pencil of rays, which are distributed round the course of the incident pencil, and which vary very much in the extent of their deviation.

When the elements of the structure are considerable multiples of a wave-length, that is, when they are relatively large, the spread of the diffracted rays is limited; but when the elements are only very small multiples of a wave-length, that is, when they are very minute, the diffracted rays are spread out very widely.

Most microscopists are by this time familiar with the practical effect of the diffraction-spectra under the Microscope, and have seen the experiments which show that the same diatom will give numerous very different images according as we admit all or some only of the diffraction-spectra. By stopping off successively the seven spectra, for instance, of *P. angulatum*, we get as many different structural appearances—indeed, no less than nine different sets of lines may be

* Engl. Mech., xxxviii. (1883) p. 431 (1 fig.).

displayed on this diatom, according as we admit or exclude particular sets of spectra. The results obtained from this manipulation may be summarized in three propositions:—

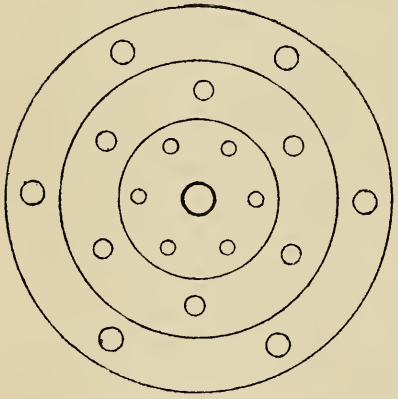
(1) The *same* structure will give *different* images when the diffraction-beams are made different.

(2) *Different* structures will give the *same* image when the diffraction-beams are made similar in each case.

(3) (the proposition which is most pertinent to our present subject). The microscopic image of a structure is never in perfect accordance with its actual composition, or true structure, unless *the whole of the diffraction-pencil is admitted to the Microscope;* or, in other words, the image is always more and more dissimilar from the true structure in proportion to the greater number of diffraction-pencils which are excluded from the Microscope.

The diagram will serve to illustrate the practical application of the last proposition to the examination of diatoms. If the structure is 'coarse,' the diffraction-beams will all be included within a small space around the central pencil (the inner circle of the figure), and in this case an objective, even of limited aperture, will receive them all, and we shall have an image of the true structure. If the object is finer, the limited aperture will not be sufficient to take up all the diffraction-pencils, but a larger aperture (the middle circle of the figure) will. Still more minute structure will require a still larger aperture, as is shown by the outer circle.

Fig. 26.



Now the elements of *S. gemma* are of such fineness that they far surpass the limits of any aperture that we are able to obtain at the present day. Aperture is limited by the refractive index of the glass of which the objectives are made, and that of the immersion fluid, cover-glass, and slide, and hitherto we have not been able to obtain more than 1·47 N.A. out of a possible 1·52. An aperture even of 1·52 would take up but a *part* of the diffraction-beams to which the structure of *S. gemma* gives rise, and, therefore, with our widest apertures it is impossible for us to see its true structure. I need not give the figures of the calculation here; but the fact is that to see the true structure in reality, we should require objectives, slides, and immersion fluids far surpassing in refractive index any substance hitherto known to exist in nature.

To quote Prof. Abbe: 'All speculations as to the true structure of even *P. angulatum*, so far as they depend on microscopic vision, are mere phantoms, castles-in-the-air. No human eye has ever seen,

or will ever see, the complete diffraction-spectra arising from a structure of this minuteness, nor will any Microscope ever show an enlarged copy of it, so long as the spectra cannot be observed in a medium of at least 5·0 refractive index, and by an objective of 5·0 N.A., which, as far as our present knowledge goes, is an impossibility. The Microscopes of the present day admit relatively a small central portion of the whole diffraction-pencil of the valve—*i.* e. the incident beam and the six spectra of the inner circle. But this portion is also yielded by a multitude of other objects which are endowed with an alternation of superficial or internal molecular structures which cross each other in two different directions at an angle of 60°. Such structures may be formed in various widely different ways; it may be by rows of spherules or other prominences of any shape whatever; rows of internal vacuoles of any figure, or the mere internal alternations of molecular aggregations within a perfectly transparent and smooth silica film. And yet all of these yield with central light the identical circular field of the *angulatum* valve, even to the most minute particular. But although these spectra are identical as far as the six inner spectral beams are concerned, they may be vastly different in regard to some or all of the more widely diffracted pencils which are not admitted by the objective.'

However expert, therefore, a microscopist may be (and every one knows the high point which Mr. Nelson has reached), he must not delude himself with the notion that perfection in technical dexterity enables him to determine the "true" structure of objects whose real structure cannot be revealed with our present appliances by any amount of manipulation. The greater his own reputation in this respect, the more undesirable it is that he should proclaim such misleading views, to the perplexity of his less experienced brethren."

Resolution of Amphipleura pellucida by Central Light.—This has been the subject of some controversy in America. Mr. A. Y. Moore* 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.

Dr. H. J. Detmers† considers this explanation to be quite untenable and the true cause to be that "the resolving rays are reflected from the (externally convex) internally concave surface of the edge of the immersion fluid."

Prof. A. Y. Moore, in reply,‡ insists upon the correctness of his view and the insufficiency of that of Dr. Detmers, inasmuch as the field of view takes the colour of the metal of which the front cell of the objective is made. This would not occur if the light were reflected from the edge of the drop of immersion fluid.

* The Microscope, iii. (1883) pp. 49–51 (1 fig.). Cf. this Journal, iii. (1883) p. 595.

† Ibid., pp. 197–201.

‡ Ibid., pp. 201–4.

ALBERTOTTI, G., jun.—Sulla Micrometria. (On Micrometry.) [*Post.*]
Ann. di Ottalmologia, XI. (1882) pp. 29–30 (1 pl.).
Klin. Monatsbl. f. Augenheilkunde, 1882.

ANON.—The Wonders of Optics.
[Inquiry for "a glass that I can see through paper or leather, and if you have one please to be kind enough to send me the price of it at once"; and reply of editor, "Punch a hole in the paper or leather."]
Micr. Bulletin, I. (1883) p. 7.

BARLOW, T.—See Tolles, R. B.

Bausch and Lomb Optical Co.'s new pattern "Investigator Improved" Microscope, and 1/4 in. objective.
[Coarse adjustment moves nearly 2 in. higher—pillar heavier and higher—separable swinging tail-pieces—Objective with extra large working distance.]
The Microscope, III. (1883) p. 239.

BELL, J. S. B.—Warm Stage and Stage Condenser for Diatomaceæ.
[Warm stage *post.* Stage condenser "simply an addition of a shutter to the hemispherical lens . . . . similar to that used by Powell and Lealand."]
Micr. News, IV. (1884) pp. 19–20.

BLACKHAM, G. E.—The relation of aperture to amplification in the selection of a series of Microscope Objectives. [*Post.*]
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 33–41.
Discussion, pp. 227–31.

„ „ See also Tolles, R. B.

BRADBURY, W.—The Achromatic Object-glass, XXIX.
Engl. Mech., XXXVIII. (1883) pp. 258–9 (1 fig.).

„ „ On Eye-pieces. „ „ (1884) pp. 401–2.

BULLOCH, W. H.—New Congress Nose-piece. Patented 1883. [*Supra*, p. 118.]
The Microscope, III. (1883) p. 218 (2 figs.).
Also U.S.A. Patent, No. 287904, of 23rd January, 1883.

C., J. A.—See Penny, W. G.

CARR, E.—Microscopic Test Objects. [*Supra*, p. 138.]
Engl. Mech., XXXVIII. (1883) p. 280.

COHEN, E., and GRIMM, J.—Sammlung von Mikrophotographien zur Veranschaulichung der Mikroskopischen Structur von Mineralien und Gesteinen. (Collection of micro-photographs for the demonstration of the microscopical structure of minerals and rocks.) Parts IX. and X. (conclusion). 38 pp. Plates 65–80. 4to, Stuttgart, 1883.

COHN, F.—Bicentenary of Bacteria.
[Calls attention to the fact that, in a letter dated 14th September, 1683, A. van Leeuwenhoek gave notice to the Royal Society that with the aid of his Microscope he had discovered in the white substance adhering to his teeth very little animals moving in a very lively fashion. "They were the first bacteria the human eye ever saw." [See also "L.," *infra.*]
Nature, XXIX. (1883) p. 154.

COLT, J. B.—Determination of the Foci of Lenses.
U.S.A. Patent, No. 288025, of 17th September, 1883.

COOMBS, C. P.—Address as President of the Postal Microscopical Society, 11th October, 1883.
[On "examining occasionally the food we eat or the clothes we wear."]
Journ. of Microscopy, III. (1884) pp. 1–7.

COX, J. D.—A new form of Microscope-stand with concentric movements. [*Post.*]
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 147–8 (1 fig.).
Discussion, pp. 235–6.

D., E. T.—Graphic Microscopy.
[Description of coloured lithograph of *Tingis Crassiochari.*]
Sci.-Gossip, 1884, pp. 1–2 (1 pl.).

DARLING, S.—Micrometer. U.S.A. Patent, No. 287420, of 1st March, 1883.

D., E. T.—Drawing from the Microscope.

[Points out the error of B. Hobson's suggestion—Vol. III. (1883) p. 725—of a semi-rotation of the stage to cure the inversion with the neutral tint reflector. Also remarks on the value of the camera lucida: "In microscopical work the camera lucida is merely a preliminary adjunct of limited utility in determining proportions; no graphic or perfect drawing is helped by its continued use; after affording the barest outlines and positions the instrument becomes an encumbrance, and those who are practised in its employment feel a palpable sense of relief, and breathe again, when it is got rid of, to settle down to the earnest work of direct vision from the Microscope."]

Sci.-Gossip, 1883, pp. 265–6 (1 fig.).

Dean, A.—Microscopical.

[Description of a "micro-magic lantern" with or without camera lucida.]

Engl. Mech., XXXVIII. (1884) p. 391 (1 fig.).

Detmers, H. J.—Resolution of *Amphipleura* by sunlight, mirror-bar central; with letters from R. B. Tolles and A. Y. Moore.

The Microscope, III. (1883) pp. 197–201 and p. 221.

Dickenson.—Art of photographing microscopic objects.

[The apparatus consists of (1) an inexpensive magic lantern, illuminated by a triplex petroleum lamp with the ordinary combination of lenses, and an extra tube with a small bull's-eye condenser; (2) a Microscope, placed horizontally, without the eye-piece; and (3) a frame to hold the glass screen for focusing the image, and to receive the sensitized plate when photographing. The period of exposure is from eighteen seconds to two hours.]

Note read before Academy of Medicine in Ireland.

Engl. Mech., XXXVIII. (1883) p. 279.

Sci.-Gossip, 1884, p. 17.

Dinner, Microscopists at.

[Facetious account of a mythical dinner at which "every article of food was carefully examined."]

The Microscope, III. (1883) p. 233.

Dippel, L.—Ein verstellbares Zeichenpult. (An adjustable drawing desk.)

[Reported as from *Lab. Hist. Collège de France*, 1883, p. 188, instead of 1879. [See Vol. III. (1883) p. 565.]

Bot. Centralbl., XVII. (1884) pp. 62–3 (2 figs.).

Eye-pieces, Report of the Committee on.

[Vol. III. (1883) p. 711.]

Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 175–7. Discussion, pp. 238–9.

Fischer, G.—Ueber einige Versuche zur Hebung der Chromatischen Aberration dioptrischer Fernrohre. (On some attempts to remove the Chromatic Aberration of dioptric Telescopes.)

[Contains an abstract of S. Merz's article "Ueber Dispersionsverhältnisse optischer Gläser" (Vol. II. (1882) p. 565), with additional remarks. Also report of letter from K. W. Zenger on his Endomersion Objectives, *ante*, Vol. III. (1883) p. 596, and *post*.]

Central-Ztg. f. Optik u. Mech., IV. (1883) pp. 265–7.

Grimm, J.—See Cohen, E.

Hager, H.—Le Microscope. Théorie et Application. (The Microscope. Theory and application.) Translated from the 4th German edition with annotations by L. Planchon and L. Hugounenq. Introduction by J. E. Planchon. x. and 264 pp., 350 figs. 18mo, Paris, 1884.

Hammond, A.—Address on resigning the chair of the Postal Microscopical Society.

[Account of the notes written by members of the Society on the slides circulated.]

Journ. of Microscopy, III. (1884) pp. 7–17.

Hilgard, Prof.—See Micrometer Scale.

HITCHCOCK, R.—Notes from Abroad.
[Ross & Co.'s establishment and Dr. Schröder. Messrs. R. & J. Beck. Mr. Crouch. Powell & Lealand. Swift & Son. Swift's Achromatic Condenser (2 figs.). Swift's Wale's Stand (1 fig.).]
Amer. Mon. Micr. Journ., IV. (1883) pp. 226–9 (3 figs.).

" " A new Camera Lucida.
[Dr. H. Schröder's, Vol. III. (1883) p. 813.]
Amer. Mon. Micr. Journ., IV. (1883) p. 230.

" " The Army Medical Museum.
[As to Dr. Woodward's retirement.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 236-7.

" " Testing a Microscope.
[Directions for testing (1) the centering of objectives, (2) the binocular.]
Amer. Mon. Micr. Journ., V. (1884) pp. 7–8.

" " A simple Eye-piece Indicator.
[A hair attached to the diaphragm of the eye-piece and extending half-way across the field of view.]
Amer. Mon. Micr. Journ., V. (1884) pp. 8–9.

" " Bulloch's improved "Biological" stand.
[Improved substage. *Post.*] *Amer. Mon. Micr. Journ.*, V. (1884) pp. 9–10.

" " Microscopical Societies.
[Recommending practical demonstrations like those of the Quekett Microscopical Club.]
Amer. Mon. Micr. Journ., V. (1884) p. 16.

See also Tolles, R. B.

HOLMES, E.—Drawing from the Microscope.
[Remarks on E. T. D. *supra*, and suggesting that with the neutral tint reflector "he has but to turn his slide over, i.e. cover downwards on the stage, to make his outlines, and then put his slide right way up when he fills in his detail freehand."]
Sci.-Gossip, 1884, pp. 17–18.

HOLMES (O. W.) Dr., and the Microscope.
[In a recent speech, in illustrating the microscopical facilities of the Harvard Medical School, he said :—"A man five feet high, enlarged to correspond with the Microscope power used, would be a mile high, would weigh 120,000,000,000 lbs., and could pick up the Boston State House and chuck it into the sea, cleaning out that ancient structure by a summary process which would put to shame the exploits of Commodus and his kind."]
Micr. News, III. (1883) p. 340.

HUGOUNENQ, L.—See Hager, H.

JAMES, F. L.—The Fakir and his little Fakes.
[I. Warning against using silver-plating fluid sold by street venders as it disintegrates the brass of objectives; formula for a good fluid. II. Anecdote of a street vender of Microscopes who showed paste eels as animalcules in water.]
The Microscope, III. (1883) pp. 193–7.

KOHL, G.—Boecker s neuer Zeichen-Apparat nach Dippel. (Boecker's new Drawing Apparatus after Dippel.) [*Supra*, p. 119.]
Bot. Centralbl., XVI. (1883) pp. 385–6 (1 fig.).

L.—Bicentenary of Bacteria.
[Suggests that the Royal Society should celebrate it by urging on the Government the formation of a national laboratory of hygiene.]
See also Cohn, F., *supra*.
Nature, XXIX. (1883) p. 154.

LIPPICH, F.—Vorschlag zur Construction eines neuen Spectral-apparatus. (Proposal for the construction of a new spectral apparatus.)
[Contains a description of an "Astigmatic Mikroskop-Ocular," consisting of two cylindrical and two plano-convex lenses, for use with a spectroscope.]
Zeitschr. f. Instrumentenk., IV. (1884) pp. 1–8 (2 figs.).

MANSFIELD, J. M.—Division of labour among microscopists. [*Post.*]
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 43–5. Discussion, pp. 231–2.

MATTHEWS' (J.) Simple Revolving Table.
[Two perfectly flat wooden boards, placed face to face, the upper one turning on a pivot in the centre of the lower. The lower board should have some rubber on its under surface, or some material which will cause it to remain in position on a table while the upper one is caused to revolve.]
Amer. Mon. Micr. Journ., IV. (1883) p. 238.

Micrometer Scale, A, 1882.
1. History of the National Committee on Micrometry. By R. H. Ward.
2. Report of the National Committee on Micrometry, and accompanying report of Prof. Hilgard.
3. A study of the Centimetre marked "A," prepared by the U.S. Bureau of Weights and Measures for the Committee on Micrometry. By W. A Rogers.
4. Rules for the control of the standard Micrometer.
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 178–200.

"Monachus."—Microscopic Test Objects. [*Supra*, pp. 140–1.]
Engl. Mech., XXXVIII. (1883–4) p. 341 and p. 431 (1 fig.).

MOORE, A. Y.—The Resolution of *Amphipleura pellucida*. A reply to Dr. Detmers.
The Microscope, III. (1883) pp. 201–4. (See also pp. 200–1.)

NELSON, E. M.—Microscopic Test Objects. [*Supra*, pp. 139–40.]
Engl. Mech., XXXVIII. (1883) p. 324 and p. 386 (3 figs.).
„ „ On the relation of Aperture to Power in Microscope Object-glasses. [*Post.*]
Engl. Mech., XXXVIII. (1883) pp. 367–8.

NUNN, R. J.—The Microscope in Medical Gynecology.
["For clinical microscopy no great depth of learning nor an intimate acquaintance with fine-spun theories is required, but a plain practical knowledge of the names and appearance of a few of the forms which the Microscope reveals. It is not necessary to know what everything seen in the Microscope is; it is sufficient to know what it is not. Just as it is not necessary to be an accomplished botanist to distinguish an oak tree from a turnip, or to be a deeply learned naturalist to tell a horse from a goat, so it is unnecessary to be a thorough pathologist to be able to make good use of the Microscope for clinical purposes."]
Sep. repr. from *Trans. Med. Assoc. Georgia*, 1883, pp. 8–10.

PENNY, W. G.—Theory of the Eye-piece. I. The Dispersion of Light. II. Dispersion of Light. Also criticisms by J. A. C. III. Spherical Aberration.
Engl. Mech., XXXVIII. (1883) p. 283 (1 fig.), p. 367 (1 fig.), p. 390 (1 fig.).

PFAFF's Mikrogoniometer.
Hoffmann's Bericht u. d. Wiss. App. a. d. Londoner Internat. Ausstell. 1876 (1881) pp. 435–6 (1 fig.), p. 738.

PLANCHON, J. E.—See Hager, H.

POULSEN, V. A.—Botanical Micro-chemistry. Translated with the assistance of the author, and considerably enlarged by W. Trelease. [*Supra*, p. 91.] xviii. and 118 pp., 8vo., Boston 1884.

POWELL, Hugh, Death of.
Engl. Mech., XXXVIII. (1883) p. 279, from *Times*, Nov. 1883; *Sci.-Gossip*, 1884, p. 17; *Journ. of Science*, VI. (1884) p. 51.

"Prismatique."—Object-glass working, IX. and X.
Engl. Mech., XXXVIII. (1883–4) p. 296 (1 fig.), pp. 420–1.

REZNER, W. B.—See Vorce, C. M.

ROGERS, W. A.—A critical study of the action of a diamond in ruling lines upon glass. [*Supra*, p. 126.]
Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 149–65.
„ „ See Micrometer Scale.

STOKES, A. C.—A Growing-cell for minute Organisms. [*Supra*, p. 122.]
Sci.-Gossip, 1883, pp. 8–9 (1 fig.).

STOWELL, C. H. and L. R.—A new Microscopical Journal.
['Science Record.'] *The Microscope*, III. (1883) p. 223.

„ „ Fasoldt's Micrometers.
[Micrometer which showed Newton's rings in a beautiful manner; also a newly ruled micrometer, each alternate line being ruled longer, so that the end of each band is half the value of the band proper; that is, if the band was in the field ruled 50,000 to the inch, then the end of that band would show 25,000 to the inch. Therefore, as Mr. Fasoldt says, "one can easily judge if there is any diffraction."]
The Microscope, III. (1883) p. 239.

„ C. H.—A Microscopic Inflation.
[Facetious rejoinder to Dr. O. W. Holmes' statement, *supra*, as to the size of an enlarged Harvard student.]
The Microscope, IV. (1883) pp. 10–11.

„ „ See Tolles, R. B.

T. T.—Microscopic Test Objects.
[Points out the error in E. M. Nelson's suggestion, *supra*, p. 139, that objectives should not be tested by oblique light.]
Engl. Mech., XXXVIII. (1884) p. 386.

„ Relation of Aperture to Power in Microscope Object-glasses.
[Reply to E. M. Nelson, *supra*, showing the wide difference between his figures and those of Prof. Abbe.]
Engl. Mech., XXXVIII. (1884) p. 410.

TETLOW, D.—Microscope. U.S.A. Patent, No. 287978, of 24th August, 1883.

TOLLES, R. B., Death of. *Boston Evening Transcript*, 28th Nov., 1883.
Engl. Mech., XXXVIII. (1883) p. 336.
Science, III. (1883) p. 726.
["Mr. Tolles has been long known for the construction of Microscopes and Telescopes of unusually short focus. He made the highest-power Microscope produced in America"!] *Athenæum*, 1883, p. 819.
Micr. News, IV. (1884) p. 25.
The Microscope, IV. (1884) pp. 3–4 (T. Barlow); pp. 4–5 (C. H. Stowell); pp. 5–6 (G. E. Blackham).
Amer. Mon. Micr. Journ., V. (1884) pp. 10–11 (S. Wells and R. Hitchcock).
Micr. Bull., X. (1883) pp. 5–6.
Science Record, II. (1883) p. 43.

„ „ See Detmers, H. J.

TÖRNEBOHM, A. E.—Ueber eine Vorrichtung an Mikroskoptischen zur allgemein gültigen Fixirung eines bestimmten Punktes in einem Präparat. (On an arrangement of the microscope-stage for the universal fixing of a given point in a preparation.) [*Post.*]
Neues Jahrb. f. Mineral., 1883, I., pp. 195–6.

TRELEASE, W.—See Poulsen, V. A.

VORCE, C. M.—A Memoir of W. B. Rezner.
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 242–5.

WALMSLEY, W. H.—Photo-micrography with dry-plates and lamplight.
[Vol. III. (1883) p. 556.]
Proc. Amer. Soc. Micr., 6th Anu. Meeting, pp. 59–64 (1 fig.).

WARD, R. H.—See Micrometer Scale.

WELLS, S.—See Tolles, R. B.

WHITING, SARAH F.—College Microscopical Societies.
[Advantages of such societies, and how they can be made a success.]
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 27–31.
Discussion, pp. 225–7.

WRIGHT, L.—Lantern and Limelight matters.
[Comparative optical conditions of wick'd lamps and the limelight—Condensers—Lime-jets.]
Engl. Mech., XXXVIII. (1883) pp. 343–4 (2 figs.).

ZENGER, K. W.—See Fischer, G.

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

Mounting and Photographing Sections of Central Nervous System of Reptiles and Batrachians.*—Dr. J. J. Mason describes the methods he employed in mounting the sections from which the plates illustrating his book † were "artotyped."

"Both the brain and spinal cord were entirely separated from the body, and, with their membranes, placed in iodine-tinted alcohol until they had acquired a slight degree of consistency—from six to twelve hours. They were then transferred to a 3 : 100 solution of bichromate of potash, with a small piece of camphor, in a tightly corked wide-mouthed bottle, and allowed to remain until ready for cutting, renewing the solution every two weeks.

The time required for the hardening process varies considerably in different animals, and this variation is more dependent upon the class of animal than upon the relative dimensions of the specimens.

For example: on the same day I placed the brain of a large rattlesnake with that of a small salamander in the same bottle, and at the end of six weeks the former was ready for section, whilst the latter was not sufficiently hard until a month afterwards. By thus employing the same reagent in all cases, I have been able to note constant differences in the action of both the hardening and the colouring agent, carmine.

Perhaps the most striking illustration of this is furnished by the nervous centres of tailed batrachians, which, while they stain very readily, invariably require about a third more time to harden than specimens from the other orders. Specimens from ophidians stain less satisfactorily than those from any other of the classes which I have studied, while with the spinal cords of alligators, turtles, and frogs failure to obtain good results in this particular is very rare.

In all cases the sections have been stained after cutting, injury from excessive handling being wholly avoided by the use of siphon-

* 'Minute Structure of the Central Nervous System of certain Reptiles and Batrachians of America,' 1879–1882. Cf. iii. (1883) p. 910.

† "The methods of histology have reached a perfection which is building up new departments of knowledge, and among successful pioneers in these labours Dr. Mason will always hold an honoured place for the technical skill with which he brings the reader face to face with the revelations of his Microscope, and for the sumptuousness with which his work is given to the world. No such monograph has previously come under our notice, for the illustrations of a difficult research leave nothing to be desired. . . .

"No words could do justice to the beauty of the plates or the value of the information they convey; and it is not too much to regard this work as opening a new era in research by substituting knowledge of facts of microscopical structure for their interpretation by the hand of artist or author; but we can scarcely hope to see many books so beautifully illustrated. The author's method has the merit of inaugurating a comparison of the minute anatomy of the nervous system by enabling the reader to see the structures which he has discovered as he saw them; and hence the book will always be a valuable work of reference; and it will certainly induce others to hand on the torch of knowledge in a like excellent way."—From Bibliographical Notice in Ann. and Mag. Nat. Hist., xii. (1883) pp. 270–4.

tubes to remove the alcohol and washings. For producing transparency, oil of cloves has been used, and the mounting has been done under thin, clear covers, in a solution of Canada balsam in chloroform.

All the negatives have been made on glass thoroughly cleaned and lightly coated with a solution of wax and benzole, so that the collodion film, previously made adherent to thin sheets of gelatine, could be safely removed from the plate. The flexible negatives thus obtained are well adapted to the artotype process, and, as they can be indefinitely preserved between the leaves of an ordinary scrap-book, are very desirable for a series of illustrations. In making the original negatives on glass, the 'wet collodion process,' with the sulphate of iron developer, has been exclusively employed.

The prints correspond exactly with the negatives, both in outline and detail. No distortion occurs as in silver printing, in which process the paper is subjected to prolonged washing.

In many of the photographs the grey substance appears lighter in shade than the white substance. This appearance is due to a greater degree of transparency of the grey substance in these sections, resulting from the action of the oil of cloves, followed by an increased action of the transmitted light on the sensitive collodion film of the negative, and hence by a thinner deposit of ink over corresponding parts of the positive plates from which the artotypes are printed."

With regard to the process employed, Dr. Mason says that after experimenting with various methods he found that satisfactory prints could be made in ink directly upon plate paper, and that these impressions were as perfect in fine detail as any of those obtained by the silver process of printing. The plates (all printed by the artotype process) are as durable as steel engravings. "While a photograph cannot often show all that can be discovered by more direct microscopic observation with a judicious working of the fine adjustment, high authority has stated, and perhaps correctly, that a good photograph with a low power—say from 3 to 1/2 in.—is a better means of illustrating the anatomical structure of the nervous tissues than hand drawing. Some of the plates with high powers leave much to be desired both in distinctness and tone, and in general it may be affirmed that the same defect as regards distinctness always exists, and for obvious reasons, in photographs of sections with powers much above 1/2 in. In fact it now appears to be established that immersion objectives can never be employed for photographing section-preparations with the success that has attended their use for blood corpuscles, diatoms, and similar specimens."

Preparing Spermatozoa of the Newt.*—G. F. Dowdeswell writes that to prepare the spermatozoa of the newt for the examination of the minute barb discovered by him, the first essential is to get them as nearly as possible in contact with the cover-glass and flat upon it; this requires some care to avoid their drying, by which they are

* Quart. Journ. Micr. Sci., xxiii. (1883) pp. 336-9 (1 fig.).

materially altered. They may be preserved by several methods, either by treating for twelve to twenty-four hours with a concentrated solution of picric acid, a dilute solution of chromic acid, by Dr. Klein's method with a 5 per cent. solution of ammonium chromate, by iodine, by silver nitrate, or by osmic acid or gold chloride; the latter are convenient as being quicker. He has most usually employed picric acid. For staining glycerine, magenta * is the best method, as it stains all parts as strongly as desired. To show the general structure alcoholic carminate of ammonia is the most satisfactory, but it does not stain the barb deeply. Other anilin dyes have not been found to answer so well.

The use of glycerine as a mounting fluid for preparations stained with any of the anilin dyes is at best troublesome,† and sooner or later, in the author's experience, the staining runs and the preparation is spoiled. Solutions of acetate of potash or chloride of calcium have not been found satisfactory, the forms, even of such resistant objects as bacteria, in some cases becoming materially altered by these reagents. With Canada balsam, even when dissolved in chloroform or turpentine, the preparations have not been found to fade, as has sometimes been said to be the case, and as we should have expected; nor, if they are sufficiently washed in alcohol and passed through oil of cloves, will they run. The risk, however, of both fading and running may be entirely obviated by using benzine as a solvent for the balsam, or by employing it undiluted and liquefied by warmth.

Killing Hydroid Zoophytes and Polyzoa with the Tentacles extended.‡—H. C. Chadwick recommends the polyzoon to be placed in a small beaker or clear glass bottle, and allowed to remain at rest for several hours. Now take a dipping-tube drawn out to a very fine point and charge it with absolute alcohol. Having ascertained by means of a pocket-lens that the polypides are fully extended, allow the alcohol to drop very gently from the point of the tube, which should be held just above the surface of the water. The success of the experiment depends largely upon the care with which the first quantity of alcohol is introduced into the water. After the lapse of an hour, if the polypides are still extended, a further quantity of alcohol is added until the quantity reaches 60 per cent.

After passing through 75 per cent. alcohol, the specimens may be kept in 90 per cent. of the same until required for mounting. Experiments with alcohol upon hydroid zoophytes were not so successful, but Kleinenberg's picrosulphuric acid solution § gave excellent results. The use of this reagent is attended with much less difficulty than that of alcohol. If the subject of the experiment is a zoophyte,

* Magenta cryst. 1 part; glycerine 200 parts; alcohol 150 parts; aq. 150 parts; immerse the preparation in the solution for from two to four minutes, according to the depth of colouring required, and then wash.

† The method is, add an equal bulk of glycerine to the aqueous solution of the anilin dye used, stain somewhat more deeply than requisite, mount on slide with cover-glass in the staining fluid, which is to be gradually replaced as the water evaporates by plain glycerine.

‡ Micr. News, iii. (1883) pp. 333–4.

§ Cf. this Journal, ii. (1882) p. 867.

such as *Aglaophenia pluma* or *Plumularia setacea*, it must be allowed to remain some hours until the polypides are fully extended. Kleinenberg's fluid must then be introduced by means of a dipping-tube. It may be allowed to flow over the specimen in a continuous stream, until the whole of the water assumes a golden yellow colour. The reagent causes instant death, so that the specimens may be transferred immediately to 60 per cent., and afterwards to 75 per cent. alcohol, allowing them to remain in each solution for some hours. Keep in 90 per cent. alcohol. From four to six minutes' immersion in Martindale's picrocarmine staining fluid is sufficient to stain specimens killed by either of the above methods.

Mounting Pollen as an Opaque Object.*—W. Blackburn gives directions for mounting pollen dry upon the anther from which it has escaped. For collecting and drying the anthers, the flowers should be gathered when full-blown, just before they begin to fade, and the stamens then cut with fine scissors a short distance from the anthers, the latter being allowed to fall upon clean writing paper, when a selection may be made with a pocket-lens of the specimens most suitable for preservation. Folding the paper without pressure, place the packet in a box, where the author lets it remain in oblivion for twelve months or perhaps two years. In the case of large anthers, such as the *Lilium auratum*, it may be advisable to lay them on a piece of blotting-paper, inside the writing-paper, in order the better to absorb moisture, care being taken when mounting, to remove any adhering fibres of the blotting material with a needle.

Thin metal and bone cells may be used for mounting. The metal ones may be either of brass or block tin. For small anthers, such as those of *Ranunculus aquatilis*, the ordinary 1/2 in. brass cells are suitable. For larger anthers, or groups of stamens and anthers, such as may be made from the *Abutilon*, 5/8 in. and 3/4 in. bone cells are the best. Bone is much preferable to metal for its adhesive capacity when affixed to glass, and the bone cells usually sold have their surfaces "truer" than those of metal. For cement use "quick-setting" gold size.

When about to mount the anthers, paint the bottom of the cell with "matt-black," using the turntable, so as to distribute it evenly over the glass. When the "black" is partially dry, place the anthers upon it in suitable positions, and gently press them with a blunt needle so as to secure their adhesion to the cement. The best effect will be produced when the anthers are arranged in the centre of the cell with the stamens directed on one side, as in their natural position. This, however, may be left to the taste of the mounter; and in many cases no arrangement of this kind will be required, as one or other will be found large enough to fill the cell. When there is found to be a deficiency of pollen on any of the anthers after mounting, some pollen may be taken on the point of a needle from other anthers and placed in position on the bare parts, when gently breathing upon it will fix it.

* Micr. News, iii. (1883) pp. 297–9.

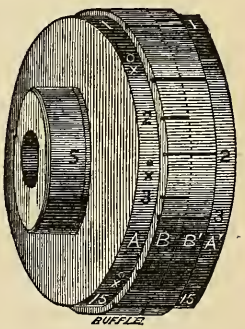
Mounting Fluid for Algæ.*—For preserving the cell-contents and the natural colour and form of desmids, volvox, and other algæ, G. W. Morehouse finds a mounting fluid made as follows to act well: Dissolve 15 grains of acetate of copper in a mixture of 4 fluid ounces of camphor water, 4 fluid ounces of distilled water, and 20 minims of glacial acetic acid; add 8 fluid ounces of Price's glycerine, and filter. When sections of plant-stems, or other vegetable specimens, are mounted in this fluid, the protoplasm is preserved. If, in any case, it is thought desirable to increase or diminish the specific gravity of the preservative, the proportion of glycerine may be changed. Used as above, or modified as indicated, he thinks it also a trustworthy medium for mounting infusoria and the softer animal tissues.

Mounting Diatoms in Series.†—P. Francotte has applied Giesbrecht's method ‡ of mounting sections in series to the mounting of diatoms. The slide is coated with the solution of shellac in alcohol washed over with oil of olives or creosote, and the diatoms, previously placed in absolute alcohol, arranged in order. The slide is then warmed, and the oil of cloves or creosote evaporated.

Schällibaum's process § for sections would also be available for the same purpose.

Registering Micrometer-screw to the Thoma Microtome.‖—Dr. C. O. Whitman gives the following more detailed description of this screw, which we described at pp. 914–5 of vol. iii. (1883) from the original article of Andres, Giesbrecht, and Mayer, the designers of the arrangement for regulating its movement. This arrangement consists of a spring which, after a given number of divisions of the drum, registers to the ear and finger of the manipulator the number of micromillimetres which the object has been raised. The intervals between the registering clicks can be varied by means of a vernier-like adjustment of the two halves of the drum, so as to equal an entire revolution of the drum, or only 1/15, 1/3, or 1/2 of a revolution.

Fig. 27.



An examination of fig. 27, which illustrates the new form of the drum, will show how the intervals are regulated. The drum is composed of two symmetrical halves, A B and A′ B′, so closely opposed that the dividing line (dotted in the figure) is scarcely visible. The periphery of each half is composed of two zones of unequal radii. The large zones, B and B′, are in apposition, and together form the graduated

* Amer. Mon. Micr. Journ., iv. (1883) pp. 234–5.
† Bull. Soc. Belg. Micr., x. (1883) pp. 43–8.
‡ See this Journal, ii. (1882) p. 888.
§ See this Journal, iii. (1883) p. 736.
‖ Amer. Natural., xvii. (1883) pp. 1313–4 (1 fig.).

portion of the drum. Each of the smaller zones is marked with the figures 1, 2, 3, and 15. When the drum is in order for work, it rotates with the screw, which is marked *g g* in fig. 53, vol. iii. (1883) p. 302.

The left half of the drum A B is held in position by the screw S, and may be rotated independently of the right half A′ B′, or [of the screw *g g*, by the aid of a handle which fits the holes *x x x*.

When the half A B is adjusted to the half A′ B′, in the manner represented in the figure, the fifteen equal parts into which the zone B is divided exactly correspond to the same number of parts in the zone B′, so that the grooves which mark these parts in one zone, become continuous with those of the other zone. Thus adjusted, the spring, which rides on the zones B B′, with a sharp edge parallel to the grooves, will give fifteen sharp clicks in the course of one rotation of the drum, the click being heard every time the sharp edge falls into coincident grooves. In order to adjust for fifteen clicks, it is only necessary to rotate A B until groove 15 becomes continuous with groove 15 of the opposite half (A′ B′). For one click in one rotation, the grooves 1, 1 must be made to coincide; for two clicks the grooves 2, 2, and for three clicks the grooves 3, 3. The intervals between successive clicks may thus be made to correspond to 1/1, 1/2, 1/3 or 1/15 of a complete rotation of the drum, and the thickness of sections corresponding to these intervals should be respectively ·015, ·0015, ·005, ·001 mm.

Acheson, G.—Biological Study of the Tap Water in the School of Practical Science, Toronto.
[Methods of examination—Diatomaceæ—Desmidiaceæ—Phycochromaceæ—Schizophytæ—Protozoa—Vermes—Arthropoda.]
Proc. Canad. Institute, I. (1883) pp. 413–26 (1 pl. to follow).

Ady, J. E.—Microscopical Technology. On the exhibition (*sic*) of Canada Balsam.
[Directions for mounting sections of tissues in Canada balsam.]
Sci.-Gossip, 1884, pp. 5–8.

Ady's (J. E.) New Morphological Institution [for the production of micrographical preparations, and especially of rock and mineral sections].
Sci.-Gossip, 1883, pp. 276–7; 1884, p. 18.
See also *Nature*, XXIX. (1884) p. 283.

Ami, H. M.—Use of the Microscope in determining Fossils, with especial reference to the Monticuliporidæ. *Science*, III. (1884) pp. 25–6.

Aylward's (H. P.) Pond-life Apparatus. [Vol. III. (1883) p. 911.]
Sci.-Gossip, 1883, p. 276.

Barré, P.—Sur un procédé de préparation synoptique d'objets pulvérulents. Diatomées des guanos, terres fossiles, &c. (On a process of synoptic preparation of pulverulent objects. Diatoms from guano, fossil earths, &c.)
[*Post.*] *Bull. Soc. Belg. Micr.*, X. (1883) pp. 16–8 (1 pl.).

Belfield, W. T.—The Microscope in the detection of Lard Adulteration.
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 97–103 (1 pl.).

Bennett, C. H.—Mounting Entomological Slides.
[Treat the object for a week or a month, as the case may require, with liq. potassæ until thoroughly bleached; then, without removing the contents of the cavities, or in any way subjecting to the slightest pressure, mount in glycerine in a cell of ample depth so as to allow the object to retain its natural form and position.]
The Microscope, III. (1883) p. 220.

Braman, B.—Microscopic Evidence of the Antiquity of Articles of Stone.
Amer. Mon. Micr. Journ., V. (1884) pp. 14–5.

BROOKS' (H.) Sets of sections of Woods for instruction in schools.
["The sections are about 2 × 4 in., and are neatly mounted between plates of mica. Three sections (one cross and two longitudinal) are given for each kind of wood, and these are thin enough to make their study with the naked eye or with a low power very easy and instructive."]
Amer. Natural., XVII. (1883) p. 1285.

BURRILL, T. J.—Preparing and mounting Bacteria.
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 79–85.
„ „ To stain *Bacillus tuberculosis*.
["Many ways have been tried to leave the alcohol out and yet obtain a stain as good as that of the published formulas. The following seems to be the thing sought:—Glycerine, 20 parts; fuchsin, 3 parts; anilin oil, 2 parts; carbolic acid, 2 parts."—Also directions for use.]
The Microscope, IV. (1884) pp. 6–8.

CARPENTER, W. B.—Remarks on Microscopical Observation.
Syllabus of Carlisle Microscopical Society, 1884.
Micr. News, IV. (1884) pp. 23–4.

CHADWICK, H. C.—On some experiments made with a view of killing Hydroid Zoophytes and Polyzoa with the tentacles extended. [*Supra*, p. 151.]
Micr. News, III. (1883) pp. 333–4.

CHESTER, A. H.—A new method of Dry Mounting.
[Vol. III. (1883) p. 737.]
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 143–5 (1 fig.).

CHEYNEY, J.—The Microscopic Study of Fibres.
[The Microscope in the dye-room—The marks of perfect dyeing—Marks of imperfect dyeing—The location of defects.]
Micr. News, IV. (1884) pp. 7–9, from *Textile Record of America*.

COLE, A. C.—Popular Microscopical Studies.
No. III. The Scalp. Vertical Section of Human Scalp. Double-stained. Plate 3 × 25. pp. 11–14.
No. IV. The Ovary of a Poppy. Transverse section of Ovary of *Papaver rhœas* (unfertilized). Plate 4 × 50. pp. 15–20.
No. V. A Grain of Wheat. pp. 21–4. Plate 5. Long. sec. of Embryo at base of wheat-grain. Stained carmine. × 50.
„ „ The Methods of Microscopical Research. Part V. The Preparation of Animal Tissues (*continued*). pp. xxv.–xxxii. (2 figs.).
[Silver nitrate—Chloride of gold—Injection of Blood-vessels (Injecting Apparatus, Fearnley's Constant Pressure Apparatus).]
Part VI. pp. xxxiii.–xl. How to preserve Botanical specimens. On Animal and Vegetable Section-cutting. Rutherford's, Williams', Fearnley's and Cathcart's Microtomes. Gum and syrup preserving fluid. To cut tissues soaked in gum and syrup medium. Cutting by imbedding.
„ „ Studies in Microscopical Science.
Vol. II. No. 7. Section 1. No. 4. Epithelium. pp. 13–16. Plate 4, × 400.
No. 8. Section 2. No. 4. Chap. II. The Cell as an Individual. pp. 13–16. Plate 3 (*Micrasterias denticulata* × 200).
No. 9. Sec. 1. No. 5. Cartilage. pp. 17–19. Plate 5. T. S. Hyaline Cartilage. Human Trachea × 250.
No. 10. Section 2. No. 5. Chap. III. The Morphology of Tissues. pp. 17–20. (Plate to follow.)

DOWDESWELL, G. F.—Note on a minute point in the structure of the Spermatozoon of the Newt.
[Contains directions for preparing the spermatozoa, *supra*, p. 150.]
Quart. Journ. Micr. Sci., XXIII. (1883) pp. 336–9 (1 fig.).

FRANCOTTE, P.—Description des différentes méthodes employées pour ranger les coupes [et les Diatomées] en série sur le porte-objet. (Description of the different methods adopted for mounting sections [and diatoms] in series on the slide.)
[Description of Mayer's, Giesbrecht's, Schällibaum's, and Threlfall's methods; also the application of the second and third to diatoms, *supra*, p. 153.]
Bull. Soc. Belj. Micr., X. (1883) pp. 43–8, 63–6.

FRANCOTTE, P.—Microtomes et méthodes d'inclusion, I. (Microtomes and methods of imbedding.)

[Describes Thoma's Microtome and various methods already published.]

Bull. Soc. Belg. Micr., X. (1884) pp. 55–63 (1 fig. and 1 pl.).

FREEMAN, H. E.—Cutting Glass-circles.

[Perforated wooden slips and writing diamond with *turned* point, the thin glass to rest on plate-glass; very little pressure on diamond; it is better to leave the circles a day or two before breaking them out of the glass.]

Journ. of Microscopy, III. (1884) p. 47.

G., W. B.—Cement for objects mounted in spirits of wine.

[Same as *ante*, Vol. III. (1883) p. 613. The cement a "secret."]

Midl. Natural., VI. (1883) p. 282.

GAGE, S. H.—Cataloguing, labeling, and storing Microscopical preparations.

[Vol. III. (1883) p. 924.]

Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 169–74 (2 figs.). Discussion, pp. 236–8.

,, „ and SMITH, T.—Serial Microscopic Sections. [*Post.*]

Medical Student (N.Y.) I. (1883) pp. 14–6.

GILLIATT, H.—Some remarks on the action of Tannin on Infusoria.

[Vol. III. (1883) p. 861.]

Proc. Linn. Soc. N. S. Wales, VIII. (1883) pp. 383–6.

GRANT, F.—Microscopic Mounting.

IV. Section Cutting, Staining, &c.

[1. Sections. 2. Section Cutting. 3. Staining. 4. Various practical details.]

Engl. Mech., XXXVIII. (1883) pp. 285–6.

V. The Use of Reagents.

[1. The use of Reagents in general. 2. Glycerine and Syrup. 3. Acids and Alkalis.]

Engl. Mech., XXXVIII. (1883) pp. 365–7.

VI. Chloroform.—Vegetable Objects.

[1. Chloroform or Benzol, for thinning Canada balsam. 2. Non-fructifying organs of higher plants. 3. Ways in which vegetable sections should be cut. 4. Bleaching. 5. Staining.]

Engl. Mech., XXXVIII. (1884) pp. 386–8.

VII. Staining.

[1. Staining in general.—Transient stains. 2. Metallic impregnations.—Diffuse, bioplasmic, and special tissue stains. 3. Hæmatoxylin and Carmine. 4. Indigo Carmine, Aniline, and Phthalein stains. 5. Double staining.]

Engl. Mech., XXXVIII. (1884) pp. 449–50.

GRIFFITH, E. H.—Practical Helps.

[Ringing slides—Photograph slides—Mounts without covers—Arranging Diatoms, *post.*]

The Microscope, III. (1883) pp. 204–6.

H., H.—Microscopic Mounting.

Engl. Mech., XXXVIII. (1883) p. 266.

HAACKE, W.—Ueber das Montiren von Alcoholpräparaten. (On the mounting of alcohol preparations.)

[For microscopic objects for Museums.] *Zool. Anzeig.* VI. (1883) pp. 694–5.

HAMLIN, F. M.—The microscopical examination of seminal stains on cloth.

[Describes a new process, as "Koblanck's method, with its soakings and manipulations, tends to destroy so many of the spermatozoa as to lessen greatly the certainty of finding them."]

Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 21–5. Discussion, pp. 220–5.

,, „ The preparation and mounting of Foraminifera, with description of a new slide for opaque objects. [*Post.*]

Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 65–8.

Hitchcock, R.—Preservation of Museum specimens.
[Description of the Naples Zoological Station specimens at the Fisheries Exhibition. The living creatures are plunged into a solution of iodine or a strong solution of corrosive sublimate and transferred to dilute spirit, in which they are permanently preserved.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 217–8.

„ „ Exorbitant prices of mounted specimens of microscopic objects in America. *Amer. Mon. Micr. Journ.*, IV. (1883) p. 218.

„ „ Glycerine in Mounting.
Amer. Mon. Micr. Journ., V. (1884) pp. 15–6.

„ „ See Vorce, C. M.

Jacobs, F. O.—How to make a section of Tooth with pulp.
The Microscope, IV. (1884) pp. 8–9.

Kellicott, D. S.—Notes on Protozoa. No. 2.
[Agrees with the opinion of H. Gilliatt, III. (1883) p. 861, that the needle-like bodies seen when *Paramecium* is treated with tannin and glycerine are not cilia but trichocysts.]
Bull. Buffalo Naturalists' Field Club, I. (1883) pp. 109–17.

Kingsley, J. S.—Rapid Microscopic Mounting.
[Describes Giesbrecht's and Caldwell's methods of series preparations.]
Science Record, II. (1883) pp. 1–2.

„ „ Glycerine Mounting.
["One great difficulty in its use is in fastening the cover-glass firmly. Various modes of procedure have been described, possibly the best the writer has seen in print being that which employs paraffin. A still better method is to use a very small amount of glycerine, so little in fact that when the cover is applied the margin of the glycerine does not reach the edge of the glass. Then with a fine brush, balsam or dammar dissolved in benzol is allowed to run in under the edge of the cover-glass, and after becoming hard the superfluous balsam is cleaned off and the slide finished in any desired manner."]
Science Record, II. (1883) p. 17.

Könike, F.—Die zweckmässigste Wasser-regeneration der Aquarien mit microscopischen Sachen. (The most effective mode of regenerating the water of Aquaria having microscopical objects.) [*Post.*]
Zool. Anzeig., VI. (1883) pp. 638–9.

Low-Sergeant, W. [*Low-Sarjeant* p. cxxxi—*Low-Sargeant* wrapper].—New process for Preserving Plants. [*Post.*]
Proc. and Trans. Croydon Micr. and Nat. Hist. Club, 1882–1883, pp. cii.–iii.

Maggi, L.—Technica Protistologica. Cloruro di Palladio. (Protistological Technics. Chloride of Palladium.) *Bollett. Scientif.*, V. (1883) pp. 48–51.

Mayer, P.—Einfache Methode zum Aufkleben mikroskopischer Schnitte. (Simple method of fixing microscopical sections.) [*Post.*]
MT. Zool. Stat. Neapel, IV. (1883) pp. 521–2.

McCalla, A.—President's Address to the 6th Annual Meeting of the American Society of Microscopists. The Verification of Microscopic Observation.
[Vol. III. (1883) p. 766.]
Proc. Amer. Soc. Micr., 6th Ann. Meeting, pp. 1–19.

Morehouse, G. W.—A new Mounting Fluid. [*Post.*]
Amer. Mon. Micr. Journ., IV. (1883) pp. 234–5.

Muller, C. J.—The discrimination of Species of Wood by a microscopical examination of sections of branches.
Trans. Eastbourne Nat. Hist. Soc., I. (1883) pp. 4–12.

Parietti, E.—Ricerche relative alla preparazione e conservazione di Bacteri e d'Infusori. (Researches on the preparation and preservation of Bacteria and Infusoria.)
Bollett. Scientif., V. (1883) pp. 95–6.

Peticolas' (C. L.) New Slides of Diatoms.

["Slide No. 1, *Stauroneis acuta.*—Microscopists are familiar with the beautiful effects of dark-field illumination upon certain diatoms. Some peculiarities of structure are shown by this method more clearly than by transmitted light. A recent gathering of *St. acuta* (*Pleurostaurum acutum* Grunow) has given me a sensation, although I have practised this method of illumination for years. With a 1/2 inch objective and a strong artificial light on dark field, this diatom seems literally to blaze, and surpasses in splendour the finest polariscope objects in my cabinet. With the light thrown across the short diameter, there is a strong resemblance to a section of ostrich tendon, only some peculiarity of striation seems to impart motion to the light, and the diatom seems on fire; across the long diameter the colour is changed to a brilliant sapphire.]

Amer. Mon. Micr. Journ., IV. (1883) p. 234.

Pillsbury, J. H.—A new Microscope Slide Cabinet. [*Post.*]

Science Record, II. (1883) pp. 25–6 (2 figs.).

Queen, J. W. & Co.—Improved Slide Box.

[Covered with cloth instead of paper; inside of lid with numbered lines for indexing.]

Micr. Bulletin, I. (1883) p. 7 (1 fig.).

R., D.—Classification and Labelling of Microscopical Objects.

[Suggestion that locality should be added to I. C. Thompson's labels, Vol. III. (1883) p. 926.]

Sci.-Gossip, 1883, p. 276.

Ralph, T. S.—Thymol as a Polariscopic Object.

[A most splendid polariscopic object. If a very small piece, about the size of a mustard-seed (or perhaps two) is placed at the edge of a cover-glass on a slide (not under), and then made to melt, it will run under it in a very fine film and crystallize on cooling. But before this take place, it should be placed on the stage, with the polarizing apparatus ready, so as to watch the process of crystallization. The effects far exceed that of most polariscopic objects. The same specimen carefully remelted can be used over and over again.]

Journ. of Microscopy, III. (1884) pp. 31–2.

Rataboul, J.—Les Diatomées. Récolte et préparation. I. Récolte des Diatomées. (The Diatomaceæ. Collection and preparation. I. Collection of the Diatomaceæ.) (In part.) *Journ. de Microgr.*, VII. (1883) pp. 644–6 (1 pl.).

Reinold, A. W., and A. W. Rücker.—Liquid Films and Molecular Magnitudes. [*Post.*] *Proc. Roy. Soc.*, XXXV. (1883) pp. 149–51.

Renson, C.—Nouveau procédé de recherche des Trichines dans les Viandes. (New method of research for *Trichinæ* in meat.) [*Post.*]

Bull. Soc. Belg. Micr., X. (1883) pp. 24–25.

Rothrock, J. T.—Some microscopic distinctions between good and bad Timber of the same species. *Amer. Phil. Soc.*, Feb. 1883.

Rothwell's (W. G.) Educational Slides. *Micr. News*, III. (1883) p. 340.

Royston-Pigott, G. W.—Note on the structure of the Scales of Butterflies.

Trans. Eastbourne Nat. Hist. Soc., I. (1883) pp. 41–5.

Rücker, A. W.—See A. W. Reinold.

Schaeffer, E. M.—The Microscopical Study of the Crystallization of Allotropic Sulphur.

[Contains directions for preparing.]

Amer. Mon. Micr. Journ., V. (1884) pp. 1–3.

Schnetzler.—Notiz über Tanninreaction bei Süsswasseralgen. (Note on the reaction of tannin in the fresh-water Algæ.) [*Post.*]

Bot. Centralbl., XVI. (1883) pp. 157–8.

Scott, W. B.—Imbedding in Egg-mass.

[Ruge's improvement of Calberla's method. Cf. Vol. III. (1883), pp. 303–4.]

Science Record, III. (1883) pp. 41–2.

Slack, H. J.—Pleasant Hours with the Microscope.
[Muscular System of Insects.]
Knowledge, IV. (1883) pp. 316–7 (2 figs.), 383–4.
„ „ [Trichinæ.] „ V. (1884), pp. 20–1 (2 figs.).
„ „ [Examination of atmospheric dust.]
„ „ pp. 51–2 (3 figs.).

Stanley's Stained Sections for use of students.
[In tubes ready for mounting and previous examination, so that students can try the effect of reagents upon them before putting them up as permanent objects. A circular accompanies, detailing the method of mounting and what to observe in the finished slides.]
Micr. News, III. (1883) p. 340.

Taránek, K. J.—Monographie der Nebeliden Böhmen's.
[Contains a note on preparing Fresh-water Rhizopoda. *Post.*]
Abh. K. Böhm. Gesell. Wiss., XI. (1882) Art. No. 8, iv. and 56 pp. (5 pls.).

Taylor, T.—Freezing Microtome.
Proc. Amer. Assoc. Adv. Sci., 1881, pp. 119–21.

Thoma, R.—Microtome à glissement et méthodes d'enrobage. (Sliding Microtome and methods of imbedding.)
[Same as *ante*, Vol. III. (1883) p. 298, and *post.*]
Journ. de Microgr., VII. (1883) pp. 576–83 (7 figs.), pp. 639–44 (1 fig.)

Thompson, I. C.– Microscope Labels.
[Claim of priority over Mr. Quinn for the labels described Vol. III. (1883) p. 926.]
Micr. News, III. (1883) pp. 334–6.

Thomson, W.—The size of Atoms.
[*Post.*] *Proc. Roy. Instit.*, X. (1883) pp. 185–213 (11 figs.).

Vorce, C. M.—The microscopical discrimination of Blood.
[Six propositions "generally and with rare exceptions true," setting forth the author's "views of micrometry in general in relation to minute objects, including blood."] Also comments by R. Hitchcock.
Amer. Mon. Micr. Journ., IV. (1883) pp. 223–5, 238–9; V. (1884) pp. 17–8.
„ „ Expanding the Blow-fly's Tongue. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) p. 12.

W., D. S.—Washing and mounting objects containing a considerable quantity of air. [*Post.*] *Amer. Mon. Micr. Journ.*, V. (1884) p. 18.

Ward, E.—Mounts and Mounting.
[Abstract of the author's 'Microscopical Mounts and Mounting,' and 'Micro-crystallization.']
Amer. Mon. Micr. Journ., IV. (1883) pp. 149–56 (in part).

West, T.—"Polariscope objects, with few exceptions, are merely pretty things, well enough calculated, in moderation, to relieve the solid bill of fare at a soirée or conversazione, but nothing whatever is to be learnt from them save that by certain arrangements of apparatus belonging to our Microscopes, some things become decked in gay colours; that is literally all."
[This statement will, we think, be generally recognized as very much too sweeping!—Ed. J.R.M.S.]
Journ. of Microscopy, III. (1884) p. 47.

Whitman, C. O.—Recent improvements in Section-cutting.
[Contains abstracts of Andres, Giesbrecht, and Mayer's section-smoother, III. (1883) p. 916—The registering micrometer-screw, III. (1883) p. 914 and *supra*, p. 153—The new object-holder, III. (1883) p. 915—An improvement in the carriers, III. (1883) p. 916—Type-metal boxes for imbedding, III. (1883) p. 913.]
Amer. Natural., XVII. (1883) pp. 1311–16 (3 figs.).

Whitman, C. O.—Methods of preventing the rolling of microtomic sections.
[Transverse knives, *post.* Schulze's section-smoother (1 fig.) III. (1883) p. 450.]
Amer. Natural., XVIII. (1884) pp. 106–8 (1 fig.).

Woodward, A. L.—Unpressed mounting of the Tongue of the Blow-fly.

["While it is an easy matter to catch and decapitate your blow-fly, unfortunately he will not always protrude his tongue properly during the operation, and my experience is that the tongue remains for ever after fixed in the position that it happens to be in when life in the fly becomes extinct. To remedy this, I tried the plan of immersing the living insect in alcohol, and with perfectly satisfactory results. At the moment of death the tongue is forcibly protruded to its entire length. Even the short proboscis of the house-fly is satisfactorily displayed. I tried carbolic acid in the same way, but the results were not nearly so good, and, besides, alcohol is a much nicer fluid to handle."]

Amer. Mon. Micr. Journ., IV. (1883) p. 239.

Wright, L.—Microscopical Mounting.

[Impossibility of procuring insect preparations "mounted in a really *first-class* manner," &c.]

Engl. Mech., XXXVIII. (1883) pp. 343-4 (2 figs.).

MICROSCOPY.

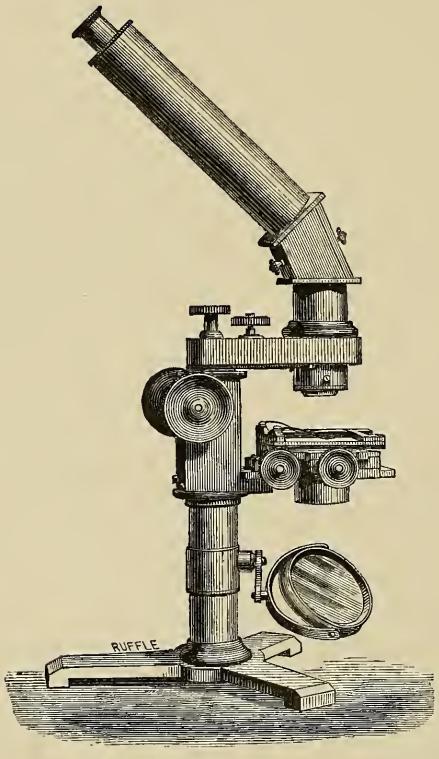
α. Instruments, Accessories, &c.

Ahrens's Erecting Microscope.—In this instrument (fig. 28), by Mr. C. D. Ahrens, the erecting prism is inserted below the body-tube, and the latter is inclined at an angle of about 45°.

The prism is similar to Nachet's erecting prism.

When the Microscope has a fine adjustment, the prism is mounted on a piece of tube, as shown in the woodcut; but when the fine

Fig. 28.



adjustment is omitted, as in the smaller forms, the prism is fixed directly on the arm.

For convenience of packing, the inclined body-tube slides off, and a cap is fitted over the top of the prism-box.

The advantages claimed by Mr. Ahrens for the instrument are

the erection of the image by a prism at the lower end of the body-tube immediately over the objective instead of over the eye-piece, "so that any objective and any eye-piece can be used without any trouble," and the convenient inclination of the tube.

Bulloch's Improved "Biological" Microscope.*—Mr. Bulloch has made further improvements in his "Biological Microscope," principally in the substage.

The substage and mirror-bars move independently, with the object as a centre, as heretofore; but immediately beneath the stage, just above where the rackwork ends, the substage-bar is cut transversely and the two parts joined together by a pinion and screw passing vertically through lateral projections cast for the purpose. About this pin the lower part, carrying the substage with its rack and centering screws, swings laterally, entirely out from beneath the stage. The space between stage and mirror is thus unobstructed by the substage, and the substage itself is practically clear of the Microscope, where it can be seen, and apparatus removed from or added to it with even more facility than if it were held in the hand.

Mr. Hitchcock regards it "as the greatest improvement in substage fitting that has been made for years, and one that is sure to be appreciated as its value becomes known."

The substage-ring is also made in two parts, and the lower part swings to one side independently. This part may carry a tinted glass to modify the light, or the diaphragms of a condenser, which could be conveniently changed. It would be better to place the condenser and its diaphragms in the upper substage-ring, while the polarizer with its plates of mica and selenite are fitted in the lower ring. Such an arrangement would give the microscopist every facility for work that could be desired. Without removing a single accessory, he would be prepared to use the light directly from the mirror by turning the substage aside. Then the condenser could be brought into use by a single motion, and the different effects of oblique light and dark-ground illumination obtained by the simplest possible operation of changing diaphragms. By bringing in the polarizer, which is always ready for use, all the effects of polarized light can be obtained.

Cox's Microscope with Concentric Movements.†—The Hon. J. D. Cox describes the new features of this stand (fig. 29) to consist in "the construction of the arm of the instrument in the form of the segment of a circle in which is a circular groove or slot; the pillars of the base have on their inner faces tongues which fit the slot in the arm. The inclination of the instrument is made by the sliding of the whole body along the fixed tongues in the pillars of the base; the centre of motion of the whole body is also the optical centre of the instrument, around which the stage, the substage bar, and the mirror bar all revolve. The body is clamped up in any position by the set-screw, with large milled head, in the base. The result is a shifting

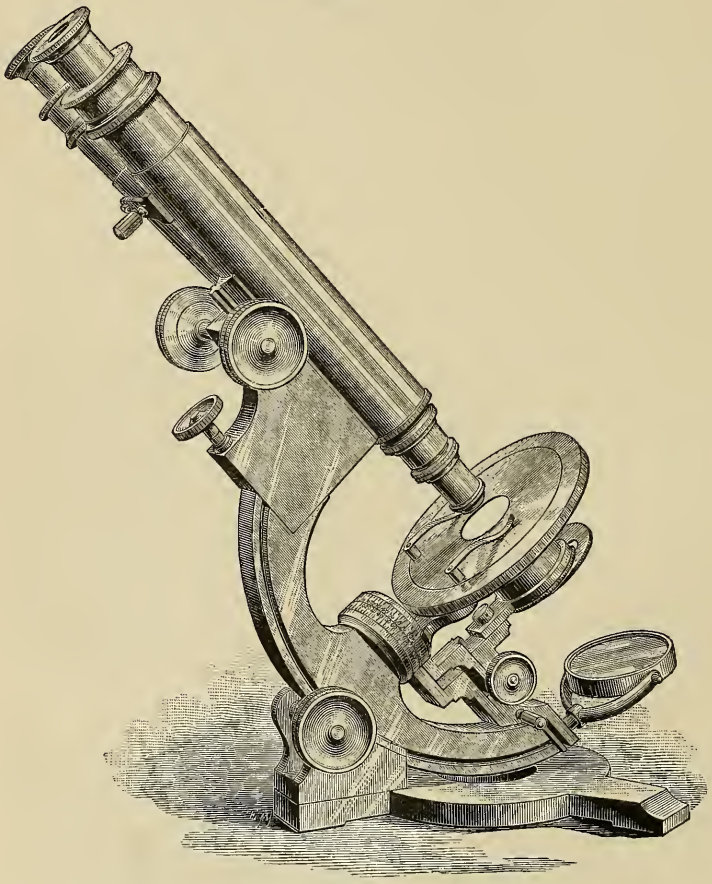
* Amer. Mon. Micr. Journ., v. (1884) pp. 9–10.

† Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 147–8 (1 fig.).

of the centre of gravity in changing the inclination of the instrument, so that great stability in all positions is secured, and the optical centre is thus made the centre of all the circular motions of the parts of the instrument.

The first application of the sliding motion of the body was made by Geo. Wale in his 'Working Model,' but he did not make the

Fig. 29.

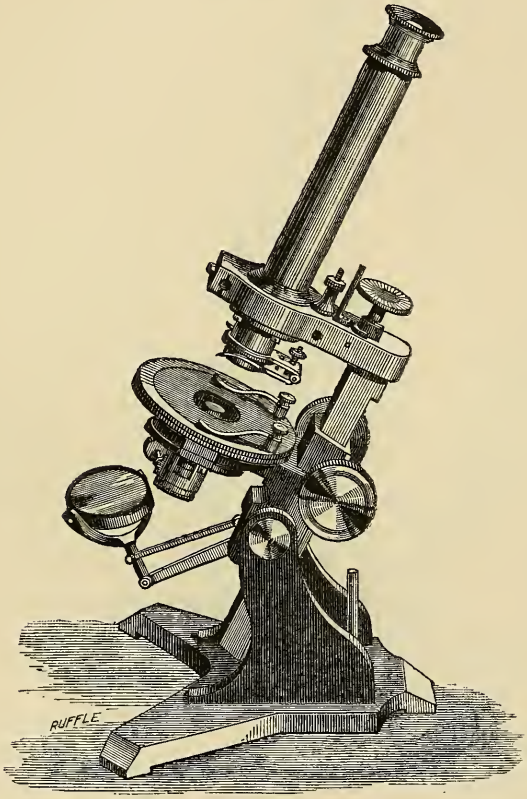


centre of motion the optical centre of the instrument. Mr. Wenham in his elaborate concentric Microscope uses a separate rocker arm with the whole body of the ordinary instrument pivoted above it. My design, which has been constructed by the Bausch and Lomb Optical Company, greatly simplifies the Wenham instrument, and extends the principle contained in Wale's, and makes a very compact,

stable, and satisfactory stand. The radius of the circular motion is $4\frac{1}{2}$ in., the stage is $4\frac{1}{2}$ in. in diameter, the concave mirror has $4\frac{1}{2}$ in. focal length, and the diameter of the mirror may be from $2\frac{1}{2}$ to 3 in."

Geneva Company's Microscope.—This instrument (fig. 30), made by the "Société Genevoise pour la Construction d'Instruments de

FIG. 30.



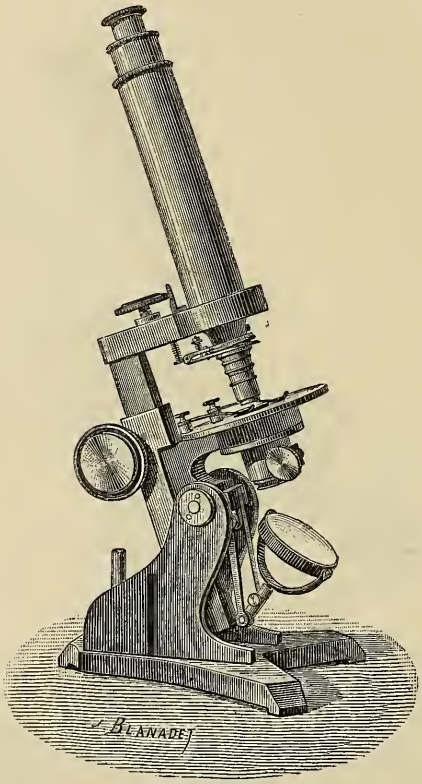
Physique," has two specialities; one being the spring pincers for rapidly inserting the objective, described *infra* p. 284, and the other the mounting of the mirror.

The mirror is attached, as shown in the woodcut, to three arms articulated in such a way that "the centre of the mirror is made to describe a curved line very nearly an arc of a circle, the centre of which is on the object under examination. The most suitable illumination is thus obtained very rapidly, the observer not having to

regulate at the same time the focal distance of the mirror and its lateral distance from the axis of the Microscope."

The condenser fits into a double cylindrical tube beneath the stage, the inner tube being moved up or down in the outer by rack and pinion. The diaphragms are also inserted in the inner tube.

Fig. 31.



The whole arrangement can be readily turned away from the axis on an excentric pivot.

The stand, in its general form, size (16 in. high), and workmanship, is one of the best that we have received from the Continent.

[Since fig. 30 was cut, the Geneva Company have supplied us with fig. 31, which shows more of the mode of attachment of the arms of the mirror.]

"**Giant Electric Microscope.**"—This Microscope (*ante*, p. 109) has continued to be the subject of somewhat ludicrous comments on the part of the newspaper press.

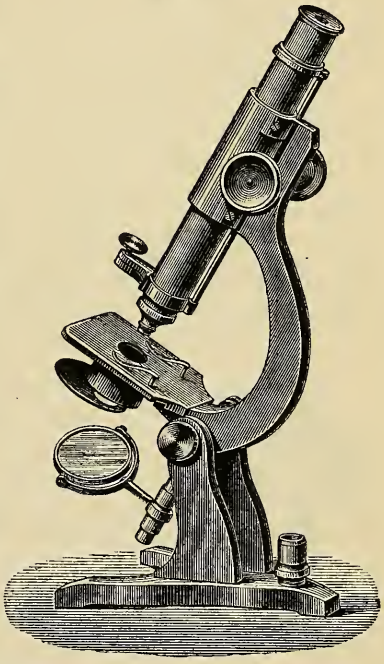
The one point of remark is the extent of the magnification

(4,000,000 times), even the *Times* (28th January) signalling specially the fact that the "eye of the smallest sewing needle made appears to be about 6 feet long by 4 feet wide, the needle itself appearing to be about 20 feet thick. *From this it will be judged how well the minutest details in the minutest specimens are brought out*" (!)

Most of the writers are not content to limit the value of such an instrument to the display of objects to large audiences, where the inferiority of the display is to some extent compensated for by the increased number of spectators who can see the objects at the same time, but evidently suppose that the increase of the magnification represents a proportionate increase in the scientific value and capacity of the instrument, and that by the use of "Giant Electric" Microscopes we are brought many degrees nearer to the vision of the ultimate molecules of matter than we are when sitting at home with a student's Microscope only.

The *Standard* of 28th January says, "But although this great Microscope can make the eye of the smallest sewing needle apparently a huge orifice some seven feet by five in dimensions, yet the component particles of the tissues of either animal or vegetable organisms cannot be *even yet* made visible, and the minute divisions of matter would remain unknown, so far as the sight is concerned, and would be an inscrutable mystery, except for the deep reasonings of the educated human mind;" while the *Norwood Review* asks "What assistance, for instance, may not surgeons derive from it in the study of nosology? It is safe to predict that Science in her onward march will find a valuable accessory in the "Giant Electric Microscope"!

Fig. 32.



Tolles's Student's Microscope.—Fig. 32 is given by Dr. L. Dippel in the latest edition of his 'Das Mikroskop' (p. 541) but without the explanation that it represents not a modern arrangement, but one of the earliest forms of Microscope devised by the late R. B. Tolles, the peculiarity of which was that the rack of the coarse adjustment was cut on a rod attached at both ends to the body-tube and passed through the straight part of the limb where the pinion acted upon it. We believe this plan was adopted for economy of manufacture, as the body-tube sliding in a socket required very

little outlay in the matter of accurate bearings. It was, however, abandoned in favour of the usual Jackson slides and rack.

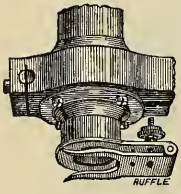
Another feature in the design of the stand, which we have found convenient in practice, was the greater bend of the limb than usual, by which the space above the stage was left free for manipulations with either hand. This latter feature has been maintained in all the later models of Microscopes issued by Mr. Tolles.

Winter's, Harris's, or Rubergall's Revolver Microscopes.—Mr. Harris of Great Russell Street, W.C., informs us that Thomas Winter was the "first and true inventor" of these instruments (described *ante*, pp 114–5) more than 56 years ago, when Mr. Harris inherited the business.

The one described as a simple Microscope bears the name of "T. Winter, No. 9, New Bond Street, London," while that figured at page 115 has, it appears, engraved on the cross arm carrying the body-tube, "Thomas Rubergall, Optician to H.R.H. the Duke of Clarence, 24, Coventry Street, London." Winter worked for Mr. Harris, and sold the first model to him (the simple form mentioned *ante*, pp. 114–5). Later Winter made some for Rubergall, probably the compound one (fig. 11). He also made some much smaller ones, which were sold for a few shillings.

Geneva Co's. Nose-piece Adapters.—This (fig. 33) consists of two pieces of brass hinged together at the back. The upper is immovably attached to the nose-piece of the Microscope; the lower terminates in a fork, which lies just under the nose-piece. The two plates are kept together by a set-screw, acting on a spiral spring, which can be tightened or loosened as required. The objectives are screwed to the collar shown in the fig., which slides in the fork. When the objective is centered with the optic axis, a slight projecting rim on the upper plate drops into the aperture of the adapter; the objective is then held fast, but is readily removed on applying a moderate downward pressure, which depresses the forked plate and enables the collar to be slipped out. By the set-screw the amount of pressure required to be applied can be varied.

Fig. 33.



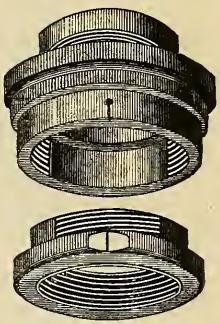
The above form is a fixture on the Microscope, but the Company make another which is removable. It does not appear, however, to differ in principle from the nose-pieces of Nachet and Vérick (see this Journal, i. (1881) pp. 661–2).

The advantages of such arrangements are explained by the Geneva Company to be (1) economy of time, (2) "a mechanical centering of the objective much more perfect than can be obtained with a screw, the defects of the centering being immediately recognized can be partly corrected, and (3) we can readily choose the side of the objective which gives the best images, when oblique illumination is used."

Zentmayer's Nose-piece.*—This (fig. 34) is yet another of the nose-pieces for rapidly changing objectives, so many of which have been brought out during the last few months.

Mr. Zentmayer's plan consists simply in the adoption of Mr. Nelson's form of adapter (see vol. ii. (1882) p. 858) with the inner screw-thread filed smooth in two opposite segments, but in place of altering the thread of the objective itself, he puts on it a separate collar, the inner thread of which is entire, but the outer thread filed smooth in two places in a similar way to that of the adapter.

Fig. 34.



Mr. Zentmayer thought it useless to adopt the original plan, "unless all the prominent manufacturers would agree to cut the screw-threads of objectives and nut in the same relation," which would be difficult to establish; but "by means of the collar he can manufacture a nose-piece and collar for any objective without having either at hand."

Törnebohm's Universal Stage Indicator.†—A. E. Törnebohm describes his arrangement as follows:—"Every petrological Microscope is now, as a rule, provided with a scale, or other arrangement on the stage, whereby we can readily find again any particular point in a preparation which it is desired to mark. According to the methods hitherto used, however, the contrivance which gives the position of a point in the preparation, is only available for a given Microscope, or at most for the Microscopes of a given maker. It would naturally be better if it were available for all petrological Microscopes, so that in sending away a preparation for inspection we could easily indicate the point to be observed without an ugly ring of ink. This advantage can be easily attained by the following simple contrivance, which I have adapted to my Microscope for years past and which I have found very effective.

The stage is divided by lines crossing at right angles, like a chess-board, the distance between the lines being exactly 2 mm. Every fifth line should be somewhat thicker so as to facilitate the counting. It is superfluous to mark the lines with figures. Two of the lines must cross each other *exactly* in the centre of the stage, and the counting starts from these. When I wish to mark a point in a preparation, I first adjust it in such a manner that the edges of the slide are parallel with the lines. I then determine the position of one corner (preferably the lower left corner) by counting from the two middle lines, and write the result, in the form of a fraction, upon the label of the preparation, as for example $\frac{113}{78}$ if the distance along the vertical edge (the writing on the preparation being horizontal) is found to be 11·3,

* Amer. Mon. Micr. Journ., v. (1884) pp. 42–3 (1 fig.).

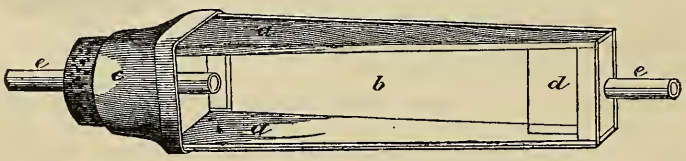
† Neues Jahrb. f. Mineral. Geol. u. Paläont., 1883, i. pp. 195–6.

and that along the horizontal edge 7·8. An estimate can be very well made within a tenth (that is to 0·2 mm.) which is sufficiently near. It may sometimes happen with large preparations and slides of ordinary size that the corner to be marked lies outside the divisions. I therefore mark the position of the opposite diagonal, and put an angle round the fraction thus: $\left|\frac{106}{47}\right|$ * * *

I have been able to convince myself by trials that divisions which are good for one Microscope are equally good for others similarly arranged, and that therefore the contrivance is a practical one."

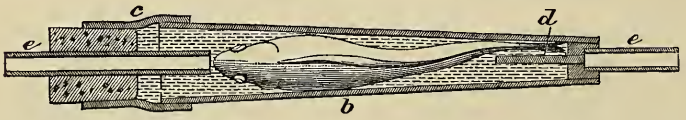
Stokes's Fish-trough.*—A. W. Stokes describes a simple apparatus for aërating living fish whilst under observation. It is shown in perspective at fig. 35, and in longitudinal section at fig. 36,

Fig. 35.



a, *a* being two wedge-shaped slips of wood well soaked in paraffin wax to render them waterproof, *b*, *b*, two 3 × 1 glass slips, so arranged as to form, with the wood slips, a wedge-shaped glass box. The larger end of this box is inclosed in a short piece of indiarubber tube *c*, and this tube is closed by a cork. A short piece of glass *d* is fixed inside about midway between the glass sides of the box, so that it will form a shelf upon which the fish's tail may be during examina-

Fig. 36.



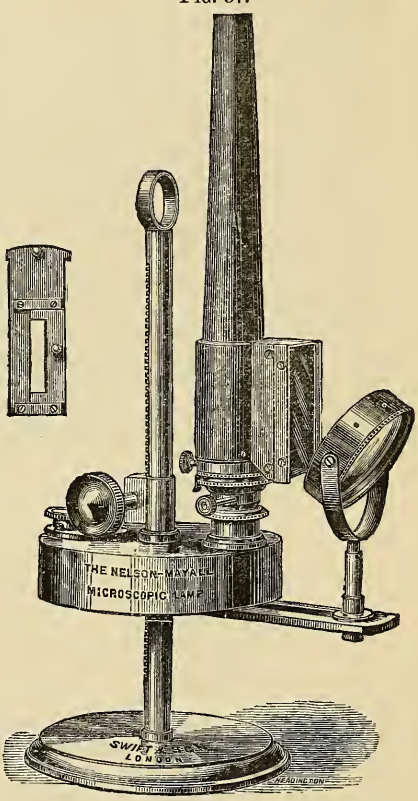
tion, as shown in fig. 36. At either end of the box are fitted two short glass tubes *e e*, which when the instrument is in use are respectively connected by indiarubber pipes with bottles at different levels, to obtain a circulation of water.

Nelson-Mayall Lamp.—At the Society's meeting in January, Mr. J. Mayall, jun., exhibited the modified form of Nelson's lamp,† shown in fig. 37. The modifications consist (1) in making the oil-well circular instead of square, so that the standard passes conveniently through the centre, and the well carrying the lamp can

* Journ. Quek. Micr. Club, i. (1884) pp. 322–3 (2 figs.).
† See this Journal, *ante*, p. 125.

be rotated for purposes of centering, &c.; (2) a rackwork is applied to the standard by which the height of the lamp can be adjusted rapidly; (3) the base is made thinner and the fittings beneath the well altered so that the burner can be put 3/4 of an inch lower than formerly; (4) the oblong frame carrying the lamp-glass (an ordinary 3 × 1 slip) is provided with two extra grooves, in which may be slid 3 × 1 slips of tinted or ground glass, or a brass plate (shown in the fig.), to which an adjustable diaphragm is fitted, can be used in combination with white or tinted light; (5) the cylindrical part of the chimney is arranged so that an opal glass reflector may be inserted if desired. Whilst adding but little to the cost of the lamp as devised by Mr. Nelson, the new form combines several points of novelty suggested by practical experience.

Fig. 37.



Standard Micrometer Scale.* — It will be remembered that the American Society of Microscopists ultimately abandoned their original micrometric unit of 1/100 mm. and adopted 1/1000 mm. or 1 μ. The United States Bureau of Weights and Measures undertook to prepare and authenticate a standard scale, and in August 1882, such a scale, ruled on a platin-iridium bar, and verified with great care by Professor C. S. Pierce, was placed at the disposal of the National Committee on Micrometry representing the various Microscopical Societies. A sub-committee for testing this micrometer was appointed, on whose behalf Professor W. A. Rogers subjected the plate to a prolonged and elaborate study which was not completed until August 1883.

This scale is divided into ten millimetres, each division being marked by three lines distant from one another ten microns, and the measurement is to be made from the mean position of one triplet of lines to that of another. The first millimetre is again divided in the same manner into tenths of millimetres. The first tenth of a milli-

* Proc. Amer. Soc. Micr., 6th Annual Meet., 1883, pp. 178-200.

metre is subdivided into ten spaces of ten microns each. There are thirteen of these lines at the beginning of the centimetre, the first tenth of a millimetre being measured from the mean of the first three to the mean of the eleventh, twelfth, and thirteenth. The scale is engraved on a piece of platin-iridium made by Matthey, and containing 20 per cent. of iridium.

Professor W. A. Rogers gives the results of a very elaborate "study" of the scale, which is now in the custody of the American Society of Microscopists, and available, under regulations, to "parties of eminent ability" for the comparison and verification of their standards. Three copies are to be made on glass, which will be lent out.

Microscopic Test-Objects.*—The correspondence on this subject between "Monachus" and Mr. E. M. Nelson has been further continued, the former finally accepting (as "that which was to be demonstrated") Mr. Nelson's admission that when he wrote that he had by particular means made the discovery of the "true structure" of *Surirella gemma* he did not mean the "ultimate true structure."

There is one point however in the correspondence left untouched, which we refer to because the misapprehension which Mr. Nelson was under on the subject has at one time or another been widely shared and we have no doubt is so still.

If we have a grating (fig. 38) it will, as we know, give rise to

Fig. 38.

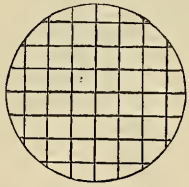
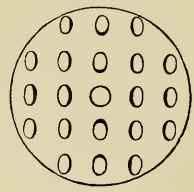


Fig. 39.



diffraction spectra as in fig. 39. But if we stop off all the spectra except two nearest the central dioptric beam (say at the top and side) we shall still see the grating. Hence it has been supposed that only those spectra were really necessary for the image, or as Mr. Nelson puts it, "the true structure can be seen without taking up all the diffraction spectra."

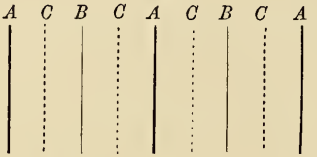
It cannot be too clearly borne in mind that this is an erroneous notion and that it is a fundamental point of the diffraction theory that if we are to see a true image of the object, *all* the diffraction spectra into which the original pencils were separated must be again gathered up and brought to the eye, so that wherever any of the diffraction spectra (up to the limit of vanishing intensity) are wanting, the image is incomplete. The absence of the spectra shut off may produce very considerable variations in the image, not only in the breadth of the lines and spaces, but otherwise.

* See Bibliography, *infra*.

Aperture and Resolution.*—L. Wright, while agreeing in the utter impossibility of ever knowing by absolute observation the "true structure" of minute objects, yet thinks there is something in the objections to overmuch dependence upon the results of very oblique light.

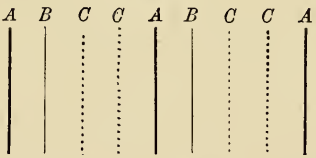
Let us suppose we have an object whose true structure is something like fig. 40, explained or described as follows:—

Fig. 40.



Let the black lines A A A denote strong ribs, or striations, or ridges 20,000 to the inch; B B lesser ridges midway between them, and C C C either valleys or fainter markings midway between these. A low-angled lens would show the black lines only; a good glass would bring out B B as well; a good immersion the faint dotted lines C C C. But even in this simple case these latter would certainly appear as lines; for the distances represented by the dots are far too minute for their spectra (transverse to the others) being included in any lens yet made. Let us, however, now suppose the real structure to be modified as in fig. 41, the second strongest markings B B being next

Fig. 41.



A A A, but C C C altogether absent, and not as here shown. The second lens would, in this case, show only a slight thickening or blurring of the coarser striation A A A; but the immersion objective might show nearly the same image as that given by the previous structure, since the narrow intervals A B, A B, A B, would give the same spectra as if the gaps C C C were filled up. It is true the wider distances B A, B A, B A would, by their own spectra, strengthen the B B lines; but the dotted lines C C C would be created, and appear to show structure which did not exist.

But no microscopic structure really consists of absolute *lines*, and hence this is a very small part of the complicated problem. If, as we have supposed, AAA are ridges, they will have some absolute breadth,

* Engl. Mech., xxxviii. (1884) pp. 470–1 (2 figs.).

and these dimensions really constitute a still more minute set of lines, whose spectra are far beyond the collecting power of our lenses. Hence the reason why real lines, like Nobert's test-bands, can be truly "resolved" or photographed, though microscopic objects cannot. Supposing the objective can resolve lines of 100,000 to the inch, all it is capable of showing in an *object* is, that something—*some* variation of structure—occurs at regular intervals of 100,000 to the inch. If this is so, it will be shown as lines; but it is perfectly obvious that very rarely can it *really be* mere lines. It will have form of some kind; and every minute variation in light and shade due to that form, constitutes an infinitely minute *set of distances*, which will all cause their own spectra, too distant, if not too faint, to be gathered in.

Error may arise in yet another way. Lord Rayleigh has shown mathematically, and partially proved experimentally (by gratings eaten out in gelatine) that if an optical grating be composed (instead of white and black lines) of equally transparent narrow stripes, whereof each alternate one retards light half a wave-length more than its neighbours, the spectra are *fourfold in brightness*. Now these also would image lines, though falsely. The application to transparent microscopic objects need not be pointed out.

Yet the more we understand the true relations of these spectra, and their optical effects, the truer will our interpretations become, within, at least, the limits of microscopic vision, and the more certainly shall we be directed to methods of manipulation which may truly interpret the phenomena. Taking merely the theory of the matter, let us consider the case of fig. 41 where only the lines A A and B B really exist, but C C are apparent by the illusory spectra of the narrow spaces between A B, A B. It is plain we have means, if our suspicion as to the existence of C C C is awakened, of clearing it up. For we can stop off not only the central pencil, but those inner spectra which give us the coarsest intervals A A A. This will bring into stronger relief the spectra representing the next widest spaces, B A, B A, and thus we may correct the former result. Also it is obvious that any skilful manipulator with a knowledge of physical optics, by stopping off central pencils, and, when necessary, inner spectra, might bring into stronger relief the much fainter spectra caused by fainter and finer striations, which were before "drowned," as it were, in the coarser phenomena. Mr. Stephenson proved this in the case of *P. angulatum*, bringing out minute patterns, when the central pencil was stopped off, which had never before been seen.

It is also evident why so much is learnt from various incidence of the light; but it will also appear that this should be studied more gradually than most mirror arrangements permit. As a rule, microscopists adjust for one obliquity, and make their observation; then try another. It would rather appear that continuous observation under a steadily increased obliquity must be necessary to good interpretation; and that even then a competent knowledge of the physical phenomena of optical gratings is necessary, as well as a careful collation and comparison of the appearances with those presented

under similar treatment by coarser objects, of which true dioptric images can be obtained. But even then it will be only a matter of interpretation more or less correct. All we know of *A. pellucida* is, that there are striæ, or ridges, or something occurring at intervals of so many to the inch. It is obvious they cannot be mere lines, as they appear to us; but as any "form" must involve another set of lines of at least double the minuteness, and probably far more, what is there can never be known, except from analogy and comparison with larger diatoms. As a rule, we must get lines only in minute structures, and as a rule, that appearance is certainly false. Nevertheless, the variations in distance between the spectra under gradually increased obliquity, and their consequent image-results, appears the most likely general method of ascertaining the true *proportions* of distances between striæ not all equidistant, while the successive stopping out of the inmost and brightest spectra appears the most promising general method of revealing those fainter spectra which may lie hidden behind, and which reveal some periodic variation in structure at the distances of the apparent lines.

The Future of the Microscope. — Amongst the reports on the South Kensington Loan Collection of Scientific Apparatus is one by Prof. Abbe on the "Optical Aids to Microscopy," * the earlier part of which (pp. 383–91) is occupied with a general description of the stands, objectives, and other apparatus exhibited, with critical comments. The succeeding thirty pages are devoted to a consideration of "the facts which throw a light on the conditions of optical performance, and furnish hints in regard to further progress."†

The author commences with expressing the opinion that no *epoch-making* advance in the way of an extension of the domain of microscopical perception is now possible, although there is still great room for improvement in other, and in a relative sense minor, respects. The curve of progress, after having risen abruptly for several decades,

* Hoffmann, A. W., 'Bericht über die wissenschaftlichen Apparate auf der Londoner Internationalen Ausstellung im Jahre 1876.' 8vo, Braunschweig, 1878. Cf. pp. 383–420, Abbe, E., 'Die optischen Hülfsmittel der Mikroskopie.'

† It appeared to us, on a perusal of Professor Abbe's paper, that he had not given sufficient weight to the increase in aperture and resolving power obtained by the use of homogeneous immersion, but to our objections on that point he writes as follows :—"Your objection leaves out of sight the general point of view from which the question of further perfection of the Microscope is discussed here. When the article was written, the opinion was generally spread, still—even among microscopists—*that it was only a question of time that the Microscope should display the molecules themselves.* This opinion I had always in view during the whole discussion. Hence results the large standard applied by me in estimating and measuring progress. The increase of delineating power from 1·1 to 1·4 or 1·5 is an exceedingly *small* increase compared with the *supposed* increase from 1·1 to ∞. That half the wave-length in air 'is the approximate limit,' and that this will not be overcome in a 'considerable' extent is true, notwithstanding homogeneous immersion, having regard to the said standard of estimation. The *important* point is that the *wave-length* does constitute a limit; that the *value* of the wave-length may be reduced in some degree by media of higher refraction is the *subordinate* feature under the point of view of the paper."

appears to have a tendency towards an asymptote parallel to the base line.

A condensed and summarized statement is given of the theoretical principles on which the compound Microscope is based, including the author's now well-known views on the formation of the images of minute objects in microscopical vision, together with observations on the important function of aperture in the Microscope, and the increase of aperture obtained by immersion lenses as compared with dry.

The remainder of the paper is devoted to a consideration of the possible ways and means by which, in the future, new successes may be hoped for, "the most important practical advantage of a rational theory of the Microscope being that, destroying mere vague hopes, it enables a proper direction to be given to the aims of the inventor."

With regard to a still further extension of aperture beyond 1·5 (the refractive index of crown glass), the author suggests that it may be thought that in process of time transparent substances, available for the construction of objectives, will be discovered, whose refractive index will far exceed that of our existing kinds of glass, together with immersion fluids of similarly high refractive power, so as to give new scope to the immersion principle. What, however, he asks, will be gained by all this? We shall perhaps, with certain objects, such as diatoms, discover further indications of structure where we now see bare surfaces; in other objects, which now show only the typical striations, we shall see something more of the details of the actual structure by means of more strongly diffracted rays; but we should get on the whole little deeper insight into the real nature and composition of the minuter natural forms, even should the resolving power of the Microscope be increased to twice its present amount; for, whatever part of the structure cannot at present be correctly represented on account of its small size, will then also give an imperfect image, although presenting a somewhat higher degree of similarity than before. If, therefore, we are not to rest upon conjectures which surpass the horizon of our present knowledge (as, for instance, would be the expectation of the discovery of substances of considerably higher refractive power than has hitherto been found in any transparent substance), our progress in *this* direction in the future will be small, and the domain of microscopy will only be very slightly enlarged, the more so because every such advance, however great, will be but of limited utility to science, on account of very inconvenient conditions. For a given extension of the aperture can only render possible a correspondingly enhanced performance of the Microscope when the object is surrounded by a medium whose refractive index at least equals that aperture. If the Microscopes of the future should utilize the high refractive power of the diamond, all the objects would have to be imbedded in diamond, without any intervening substance. The result of this consideration is, therefore, that as long as aperture serves that specific function, which experiment and theory compel us to ascribe to it at present, there is a *limit* to the further improvement of the Microscope, which, according to the present condition of our knowledge, must be considered as insurmountable. The optics of the day have already so

nearly approached this limit, that any very important improvement in the way of a further development is no longer to be anticipated. This limit to all optical observation, in the direction of minuteness, can be approximately defined by half the wave-length (in air); at least microscopical observation cannot be applied to objects which are smaller to a *considerable* extent than half the wave-lengths, although the latter can be somewhat exceeded with immersion lenses.

The measure of the details accessible to our vision is not an absolute one, but is related to the wave-length of the light by which in any particular case the image is formed. There is, therefore, a certain latitude which can be utilized to some extent in favour of optical perception. In observations with white light those rays predominate, in the formation of the image visible to our eye, which show the greatest intensity in the visible spectrum. The mean wave-length will therefore correspond with the bright green, and may be taken as $0{\cdot}55\ \mu$. Somewhat smaller wave-lengths, those of the blue rays, allow of effective observations with so-called monochromatic illumination, the advantages of which for the recognition of the finest details have long been known to the microscopist.

Still more favourable are the conditions of image-formation with photography, since in this case the wave-length of the violet rays, which are the active ones, is $0{\cdot}40\ \mu$ only. The performance of objectives under otherwise similar circumstances extends, therefore, perceptibly further with photography than with direct observation. Not only does the photograph show finer details at the limit of the resolving power than would be directly visible to the eye, but even when the object is not at the extreme limits of resolution, but the correctness of the image is yet more or less problematical, it gives a greater guarantee of the truth of the representation than does the ordinary image. Hence photo-micrography, in difficult examinations, has a value not to be underrated.

A further step may be taken in this direction by utilizing rays which probably lie far beyond the limits of the visible spectrum in the ultra-violet. If these images are not directly visible, it is possible to imagine them made visible by means of fluorescent substances. But for this the optician must have materials for the construction of the objective which possess at least the transparency of quartz for the ultra-violet rays, without those properties which now preclude its application for such a purpose, and substances of similar transparency must also be found for imbedding the object and for the immersion fluid.

This consideration shows to what extent we must quit the sure ground of experience if from our present standpoint we reckon on a *fundamental* improvement of microscopy. The result of such attempts leaves no prospect in the main of the realization in the future of hopes and wishes which rest on the notion of an ever-extending and unlimited improvement in our optical instruments. Judging from what lies within the horizon of our present knowledge, a limit is put to the range of our eyes by the action of light itself, a limit which is not to be overstepped with the tools given us by our present know-

ledge of nature. "There remains, of course," says the author, "the consolation that there is much between heaven and earth that is not dreamt of in our philosophy. Perhaps in the future human genius may succeed in making forces and processes serviceable which may enable the boundaries to be overstepped which now seem impassable. Such is, indeed, my idea. I believe, however, that those instruments which may perhaps in the future more effectively aid our senses in the investigation of the ultimate elements of the material world than the Microscope of the present, will have little else than the name in common with it."

There is, therefore, but small scope left for the advance of optical art, in regard to the most important point in the efficiency of the Microscope—aperture—the possible direction of which has been indicated in the foregoing observations. The further perfecting of the instrument must chiefly relate to the two other factors of its optical performance, viz. the magnifying power and the dioptrical exactitude with which the image is formed. In these is to be found the most important task left for the optician in reference to the Microscope.

With regard to the first—the amplification of the image—the author proceeds to explain in outline the point since dealt with more in detail in his papers on the relation of aperture to power,* and the uselessness of a magnifying power that is out of proportion to the aperture—increased size without visible detail, so that we have "mere emptiness." There is room for improvement of the eye-piece in reference to many points—the size of the field, the uniformity of the magnifying power, &c.; but they are points of subordinate importance, because they do not touch the performance of the Microscope in its most essential respects. The practical optician has, it appears, adopted this view. At least the fruitless efforts to increase the actual capacity of the Microscope by special eye-pieces have ceased.

It is an essentially different matter with the remaining factor. The conditions on which depend the more or less perfect union of the rays in an optical system are so manifold and so complex, and the ways and means of satisfying certain requirements are so numerous that a wide field will remain open to optical science for all time. The imperfection of the optical image at the focal point springs from two causes very similar in their effects. The one arises from the residual spherical and chromatic aberration which even the best devised combinations of refracting media still leave; the other lies in the want of homogeneity, precise form, and exact centering of the lenses which even the most perfect art can never wholly remove. The result is that every objective unites the cones of rays proceeding from the points of the object, not in mathematically exact image points, but in light surfaces of greater or less extent—circles of dissipation—and thereby limits the distinct representation when the details are of a certain minuteness.

Of course every part of the optical system, the objective as well as the eye-piece, contributes to this imperfection of the image. In its practical importance, however, the part played by each of the elements

* See this Journal, ii. (1882) pp. 300 and 460, and iii. (1883) p. 790.

of the compound Microscope is extraordinarily different. If we disregard the faults of the image towards the margin of the field, and consider only the maximum sharpness of the image in the region of the axis, the eye-piece is, as a matter of fact, quite without influence. In the simplest eye-pieces with unachromatic lenses, their action in the centre of the field is practically free from error, when we estimate the conditions under which they act. It is undoubtedly accurate, as is often urged, that the eye-piece, even in the axis, exercises *an* influence on the spherical and chromatic aberration of the pencils, but at the same time as accurate as it is to say that the sun rises earlier for a tall man than it does for a short one.

For the proper performance of the Microscope, those faults in the image are alone important which originate in the action of the *objective*, and are only enlarged in the objective-image by the eye-piece. From whatever cause these may spring, whether from external imperfection of the lenses, or from aberrations, their common influence consists in their imposing a certain limit to the useful magnifying power in the case of every objective. The more perfectly an objective of given focal length acts in both respects, the higher the magnifying power it admits of by means of tube and eye-piece; the more imperfect the union of the rays, the lower the magnifying power at which the dispersion circles from each point of the image destroy its sharpness and clearness. Moreover it is entirely unimportant in itself by what means a given magnifying power is to be produced, whether by longer tube and weaker eye-piece, or by shorter tube and stronger eye-piece; the amount of the *united* magnifying power is alone to be considered, and must be compared to the magnifying power which the objective, used as a magnifying glass, would give by itself. The ratio in which tube and eye-piece may increase the available magnifying power over that of the objective alone, without deterioration of the image, forms the exact standard of the perfection of an objective. On the one hand, this points out the reason why the attainment of a higher magnifying power always necessitates objectives of shorter focal length. This would not be the case if the objective could be arranged so as to unite the rays perfectly, for nothing would then hinder the production of any desired amplification of the image, by means of tube-length and eye-piece, however great the focal length of the objective might be. On the other hand, it is shown that every advance in perfecting the objective, with regard to its dioptrical functions, must enable amplifications, hitherto attained with sufficient clearness by lenses of short focal length only, to be equally well attained by lower power objectives.

A comparison of the Microscope of the present day with those which twenty, thirty, and forty years ago gave the best performance, shows the steady progress which optics have made in this respect. Without doubt it is of the greatest interest to examine what prospects there are for the further perfecting of optical instruments in this direction. If the opinion previously expressed on the importance of aperture and on the extreme limit of microscopical perception is right, no improvement of the objectives in their dioptrical action can substan-

tially enhance the performance of the Microscope in the whole; for, with the present constitution of the objective, magnifying powers are attainable with which the smallest detail that can be represented is distinctly visible; *the progress will merely consist in obtaining in equal perfection the same amplifications that we now have at command by means of relatively lower power objectives.* But even this would be a matter of great practical importance if we should succeed in materially surpassing the present performance, so that, for instance, the strongest magnifying power, for which we now use lenses of 1 mm. and less focal length, would be at least as perfectly obtained with objectives of from 3 to 4 mm. Not only would the great difficulties be removed, which are now attendant upon work with high magnifying powers, in consequence of their too short working distance, but it would be no less an advantage that every objective would offer a greater latitude for useful magnifying power. Even with regard to purely optical perfection, the production of higher magnifying powers by stronger eye-pieces, instead of stronger objectives, would be a decided gain, by lessening certain faults in the image which impair its clearness outside the axis. The aberrations outside the axis (erroneously attributed to the convexity of the field) which in objectives of large aperture are always but very imperfectly corrected, vary for the most part with the *square* of the distance from the axis, for which reason their obnoxious influence will, with the employment of stronger eye-pieces, diminish more quickly than the magnifying power increases. Possible apprehensions of other drawbacks which might attend the use of stronger eye-pieces are groundless, for, if it should become necessary, combinations of lenses could be constructed, by which any high magnifying power that may be desired could be as conveniently obtained as with the present eye-pieces.

In judging of the ways and means which are open, according to this view, for the perfecting of the Microscope, we must consider the various sources of error which spring from its deficiencies.—At the present day an extraordinary perfection is attainable in the technical accomplishment of objectives. With technical aptitude and a rational method of work we can correctly produce given curves, even in very small lenses, up to a few thousandths of the radius. The irregular deviations of the surface from a strictly spherical form, however, can be restricted, when necessary, in their absolute quantity to small fractions of the wave-lengths and the centering of the separate surfaces can be exactly executed with exceedingly small deviations. With the exception, perhaps, of the strongest objectives, which, in consequence of their very small dimensions, allow of only uncertain means of measuring and proving, we can see the unavoidable errors diminishing almost to the vanishing point. The actual imperfections which are seen in the dioptrical working of the Microscope of the present time must chiefly be referred, therefore, to the imperfect correction of the aberrations.

The study of the conditions which must be fulfilled for the perfect correction of the chromatic and spherical aberrations in an objective shows two drawbacks not to be overcome by the practical optics of the day.

One arises from the unequal course of the dispersion in crown-glass and flint-glass, in consequence of which it is impossible with the present kinds of glass, to unite perfectly all the coloured rays in the image. In the best combinations of lenses which can be made, there is always therefore a considerable secondary chromatic aberration in the image which impairs its clearness.

The second still greater hindrance is the inequality of the spherical aberration of an objective for light of different colours, and the impossibility of compensating this inequality with our present resources. It is not difficult even with a large aperture (using light of one particular degree of refrangibility) to remove perfectly, practically speaking, the spherical aberration, at least in the axis, so that the objective, with monochromatic light of this fixed colour, will give an almost perfect union of the rays; the system is however under-corrected for the less refrangible rays, and over-corrected for the stronger. The larger the aperture of an objective, the greater of course will be the residual aberration which originates in this difference of the spherical correction for the various colours. Their effect appears in the form of a characteristic diversity which the chromatic correction of the objective shows for the different zones of the free aperture, an objective which possesses the most perfect possible chromatic correction for the central rays, and gives the most favourable images with direct illumination, being more or less strongly over-corrected chromatically for the peripheral rays, and with oblique illumination shows the outline of the object with distinct chromatic fringes, and conversely. In objectives of moderate aperture, perhaps up to 40° or 50°, we may restrict the detrimental effect of this chromatic difference of the spherical aberration, by dividing the refractions over a greater number of separate lenses than would be otherwise required by the aperture. English and American opticians have in this way constructed weak objectives of from 30 to 20 mm. focal length, which give a more perfect union of the rays than the corresponding more simply constructed lenses in use on the Continent, and which allow of a much higher magnifying power by means of draw-tube and eye-piece. The above-mentioned class of aberrations offer, however, an insurmountable difficulty in the case of the large apertures of dry and immersion objectives. The impossibility of removing them entirely with the present resources must be unquestionably considered the greatest difficulty which has hitherto hindered a more perfect action of the objective, with regard to its dioptrical working.

It is not difficult to define the cause from which this defect springs. The impossibility of removing the chromatic difference of spherical aberration, originates in the fact that with the existing kinds of glass (crown-glass and flint-glass), the dispersion increases with the mean refractive index in such a manner that greater dispersion always accompanies the higher index (with very slight deviations) and conversely. The aberrations could be compensated for, or at least nearly so, if there were materials applicable to optical purposes, by which a relatively smaller refractive index could be united with

higher dispersive power, or a higher refractive index with a relatively lower dispersive power. It would then be possible by proper combination of such materials with the usual crown and flint glass, to partly remove the chromatic and spherical aberrations, independently of each other, and thus fulfil the essential conditions on which the removal of the chromatic difference depends.

As the defects of the present objectives, in regard to the chromatic as well as the spherical aberration, originate in the optical properties of the substances on which the optical art of the day is based, the further perfecting of the Microscope in its dioptrical working, is therefore chiefly dependent on the progress of the art of glass-making, and will in particular require, *that new kinds of glass should be produced, which admit of a better correction of the so-called secondary spectrum and which show a different relation of the refractive to the dispersive power than at present has been obtained.*

The hope that such claims can be satisfied, in the more or less distant future, and the way opened for a substantial perfecting of the Microscope, as well as of the other optical instruments, rests on thoroughly established facts. The mode in which, in the kinds of glass now used, the indications of refraction and of chromatic dispersion appear, need not be considered as a natural necessity. For a sufficient number of different transparent substances may be chosen from amongst natural minerals and out of the many artificially formed chemical compounds, which offer essentially different properties as regards their refraction and chromatic dispersion, only that in other respects they are not adapted for optical use. Experiments for the manufacture of glass with less secondary dispersion, which were undertaken several years ago in England, with the co-operation of Prof. Stokes, although they were without practical result, gave noteworthy suggestions on the specific effect of certain bases and acids on the refractive properties. The uniformity which the present kinds of glass show in their optical properties, is to be attributed to the fact that the glass factories have hitherto used only a small number of materials, scarcely any other than aluminium and thallium, besides silica, alkali, lime, and lead, and we might reckon with some confidence on a greater variety of production, if only the glass manufacturers, led by methodical study of the optical properties of various chemical elements in their combinations, would leave that very limited field.

Unfortunately there seems little hope under present circumstances of any important advance in this direction in the immediate future. The present prospect, on the contrary, indicates a state of affairs which endangers many scientific interests. The manufacture of optical glass has been for a long time not far removed from a kind of monopoly; at least the art is in the hands of so few, that competition is out of the question. Since Daguet's glass-works were closed, there are now only two such institutions, which supply the general demand, while the third, founded by Utzschneider and Fraunhofer—the only one in Germany—has remained exclusively in the service of one optical workshop. It must, it is true, be admitted that this art has made very important progress in many respects during the last

thirty years. Not only are the present kinds of crown and flint glass produced in formerly unattained perfection, as regards purity, homogeneity, and freedom from colour, but the whole series of optical glass has been widely extended in one direction by the manufacture of flint glass which considerably surpasses the previous kinds in high refractive power and dispersion. This progress, however, is all in the direction of inherited tradition. The art of glass-making has not apparently started on a fresh path, to enrich practical optics with new materials, and from the lack of earnest competition, the business interests of the proprietors of this manufacture do not offer any special incentive to the pursuit of ends which do not promise them assured advantages. Further, let us reflect how dangerous it is, that a branch of industry so important and so indispensable to many sciences should be in the hands of the few, so to speak, for under these circumstances unfortunate coincidences might threaten its continuance, and occasion a serious calamity. It is therefore a vital question for optical and other sciences interested therein, that in the future more forces should be gathered into the field, and that a keener competition should call forth stronger incentives to progress.

We can scarcely suppose that private initiative will suffice to supply this need without a strong external impulse. Undertakings of this kind are attended with so much difficulty and necessitate so large an outlay for results, which even under favourable circumstances, are so remote, that they can have little attraction even for enterprising people. A great rise in the industry in question can scarcely be expected unless funds are freely granted for its furtherance by Corporations or the State. The field is open here for learned societies which are in a position to offer material help towards the needs of science, to perform a most beneficial and worthy task. For great and various interests are dependent on the increasing efficaciousness and progress of the glass-manufacture. It is not, by any means, the Microscope alone which is here considered, but all arts and sciences dependent on the use of optical resources.

A retrospect of the last portion of this discussion on the ways and means of perfecting the Microscope in the future, shows a more favourable prospect than the earlier considerations. As regards that part of the performance of the Microscope which touches the dioptrical functions of the objectives, an increasing improvement of the instrument in important points may be expected in the future. The difficulties which at present oppose further progress in this respect, and will perhaps long continue to do so, need not in any way be considered as insurmountable. This is the proper field in which optical art may hope to attain further results. The question of the best adapted and most advantageous means of solving the difficulty under consideration is certainly not exhausted either as regards theoretical optics, or those practical arts which co-operate in the work of opticians. Theory may, in time, by a deeper insight into optical problems, point out new methods of removing, more effectually than at present, the chromatic dispersion and spherical aberration in objectives; practical optics may, by the perfecting and refining of the method of

work, render possible a still greater exactness of the mathematical forms which theory seeks to realize, and the art of glass-making may in the future produce new materials instead of those now used, which, in their optical properties, may offer more favourable conditions for the construction of perfect objectives than our present crown and flint-glass. Doubtless united efforts in this direction will result in a continual progress towards perfection of construction, which will bring great benefits to the scientific application of the Microscope, if even it does not increase the absolute capacity of performance of the instrument.

In this direction lie the ends attainable. Efforts grounded on a fundamentally different aspect of the question will be thwarted in the future, as in the past, by the barriers which nature opposes to human illusions.

Webb's 'Optics without Mathematics.' *—The author of this work makes the astonishing statement that "the magnifying power of the Microscope is more frequently given in superficial measure!" though he considers that "it is better for our purpose to reckon it in the linear form."

Benecke, B.—Die Anwendung der Photographie zur Abbildung mikroskopischer Objecte. (The use of photography for representing microscopic objects.)
[Summary of recent papers on the subject by T. C. White, W. H. Walmsley, G. J. Johnson, R. Hitchcock, C. Kiär, &c.]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 109–13.

Botterill, C.—Protoplasm. (Presidential Address to the Liverpool Microscopical Society.)
Micr. News, IV. (1884) pp. 57–68.

Bradbury, W.—The Achromatic Object-glass, XXX.
Engl. Mech., XXXVIII. (1884) pp. 485–7.
" " " " XXXI. Littrow's Formulæ.
Engl. Mech., XXXIX. (1884) pp. 6–7.

"Brass and Glass," A night with.
[Report of Meeting of Western Microscopical Club.]
Engl. Mech., XXXVIII. (1884) pp. 513–4.

Bulloch, W. H.—The Congress Nose-piece.
[Reply to A. McCalla *infra*, agreeing that he suggested the idea, "but it is one thing to suggest an idea and another to put it into practical shape."]
Amer. Mon. Micr. Journ., V. (1884) pp. 58–9.

C., J. D.—New Eye-piece Micrometer. [*Post.*]
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D., E. T.—Graphic Microscopy.
II. Eyes of *Epeira conica.*
III. Palate of Limpet.
Sci.-Gossip, 1884, pp. 25–6 (1 pl.); pp. 49–50 (1 pl.).

Dallinger's (Rev. W. H.) Nomination to the Chair of the Society.
Journ. of Science, VI. (1884) p. 118.

Dippel, L.—Mikrographische Mittheilungen. (Microscopical Notes.)
[(1) The formula for *a* on p. 312 of his 'Handbook of General Microscopy.' (2) Remarks on some test-objects of the genus *Grammatophora.* (3) Correction-adjustment with homogeneous immersion objectives.] [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 23–33 (1 fig.).

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Micr. Bull., I. (1884) p. 14.

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* See Bibliography, *infra*, p. 303.

ENGELMANN, T. W.—Das Mikrospectral-photometer, ein Apparat zur quantitativen Mikrospectralanalyse. (The microspectral photometer, an apparatus for quantitative microspectral analysis.) [*Post.*] *Bot. Ztg.*, XLII. (1884) pp. 81–8.

FAWCETT, J. E.—Photomicrography.
[An ordinary camera can be used.] *Micr. News*, IV. (1884) pp. 52–3.

FEUSSNER, K.—Ueber die Prismen zur Polarisation des Lichtes. (On prisms for the polarization of light.) [*Post.*]
Zeitschr. f. Instrumentenk., IV. (1884) pp. 41–50 (8 figs).
Nature, XXIX. (1884) pp. 514–7 (8 figs.).

FLESCH, M.—Ueber einen heizbaren, zu schnellem Wechsel der Temperatur geeigneten Objecttisch. (On a hot stage for a rapid change of temperature.) [*Post.*] *Zeitsch. f. Wiss. Mikr.*, I. (1884) pp. 33–8 (1 fig.).

FRANCOTTE, P.—Description d'une Chambre-claire. (Description of a camera lucida.) [*Post.*]
Bull. Soc. Belg. Micr., X. (1884) pp. 77–9.

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GILTAY, E.—Theorie der Wirkung und des Gebrauches der Camera Lucida. (Theory of the action and use of the camera lucida.) [*Post.*]
Zeitschr. f. Wiss. Mikr. (1884) pp. 1–23 (10 figs.).

GRUNOW, J.—The Abbe Illuminator.
[Instructions for using this illuminator as constructed by him.]
Amer. Mon. Micr. Journ., V. (1884) pp. 22–3.

HERRICK, S. B.—The Wonders of Plant Life under the Microscope. 248 pp. and 85 figs. 16mo, New York, 1883.

HITCHCOCK, R.—The Standard Micrometer of the American Society of Microscopists. [Cf. *supra*, p. 287.] *Amer. Mon. Micr. Journ.*, V. (1884) pp. 34–5.
„ „ "Our Advertisers."
[Brief notices of various American opticians.]
Amer. Mon. Micr. Journ., V. (1884) pp. 56–7.
„ „ Giant Electric Microscope.
[Notes as to the absence of novelty and the unsteadiness of the light.]
Amer. Mon. Micr. Journ., V. (1884) p. 57.

HURD (F.) Portable Microscope.
[Statement only of "a design which he believes will prove satisfactory," packing 5 × $2\frac{7}{8}$ × $1\frac{3}{8}$ in.]
Amer. Mon. Micr. Journ., V. (1884) pp. 37–8.

Journal of the Royal Microscopical Society, Vol. III.
[Review.] *Journ. of Science*, VI. (1884) pp. 106–7.

JULIEN, A.—Immersion Apparatus.
[Title only of paper read at meeting of Society of Naturalists of the Eastern United States.]
Amer. Nat., XVIII. (1884) p. 224.

KAROP, G. C.—Table for Microscopical Purposes.
[Soft white wood, 2 ft. 9 in. long, 1 ft. 6 in. wide, and 2 ft. 3 in. high. No cross-bar to the legs in front. Top 1 in. thick, "so that at any time it may be planed afresh if discoloured or eroded by acids." On each side in front is a sliding board to serve as an arm-rest, 6 in. wide and 15 in. apart. A piece of plate glass 7 in. × 6 in. let in the top over a piece of white paper or card. Half the glass blackened behind, and on the card opposite the other half is marked a 3 × 1 space, with centering lines, microscopical measurements, magnifying powers, &c.]
Journ. Quek. Micr. Club, I. (1884) pp. 312–3 (1 fig.).

KITTON, F.—Drawing with the Microscope.
[Objects to E. Holmes' suggestion of placing the slide cover downwards (*ante*, p. 146) that "the upper and under surfaces of an object are not as a rule alike; a further objection is that all powers exceeding 4/10 could not work through an ordinary slide." Gives the Wollaston camera the preference over all others tried.]
Sci.-Gossip, 1884, pp. 41.

KNAUER, F.—Das Mikroskop und seine Anwendung. (The Microscope and its use.) *Naturhistoriker*, V. (1883) pp. 525–7 (*concl.*).

MAINLAND.—Substitute for a Revolving Table.
[Highly lacquered Japanese tray, 20 in. × 12 in.]
Journ. Quek. Micr. Club, I. (1884) p. 323.

MATTHEWS, J.—Revolving Table.
[*Ante*, p. 147.] *Journ. Quek. Micr. Club*, I. (1884) p. 319.

McCALLA, A.—The "Congress" Nose-piece.
[Claims to be the original inventor and not W. H. Bulloch.]
Amer. Mon. Micr. Journ., V. (1884) pp. 38-9.

" " "Give credit to whom credit is due." [Same subject.]
The Microscope, IV. (1884) pp. 30–3.

MELLOR, T. K.— Gauss on the Object-glass.
Engl. Mech., XXXIX. (1884) pp. 56–7.

MICHAEL, A. D.—Polarization of light by a concave mirror of opal glass, or a piece of white china. *Journ. Quek. Micr. Club*, I. (1884) pp. 323–4.

"Microscopists" and the position of the Microscope.
["The statement is often made that the Microscope owes its present approximation to perfection, and microscopical methods their extensive development, to "microscopists," that term being applied to those who consider the Microscope as an end, not a means, and whose whole use of the instrument is confined to the resolution of test-objects and the study of the marking of diatoms. Nothing is more erroneous. The Microscope is far more in debt to the biologist who uses it as a means to solve some problem. To him we owe all our methods for staining, all our facilities for section-cutting, and every discovery in the use of microchemical reagents."]
Science Record, II. (1884) p. 87.

"Monachus."—Microscopic Test-Objects.
[Reply to L. Wright and E. M. Nelson, *infra*.]
Engl. Mech., XXXVIII. (1884) pp. 517 and 560.

MOORE, A. Y.—Slide of *Amphipleura pellucida* mounted in a medium of refractive index 2·3. [*Infra*, p. 319.] *Amer. Mon. Micr. Journ.*, V. (1884) p. 37.

" " The Parabola as an Illuminator for Homogeneous-immersion Objectives. [*Post*.] *The Microscope*, IV. (1884) pp. 27–30 (1 fig.).

NELSON, E. M.—Microscopic Test-Objects.
[Reply to (1) "Monachus," *ante*, p. 141—*supra*, p. 288; (2) T. T., *ante*, p. 148; and (3) L. Wright *infra*.]
Engl. Mech., XXXVIII. (1884) pp. 516–7 (4 figs.).

" " Möller's Probe-Platte.
[Remarks on plates mounted in phosphorus, monobromide, balsam, and dry.]
Engl. Mech., XXXVIII. (1884) p. 540.

" " Microscopic Test-Objects.
[Further in reply to "Monachus."]
Engl. Mech., XXXVIII. (1884) p. 560 (4 figs.).

" " On the Selection and Use of Microscopical Apparatus.
[*Résumé* of "demonstration" at the Quekett Microscopical Club.]
Engl. Mech., XXXIX. (1884) p. 48.

OLLARD, J. A.—Simple form of Revolving Table made out of two mincing boards.
[Exhibition only.]
Journ. Quek. Micr. Club, I. (1884) p. 323.

PELLETAN, J.—Le Microscope "Continental."
[Warning against imitations!] *Journ. de Microgr.*, VIII. (1884) p. 121.

PENDLEBURY, C.—Lenses and Systems of Lenses, treated after the manner of Gauss. 95 pp. and 24 figs. 8vo, Cambridge, 1884.

PENNY, W. G.—Theory of the Eye-piece. IV. Distortion of Curvature.
Engl. Mech., XXXVIII. (1884) p. 497 (1 fig.).

" " " " V. Summary of Formulæ—On Further Approximations for the Distortion, and General Remarks—Proposed Eye-piece.
["The first lens plano-concave, the second plano-convex, with focal length *numerically* equal to that of the first, and placed at a distance from it equal to twice the focal length of the eye-lens, the curved side of each of

them being turned towards the eye." Proposed to be called "an undistorted eye-piece, not because the distortion is absolutely 0, but because it would seem to be much smaller than that of those in use."

Engl. Mech., XXXVIII. (1884) p. 541.

Physicians, Microscopes for.

[Recommendation of Beck's 'Economic.']

Cinc. Med. News, XVI. (1883) pp. 833–4.

"Prismatique."—Object-glass working, XI.

Engl. Mech., XXXIX. (1884) p. 24.

Prize, Questions for Examination in Competition for Bulloch and Grunow's.

4to, 1 p. (11th February, 1884).

[Seventeen questions on optics, lenses, objectives, camera lucida, magnifying powers, diffraction, and mounting. Open to any student in the senior class for five years of the Chicago Medical College.]

Queen's (J. W. & Co.) New Spot-lens Mounting. [*Post.*]

Micr. Bull., I. (1884) p. 11 (3 figs.).

Rogers, W. A.—Corrections to paper on the "Conditions of success in the construction and the comparison of standards of length."

Proc. Amer. Soc. Micr., 6th Ann. Meeting (1883) pp. 240–1.

Rohrbach, C.—A new fluid of great specific gravity, of large index of refraction, and of great dispersion.

[100 parts of iodide of barium are mixed with 130 parts of scarlet biniodide of mercury. About 200 cc. of distilled water are added to the powders, and they are then stirred up with a glass rod while heated in a test-tube plunged into an oil bath previously warmed to 150° or 200° C. A fluid double iodide of mercury and barium is formed, which is then poured into a shallow porcelain dish and evaporated down until it acquires a density so great that a crystal of epidote no longer sinks in it. When cold even topaz will float in it. It is then filtered through glass-wool. The fluid so prepared has a density of 3·575–3·588, boils at about 145°, and is of a yellow colour. Its refractive index is 1·7755 for the C line, and 1·8265 for the E line of the spectrum. For the two D lines of sodium the refractive indices are 1·7931 and 1·7933 respectively. So great is the dispersion that, using a single hollow prism with a refracting power of 60°, the dispersion between the two D lines is almost exactly 2′ of angle.]

Amer. Journ. Sci., XXVI. (1883) p. 406.

from *Ann. Physik u. Chem.*, No. 9, pp. 169–74.

Seip, A.—Address to the Lehigh Valley Microscopical Society.

(On the value of the Microscope.]

Amer. Mon. Micr. Journ., V. (1884) pp. 39–40.

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

[Horizontal position of Microscope. *Post.*]

Knowledge, V., (1884) pp. 109–10.

Stodder, C., Death of. *Micr. Bull.*, I. (1884) p. 9.

Amer. Mon. Micr. Journ., V. (1884) pp. 55–6.

Stokes, A. W.—Simple apparatus for aërating living fish whilst under microscopical observation. [*Supra*, p. 286.]

Journ. Quek. Micr. Club, I. (1884) pp. 322–3 (2 figs.).

Stowell, C. H.—Gleanings from the Journ. R.M.S. for December.

[Claims for Mr. E. H. Griffith the invention of a Revolver Microscope similar to Mirand's, III. (1883) p. 897, and of a nose-piece adapter similar to Matthews's, ibid., p. 903.]

The Microscope, IV. (1884) pp. 35–7.

Stowell, C. H. and L. R.—Proceedings of the American Society.

[Urging earlier publication.]

The Microscope, IV. (1884) p. 39.

Washington Microscopical Society, formation of.

Amer. Mon. Micr. Journ., V. (1884) p. 58.

Wassell, H. A.—Plate Glass for Optical work.

Engl. Mech., XXXIX. (1884) p. 57.

Webb, T. W.—Optics without Mathematics. 8vo, London, n.d., 124 pp. and 58 figs. [Microscope, pp. 61–6, 107–8. *Supra*, p. 300.]

Wicksteed, R. J.—The Microscope; its history, construction, utility and improvement.
[Title only of communication to the Ottawa Microscopical Society.]
Science, III. (1884) p. v.
Wright, L.—Microscopic Test-Objects—Aperture and Resolution.
[Criticism of "Monachus" and E. M. Nelson.]
Engl. Mech., XXXVIII. (1884) pp. 470–1 (2 figs.).
" " Microscopic Tests.
[Reply to "Monachus" and E. M. Nelson.]
Engl. Mech., XXXIX. (1884) p. 34.
Zentmayer's Nose-piece. [*Supra*, p. 285.]
Amer. Mon. Micr. Journ., V. (1884) pp. 42–3 (1 fig.).

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

Preparing and Mounting Sections of Teeth and Bone.*—J. E. Ady explains as follows what he terms the "laccic" method of occlusion.

1st. Saw a piece off the tooth or bone, rub it flat on an engineer's file, polish the flat surface on a fine hone, Water-of-Ayr stone being preferable.

2nd. Fasten the section on to a piece of plate-glass, 1 in. square, with a cement made by melting six parts of "button" lac with one part Venice turpentine.

3rd. File the section down moderately thin, and then reduce further on the Water-of-Ayr stone, examining from time to time with the Microscope.

4th. Soak the section off with strong methylated spirit, wash thoroughly in clean spirit, and dry between tissue paper.

5th. Make a thin solution of white shellac in methylated spirit, filter, and keep in a stoppered bottle.

The section is to be dipped in this solution, drained, and laid on a cold plate under a bell-glass. In about half an hour it will be dry.

6th. Mount in cold balsam and benzol in preference, in order to avoid heating the section, as that would give it a tendency to curl; but as the melting point of the shellac is higher than that of the balsam, the latter may be used if thought desirable, as it may even be caused to boil without affecting the shellac.

Expanding the Blow-fly's Tongue.†—C. M. Vorce writes:—

If the head of a living fly be cut off, the tongue will usually retract; pressure on the head will expand the tongue, but unless it be secured by some means before the pressure on the head is released, it is apt to wholly or partly retract again. If only the tip is wanted, it is easily secured by placing the severed head on a clean slip and pressing it with a needle till the tongue is fully expanded, when a drop of turpentine is applied, a cover laid on the tongue, and a clip applied before the pressure is removed from the tongue. To secure the whole tongue, split one end of a small stick for an inch or so,

* Journ. Quek. Micr. Club, i. (1884) p. 332.
† Amer. Mon. Micr. Journ., v. (1884) p. 12.

and holding the split open by a knife-blade, place the severed head in the cleft with the top downward, and, withdrawing the knife-blade, allow the stick to close upon the head, when it will fully distend the tongue. Now dip the head and tongue in turpentine and leave it immersed for a few days, when it will be found well cleaned, still perfectly distended, and can be released from the stick or cut from the head without danger of its collapsing. Mounted in a cell in balsam, it is a truly beautiful object.

Perchloride of Iron as a reagent for Preserving Delicate Marine Animals.—We have already referred (vol. iii. (1883) p. 729) to Dr. H. Fol's objection that the reagents in common use for instantaneous killing, such as picro-sulphuric acid, osmic acid alone or in combination with chromic and acetic acid, and corrosive sublimate, fail to give successful preparations, and noted his success with perchloride of iron. He now adds some further remarks on the subject.*

An alcoholic solution diluted to about 2 per cent. will answer ordinary purposes, but a stronger solution should be used in case it is desired to kill a large number of animals in a large vessel. It will not do, however, to turn a saturated solution directly into sea water, as precipitates would be copiously formed which would utterly ruin the preparations. After the animals have sunk to the bottom of the vessel, most of the water may be turned off, and 70 per cent. alcohol added. In order to remove from the tissues the ferric salts adhering to them, it is necessary to replace this alcohol with alcohol containing a few drops of hydrochloric acid.

The "fixation" of the animals in an expanded life-like form is perfect, and the action of the dilute acid is of so short a duration that it causes no injury to the tissues. Not only infusoria and Rhizopods, but also large pelagic animals, such as Medusæ, Ctenophora, Salpæ, Heteropods, *Doliolum*, &c., may be thus killed and transferred to alcohol, with their form, histological structure, and cilia perfectly preserved. After complete removal of the yellowish colour due to the presence of ferric salts by washing in acidulated alcohol, the tissues of transparent animals remain almost free from cloudiness.

The best method of staining such objects is to add a few drops of gallic acid (1 per cent. solution) to the alcohol. After twenty-four hours the alcohol is turned off, and pure alcohol added. Thus treated, the protoplasm will take a light-brown colour, the nuclei a much deeper brown. Carmine stains too deeply and diffusely, and cannot be successfully removed.

Action of Tannin on Infusoria.†—H. Gilliatt, struck with the remarkable appearance shown in Mr. Waddington's illustrations (vol. iii. (1883) p. 185), made a number of experiments with glycerole of tannin, as described by him. On exposing *Paramecium aurelia* to the action of the tannin, he found the effect quite as startling as described; the animalcules, as the acid began to affect them, darted

* Zeitschr. f. Wiss. Zool., xxxviii. (1883) pp. 491–2. See Amer. Natural., xviii. (1884) pp. 218–9.

† Proc. Linn. Soc. N. S. Wales, viii. (1883) pp. 383–6.

about with great rapidity, endeavouring to conceal themselves beneath any vegetable matter on the slip, their motions gradually growing slower; then they revolved slowly two or three times. A sudden contraction of the body followed, and in a few seconds the appearance shown in Mr. Waddington's illustrations.

The regularity of the fine transparent acicular fringe that now surrounded the animalcule, or whether it was completely thrown off, appeared to depend, as described by Mr. Waddington, on the strength of the solution. In those cases where the appendages were separated from the body, it was not unusual to find a few spiral shaped, although after careful comparison the majority were rod-like.

After examination of numerous specimens treated with the acid, it seemed difficult to reconcile cilia of such length—in some cases exceeding the width of the body—with the action apparent in the ciliary movements of the living animalcule. But while observing an example under oblique illumination, Mr. Gilliatt was struck with the appearance of fine lines across it, and was thus reminded of the rod-like bodies or trichocysts so fully developed beneath the cuticle of *P. aurelia;* and after referring to the views of W. S. Kent, Stein, Allman, and Ellis, on the effects produced "on the trichocysts by the use of acetic acid, or a small stalk of *Geranium zonale* (Horseshoe Geranium), he considers that it may be "fairly concluded that the effects observed by Mr. Waddington in his experiments must be attributed to the action of tannic acid on the trichocysts of *Paramecium aurelia*, and not, as he considers, to its action on the cilia."

Professor D. S. Kellicott * has also satisfied himself that the bodies are trichocysts. Glycerole of tannin acts even more energetically than acetic acid, and is, he considers, sure to become a valuable reagent in the study of infusoria. By applying in proper dilution, the infusorian is not at once killed, and the cilia may be seen yet in motion, with the trichocysts extending far beyond them.

Another writer † refers to "the hirsute covering of *Paramecium* and other infusoria shown when a solution of quinine is added to the water in which they live, although the cilia are quite invisible when the animals are swimming about. Quinine may prove to be a valuable reagent for killing the infusoria and rendering their cilia visible."

Preparing Fresh-water Rhizopoda.‡—In fixing the living animal, K. J. Taránek uses small (8–10 cm. long) pieces of soft red blotting-paper of triangular shape, and, in order to draw off the water under the cover-glass, lays a piece of this paper upon the slide in such wise that the point of it reaches the edge of the cover-glass, and comes in contact with the water beneath. The blotting-paper immediately causes a current, which, however, is very weak, as only the corner of the paper is active. If the current is strong, so that the animal begins to move with the water, the paper must be removed; but if

* Bull. Buffalo Nat. Field Club, i. (1883) p. 110.

† Engl. Mech., xxxviii. (1883).

‡ Abh. math.-naturwiss. Cl. K. Böhm. Gesell. Wiss., xi. (1882) Art. No. 8, iv. and 56 pp. (5 pls.). See also *supra*, p. 247.

the current is weak, which can be well regulated by the shape of the blotting-paper, the animal keeps its position unaltered; and as by the absorption of the water the cover-glass exercises greater pressure upon the slide, there is less danger of losing the animal from the field. Then add to the opposite edge of the cover-glass by means of a glass rod a drop of 1/2 per cent. osmic acid, which immediately penetrates to and kills the animal without altering its shape. In the same way are added to the preparation the different alcohols, 15, 45, 90, up to 100 per cent., whereby the animal obtains the required hardness. Then follows the staining with picro-carmine or methyl green (which have proved to be the best for Protozoa). In the same manner, after 5–7 minutes the stream of colour is replaced by weak alcohol (50–30 per cent.), when the whole preparation is complete.

This method is very simple and very quick, the whole manipulation lasting 7–12 minutes, so that the preparation is finished in a quarter of an hour. Care must be taken to have the object always in sight, and not to keep up too strong a current.

The stained object can be well examined in the weak alcohol, and, if the blotting paper is removed, can be kept whole hours in it. The manipulation is well adapted for drawing with the camera; but to make a permanent preparation, it must be treated with a clearing fluid, glycerine, oil of cloves, &c., and finally with Canada balsam, which, dissolved in benzine, is quite thin and liquid. The application of the clearing fluids is the chief difficulty in the preparation, because the absolute alcohol flows through quicker than the liquids which follow, which gives rise to small air-bubbles between the two liquids. "It is, of course, obvious that the preparations often do not come up to the requirements of our day, especially as regards beauty. For, beside the objects prepared, there are a number of algæ, infusoria, mud, &c., in the preparations, by which they are made more or less dirty."

Arranging Diatoms.*—E. H. Griffith thinks that those who wish to arrange diatoms will find the following of great assistance:—

With a pipette place the diatoms on a film of mica, as the mica is very thin, and when mounted can instantly be heated to an intense heat over an alcohol lamp. With a pair of scissors cut small strips from the best part of the diatom field of mica, moisten the mica on the other side and lay it on the prepared slide near the centre of the slip to be used, or if the diatoms are to be mounted on a cover-glass, place the strip near it, and with a pen make a delicate dot of ink on the under side of the slide to mark the place for placing the diatom. From the mica the diatoms can be very easily picked, while from the glass sometimes it is almost impossible to pick them. Several strips of mica may be placed side by side with different kinds of diatoms if desired.

Instead of putting the diatoms on a cover-glass and the cover-glass on a metal strip, in order that organic matter may be burned away over a spirit-lamp, put them with a pipette on the end of a thin

* The Microscope, iii. (1883) pp. 205–6.

strip of mica and then burn them, avoiding the great annoyance of having a cover-glass, diatoms and all, slide or fly off. The mica being thin and a poor conductor of heat, the end may be brought to a red heat almost instantly. Now place a glass slip on the turntable, and make a dot or a small circle in the centre as a guide for placing the diatoms. Turn the marked side down, and with gelatine or other material size the spot over the dot or circle; then with scissors cut from the film of mica a small piece from the best part of the diatom field, moisten the other side and lay it on the glass slide near the marked centre. A crescent-shaped piece may be cut, if desired, that may extend partially around the marked spot. The mica being thin, the focus of low powers need not be changed while transferring the diatoms from the mica to the slide, and one trial will demonstrate that it is much easier to pick from mica than from glass; also that there is less danger of having the mica fall from the slide while at work. Those who desire to make the arrangement on a cover-glass can do so by placing a cover over the marked centre, sizing it, and then transferring to the cover instead of to the slide.

Mounting Diatoms in Series.*—P. Francotte uses Threlfall's method † for arranging diatoms in series. The solution of caoutchouc being poured upon the slide, the benzine evaporates, and the diatoms are arranged; it is then slightly heated, and the diatoms sink into the layer of caoutchouc, where they remain definitively fixed, and can be covered with a thin glass coated with balsam.

Synoptical Preparation of Pulverulent Objects (Diatoms from Guano, Fossil Earths, &c.).‡—P. Barré describes as follows his process of making these preparations, which enable specimens of different pulverulent objects to be compared.

After covering one of the surfaces of a cover-glass with balsam in the manner described for arranging diatoms, § and heating it until the hardened balsam no longer contains any trace of chloroform, the cover-glass is placed in the instrument fig. 42, A. *a* is a plate of brass, ·75 mm. in thickness. *b* is a strip of steel, fixed at *e* to the plate *a*, and to which is riveted another brass plate *c*. To the latter are soldered nine copper tubes, made as thin as possible (1/5 or 1/6 mm.) These tubes pass through the plate *c*, and project about 1 mm. from its under surface. The tubes are of exactly the same length, so that the cover-glass, covered with hardened balsam, meets all the nine tubes at once.

The plate *a* has a rectangular aperture *d* (indicated by dotted lines), and exactly opposite to the orifices of the nine tubes in the plate *c*.

The cover-glass is placed between *a* and the tubes, the surface covered with balsam being *in contact with the nine tubes.*

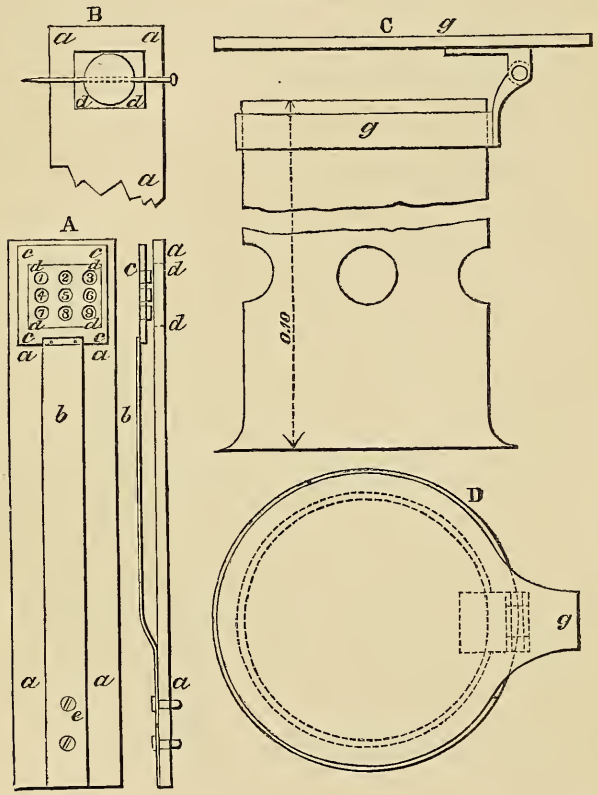
This operation complete, a copper or steel wire, or even simply an

* Bull. Soc. Belg. Micr., x. (1884) p. 65.
† See this Journal, iii. (1883) p. 600.
‡ Bull. Soc. Belg. Micr., x. (1883) pp.16-18 (1 pl.).
§ See this Journal, iii.(1883) p. 453 (1 pl.).

ordinary pin, is introduced transversely between the lower surface of the cover-glass and the square opening (fig. 42, B). This causes the cover-glass to rest with equal pressure on all the nine tubes at once.

Thus prepared, the glass, fixed in the instrument, is exposed to

Fig. 42.



the heat of a spirit-lamp. The balsam is again liquefied, the extremity of the tubes in contact with it become attached, and it is then allowed to cool.

The varieties of powder containing diatoms are then introduced into the tubes by means of a quill, and spread by a fine and very soft brush on the inner surface of each tube. The operation should be performed very carefully, so as not to allow particles of powder to fall into the adjoining tubes. The glass is again heated, and the diatoms adhere to the softened balsam in all the tubes at once—after which it is again allowed to cool. Then, by raising the spring *b*, the cover-glass is carefully loosened, and can then be

detached with a slight pressure. The surface of the glass having the diatoms is then blown and brushed, and the preparation is completed by the process described for arranging diatoms.

The essential point of the operation is in sufficiently hardening the balsam on the cover-glass. The heating must be carried as far as is possible without altering the colour. To succeed, it is advisable to cover the spirit-lamp with a metal chimney to avoid the flickering of the flame. This chimney has a cap (*g*, fig. 42, C and D), movable vertically, so that it can be raised or lowered. It is also convenient to joint it in such a manner that the hot plate can be placed perpendicularly, if desired.

It is, of course, permissible to increase at pleasure the number of tubes. The author makes preparations containing sixteen and even twenty-five varieties of earths; and expects to greatly exceed this number. Indeed, the only limit is the size of the cover-glass.

Logwood Staining.*—A. C. Cole says that "up to the present time, no stain has been found to equal logwood for certainty and permanency of results, and beauty of colour, which, besides being beautiful, is also not too tiring for the eye. We go further, and say that the more a histologist departs from a use of logwood and adopts other stains, the more unsatisfactory will be his total results. If ten men were each to make for himself a histological cabinet, the work of each being equal in other ways, the one who would produce the best cabinet would be found to have used logwood and picro-carminate of ammonia for the great majority of his slides, using other stains which have been found to suit special cases, such as aniline-blue-black for nerve-centres, methyl-aniline for amyloid or waxy degenerations in pathological histology in a few cases only. He would further have been found to have used benzole balsam as his mounting medium in the case of his logwood stains, and glycerine jelly for mounting his picro-carmine slides. Such a cabinet would last a thousand years, and be as perfect the last day as on the first. On the other hand, the worst cabinet, especially after, say about ten years, would be found to have been composed of a few logwood slides, mounted in dammar varnish, and the great majority stained with all sorts of aniline and other fancy dyes, and mounted in glycerine. The dammar preparations would be found to be little better than fine grey dust, and the fancy dyes to be conspicuous by their absence. So far as can be judged by our present data, a preparation stained with logwood and mounted in balsam is unchangeable; so is a preparation stained with picro-carminate of ammonia and mounted in good glycerine jelly.

With these preliminary remarks, we now proceed to give formulæ for those stains, and those only, which have been found really good in every way. As staining is yet in its infancy, we daily read of a fresh stain, and a new method of staining. We need scarcely draw the attention of our readers to the present mania for 'rushing into print,' and the numerous worthless, not to say senseless, communications to

* 'The Methods of Microscopical Research,' Part VII. (1884) p. xli.

our various journals on the subject of dyes for histological work. We advise the histologist to ask himself this question:—Is it my object to make for myself a complete educative histological cabinet, or to investigate the subject of stains, and therefore to experiment with the various stains? The operator should settle this question once for all, and *before* he commences his work."

Staining with Hæmatoxylon.*—Dr. C. L. Mitchell describes a new and simple method of preparing a logwood staining fluid, by which a permanent, reliable, and satisfactory preparation can, he claims, be easily made, and which places within the reach of every microscopist, a staining fluid "stable in composition, comparatively easy of preparation, and unequalled in the delicacy and clearness of differentiation of its colouring."

In staining fluids prepared from extract of logwood, the partially oxydized tannin in the liquid gradually absorbs more oxygen from the air and changes to other complex organic compounds; the colouring matter is also affected by the decomposition, and gradually becomes converted into other substances, and the liquid finally becomes of a dirty muddy colour, and is half filled with a lumpy sediment. This change will be found to take place in all ordinary logwood staining fluids, whether prepared from the extract or from the drug itself, although from the nature of the case those made from the extract would be most quickly affected. The idea therefore occurred to the author, that if the tannin could be removed, and the lake of logwood isolated in a state of comparative purity, a staining fluid could be prepared which might possibly be both permanent and satisfactory, and the following formula is the result of his investigation:—

Mitchell's Hematin Staining Fluid.

℞	Finely ground logwood	℥ ij.
	Sulph. alumin. and potash (potash alum) ..	ix.
	Glycerine	f. ℥ iv.
	Distilled water	a sufficient quantity.

Moisten the ground logwood with sufficient cold water to slightly dampen it, place it in a funnel or percolator, packing it loosely and then percolate sufficient water through the drug until the liquid coming from the percolator is but slightly coloured. Allow the drug to drain thoroughly, and then remove it from the percolator and spread out on a paper or board to dry. Dissolve the alum in eight fluid ounces of water, moisten the dry drug with a sufficient quantity of the fluid and again pack in the percolator, this time rather tightly, and pour on the remainder of the alum solution. As soon as the liquid percolates through and commences to drop from the end of the percolator, close the aperture with a tightly fitting cork and allow the drug to macerate for forty-eight hours. Remove the cork at the expiration of that time, allow the liquid to drain off, and then pour sufficient water upon the drug to percolate through twelve fluid ounces

* Proc. Acad. Nat. Sci. Philad., 1883, pp. 297–300.

altogether. Mix this with the glycerine, filter and place in a close-stopped bottle.

In this process nearly all the tannin is removed by percolating the drug with cold water, a menstruum in which the colouring principle is not very soluble, and the subsequent maceration and percolation with the alum solution removes the logwood lake in a state of comparative purity. The glycerine is added simply for its preservative qualities, and this may still be increased by the addition of a few drachms of alcohol to the solution.

The hematin staining fluid thus prepared is a clear heavy fluid of a deep purplish red colour. It will keep its colour for a length of time and deposits no sediment. A sample exhibited by the author had been made for nearly a year, frequently exposed to a strong light and open to the air, but was unchanged. Permanent and beautiful in its colour, which is of a delicate violet hue, clear and sharp in its definition of the different tissues under examination, it will bear use with the very highest powers and it is hoped enables observers to distinguish minute differences of tissue which have hitherto escaped notice.

As to the method of using the fluid, it yields good results when used undiluted, as a quick stain; but the best results are obtained by placing the tissues in a weak solution (ten drops to two fluid drachms) with warm distilled water for about twelve hours. This produces results of surpassing delicacy and beauty.

Dry Injection-masses *—The variously coloured gelatine emulsions in common use as injections keep for only a short time, and have, therefore, to be prepared as occasion arises for their use. The dry emulsions recommended by Dr. H. Fol are very easily prepared and convenient in use. As they will keep for any length of time they can be prepared in quantities, and will thus be ready for use at any moment.

Carmine Emulsion.—One kilogramme gelatine (softer kind used in photography), soaked in water for a few hours until thoroughly softened; after turning off the water, heat the gelatine over a water bath until liquefied, and then add to it, little by little, one litre of a strong solution of carmine in ammonia. The mixture, stiffened by cooling, is cut up, and the pieces packed in a fine piece of netting, Vigorous pressure with the hand under water forces the emulsion through the net in the form of fine strings or vermicelli. These strings are placed in a sieve and washed until they are free from acid or excess of ammonia; then collected and re-dissolved by heating. The liquid is poured upon large sheets of parchment which have been saturated with paraffin, and these sheets are then hung up to dry in an airy place. The dried layers of the emulsion, which are easily separated from the parchment, may be cut into strips and placed where they are protected from dust and dampness.

The carmine solution used in this emulsion is prepared as

* Zeitschr. f. Wiss. Zool., xxxviii. (1883) pp. 492–5. Cf. Amer. Natural., xviii. (1884) pp. 219–20.

follows:—A strong solution of ammonia is diluted with 3–4 volumes of water, and carmine added in excess. After filtering, the solution is mixed with the gelatine, and then enough acetic acid added to change the dark purple-red into blood-red. It is not necessary to completely neutralize the ammonia. The dry emulsion requires only to be placed in water for a few minutes and melted over the water-bath to be ready for use.

Blue Emulsion.—A slightly modified form of Thiersch's formula:—

1. To 300 ccm. of melted gelatine add 120 ccm. of a cold saturated solution of green vitriol (ferro-sulphate).

2. To 600 ccm. of melted gelatine add first 240 ccm. of a saturated solution of oxalic acid, then 240 ccm. of a cold saturated solution of red prussiate of potash (potassic ferricyanide).

3. No. 1 poured slowly into No. 2 while stirring vigorously; the mixture heated for 15 minutes.

4. After cooling, the emulsion is pressed through netting, the vermicelli washed and spread on waxed paper for drying. In this case the vermicelli must be dried directly, as they do not melt well without the addition of oxalic acid.

The dry vermicelli are prepared for use by first soaking in cold water, and then heating with the addition of oxalic acid enough to reduce them to a liquid.

Black Emulsion.—1. Soak 500 g. gelatine in two litres of water in which 140 g. of common salt have previously been dissolved, and melt the mass on the water-bath.

2. Dissolve 300 g. nitrate of silver in one litre distilled water.

3. No. 2 poured very slowly into No. 1 while stirring. An extremely fine-grained emulsion may be obtained by using 3–4 times as much water in Nos. 1 and 2.

4. No. 3 pressed into vermicelli as above, and then mixed with No. 5. by clear daylight.

5. Mix 1½ litre cold-saturated potassic oxalate with 500 ccm. of a cold-saturated solution of ferro-sulphate.

6. No. 4 mixed with No. 5 gives a thoroughly black emulsion, which should be washed several hours, again melted, and finally poured in a thin layer on waxed paper.

A grey-black emulsion may be obtained by using 240 g. potassic bromide in the place of common salt in No. 1, the remaining operations being the same.

Schering's Celloidin for Imbedding.*—Mr. G. C. Karop finds that a form of pyroxylin, known as Schering's patent celloidin, used by photographers for making a uniform quality of collodion, is an excellent material for imbedding. It is in the form of flat cakes of extremely tough, horny consistence, and "said to be non-explosive," burning like paper, and simply carbonizing if heated in a test-tube.

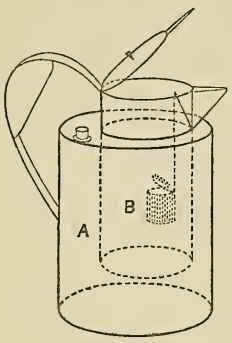
"A sufficient quantity is cut up and dissolved in equal parts of absolute alcohol and absolute methylated ether 0·717, until the solution is thin enough to pour. This takes some time, and the

* Journ. Quek. Micr. Club, i. (1884) pp. 327–8.

mixture should be well stirred daily, and kept in a warm room. The mass to be cut is hardened in any desired manner, and fastened by needles in the requisite position for cutting in a paper case the same size as the well of the microtome. The celloidin solution is poured in as free from bubbles as possible, and allowed to set slightly. The paper case and its contents is then placed in a quantity of methylated alcohol of 80°, not less, as otherwise the colloidin becomes tough, and not more, or it will dissolve it. It is left in this until of the proper consistence to cut, about as firm as boiled egg albumen. If possible, the sections should be cut under the surface of methylated spirit. Katsch's machine is made for, and is simply perfect for this purpose, but sections can be cut very well if the whole surface of the microtome in use is kept flooded with spirit. The sections can be stained by any of the ordinary fluids; the celloidin takes a slight stain, but as it is perfectly amorphous it does not in any way interfere, and can, of course, if the species of section admit it, be dissolved away by the mixture of ether and alcohol. On the whole, it seemed about the best thing for the purpose that he had met with, and members might judge of its fitness by the fact that it enabled one to cut sections of the whole eye, every structure remaining *in situ*, a feat he supposed impossible with any other material."

Gage's Imbedding-mass Cup.*—S. H. Gage describes the imbedding-mass cup, shown in fig. 43, about 1/5 natural size. A is a water-bath, into the top of which is firmly soldered the cup B for the imbedding-mass, having a fine wire gauze basket, suspended by a stiff wire, for holding the tissue. The cup is placed on one side of the water-bath to facilitate the pouring out of the imbedding-mass. The apparatus may be heated on a stove or by a gas or alcohol flame.

Fig. 43.



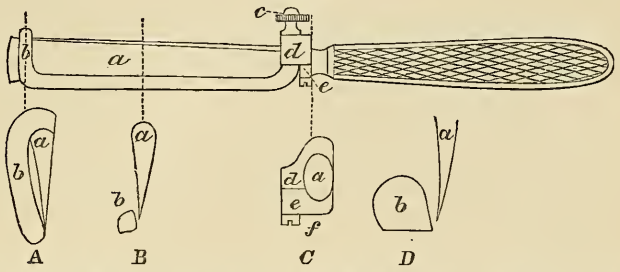
Gage and Smith's Section-flattener.†—S. H. Gage and T. Smith have devised a section-flattener somewhat similar to that of Andres, Giesbrecht, and Mayer,‡ but, as they consider, simpler and applicable to every form of section knife.

The section-flattener (fig. 44) consists of a rod *b* of spring brass about 5 mm. in diameter, flattened on two sides *b* and *d*, extending parallel with the edge of the knife, and projecting about 2 mm. beyond it. Opposite the cutting edge the space between the rod and knife is about 1 mm., while nearer the back of the knife the distance is greater (D, *a*, *b*). At each end the rod is bent at right angles. Next the handle it passes through a hollow cylinder *d*, into which it is secured by a milled nut *c*. At the free end of the knife the rod is

* Medical Student (N.Y.) i. (1883) pp. 14–16 (2 figs.).
† 'The Microscope,' iv. (1884) pp. 25–7 (1 fig.).
‡ See this Journal, iii. (1883) p. 916.

hooked over the back of the blade A, the spring of the wire securing it firmly. At the two angles of the rod it rests on the blade, so that in cutting sections any amount of pressure may be applied at these points. The rod is attached to the knife by means of a clamp, which

Fig. 44.



The section-flattener attached to a section knife:—*a*. Blade of the section knife; *b*. section-flattener; *c*. milled nut; *d*. the part of the clamp bearing the hollow cylinder; *e*. part of the clamp; *f*. screw holding the two parts of the clamp together.

A. Section showing the manner of hooking the section-flattener over the back of the blade.

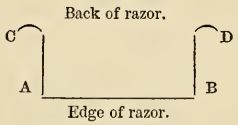
B and D. Sections showing the form of the section-flattener and its relation to the cutting edge, except at the ends.

C. Section of the tang of the knife, showing the manner of attaching the clamp.

consists of two pieces clasping the tang, and held together by a screw *c*. To clean the knife and rod, or to remove sections, the rod may be raised as it swings freely in the hollow cylinder attached to *d*. The rod may be entirely removed, as is necessary in sharpening the knife, by removing the milled nut *c*; the entire apparatus may be removed from the knife by loosening the screw *f*.

Francotte's Section-flattener.*—P. Francotte also describes a simple apparatus made by bending an iron wire or knitting needle 1 mm. in diameter into two right angles, the points A and B being 7 to 8 cm. apart.

Fig. 45.



The arms A C and B D are bent into hooks, so as to attach the apparatus to the back of the razor. A C and B D should be of such a length that A B is 0·1 or 0·2 mm. behind the edge.

In cutting, the sections are partially rolled round A B. It is then easy to transfer them to a glass slide and to make them flat, which is generally done without difficulty.

* Bull. Soc. Belg. Micr., x. (1884) pp. 58–60 (1 fig.).

Employment of the Freezing Method in Histology.*—Dr. Axel Key and Professor Gustav Retzius reproduce in German an account of the freezing method which had been previously published by them in Swedish. The method is in many cases of great advantage, but it often causes certain abnormal appearances which, without due care, might be taken for actual features in the tissue examined; for example, in fine sections of tendon cut when frozen and fixed afterwards by means of perosmic acid, a series of longitudinal canals were seen; and in sections of brain a regular system of lacunæ communicating with each other appeared to exist which it was quite impossible to demonstrate by means of an injection. All these appearances, in fact, are produced by the freezing method itself; the water contained in the tissues is driven out at the moment of freezing, and collects into lacunæ where there is the least resistance. It is evident, therefore, that the greatest care must be exercised by histologists who make use of this method.

Improved Method of Using the Freezing Microtome.†—Prof. W. J. Sollas considers that the process of obtaining thin slices of soft structures by means of imbedding in paraffin has now been brought to a state of almost ideal perfection; on the other hand the method of "freezing" still remains almost in its infancy. At present it is only with great trouble that a continuous series of slices can be obtained with it, and if these are cut from a loose disconnected tissue, they break up immediately on being introduced into water to free them from the gum in which they are always imbedded. Moreover the waste of time involved in transferring from water to a glass slide is simply appalling.

Yet the freezing process has special advantages of its own.

In the case of many tissues it affords a clearer insight into structure; perfect staining is not so indispensable (provided, as is usually the case, glycerine be used as a medium for mounting): and when hard parts occur in a preparation along with soft, both may be evenly cut through with equal ease. It is not likely, therefore, to fall wholly out of use, particularly for certain refined histological work, and improvements may be confidently expected.

The following may perhaps be regarded as a first step to others. Instead of freezing in gum, as is usual, one uses gelatine jelly. This is prepared and clarified in the ordinary manner. It should set into a stiff mass when cold, how stiff will best be learned by experience.

The tissue to be cut is transferred from water to the melted jelly, and should remain in it until well permeated.

It is then placed on the piston of a Rutherford's microtome; the "well" should not be filled, for adherence it is sufficient to roughen the surface of the piston with a file. No more jelly should be used than is sufficient to surround the specimen; if too much has been added, it may be removed when frozen by careful paring.

When well frozen, slices may be cut in the ordinary way; while

* Retzius's Biol. Untersuchungen, ii. (1882) pp. 150–3.

† Quart. Journ. Micr. Sci., xxiv. (1884) pp. 163–4.

frozen they should be quickly transferred to the glass slide on which they are to be mounted. On touching the glass, the slice of jelly almost immediately thaws and adheres as a consistent fibre to the surface. When enough slices have been placed on the slide, they should each be covered with a drop of glycerine (the sooner this is added the better); a cover-glass is then superposed, zinc white or some similar cement is run round it, and the preparation is complete. In process of time the glycerine will permeate the gelatine and convert it into glycerine jelly; if this does not take place soon enough, it may be hastened by placing it in an oven kept at a temperature of about 20° to 30° C.

In this way a series of entire slices of great thinness may be obtained from the most disconnected structures; even when they contain hard silicious spicules, as in the case of sponges.

Diatoms may be cut without difficulty by this method, and the author says he has now beside him some slices of *Pleurosigma* which reveal the internal anatomy of these in an admirable fashion. It need not be added that the process effects a considerable saving in labour and time.

Mayer's method of Fixing Sections.*—P. Mayer proposes an improvement on the methods of Frenzel, Threlfall, and Schällibaum.

A mixture of equal volumes of filtered white of egg and glycerine is made, and spread with a fine brush in a very thin and uniform layer on a cold slide. The sections are then laid on it, and the whole warmed for some minutes on a water-bath; they can now be treated with oil of turpentine, alcohol, water, and colouring reagents, without any danger of their moving. The glycerine only serves as a means of keeping the surface of attachment moist; if the paraffin in the sections melts, it immediately carries away the albumen, so that the neighbourhood of the section is almost or altogether freed from it, and this is an additional advantage of the method. The mixture of albumen can be kept clear by the use of antiseptics (carbolic acid).

Alum-carmine and strong alcoholized solution of carmine are very useful staining reagents. The latter is slightly modified from the well-known preparation of Grenacher in that 4 gr. of carmine are dissolved in 100 ccm. of 80 per cent. alcohol, with the addition of 30 drops of concentrated pure hydrochloric acid, heated for about half an hour in the water-bath; this solution is filtered, while still hot, and the superfluous acid is carefully removed by the addition of caustic ammonia, added till the carmine begins to be deposited. When quite cold this solution stains very rapidly (for example, embryos of lobsters are stained in about a minute) and intensely, though diffusely; washing in alcohol acidulated with hydrochloric acid is therefore necessary if the nuclei alone are to be stained. The moment of satisfactory cleansing may be judged by the appearance presented by the albumen, which will completely give up the carmine to the alcohol, or will, at most, be only faintly coloured.

* MT. Zool. Stat. Neapel, iv. (1883) pp. 521–2.

Gum and Syrup Preserving Fluid.*—The very great objection to the use of freezing microtomes was the impossibility of taking spirit-hardened material and cutting it without an eighteen or twenty-four hours' preparation. Up to a few months ago, any one wishing to cut by freezing had to take his specimens out of spirit, cut them of convenient size, and soak them in water for twelve or more hours to get rid of the spirit, then place them in gum solution some hours further. This was a great drawback, and rendered it a necessity that the operator must think over what he wished to cut, and prepare it through twenty-four hours previously!

All this is changed. Specimens are now kept the year round, if the operator chooses, in gum and syrup, having a little carbolic acid in it, and he freezes and cuts any tissue so placed at any moment he likes.

To make the gum and syrup medium, take of gum mucilage † (B.P.) five parts; syrup, ‡ three parts. Add five grains of pure carbolic acid to each ounce of the above medium.

Tissue may remain in this any length of time. For brain, spinal cord, retina, and all tissues liable to come in pieces, put four parts of syrup to five of gum.

The operator will do well to make the gum mucilage and syrup separately, and to keep them so till wanted.

Cutting Tissues Soaked in Gum and Syrup Medium.§—Take a piece of tissue not more than an eighth of an inch thick, and press it gently between a soft cloth to remove all the gum and syrup from the *outside* of the tissue. Set the spray going, and paint on the freezing-plate a little gum mucilage: then put the tissue upon this and surround it with gum mucilage with a camel-hair brush. The tissue is thus saturated with gum and syrup, but surrounded when being frozen with gum mucilage only. This combination prevents the sections curling up, on the one hand, or splintering from being too hard frozen on the other. Should freezing have been carried too far, the operator must wait a few seconds. It ought to cut like cheese.

Gum Styrax as a Medium for Mounting Diatoms. ‖—Referring to Dr. Van Heurck's recommendation of "styrax," ¶ Mr. F. Kitton writes that the resin which is the product of *Liquidambar orientale* is prescribed in the British Pharmacopœia under the name of gum styrax, and in the drug trade is known as "strained gum styrax." It has the colour of the old-fashioned black treacle, but is of greater consistency; a temperature of 212° renders it fluid. In its commercial state it is unfit for microscopic purposes, first from its

* Cole's 'Methods of Microscopical Research,' 1884, p. xxxix.

† Gum mucilage B.P. is made by placing 4 oz. of picked gum acacia in 6 oz. of distilled water and stirring occasionally until the gum is dissolved. This is to be strained through muslin.

‡ Syrup is made by dissolving 1 pound of loaf sugar in 1 pint of distilled water and boiling.

§ Cole's 'Methods of Microscopical Research,' 1884, pp. xxxix.–xl.

‖ Sci.-Gossip, 1884, p. 66.

¶ See this Journal, iii. (1883) p. 741.

impurities, probably owing to the rough method employed in obtaining it—the stems are cut in small pieces and boiled, when the gum rises to the surface, and is skimmed off; and second, from its thickness. It is therefore necessary that it should be dissolved in one of the following menstrua: chloroform, benzol, ether, a mixture of benzol and absolute alcohol. When the resin is dissolved it must be filtered, and it is then ready for use. The solution should be of the colour of brown sherry, and the consistency of limpid olive oil. Its consistency can of course be increased by evaporating a portion of the benzol, and the whole of the latter should be eliminated before placing the cover-glass on the slip. Its refractive index is then 1·63, very nearly that of monobromide of naphthaline. The American liquid-amber is prescribed in the American Pharmacopœia, but seems to be unknown in Europe. It would, if obtainable, be preferable to gum styrax, as its colour is a pale yellow. The colour of the styrax is practically of little consequence, as the film between the cover and slip is very thin, and does not show any appreciable amount of colour when placed under the Microscope.

During the past four or five months Mr. Kitton has used this medium for various Diatomaceæ. The transverse striæ on *Pleurosigma littorale* and the longitudinal on *Navicula cuspidata* are much more sharply defined, and the striæ on all of them are more easily resolved than when mounted in Canada balsam. The most striking difference between gum styrax and Canada balsam is displayed by *Polymyxus coronalis*. In balsam, the valves are perfectly hyaline, and the rays and puncta almost invisible; in gum styrax the valves are light brown, and the markings easily resolved. *Heliopelta*, as might be expected, does not exhibit more structural detail, but every line and dot is more distinct than when it is balsam-mounted. Several of the *Aulisci* are also much improved when mounted in this medium. Mr. Kitton cannot say much of its merits as a medium for mounting other microscopic objects. He has tried it for thin wood sections, hairs, chalk foraminifera, and a few butterfly scales, all of which show better than they do in balsam. The colour of styrax becomes objectionable when a thick layer is necessary. Dr. Van Heurck directs that the commercial gum styrax should be exposed in thin layers to the light and air for several weeks, to eliminate the moisture contained in it previous to dissolving it, but Mr. Kitton has not found this necessary with his sample.

Mounting Medium of High Refractive Index.*—Professor Hamilton Smith is reported to have mounted *Amphipleura pellucida* and *Navicula rhomboides* in "something having a refractive index of 2·4," the result being "past all expectation, beating everything yet seen," "making a new era in diatom mounting," and "far surpassing all that has been done in phosphorus."

Dr. A. Y. Moore has also † mounted *A. pellucida* in a medium of index 2·3. The appearance of the frustule is said to be "quite

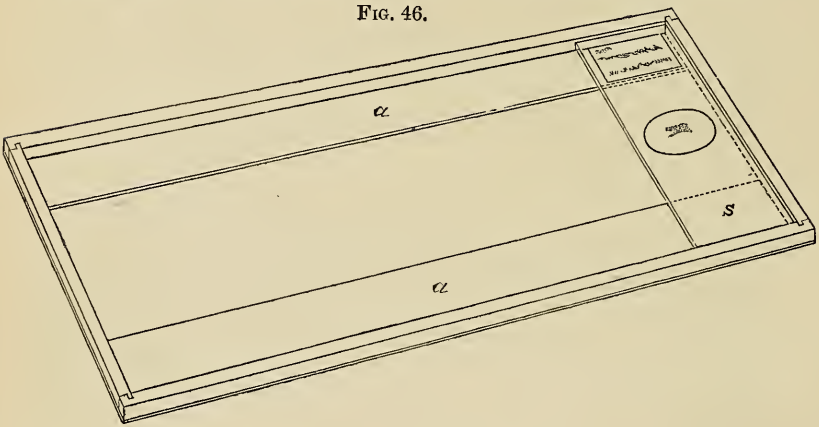
* Journ. Quek. Micr. Club, i. (1884) pp. 333–4.
† Amer. Mon. Micr. Journ., v. (1884) p. 37.

remarkable. It can be distinctly seen under a low-power objective under circumstances that a specimen in balsam would be quite invisible." He "has had no difficulty in seeing the dots on the valves with a Spencer 1/10 in. N.A. 1·35, with Beck's vertical illuminator, using lamplight."

Kingsley's Cabinet for Slides.*—J. S. Kingsley has had in use for some time a cabinet for holding his preparations, which, while not entirely new, possesses (it is claimed) some original features. It is based upon the model of Dr. Hailes,† but is more compact.

Rectangular frames of light wood are made, measuring inside $3\frac{1}{8}$ by $6\frac{1}{4}$ in., and just the depth of the thickness of a slide (fig. 46).

Fig. 46.



On one side of this strips are glued of four-ply Bristol board *a*, in the manner shown in the figure. These skeleton trays are kept in a box, piled one upon another. By this plan the slides are kept flat, and each one is held in place by the strips of Bristol board, which form the bottom of the tray above it. The preparation and its cover project between these strips; but, as will readily be seen, are prevented from touching the under surface of the slides in the tray above.

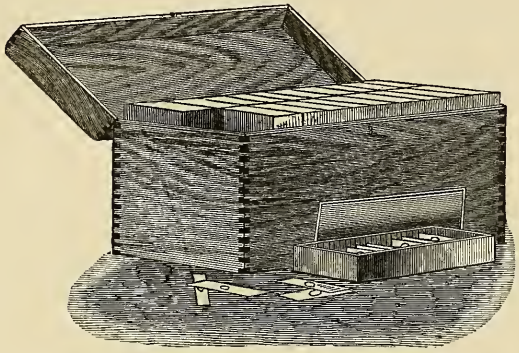
The especial advantage claimed for this plan is its compactness, safety, and portability; features of no small importance when one is returning from the sea-shore after the summer's work.

Pillsbury's Slide Cabinet.‡—J. H. Pillsbury has devised a cabinet (fig. 47) to allow of a set of slides being taken out and carried to the class-room or the society-room in safety, without being transferred to trays for that purpose and afterwards replaced in the cabinet.

* Science Record, ii. (1884) p. 67 (1 fig.).
† See this Journal, iii. (1883) p. 456.
‡ Science Record, ii. (1883) pp. 25–6 (2 figs.).

Neat, light, and yet firm "trays," each with sawn slots for holding twenty-five slides, are fitted to a polished cherry cabinet in such a way that they stand on end in two rows with sufficient space between the rows to make it convenient to get hold of the trays to take them out. The slides thus lie flat. The upper end of each tray

Fig. 47.



has a printed label with numbered lines for the name of the objects contained in the tray. There is a series of corresponding numbers on the bottom of the box to facilitate the replacing of the slides. This arrangement gives a complete list of the slides in the collection, spread out when the lid of the cabinet is opened, without any handling of the specimens.

The slides should be arranged by series, those likely to be wanted for use together being put in the same tray.

Examining the Heads of Insects, Spiders, &c., alive.*—Mr. E. T. Draper recommends a cone of pasted paper to be made rather larger than the specimen, with the apex cut off. A vigorous spider will soon project its head through the aperture. When in this position it should be blocked behind with cotton wool slightly wetted. The cone can then be gummed to a slip, apex upwards.

Many insects can be arranged in the same way for the observation of facial movements, and such front views admit of interesting and extended study, the action of the antennæ, palpi, and various organs of the mouth may be watched, and curious effects produced by the excitation of saccharine or nitrogenous juices, administered from the top of a sable pencil.

Examining Meat for Trichinæ.†—C. Renson describes the following new process for discovering *Trichinæ*:—Slices from 2–3 mm. thick are taken from several different portions of the piece of meat to be examined—by preference from the surface of the flesh. From each is cut a series of thin sections, which are placed together in

* Sci.-Gossip, 1884, p. 26.

† Bull. Soc. Belg. de Micr., x. (1883) pp. 24–5.

the following solution:—Methyl-green, 1 gramme; distilled water, 30 grammes. After about ten minutes' maceration, the sections are withdrawn and placed to decolour in a large test-tube filled with distilled water for half an hour, the water being shaken and changed two or three times.

When the water is very clear, it should be stirred with a glass rod, and on holding the test-tube against the light it is very easy to distinguish with the naked eye the sections containing *Trichinæ*. These present themselves under the form of small, dark-blue, elongated spots, methyl-green staining much more deeply the cysts of the *Trichinæ* than the rest of the tissue.

It is sufficient to examine the sections with a power of 50, and if "no *Trichinæ* are found, one may be absolutely certain that the meat does not contain any."

Bolton's Living Organisms.—Mr. T. Bolton continues his praiseworthy efforts to supply microscopists with a variety of living organisms, animal and vegetable. Several which he has sent out were entirely new to science, while others were new to England. His portfolio of drawings has now reached its tenth number. Microscopists subscribing to Mr. Bolton's "bottles," may certainly feel that apart from the practical return which they receive for their subscription, they are doing a real service to microscopy.

Cole's Studies in Microscopical Science.—Here, also, great credit is due to the editor, Mr. A. C. Cole, for the exertions which he has made to meet a want that has been felt by microscopists for the last half century. During that time the cry has constantly been that, though slides could be bought in profusion, no guide to their intelligent examination was forthcoming. Mr. Cole supplies weekly, not only a slide with a full description of the object, but also a coloured plate. It will be a matter of very great regret if these "Studies" are allowed to lapse for want of proper support from microscopists.

In addition to the "Studies," Mr. Cole is also publishing in parts, "Popular Microscopical Studies," and "Methods of Microscopical Research."

Alcohol, Absolute, preparing.

["The microscopist can prepare an alcohol which is so nearly devoid of water as to fulfil all ordinary requirements by a very simple process. Ordinary blue vitriol (cupric sulphate) is burnt or calcined until all water of crystallization is expelled and the resulting powder is put into (95 per cent.) alcohol, from which it extracts a large proportion of the water. By repeating the operation several times, an almost absolute alcohol may be obtained."]

Science Record, II. (1884) p. 65.

Baumgarten, P.—Beiträge zur Darstellungsmethode der Tuberkelbacillen. (Contributions to the method of demonstrating the bacillus of tubercle.)

Zeitschr. f. Wiss. Mikr., I. (1884) pp. 51–60.

Bergonzini.—Sull' uso del collodio e del fenolo nella technica microscopica. (On the use of collodion and fennel oil in microscopical technics.)

Spallanzani Modena, XII. (1883) Fasc. 4.

Blackham, G. E.—Boxes for Objects. [*Post.*]

Proc. Amer. Soc. Micr., 6th Ann. Meeting (1883) pp. 236–7.

Bradley's Mailing Cases. See Pillsbury, J. H.

Brass, A.—Die Methoden bei der Untersuchung thierischen Zellen. (The methods for the investigation of animal cells.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 39–51.

Breckenfeld, A. H.—A new method of mounting *Hydra*. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) pp. 49–50.

Browne's (R., jun.) Case for Objects.
["Each box holds thirty slides in a case that will easily slip into the pocket, and can be set up on the shelf of a bookcase. It has a movable flap-cover over the slides, on which there is a list of numbers so that the slides can be catalogued."]
Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, p. 236.

Calliano.—Il regolatore del preparato al microscopio. (Guide for microscopical preparation.)
Giorn. R. Accad. Med. Torino, XLVI. (1883) Nos. 4, 5.

Casse. See Renard, A.

Cattaneo, G.—Fissazione, colorazione e conservazione degli Infusorii. (Fixing, colouring, and preserving Infusoria.)
Bollett. Scientif., V. (1883) pp. 89–95.

Certes, A.—Analyse micrographique des Eaux. (Microscopical analysis of water.) 8vo, Paris, 1883, 28 pp. and 2 pls. [*Post.*]

Cleaning Slides and Covers.—Letters by F. Dienelt, A. L. W., E. W. Owen, S. Wells, and D. S. W. *Amer. Mon. Micr. Journ.*, V. (1884) pp. 59–60.

Cole, A. C.—Studies in Microscopical Science.
Vol. II. No. 11. Sec. I. No. 6. Fibrous Connective Tissue. Plate 6. Areolar Tissue × 40, pp. 21–4.
No. 12. Sec. II. No. 6. Chap. III. The Morphology of Tissues (*continued*), pp. 21–4. Plate 5. Types of Simple Tissues. Plate 6. Prothallus of Fern × 250.
No. 13. Sec. I. No. 7. Fibrous Connective Tissue (*continued*). Tendon, pp. 25–7. Plate 7. Tendon of Lamb T. S. × 70.
No. 14. Sec. II. No. 7. Primary Tissue, pp. 25–8. Plate 7. L. S. through apex of root of Maize (Sachs).
" " Methods of Microscopical Research.
Part VII. Stains and Staining. pp. xli.–iv. [*Supra*, p. 310.]
Part VIII. pp. xlv.–viii. Mounting. (Slides. Covers. Cleaning Covers and Slips. Labels. Transference of Sections. 1. The floating method. 2. Transferring with brushes. 3. By section-lifters.)
" " Popular Microscopical Studies. No. 6. A Grain of Wheat (*continued*). pp. 25–8. Plate 6. Germination of Wheat.

Day, F. M.—The microscopical examination of Timber with regard to its strength.
[Title only of paper read before American Philosophical Society, 21st Dec. 1883.]
Amer. Nat., XVIII. (1884) p. 333.

Dienelt, F.—See Cleaning.

Dimmock, G.—Pure carminic acid for colouring microscopical preparations. [*Post.*] *Amer. Nat.*, XVIII. (1884) pp. 324–7.
" " See Minot, C. S.

Errera, L.—See Renard, A.

Fastening Insects and other small forms for dissection.
[In such dissections one occasionally experiences considerable difficulty in fastening the object in the dissecting pan. Pins are inconvenient as they are in the way, and besides they frequently injure portions of the specimen. These difficulties may, however, be avoided by partially imbedding the object in wax or paraffin, which, however, should not extend above the middle line of the body. The paraffin and the imbedded object may then be readily fastened in the dissecting tank, or, when it is necessary to stop operations, the paraffin and object may be placed in alcohol.]
Science Record, II. (1884) p. 86.

Fearnley, W.—On a new and simple method of applying air-pressure to Wolff's bottles. [*Post.*] *Brit. Med. Journ.*, 1883, pp. 859–60 (2 figs.)

Fennessy, E. B.—Microscopic.

[A very pretty slide, and one very easily made, is the raphides in the sap of the daffodil. It is only necessary to squeeze out a drop of sap from the flowering stem on to a slide, and on its drying, which may occur spontaneously, or be done over a spirit-lamp, we find hundreds of crystals strewn over the field of view. With the polariscope they are exceedingly interesting and brilliant. If we drop over the warmed glass a little Canada balsam, we can press on a cover-glass.]

Engl. Mech., XXXIX. (1884) p. 34.

Francotte, P.—Nouveaux réactifs colorants. (New staining reagents.) [*Post.*]

Bull. Soc. Belg. Micr., X. (1884) pp. 75–7.

Gage, S. H., and T. Smith.—Section-flattener for dry section-cutting. [*Supra*, p. 314.] *The Microscope*, IV. (1884) pp. 25–7 (1 fig.).

Gierke, H.—Färberei zu mikroskopischen Zwecken. (Stains for microscopical purposes.) *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 62–100.

Giltay, E.—Ueber die Art der Veröffentlichung neuer Reactions- und Tinctionsmethoden. (On the mode of publication of new reactions and stains.)

Zeitschr. f Wiss. Mikr., I. (1884) pp. 101–2.

Grant, J.—Microscopic Mounting. VIII. Hardening and Wet Mounting.

[1. Hardening, agents; alcohol and chrome solutions; water. 2. The process of hardening.]

Engl. Mech., XXXVIII. (1884) pp. 517–9.

Hall, J.—Preparation of Rock-sections.

[Title only of paper read at meeting of Society of Naturalists of the Eastern United States.]

Amer. Nat., XVIII. (1884) p. 224.

Hamlin, F. M.—[" Advises the use of crimson lake as a colour for the ground of opaque mounts. When the object is white he considers this better than a black ground, but for objects of different colours he selects a ground which seems to show them best."]

Amer. Mon. Micr. Journ., V. (1884) p. 37.

Haushofer, K.—Beiträge zur Mikroskopischen Analyse. (Contributions to Microscopical Analysis.) [*Post.*]

SB. K. Bayerisch. Akad. Wiss., XIII. (1883) pp. 436–48 (1 pl.).

Hitchcock, R.—Microscopical Technic. I. Apparatus and Material. II. Mounting in general.

Amer. Mon. Micr. Journ., V. (1884) pp. 27–31, 51–2.

„ „ Imbedding Diatoms for making sections. [*Post.*]

Amer. Mon. Micr. Journ., V. (1884) pp. 54–5.

Ingpen, J. E.—Remarks on Mounting in Phosphorus.

[An attempt is being made to mount diatoms in absolutely solid phosphorus.]

Journ. Quek. Micr. Club, I. (1884) p. 334.

Insley, H.—Preparation of Coal.

[Has tried section-making of every kind of fire coal he could get, grinding as thin as possible,—could get no light to pass through the section on account of the presence of so much colouring matter.]

Midl. Nat., VII. (1884) p. 51.

Kain, C. H.—Some thoughts about Mounting.

[Discussion of various media.—" Some experiments by Mr. E. E. Read, of the Camden Microscopical Society, would seem to indicate that cosmoline may prove a valuable medium in which to mount the starches. The starch-grains are certainly remarkably well displayed in it. How permanent the mounts may prove is a question of time. It is not improbable that several of the petroleum products—even the plebeian kerosene itself—may be found not unworthy of the microscopist's attention."—" Dr. W. W. Munson some time ago called attention to the preservative properties of a solution of hydrate of chloral, and the medium is

evidently deserving of more attention than it has had. A slide of algæ put up in this solution over four years ago still remains as bright and pure as when first mounted, and, what is quite important, the cell contents of the algæ appear to be less contracted than is usually the case."—Cells and Cements.]

Micr. Bull., I. (1884) pp. 9–11.

KAROP, G. C.—Schering's patent Celloidin for Imbedding. [*Supra*, p. 313.]
Journ. Quek. Micr. Club, I. (1884) pp. 327–8.

KINGSLEY, J. S.— A new Cabinet for Slides. [*Supra*, p. 320.]
Science Record, II. (1884) p. 67 (1 fig.).

KITTON, F.—Glass Cells.
[Directions for perforating thin glass and thick glass slips.]
Sci.-Gossip, 1884, p. 41.

" " On Gum Styrax as a medium for Mounting Diatoms.
[*Supra*, p. 318.] *Sci.-Gossip*, 1884, p. 66.

MARPMANN, G.—Die Spaltpilze. (The Schizomycetes.) 193 pp. and 25 figs. 8vo, Halle, 1884.
[Contains a chapter on "Methods of Research," pp. 107–13.]

MILES, J. L. W.—Mounting in Canada Balsam.
[Report of meeting of Mounting Section of the Manchester Microscopical Society. Mentions that a "new cell having alternate elevations and depressions has been devised by a member of the section, in the use of which, by leaving an excess of balsam round the cell and cover-glass, air-bubbles ultimately escape through the spaces and loss by evaporation of essential oil in the balsam is provided for."]
Micr. News, IV. (1884) pp. 55–6.

MINOT, C. S.—Classification of Microscopic Slides.
[Also includes a note on Dr. Dimmock's plan. [*Post.*]
Science Record, II. (1884) p. 65.

MITCHELL, C. L.—Staining with Hæmatoxylon. [*Supra*, p. 311.]
Proc. Acad. Nat. Sci. Philad. (1883) pp. 297–300.

OSBORN, H. F.—Method for Double Injections.
[The veins are first injected through the arteries with coloured gelatine and then a differently coloured plaster of Paris is injected in the same way, forcing the gelatine before it, but as this stops at the capillaries, the arteries and veins can readily be distinguished.]
Science Record, II. (1884) p. 84.

OWEN, E. W.—See Cleaning.

PILLSBURY'S (J. H.) New case for Mailing Slides. [*Post.*]
Science Record, II. (1884) p. 86 (2 figs.).
Micr. Bull., I. (1884) p. 12 (2 figs.).
The Microscope, IV. (1884) p. 41 and Advt. i. (2 figs.).

PRINZ, W.—See Renard, A.

QUEEN'S (J. W. & Co.) Slides of Animal Hairs and Fibres (textile). Vegetable Esculents and Adulterations. *Micr. Bull.*, I. (1884) p. 13.

RASMUSSEN, A. F.—Om Dyrkning af Mikroorganismer fra Spyt af sunde Mennesker. (On the culture of Micro-organisms from the sputum of healthy men.) 136 pp. and 2 pls. 8vo, Copenhagen, 1883.

RENARD, A., L. ERRERA, CASSE, and W. PRINZ.—Discussion on the present condition of Physiological Chemistry and the advantage of the employment of Microchemical methods.
Bull. Soc. Belg. Micr., X. (1884) pp. 67–9.

SCHAARSCHMIDT, J.—Ueber die Mikrochemische Reaction des Solanin. (On the Microchemical Reaction of Solanin.)
Zeitschr. f. Wiss. Mikr., I. (1884) p. 61–2.

SHARPE, B.—Various methods of Carmine Staining.
[Title only of paper read at meeting of Society of Naturalists of the Eastern United States.]
Amer. Nat., XVIII. (1884) p. 224.

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

[Commensalists—Symbiosis—Lichens and the Schwendeneriau Theory. [Trachelomonads and *Amœbæ*] [*Astasia trichophora*] [Flower and Pollen of Hazel, Gymnosperms, &c.]

Knowledge, V. (1884) pp. 82–3 (1 fig.), pp. 109–10 (2 figs), pp. 141–2 (6 figs), pp. 182–3 (2 figs.).

Smith, T.—See Gage, S. H.

Smith, W. D.—New modification of.a Turntable.

[An attempt to unite in one piece of apparatus the most valuable points in Kinné's and Dunning's instruments. It consists of a circular brass plate, on the under side of which is a lever having its fulcrum on the axle of the table. This lever moves two arms which work in slots cut in the plate so that they always approach or recede from the centre in an exactly equal degree. The arms carry on the upper side of the plate two flat pieces of brass 2 in. in length, which grasp the slide, one of these being fixed at right angles to the slot, and the other pivoted so as to be able to adjust itself to the slide, as in Dunning's instrument.]

Journ. Quek. Mikr. Club, I. (1884) p. 31.

Smith's (H.) new Mounting Medium. [*Supra*, p. 319.]

Journ. Quek. Mikr. Club, I. (1884) pp. 333–4.

Sollas, W. J.—An improvement in the method of using the Freezing Microtome. [*Supra*, p. 316.] *Quart. Journ. Micr. Sci.*, XXIV. (1884) pp. 163–4.

Stillson, J. O.—Cabinet for Objects. [*Post.*]

Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, p. 237.

Streng, A.—A new Microchemical Test for Sodium.

Jahrb. f. Mineral., 1883, II., Ref. p. 365.

See *Journ. Chem. Soc.*—Abstr., XLVI. (1884) pp. 366–7.

Up de Graff, T. S.—Measuring Blood-corpuscles.

[Remarks on C. M. Vorce's article and R. Hitchcock's comments, *ante*, p. 159.]

Amer. Mon. Micr. Journ., V. (1884) pp. 26–7.

W., A. L.—See Cleaning.

W., D. S.—See Cleaning.

Wells, S.—See Cleaning.

White, T. C.—Method of preparing Sections of Hard Tissues.

[First "Demonstration" of the second series, with remarks by J. E. Ady on preparing and mounting sections of teeth and bone, *supra*, p. 304.]

Journ. Quek. Micr. Club, I. (1884) p. 330–2.

Wilson, E. B.—Methods of Section-cutting.

[Title only of paper read at meeting of Society of Naturalists of the Eastern United States.]

Amer. Nat., XVIII. (1884) p. 224.

Wright, L.—Mounted Insect Preparations.

[Commendation of A. Topping's preparations.]

Engl. Mech., XXXIX. (1884) p. 34.

Zentmayer's (J.) new Centering Turntable. [*Post.*]

Amer. Mon. Micr. Journ., V. (1884) p. 23 (1 fig.).

cell of each end of the filament. In those species which have no such sheath, variations in the turgidity are also brought about by variations in the exosmotic and endosmotic phenomena of the cells.

Alveoli of Diatoms.*—A. Grunow considers that the perforation of the alveoli has been completely proved in diatoms from the Jutland cement-stone and from the London clay; but that this can only modify the previously adopted interpretation, since he considers that the diatoms from these localities have already begun to undergo dissolution—this being unquestionably the case in those from the London clay—in consequence of which the delicate closing membranes of the alveoli disappear first of all. He believes that whenever diatoms are accompanied by lime, and especially when iron pyrites is present, as is the case in these localities, alkaline reactions have been set up, which may have been very weak, but which always act more strongly on silica than even very strong acids. In valves treated with very strong acids the alveoli may sometimes be seen actually perforated; while others close by will still be closed. *Coscinodiscus oculus-iridis* and *C. Asteromphalus*—the former of which (in cement-stone) has open, and the latter unquestionably closed membranes—are so closely related to one another that no sharp line of demarcation can be drawn between them. The author has given a close examination to this group of diatoms from Franz-Josef Land; and believes that the alveoli are closed above and below by delicate membranes proceeding from the thickening-ring. In *Triceratium Favus* the upper one is sometimes furnished with small spines. He considers it very improbable that in nearly related forms there should be so great a diversity of structure as that between perforation and complete continuity of the valves.

MICROSCOPY.

a. Instruments, Accessories, &c.

Hensoldt's and Schmidt's Simplified Reading Microscopes.†—Dr. C. Bohn refers to the necessity for insuring that the divisions of the micrometer of these instruments ‡ shall be a simple fraction of the magnified image of the circle divisions. If the distance of the latter from the objective is altered by moving the objective or the Microscope, the power is no doubt changed, but the image no longer coincides with the micrometer scale. Shifting the scale alone is of no use, for the same reason. The only course is to alter the distance of the objective from the circle divisions and the distance of the micrometer scale simultaneously in a proper ratio, the conditions for which he discusses. A Ramsden eye-piece must be used.

* Bot. Centralbl., xvii. (1884) p. 67.
† Zeitschr. f. Instrumentenkunde, iii. (1884) pp. 87–8.
‡ See this Journal, ii. (1882) p. 548.

Geneva Company's Travelling Microscope.—This is a very ingeniously constructed instrument, shown set up in fig. 51, and as folded for travelling in fig. 52.

To fold it, the narrow curved support between the base and the uprights is turned back within the latter, a pin which fixes it in position (not shown) being first withdrawn from the base. The uprights are then brought down to meet the base, the body-tube, stage, and mirror being at the same time swung so as to be horizontal. The base consists of an open frame only, but is heavy enough to give complete steadiness.

Fig. 51.

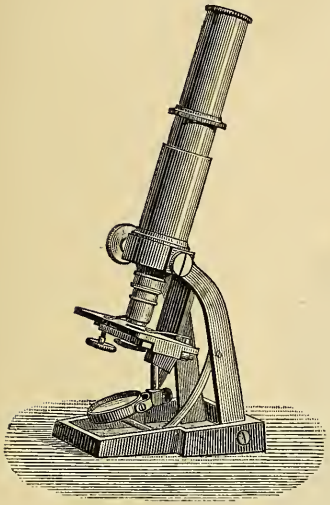
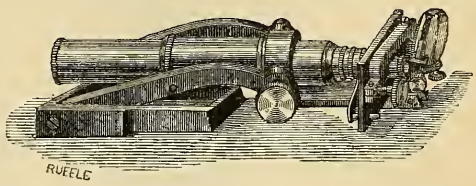


Fig. 52.



The milled head seen on the right of the body-tube clamps the socket of the latter between the uprights, so as to prevent it altering its inclination. The fine adjustment is effected by tilting the stage at one end by the screw beneath it.

When folded, the instrument measures $7\frac{1}{2} \times 3$ in. $\times 1\frac{3}{4}$ in.

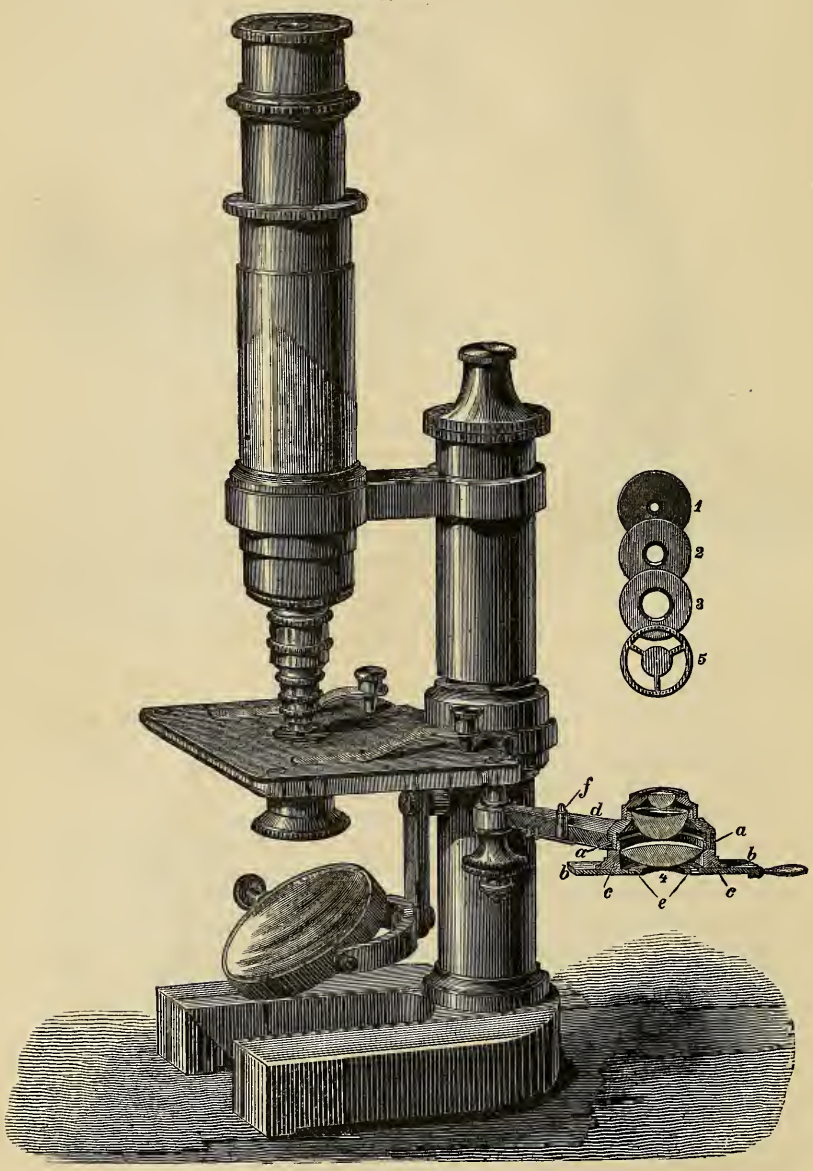
Reichert's Microscope with modified Abbe Condenser.—C. Reichert, of Vienna, with his medium stand (No. III.) supplies a modified form of Abbe condenser, shown in fig. 53, with which may be contrasted the original form by Zeiss (fig. 54).

The optical combination, consisting of three lenses with an aperture of 1·30 N.A., is screwed in a ring *a* attached to an arm *d*. This arm revolves on a pivot beneath the stage, so that it can be turned away from the stage, as shown in the figure. The fitting *c* of the lower lens has inner grooves to receive the diaphragm slide *b*, which can be drawn out entirely, for changing the five diaphragm-stops which drop into an aperture at *e*, or partially (to the right or left), so that the aperture may lie eccentrically to the optic axis for oblique illumination. A spring-pin falling in three holes marks the central or extreme lateral positions of the slide. The lenses with the diaphragm slide can be rotated in the ring, so that all azimuths of obliquity can be obtained. The pin *f* fits into a hole beneath the stage when the condenser is centered.

A slide beneath the stage for the ordinary cylinder diaphragms can be used when required on the condenser being turned aside.

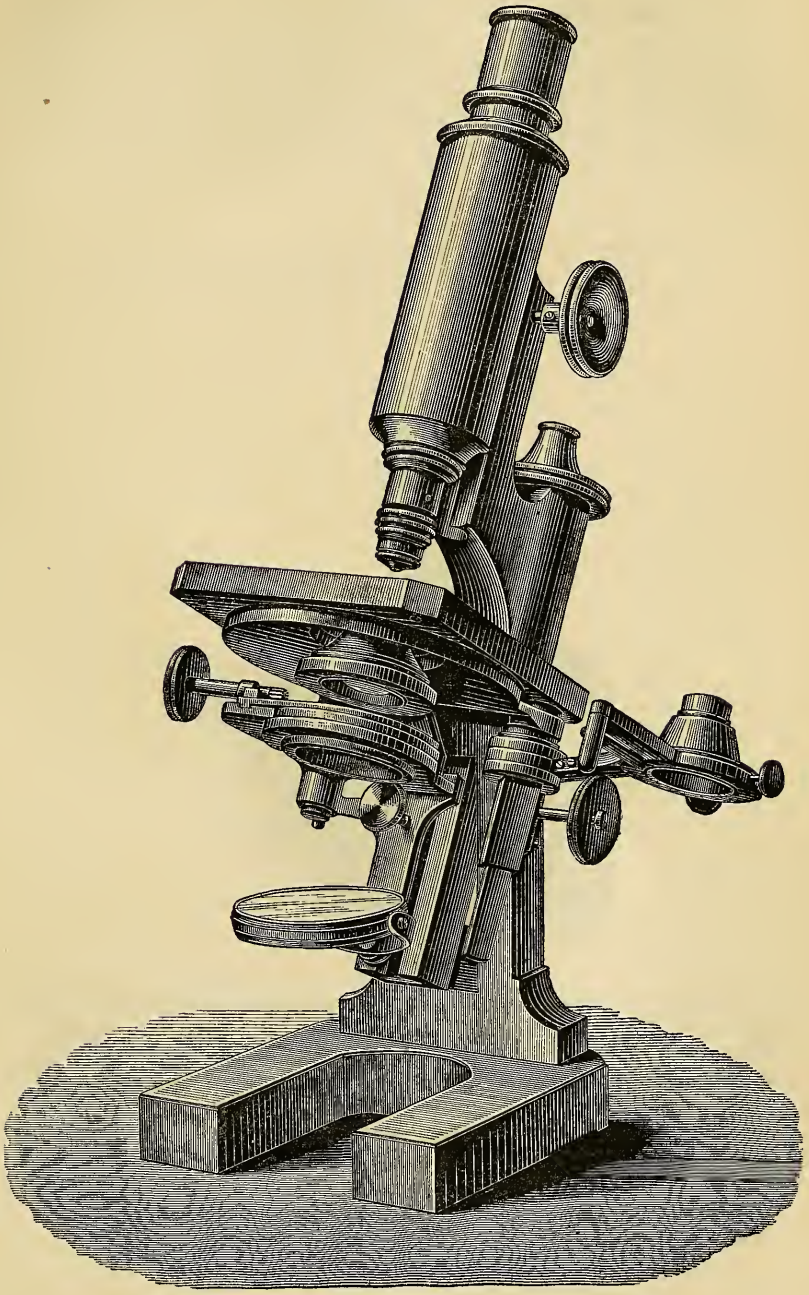
This apparatus seems to supply effectively the want which has long been felt for an adaptation of the Abbe condenser to the smaller

FIG. 53.



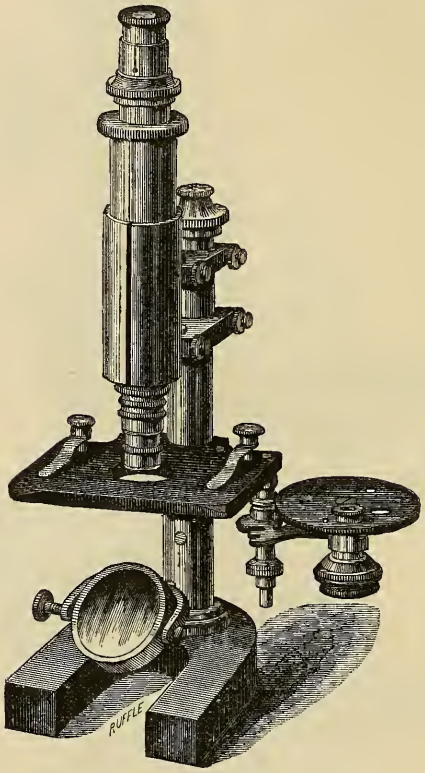
stands, though some of the advantages of the original form must necessarily be lost in such a case.

FIG. 54.



Reichert's Polarization Microscope.—This (fig. 55) is an inexpensive form of stand by C. Reichert, the chief peculiarity of which is that the wheel of diaphragms with five apertures rotates at the end of a horizontal arm, which, as with the condenser in the preceding form, swings on a pivot away from the stage, as shown in the figure. The diaphragm-plate is raised above the arm on a vertical axis, so that the tube attached to the largest aperture to hold the polarizer

Fig. 55.



may not prevent the complete rotation of the plate.* A notched projection on the arm falls against a second spindle beneath the stage when the apertures of the diaphragm-plate are central. The tube which holds the polarizer has a rotating fitting, and carries the polarizer with it.

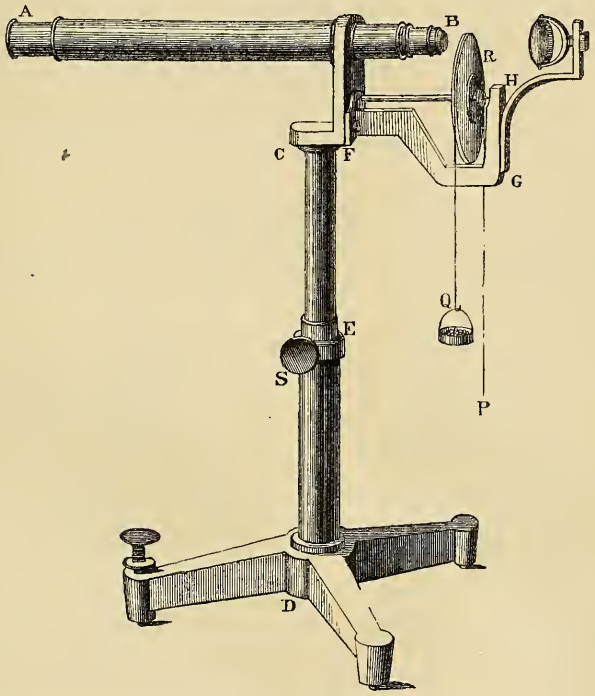
The analyser fits over the eye-piece without any attachment, which would seem to be undesirable, even though the Microscope can only be used in an upright position.

* When the polarizer is in place the plate cannot rotate completely, but no rotation is then required.

Reinke's Microscope for observing the Growth of Plants.*—J. Reinke, amongst other apparatus for observing the growth of plants, devised the instrument shown in fig. 56.

A tripod D supports a hollow pillar S in which slides a second pillar C E which can be raised to a height of 32 cm. from the table and is fixed with a clamp screw. To the latter pillar is attached a horizontal Microscope A focusing by the eye-piece and magnifying about 100 times. In front of the objective B is a glass wheel R

Fig. 56.



6 cm. in diameter with a grooved edge which runs very easily on two fine steel points let in the bent arm F G shown in the figure. A mirror on a second arm H illuminates the field of view.

A thread P passes over the groove in the wheel, the end of which is attached to the plant under examination, and at the other is a weight Q to keep the thread stretched. The circumference of the wheel for 10 cm. is graduated in half millimetres, and each millimetre is numbered. In the body-tube of the Microscope is a micrometer scale with 50 divisions. This is to be adjusted so that the 0 and 50 of

* Bot. Ztg., xxxiv. (1876), pp. 65–9, 91–5, 105–43, 145–60, 169–71 (2 pls.).

the scale exactly coincide with two consecutive divisions of the wheel. The half millimetres of the wheel can then be read to 1/50ths (= 0·01 mm.).

As the plant grows the wheel revolves, and the extent of the revolution is read on the wheel and scale by the aid of the Microscope. If the weight reaches the table, the movable pillar can be drawn out, and when the divisions on the 10 cm. of the wheel are passed over it can be brought back to 0 again by gently raising the weight.

Tetlow's Toilet-bottle Microscope.*—D. Tetlow has patented the following instrument, the specification of which we give verbatim without any attempt at an abstract, venturing only to emphasize one paragraph by italics of our own. The figures are also facsimile.

"To all whom it may concern: Be it known that I Daniel Tetlow, of the city and county of Philadelphia, and State of Pennsylvania, have invented a new and useful Improvement in Microscopes, which improvement is fully set forth in the following specification and accompanying drawings, in which—

Fig. 57 is a perspective view of a Microscope embodying my invention with central vertical sections thereof in line *x x*.

My invention consists of a Microscope having a body of the form of a bottle and the eye-piece removably fitted to the neck thereof, the construction, operation, and advantages being hereinafter set forth.

Referring to the drawings, A represents the body of a Microscope, the same being essentially of the form of a glass bottle having a closed bottom which is integral with the body; and B represents the eye-piece, consisting of the lens or glass C and metallic cap or holder D, the lens being properly set in the holder, and the latter removably fitted on the neck of the bottle.

E represents a base on which the bottle is stood, the same being formed of metal and receiving the bottom of the bottle, said bottom being shouldered, so as to properly set in the base and provide a neat joint for the parts.

While I have described the holder D and base E as metallic, sheet metal being preferred, it is evident that they may be formed of any suitable material and the base may be part of the glass.

The eye-piece is removed and an object to be examined placed in the bottle. The eye-piece is then restored, and the object may then be viewed through the lens C, as in Microscopes.

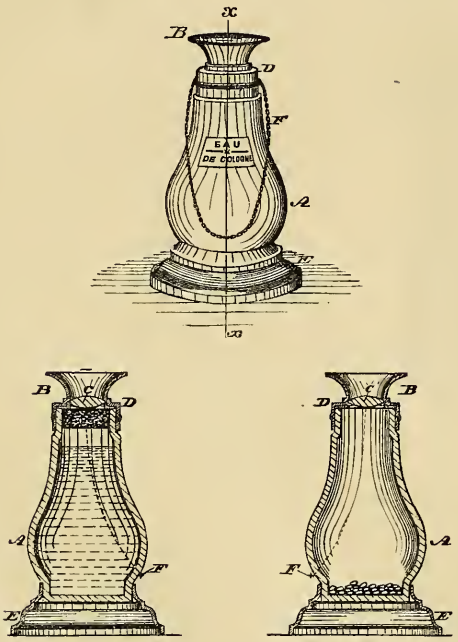
The body, being of the form of a bottle, has the following advantages: The object is not liable to be lost or displaced. It may be seen through the wall of the body and comparisons readily made as to its natural and magnified conditions and remain in the body for further examination, as the bottle provides an inclosure, the access to which being the mouth of the bottle, and this is covered by the lens C.

Another object of the invention is to employ the body A, *primarily*,

* Specification forming part of U.S.A. Letters Patent No. 287,978, dated November 6, 1883. Application filed August 24, 1883.

as a receptacle for some material or substance, such as perfumery. When the body is filled, it is corked and the eye-piece fitted to the neck, an attractive and convenient toilet-bottle thus being produced. The cork is concealed by said eye-piece, so that unauthorized persons will experience some difficulty in abstracting the perfumery. When the

Fig. 57.



perfumery is exhausted, the cork is thrown away and the service of the Microscope begins, said service being similar to that hereinbefore stated.

To the eye-piece is secured a chain, F, whereby the device may be readily carried, whether as a Microscope or toilet-bottle.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

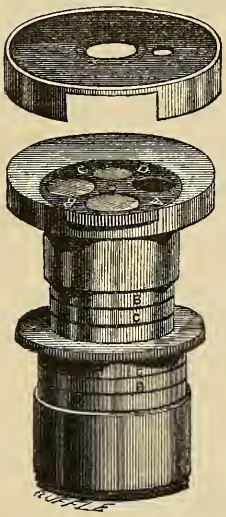
1. A glass bottle having a closed bottom integral with the body thereof and an open mouth, in combination with an eye-piece closing said mouth, formed of a lens and holder therefor, said mouth being adapted to contain a cork, substantially as and for the purpose set forth.

2. A bottle provided with a removable eye-piece and a base and chain, substantially as and for the purpose set forth."

Griffith's Multiple Eye-piece.—Mr. E. H. Griffith sends us the eye-piece (fig. 58) which he has devised.

A disk at the top of the eye-piece, with projecting milled edge, carries different eye-lenses which by rotation are brought successively into the optic axis. An aperture in the cap shows by a letter which lens is in place.

Fig. 58.



The upper tube to which the eye-glass disk is attached can be drawn out as shown in the figure, and the lower one, in which the field-lens is set, can be similarly drawn out.

Rings marked B and C show the proper position for each power, and when entirely closed, the eye-piece is of the proper length for a D eye-piece.

It was intended by the inventor to have a slit with stops for regulating the length of the eye-piece, and that a revolving diaphragm-disk should also be included, but these have not yet been added.

As to the utility of the eye-piece, it may be pointed out that whilst it would be very convenient to be able to obtain different eye-piece powers by simply rotating a disk, yet most of the advantage is lost by the necessity of withdrawing the eye-piece from the tube to alter its length—a process which would occupy as long a time as would be required to insert a different eye-piece. Moreover, it is optically impracticable to make use of the same field-lens for B, C, and D eye-pieces.

Francotte's Camera Lucida.*—P. Francotte thinks that Beale's camera lucida has a capital defect; the image is formed on the reflector too close to the eye-piece. The consequence is that the whole field is not visible at one time to the eye; whilst, for instance, the centre can be seen, the periphery is invisible; and in order to see all parts of the field, it is necessary to move the eye. Besides this, the short space left free between the eye-piece and the glass is very inconvenient.

To obviate this he replaces the eye-piece by a single lens, giving an image which is reflected by an inclined glass plate or a mirror. The inclination of the reflecting surface may vary between 40° and 50°, according to the point of the table upon which the image is to be projected. The image is erect, and the whole field is included.

The apparatus can be easily and very cheaply constructed. An ordinary lens (3 to 6 times) in a tube of cardboard is used as the eye-piece. The tube is cut obliquely, so that, on the elliptical section, a thin plate of glass or a mirror may be applied. On the upper surface an opening is made exactly over the place where the image is reflected.

By adopting the same principle and replacing the large prism of

* Bull. Soc. Belg. Micr., x. (1884) pp. 77–9.

Oberhäuser's camera by a mirror, the eye-piece by a single lens, and the small prism by a reflecting glass plate or a mirror, a convenient instrument is obtained which will not necessitate the inclination of the Microscope.

Rogers's New Eye-piece Micrometer.*—"Professor W. A. Rogers, of Harvard Observatory, has again laid microscopists under obligation by making an eye-piece micrometer for high oculars. It is a cover-glass of proper size to fit above the diaphragm of a 1/2 in. or 3/8 in. ocular, ruled in a scale with the fifth and tenth lines longer, and so fine as to need the magnifying power of the eye-lenses to separate the lines well. The high-power ocular separates also the striæ of diatoms, or other minute subdivisions of objects, and the scale enables one to count them with a readiness and ease which has not before been possible. It is a simple and inexpensive thing, that takes the place of the most expensive spider-web micrometers."

Geneva Co.'s Nose-piece Adapters.—Thury Adapters.—Prof. M. Thury takes exception to the remark at p. 284 that these adapters do not "differ in principle from the nose-pieces of Nachet and Vérick."

The first adapter was, he says, made in October 1863 after his designs for Count Castracane, and another in 1865 for Prof. E. Claparède. A Microscope exhibited by the Geneva Co. at the Paris Exhibition in 1867 was fitted with a similar adapter and was accompanied by a written description. At the 1878 Exhibition the modified movable form was exhibited. M. Nachet, who adopted the fixed form in 1877, "loyally termed it the 'Pince-Thury.'" It was after the 1878 Exhibition that the movable form came to be made by others.

Prof. Thury's apparatus was evidently therefore the precursor of all such contrivances.

Selection of a Series of Objectives.—Several writers have published their views on this subject, differing (with the exception of Dr. Carpenter) more or less from those put forward by Prof. Abbe in his paper on the "Relation of Aperture and Power."

Dr. G. E. Blackham† selects "as a set of powers sufficient for all the work of any microscopist the following:—

One 4 in. objective of 0·10 N.A. = 12° air angle nearly.
One 1 in. objective of 0·26 N.A. = 30° air angle nearly.
One 1/6 in. objective of 0·94 N.A. = 140° air angle nearly.
One 1/8 in. objective of 1·42 N.A.

The first two to be dry-working objectives without cover correction, the third to be dry-working with cover correction, and the fourth to be a homogeneous-immersion objective with cover correction, and all to be of the highest possible grade of workmanship. The stand . . . to be furnished with six eye-pieces, viz. 2 in., 1 in., and 3/4 in. Huyghenian, and 1/2, 1/3, and 1/4 in. solid. The following table

* Amer. Mon. Micr. Journ., v. (1884) p. 52.
† Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 33-41, 227-31.

shows the application of these powers to all grades of work, from that which is ordinarily done with a pocket lens to the extreme limits of microscopical vision :—

No. of lines to 1 in.	N. A. required to resolve.	Equivalent angular aperture.	Amplifying power needed to give apparent size of 100 to 1 in. at 10 in.	Amplifying power actually used.	How obtained.	
					Objective.	Eye-piece.
100	Less than 0·10	Less than 10° air	None	None	Naked eye	Naked eye
500	Less than 0·10	Less than 10° air	5	12½	4 in. of 0·10 N.A.	2 in.
5,000	Less than 0·10	Less than 10° air	50	50	1 in. of 0·26 N.A.	2 in.
10,000	0·11	12° 38′ air	100	100	..	1 in.
20,000	0·21	24° 16′ „	200	200	..	1/2 in.
30,000	0·32	37° 20′ „	300	300	1/6 in. of 0·94 N.A.	2 in.
40,000	0·41	48° 26′ „	400	600	..	1 in.
50,000	0·52	62° 40′ „	500	600	..	1 in.
60,000	0·63	78° 08′ „	600	600	..	1 in.
70,000	0·73	93° 48′ „	700	800	..	3/4 in.
80,000	0·84	104° 17′ „	800	800	..	3/4 in.
90,000	0·94	140° 16′ „	900	1200	..	1/2 in.
96,000	1·00	180° air, 82° 17′ homogeneous imm. fluid	960	1066	1/8 in. of 1·42 N.A.	3/4 in.
100,000	1·04	86° 21′ „	1000	1066	..	3/4 in.
110,000	1·15	About 98° „	1100	1600	..	1/2 in.
120,000	1·25	About 110° „	1200	1600	..	1/2 in.
130,000	1·35	About 125° „	1300	1600	..	1/2 in.
136,888	1·42	About 138° „	1368	1600	..	1/2 in.

. . . It has not been my purpose to lay down any single set of objectives as the only proper one, but to indicate the principles on which selection should be made, and the relation of aperture to amplifying power, and to show that there is at present no good theoretical reason for the use of objectives of greater amplifying power than the 1/8 in."

Dr. Blackham, it will be seen, advocates the use of eye-pieces as high as 1/4 in. which is largely in excess of Prof. Abbe's figures, which do not go beyond an amplification of 15 times.*

Mr. J. D. Cox believes† " Dr. Blackham has the verdict of experience with him when he says four or five lenses with a proper number of eye-pieces will cover the whole range of microscopical examination. In such a number of lenses you may get all the necessary combination of the three qualities of angle, power, and working distance which you may need. Different investigators may choose different series, but no one need have a greater number in the series. Economy is to be considered in deciding whether we shall choose one or another lens; but this is also consistent with the state-

* See this Journal, iii. (1883) p. 808.

† Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 229–30.

ment that all the elements, including economy, may be combined in such a small series. The lowest glass may be anything from a 1½ in. to a 3 in. If of an angle of 20° to 25° it will have plenty of working distance and penetration. The next glass should be of 40° angle, or very near it, as this is the maximum normal angle for binocular vision of opaque objects. Its working distance should be enough to allow the use of dissecting-needles under it, and the easy illumination of dry opaque objects. These conditions are found in good glasses ranging from 1 in. to 1/2 in. objectives. The third glass should also be a dry glass, having working distance enough to accommodate work with the animalcule-cages and compressors, and upon rough histological material. Its angle should be from 100° upwards, to as wide an angle as is consistent with the necessary working distance. These conditions are found in glasses ranging from 4/10 in. objectives to 1/6 in. Beyond the three lenses thus generally described, a single immersion lens of widest possible angle seems to give all the advantages that can be attained in the present condition of the art of making objectives.

In the third and fourth of the series, the angle should be the widest consistent with the other conditions specially named, and this is the only demand of the practical microscopist in which, as it seems to me, the phrase 'wide angle' can have any appropriate place."

Dr. J. Edwards Smith * says that he has practically, for the past four years, confined himself to the use of four object-glasses, namely, a 1 in. or 2/3 in. of 45° or 50°, a 1/2 in. of 38°, a 1/6 in. immersion, balsam angle ranging from, say 87° to 95°, according to the position of its collar, and a 1/10 in. immersion having a constant angle of 100°. Of the last two glasses, the 1/6 in. has a working distance of 1/50 of an inch. The 1/10 in. will work readily through covers 1/100 of an inch thick. A large amount of his work is on urinary deposits. For the examination of malignant growths and for minute pathology generally, a dry 1/4 in. of 100° is in reserve.

Mr. E. M. Nelson's† view is to give the beginner a 1½ in. and a 2/3 in.; later on a 1/6 in. may be added, and as a higher power a 1/12 in. immersion of 1·43 N.A. "For all working purposes the battery would then be complete, and the microscopist equipped to repeat any results hitherto obtained. As luxuries, a 3 in., 1/3 in., and 1/25 in. might be got. It sometimes happened that the high initial magnifying power of the 1/25 in. enabled the observer to find some hitherto unknown object, or portion of an object, more easily than with the 1/12 in.; but when once found its details of structure would be better made out with the 1/12 in. So far it had not been possible to construct a 1/25 in. as perfectly as a 1/12 in., nor with so high an aperture; hence it would rarely bear any eye-piece beyond the lowest. The 1/12 in., however, with proper manipulation, would bear the 1 in. eye-piece, and then reveal structure that could not be made out with 1/25's, as hitherto constructed.

* 'How to see with the Microscope,' 1880, pp. 202, 203, and 206.
† Engl. Mech., xxxix. (1884) p. 48.

"Half-inch objectives had been made with apertures of 80°. Some authorities had declared that 40° was the highest aperture that could be usefully employed with that focal length. He had obtained one of the best examples of the 1/2 in. of 80°, and had made a careful series of trials with it. He had applied diaphragms above the back combination to cut down the aperture to 60° and 40° respectively, and the results might be briefly told. Taking the proboscis of the blow-fly and viewing it with the 1/2 in. diaphragmed down to 40° aperture, and arranging the illumination in the most favourable manner, he noted every detail of the picture, the sharpness and blackness of the points of the bristles, the transparency and clearness and general precision of the image; then removing the diaphragm behind the lens, he increased the aperture to 60°, and he found the image improved in every way. Increasing the aperture to the fullest extent, 80°, gave no advance upon the quality of image seen with 60° up to the 1 in. eye-piece; for this reason he concluded that 60° was the really useful aperture for a 1/2 in., and gave as much resolving power as the eye could well sustain with that combined power. No doubt the extra 20° would give the lens a higher resolving power with a stronger eye-piece, but he thought that might be better obtained with a lens of shorter focal length."

Mr. Nelson gives * the following table of apertures for object-glasses (with 1 in. eye-piece on a 10 in. tube), and says that "if ideal perfection is to be reached, the values given in the above table must be aimed at."

In.		N.A.			°
3	..	·08,	air angle		10
2	..	·12,	„		15
1½	..	·17,	„		20
1	..	·26,	„		30
2/3	..	·39,	„		46
1/2	..	·52,	„		63
4/10	..	·65,	„		81
1/4	..	1·04,	„ water angle		103
1/5	..	1·3,	crown glass angle		117
1/6	..	1·56, which has yet to be constructed.			

It will be seen that there is a wide divergence between Mr. Nelson's and Prof. Abbe's figures. For instance, for N.A. 0·65 Prof. Abbe suggests an objective of 1/8 in. and Mr. Nelson a 4/10 in.

Lastly, we may give Dr. W. B. Carpenter's views as expressed in his latest publication on the subject.†

"The 1/8 in. is (according to the writer's experience, which is confirmed by the theoretical deductions of Prof. Abbe) the lowest objective in which resolving power should be made the primary qualification,—the 1/6, 1/5, 1/4, and 4/10 in. being specially suited to kinds of biological work in which this is far less important than focal depth and dioptric precision. This view is strengthened by the very important consideration that the resolving power given by

* Engl. Mech., xxxviii. (1883) pp. 367-8.

† 'Encyclopædia Britannica,' 9th ed., xvi. (1883) pp. 269-70.

wide aperture cannot be utilized, except by a method of illumination that causes light to pass through the object at an obliquity corresponding to that at which the most divergent rays enter the objective. Now, although in the case of objects whose markings are only superficial such may not be productive of false appearances (though even this is scarcely conceivable), it must have that effect when the object is thick enough to have an internal structure; and the experience of all biological observers who have carried out the most delicate and difficult investigations is in accord, not only as to the advantage of direct illumination, but as to the deceptiveness of the appearances given by oblique, and the consequent danger of error in any inferences drawn from the latter. Thus, for example, the admirable researches of Strasburger, Fleming, Klein, and others upon the changes which take place in cell-nuclei during their subdivision can only be followed and verified (as the writer can personally testify) by examination of these objects under axial illumination, with objectives of an angle so moderate as to possess focal depth enough to follow the wonderful differentiation of component parts brought out by staining processes through their whole thickness.

The most perfect objectives for the ordinary purposes of scientific research, therefore, will be obviously those which combine exact definition and flatness of field with the widest aperture that can be given without an inconvenient reduction of working distance and loss of the degree of focal depth suitable to the work on which they are respectively to be employed. These last attributes are especially needed in the study of living and moving objects; and in the case of these, dry objectives are decidedly preferable to immersion, since the shifting of the slide which is requisite to enable the movement of the object to be followed is very apt to produce disarrangement of the interposed drop. And, owing to the solvent power which the essential oils employed for homogeneous immersion have for the ordinary cements and varnishes, such care is necessary in the use of objectives constructed to work with them, as can only be given when the observer desires to make a very minute and critical examination of a securely mounted object."

A table is then given which in addition to the magnifying-powers of objectives with the A and B eye-pieces also "specifies the angle of aperture which, in the writer's judgment, is most suitable for each. He has the satisfaction of finding that his opinions on this latter point, which are based on long experience in the microscopic study of a wider range of animal and vegetable objects than has fallen within the purview of most of his contemporaries, are in accordance with the conclusions drawn by Professor Abbe from his profound investigations into the theory of microscopic vision, which have been carried into practical accomplishment in the excellent productions of Mr. Zeiss." An extract from the table will be found on the next page.

"For ordinary biological work, the 1/8, 1/10, and 1/12 objectives, with angles of from 100° to 200°, will be found to answer extremely well if constructed on the water-immersion system."

Focal Length.	Angular Aperture.	Focal Length.	Angular Aperture.
in.	°	in.	°
4	9	1/4	50-80
3	12	1/5	95
2	15	1/6	110
1½	20	1/8	140
1	30	1/10	150
2/3	40	1/12	160
1/2	45	1/16	170
4/10	70		

"It must be understood that there is no intention in these remarks to undervalue the efforts which have been perseveringly made by the ablest constructors of microscopic objectives in the direction of enlargement of aperture. For these efforts, besides increasing the resolving-power of the instrument, have done the great service of producing a vast improvement in the quality of those objectives of moderate aperture which are most valuable to the scientific biologist; and the microscopist who wishes his *armamentum* to be complete will provide himself with objectives of those different qualities as well as different powers which shall best suit his particular requirements."

"High-angled" Objectives.†—Dr. J. Edwards Smith "prefers to regard as 'high-angled,' any, and all glasses, without reference to their focal lengths, which are endowed with the widest apertures obtainable. If this be accepted, then it will occur that a 1 in. of 50° should be classed as a high-angled objective, and similarly a 2 in. of 25°. And, again, it would also then occur that a 1/6 in. of 130°, which fifteen years ago ranked as a wide, would now be classed as a glass of medium power."

Zeiss's A* Variable Objective and "Optical Tube-Length."—The demonstration of the important influence of "optical tube-length" on the magnifying power of the Microscope explains what has hitherto seemed a curious anomaly in the action of this objective.

It will be remembered that it has a considerable range of power according as its two lenses are "closed" (when they are 44 mm. apart) or "open" (when they are at a distance of 52 mm.), the closing and opening being effected by rotating the collar on the objective.

In the closed position the equivalent focal length of the objective is 54·1 mm., and in the open 39·7 mm., or a ratio of approximately 4 : 3. The power of the Microscope is however increased not in the ratio of 3 : 4 only, but of 3 : 5·28.

The explanation of this difference is found in the fact that Δ, or the optical tube-length, varies considerably according to the position of the lenses of the objective. When they are closed the posterior focal plane is 153·6 mm. from the back lens of the objective, but when open 125·7 mm. only. Δ is therefore (with a tube-length of 10 in. or 250 mm. from the back lens of the objective to the anterior focal plane of the ocular) 250 − 153·6 = 96·4 mm., *or* 250 − 125·7 = 124·3 mm.

† 'How to see with the Microscope,' 1880, p. 104. Cf. also p. 146.

In the formula, therefore, for the magnifying power of the Microscope as a whole

$$N = \frac{250\ \Delta}{f\phi}$$

(f and ϕ being the focal lengths of the objective and ocular respectively), N is in the one case 17·8 and in the other 31·3, assuming ϕ to be 25 mm.

Those who are interested in optical formulæ may like to have before them the method by which (1) the focal length of the objective and (2) the distances of its posterior focal plane are determined, according to the improved methods of Prof. Abbe, of which we hope to give a more detailed account later.

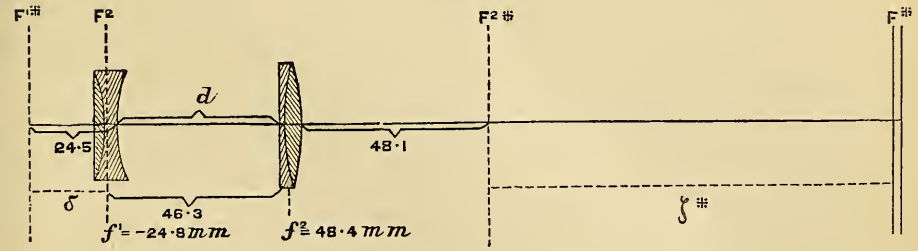
(1) To determine the focal length f of the combination, we require to know only the focal lengths f_1 and f_2 of the two lenses, and the position of their anterior and posterior focal planes, whence we derive f according to the formula

$$f = -\frac{f_1 f_2}{\delta}$$

(δ being the distance of the posterior focal plane of the first lens † from the anterior focal plane of the second lens).

Thus suppose in fig. 59 that we have given $f_1 = -24{\cdot}8$ mm. and

Fig. 59.



$f_2 = 48{\cdot}4$ mm., we require only to determine δ to solve the equation.

We can determine δ from the distances (supposed to be given) of the focal planes from the respective lenses, the distance of the posterior focal plane of the first lens $F_1^* = 24{\cdot}5$ mm. and that of the anterior focal plane of the second lens $F_2 = 46{\cdot}3$ mm. For the diagram shows that if from the total distance between F_1^* and the front of the second lens (which is made up of the variable distance between the lenses d and the quantity 24·5), we deduct the distance 46·3 mm. of the focal plane F_2 from the second lens we shall have the distance δ.

† The first lens being a plano-concave the *posterior* focal plane (i. e. which relates to the posterior medium, or to the image) is in *front* of the lens, and not, as with convex lenses, at the back.

Thus, according as the lenses are closed or open ($d = 44$ mm. or 52 mm.),

$$\delta = 44 + 24{\cdot}5 - 46{\cdot}3 = 22{\cdot}2$$
$$= 52 + 24{\cdot}5 - 46{\cdot}3 = 30{\cdot}2.$$

Having thus found δ, f is also found, as it is

$$\frac{24{\cdot}8 \times 48{\cdot}4}{22{\cdot}2} = 54{\cdot}1,$$

or

$$\frac{24{\cdot}8 \times 48{\cdot}4}{30{\cdot}2} = 39{\cdot}7.$$

(2) The second step is to find the distance of the posterior focal plane F* of the combination, which being deducted from 10 in. gave us Δ.

This distance, as the diagram shows, is made up of two quantities, one being the distance of the posterior focal plane F_2* of the second lens, which is supposed to be given, and $= 48{\cdot}1$ mm., and the other, an unknown quantity, which we will call ζ*. This unknown quantity may be determined from the known quantities of f_2 and δ by the formula

$$\zeta^* = \frac{(f_2)^2}{\delta}.$$

It is therefore

$$\frac{(48{\cdot}4)^2}{22{\cdot}2} = 105{\cdot}5,$$

or

$$\frac{(48{\cdot}4)^2}{30{\cdot}2} = 77{\cdot}6,$$

according as the lenses are open or closed.

Adding these values of ζ* to $48{\cdot}1$ we get the figures given above as the distance of the posterior focal plane from the back lens, i. e. $153{\cdot}6$ or $125{\cdot}7$.

The focal length of the objective and the distance of its posterior focal plane are thus very readily found, without elaborate calculations, by simply knowing the focal lengths and the position of the focal planes of the separate lenses, data which can be obtained very simply and without the necessity of knowing anything about the formulæ on which the objective is constructed or the refractive index of the glass of which its lenses are made. We hope, as we have said, to return to this subject hereafter and in more detail.

Queen's Spot-lens Mounting.†—In order to overcome as far as possible the difficulty J. W. Queen and Co. have felt in fitting the spot-lens to instruments of various patterns (some with movable substage and some with fixed tube, the latter at varying distances from the upper surface of the stage), they have devised the following mount:—

The tube A (figs. 61 and 62) is made of standard size to fit the

† Micr. Bulletin, i. (1884) p. 11 (3 figs.).

usual English and American substage or accessory tubes. The tube B carries a third tube C (blackened inside), sliding easily within it. Securely mounted in the latter tube is the spot-lens, which thus may be accurately focused upon the object; and when once adjusted for any stand, there is no occasion to alter it. If the small tubes be only 1/2 in. or 5/8 in. in length, the focusing range is a long one.

FIG. 60.

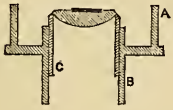


FIG. 61.

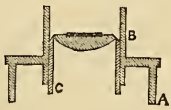


FIG. 62.

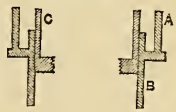


Fig. 60 shows the instrument as fitted to a Microscope which has the fixed tube beneath the stage. By reversing, as shown in fig. 61, the same mount may be used equally well in the movable substage of larger instruments.

They have also applied the same device to the usual substage Society-screw adapter, for carrying achromatic condenser or objective used as such (fig. 62).

The inside diameter of the tube C in this case is made $1\frac{1}{8}$ in., which will exclude very few objectives. It may, of course, be used, as the other, either in Microscopes with fixed stage tubes, or with movable substage.

Paraboloid as an Illuminator for Homogeneous-Immersion Objectives.*—A. J. Moore attempts "to make two comparatively inexpensive pieces of apparatus take the place and do the work of any first-class wide-angled immersion condenser. These accessories are the ordinary parabola and the hemispherical lens."

Ordinarily the former is a dark-ground illuminator, but when the aperture of the objective exceeds that of the parabola, the effect is simply that of a dry condenser, in which the central rays are stopped out. But even at its best the light cannot traverse the slide at a greater angle than 41° from the axis; and it is rarely, if ever, even so great as this. Now, if the light reflected by the parabola could be converted into a glass (or balsam) angle without altering its angular direction, it would be amply sufficient to give light to the objective at the widest balsam angle now used in the best homogeneous-immersion objectives. This may be done by using, under the slide, a hemispherical lens,† whose radius is less than that of the concavity of the parabola, making optical contact by the immersion fluid. This is to be accurately centered and the parabola brought up so close that the hemispherical lens will occupy the concavity. When properly adjusted, it will be obvious that those rays which are transmitted by the parabola impinge normally to the surface of the hemispherical

* 'The Microscope,' iv. (1884) pp. 27-30 (1 fig.).

† This was described and figured by Mr. F. H. Wenham, Trans. Micr. Soc. Lond., iv. (1856) pp. 57-8 (1 fig.).—ED.

lens, and hence are not refracted; that is, they traverse the same path in the lens that they had upon the parabola. The effect, then, is that of the wide-angled immersion condenser with the central rays stopped out.

Although this may be very desirable for some objects, it is not generally so, and it becomes necessary to limit the direction from which the light comes. This may be very easily accomplished by the use of a cardboard diaphragm. This may be made by cutting a circle of blackened cardboard, the diameter of the inside of the mounting of the parabola, so that when pushed home against the glass surface the circle will be held friction-tight. By cutting small holes in this card the light may be regulated; and it should be kept well in mind that when the holes are cut in the outer edge of the card, the light, although oblique, will be more nearly central than when admitted to the reflecting surface through a hole nearer the centre; but should the hole be too near the centre of the card the light will not be transmitted at all, owing to the fact that it will strike the top of the concavity of the parabola. A good guide to go by is a circle upon the card whose diameter is the same as that of the top of the concavity. The most of the oblique light may then be obtained by cutting the holes near this line. Holes may be cut at various angles to each other, to effect the resolution of the various sets of lines by which some objects are marked.

The author adds: "The chief objection to this method of illumination is, that central light cannot be obtained; but this, of itself, is of no particular account, as the parabola may be removed from the substage when it is desired. As to the performance of this arrangement, I can speak in the highest terms; the resolution of the diatoms of Möller's balsamed plate being easily accomplished; and when the full operation of the parabola was used, the dots of No. 18 showed better than I have ever seen them by any other method of illumination."

Fig. 63.

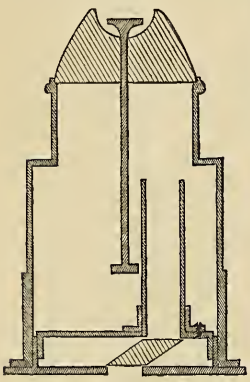


Fig. 64.

Paraboloid for Rotating Illumination in Azimuth.—We have a paraboloid with an arrangement shown in section in fig. 63. The bottom of the fitting is closed by a brass box in which is a rhomboidal prism, the lower face of which is over an oblong slot in the centre of the lower plate of the box, while the upper face is towards the side of the upper plate, and just beneath the outer zone of the paraboloid. Over the upper face is a tube 1½ in. high (the horizontal section of which is shown in fig. 64). Axial rays are, by means of the prism, made to fall on a part of the outer zone of the paraboloid, and by rotating the box can be brought into any azimuth of the latter.

Horizontal Position of the Microscope.*—Mr. H. J. Slack considers that the usual position of a Microscope with a tube slanting a little and the head leaning forward to look down it, is all very well for a short examination of any object, but not at all desirable for continuous work. A better plan is to get a carpenter to make a light stool 2 ft. long and 14 in. wide, standing on four legs, the length of which should be determined by that of the Microscope it is intended to use and the height at which the observer sits. His own stool is 7 in. high, and when placed on an ordinary table brings a full-sized Microscope with its tube in a horizontal position at a convenient height for the eye of an observer sitting in an ordinary chair. The late Mr. Lobb, who was skilful in exhibiting troublesome objects, always used his Microscope in this position; but as far as Mr. Slack knows, it is seldom adopted. When the instrument is in position as described, the substage mirror should be turned out of the way, and the lamp placed so that its flame is exactly opposite the axis of the instrument, and can be seen in the middle of the field on looking through it. If the objects to be watched are large enough for a low power, the light may be softened by placing under the slide a piece of foreign post paper saturated with spermaceti. For high powers, an achromatic condenser is desirable, and one of the smallest central stops is usually the most useful for displaying fine cilia, or delicate whips, as well as for lighting up without glare the interior of various creatures. If all is arranged properly, the manners and customs of infusoria may be watched for hours without more fatigue than reading a well-printed book. A tenth part of the time spent with the head leaning forward in the usual way is far more exhausting.

Flögel's Dark Box.—Dr. J. H. L. Flögel some fourteen years ago devised the dark box, shown in fig. 65, to put over the Microscope and shut out all extraneous light. It is open behind and has an aperture in front to admit light to the mirror. From back to front it measures 20–25 cm., and in width 60–80 cm.; its height depends upon the stand to be used.† He now adds a few words in the interest of those microscopists who may wish to have similar boxes made. ‡

The principal thing is the right position of the aperture by which the light is admitted; its upper edge must lie exactly at the level of the stage—not lower, in order that the full light from the window may be used; and not higher, in order that light may not fall from above on the stage, which would do away with most of the advantages of the box. The Microscope is put as far as possible in the box, so that the edge of the stage touches it, and, in order that there may be sufficient room for the head of the observer in this position, the anterior portion of the box is bowed out. On the right and left of the

* 'Knowledge,' v. (1884) pp. 109–10.

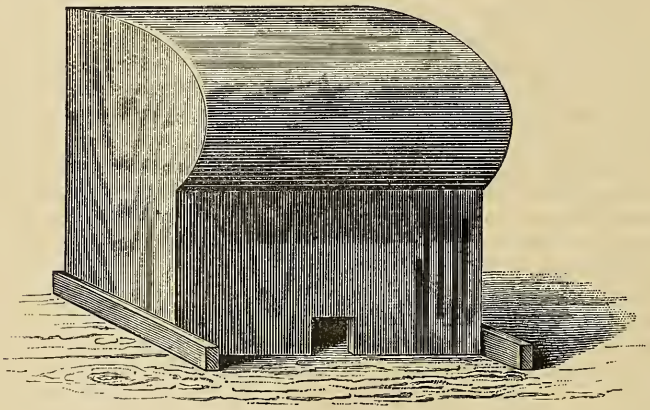
† Dr. L. Dippel considers this plan preferable to a darkened room with an opening in the shutter to admit light. The contrast between the illuminated field and the dark room is too great. The pupil of the eye is now enlarging and now contracting, and injurious results must inevitably follow. 'Das Mikroskop,' 1882, pp. 751–2 (1 fig.).

‡ Zool. Anzeig., vi. (1883) pp. 566–7.

Microscope there should be enough room for the hands to move comfortably and to be able to draw.

The action of the dark box is that it strengthens the retina wonderfully in the perception of the finest details. This takes place in two ways. First, in the ordinary mode of observing with the

Fig. 65.



Microscope, the eye of the observer is so much disturbed by the light from the illuminated eye-piece setting, and the surrounding objects, that many microscopists are accustomed to shade the eye with the hollowed hand as a remedy in delicate observation. This is obviated in the most perfect manner by the dark box. In the next place, it is by no means a matter of indifference whether strong or weak light-impressions are simultaneously received by the other open eye, which is at rest. Every more intense light-impression prejudices the sight of the other eye more than is commonly supposed. Into the dark box, however, only a faint illumination can enter from the light of the room behind it, especially when the table is black.

Feussner's Polarizing Prism.*—Dr. K. Feussner gives a detailed description of the polarizing prism lately devised by him, which presents several points of novelty, and for which certain advantages are claimed. The paper also contains an account, although not an exhaustive one, of the various polarizing prisms which have from time to time been constructed by means of different combinations of Iceland spar.

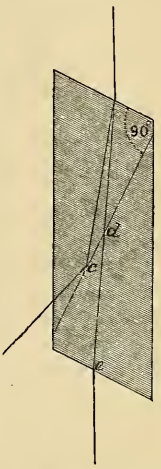
I. *Older Forms of Polarizing Prisms.*—In comparing the various forms of polarizing prisms, the main points which need attention are:—the angular extent of the field of view; the direction of the

* Zeitschr. f. Instrumentenk., iv. (1884) pp. 42–50 (8 figs.). See P. R. Sleeman in 'Nature,' xxix. (1884) pp. 514–7 (8 figs.).

emergent polarized ray, whether it is shifted to one side of or remains symmetrical to the long axis of the prism; the proportion which the length of the prism bears to its breadth; and, lastly, the position of the terminal faces, whether perpendicular or inclined to the long axis. These requirements are fulfilled in different degrees by the following methods of construction.

1. *The Nicol Prism.**—This (fig. 66), as is well known, is constructed from a rhombohedron of Iceland spar, the length of which must be fully three times as great as the width. The end faces are cut off in such a manner that the angle of 72° which they originally form with the lateral edge of the rhombohedron, is reduced to 68°. The prism is then cut in two in a plane perpendicular to the new end surfaces, the section being carried obliquely from one obtuse corner of the prism to the other, in the direction of its length. The surfaces of this section, after having been carefully polished, are cemented together again by means of Canada balsam. A ray of light, on entering the prism, is separated by the double refraction of the calc-spar into an ordinary and an extraordinary ray: the former undergoes total reflection at the layer of balsam at an incidence which allows the extraordinary ray to be transmitted; the latter, therefore, passes through unchanged. This principle of obtaining a single polarized ray by means of total reflection of the other is common to all the forms of prism now to be described.

Fig. 66.



Dr. Feussner gives a mathematical analysis of the paths taken by the two polarized rays within the Nicol prism, and finds that the emergent extraordinary ray can include an angular field of 29°, but that this extreme value holds good only for rays incident upon that portion of the end surface which is near to the obtuse corner, and that from thence it gradually decreases until the field includes an angle of only about half the previous amount. He finds, moreover, that, although of course the ray emerges parallel to its direction of incidence, yet that the zone of polarized light is shifted to one side of the central line. Also that the great length of the Nicol—3·28 times its breadth—is not only an inconvenience, but, owing to the large pieces of spar thus required for its construction, prisms of any but small size become very expensive. To this it may be added that there is a considerable loss of light by reflection from the first surface, owing to its inclined position in regard to the long axis of the prism.

It is with the view of obviating these defects that the modifications represented in figs. 67 to 71 have been devised.

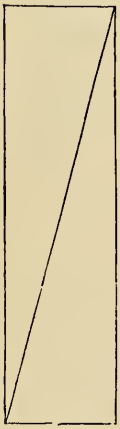
* Edin. New Phil. Journal, vi. (1828) p. 83.

2. *The Shortened Nicol Prism* (fig. 67).—This arrangement of the Nicol prism is constructed by Steeg and Reuter of Homburg v. d. H. For the sake of facility of manufacture, the end surfaces are cleavage planes, and the oblique cut, instead of being perpendicular, makes with these an angle of about 84°. By this alteration the prism becomes shorter, and is now only 2·83 times its breadth; but if Canada balsam is still used as the cement, the field will occupy a very unsymmetrical position in regard to the long axis. If balsam of copaiba is made use of, the index of refraction of which is 1·50, a symmetrical field of about 24° will be obtained. A prism of this kind has also been designed by B. Hasert, of Eisenach,* but its performance appears to be inferior to the above.

Fig. 67.

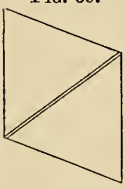
3. *The Nicol Prism with Perpendicular Ends* (fig. 68).—The terminal surfaces in this prism are perpendicular to the long axis, and the sectional cut makes with them an angle of about 75°. The length of the prism is 3·75 times its breadth, and if the cement has an index of refraction of 1·525, the field is symmetrically disposed, and includes an angle of 27°. Prisms of this kind have been manufactured by Steeg, C. D. Ahrens, and others.

Fig. 68.



4. *The Foucault Prism* † (fig. 69).—This construction differs from all those hitherto mentioned, in that a film of air is employed between the two cut surfaces as the totally reflecting medium instead of a layer of cement. The two halves of the prism are kept in position, without touching each other, by means of the mounting. The length of the prism is in this way much reduced, and amounts to only 1·528 times its breadth. The end surfaces are cleavage planes, and the sectional cut makes with them an angle of 59°. The field, however, includes not more than about 8°, so that this prism can be used only in the case of nearly parallel rays; and in addition to this the pictures which may be seen through it are to some extent veiled and indistinct owing to repeated internal reflection.

Fig. 69.

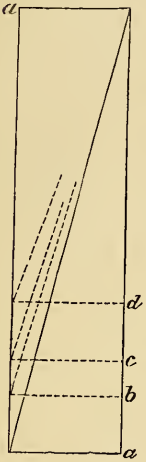


5. *The Hartnack Prism* † (fig. 70).—This form of prism was devised in 1866 by Hartnack and Prazmowski, and was described, vol. iii. (1883) p. 428. It is considered by Dr. Feussner to be the most perfect prism capable of being prepared from calc-spar. The ends of the prism are perpendicular to its length; the

* Pogg. Ann., cxiii. p. 189.
† Comptes Rendus, xlv. (1857) p. 238.
‡ Ann. Chem. et Physique, vii. (1866) p. 181.

section carried through it is in a plane perpendicular to the principal axis of the crystal. The cementing medium is linseed oil, the index of refraction of which is 1·485. The field of view afforded by this construction depends upon the cementing substance used, and also upon the inclination of the sectional cut in regard to the ends of the prism; it may vary from 20° to 41°. If the utmost extent of the field is not required, the prism may be shortened by lessening the angle of the section at the expense however of interfering with the symmetrical disposition of the field.

Fig. 70.



6. *The Glan Prism* * (fig. 71).—This is a modification of the Foucault, and in similar manner includes a film of air between the sectional surfaces. The end surfaces and also the cut carried through the prism are parallel to the principal axis of the calc-spar. The ends are normal to the length, and the field includes about 8°. This prism is very short, and may indeed be even shorter than it is broad. It is subject to the same defect as that mentioned in the case of the Foucault, although perhaps not quite to the same extent.†

Fig. 71.

II.—*Feussner's Prism* (figs. 72–3).—This prism differs very considerably from the preceding forms, and consists of a thin plate of a doubly refracting crystal cemented between two wedge-shaped pieces of glass, the terminal faces of which are normal to the length. The external form of the prism may thus be similar to the Hartnack, the calc-spar being replaced by glass. The indices of refraction of the glass and of the cementing medium should correspond with the greater index of refraction of the crystal, and the direction of greatest and least elasticity in the latter must stand in a plane perpendicular to the direction of the section. One of the advantages claimed for the new prism is that it dispenses with the large and valuable pieces of spar hitherto found necessary: a further advantage being that other crystalline substances may be used in this prism instead of calc-spar. The latter advantage, however, occurs only when the difference between the indices of refraction for the ordinary and extraordinary rays in the particular crystal made use of is greater than in calc-spar. When this is the case, the field becomes enlarged, and the length of the prism is reduced.

The substance which Dr. Feussner has employed as being most suitable for the separating crystal plate is nitrate of soda (*natron-salpeter*), in which the above-mentioned values are $\omega = 1{\cdot}587$ and

* Carl's 'Repertorium,' xvi. p. 570 and xvii. p. 195.

† Amongst others, the modifications of the Nicol prism which have recently been devised by Prof. S. P. Thompson (see this Journal, iii. (1883) p. 575), and by Mr. R. T. Glazebrook (Phil. Mag., 1883, p. 352), do not appear to have been known to Dr. Feussner.

$\epsilon = 1{\cdot}336$. It crystallizes in similar form to calcite, and in both cases thin plates obtained by cleavage may be used.

As the cementing substance for the nitrate of soda, a mixture of gum dammar with monobromonaphthalene was used, which afforded an index of refraction of 1·58. In the case of thin plates of calcite, a solid cementing substance of sufficiently high refractive power was not available, and a fluid medium was therefore employed. For this purpose the whole prism was inclosed in a short glass tube with air-tight ends, which was filled with monobromonaphthalene. In an experimental prism a mixture of balsam of tolu was made use of, giving a cement with an index of refraction of 1·62, but the low refractive power* resulted in very considerable reduction of the field. The extent and disposition of the field may be varied by altering the inclination at which the crystal lamina is inserted (fig. 72), and thereby reducing the length of the prism, as in the case of the Hartnack.

Fig. 72.

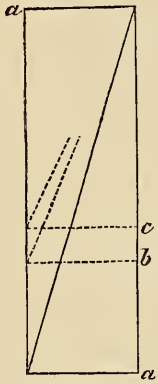
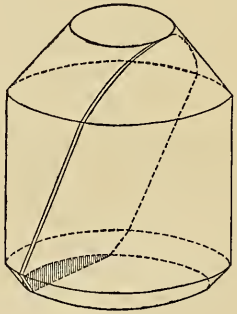


Fig. 73.



In order to obviate the effects of reflection from the internal side surfaces of the prism, the wedge-shaped blocks of glass of which it is built up may be made much broader than would otherwise be necessary; the edges of this extra width are cut obliquely, and suitably blackened.

The accompanying diagram (fig. 73) represents a prism of cylindrical external form constructed in this manner, the lower surface being that of the incident light. In this the field amounts to 30°, and the breadth is about double the length.

Dr. Feussner remarks that a prism similar in some respects to his new arrangement was devised in 1869 by M. Jamin,† who used a thin plate of calc-spar inclosed in a cell filled with bisulphide of

* i. e. low as against 1·6585 the greater index of the calc-spar.

† Comptes Rendus, lxviii. (1869) p. 221.

carbon; and also by Dr. Zenker, who replaced the liquid in M. Jamin's construction by wedges of flint glass.

The following tabular view of different forms of polarizing prisms is taken from the conclusion of Dr. Feussner's paper:—

	Field.	Inclination of section in regard to long axis.	Ratio of length to clear width.	Fig.
	°	°		
I. The Old Polarizing Prisms.				
1. Nicol's prism	29	22	3·28	66
2. Shortened Nicol prism.				
a. Cemented with Canada balsam	13	25	2·83	67
b. „ „ copaiba „	24	25	2·83	67
3. Nicol with perpendicular ends.				
a. With Canada balsam	20	15	3·73	68
b. With cement of index of refraction of 1·525	27	15	3·73	68
4. Foucalt's prism	8	40	1·528	69
5. Hartnack's prism.				
a. Original form	35	15·9	3·51	70 *a b*
b. With largest field	41·9	13·9	4·04	70 *a a*
c. With field of 30°	30	17·4	3·19	70 *a c*
d. With field of 20°	20	20·3	2·70	70 *a d*
6. Glan's prism	7·9	50·3	0·831	71
II. Feussner's Polarizing Prism.				
1. With calc-spar: largest field	44	13·2	4·26	70 *a a*
2. „ „ field of 30°	30	17·4	3·19	70 *a c*
3. „ „ field of 20°	20	20·3	2·70	70 *a d*
4. With nitrate of soda: largest field	54	16·7	3·53	72 *a a*
5. „ „ „ field of 30°	30	24	2·25	72 *ab* & 73
6. „ „ „ field of 20°	20	27	1·96	72 *a c*

As an analysing prism of about 6 mm. clear width, and 13·5 mm. long, the new prism is stated by its inventor to be of the most essential service, and it would certainly appear that the arrangement is rather better adapted for small prisms than for those of considerable size. Any means by which a beam of polarized light of large diameter—say 3 to 3½ in.—could be obtained with all the convenience of a Nicol would be a real advance, for spar of sufficient size and purity for such a purpose has become so scarce, and therefore so valuable, that large prisms are difficult to procure at all. So far as an analyser is concerned, the experience of Mr. P. R. Sleeman would lead to the opinion that improvements are to be looked for rather in the way of the discovery of an artificial crystal which absorbs one of the polarized rays than by further modifications depending upon total reflection. The researches of Dr. Herapath on iodosulphate of quinine * are in this direction; but crystals of

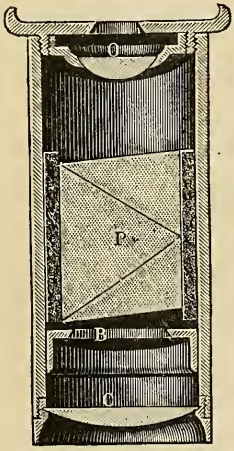
* Phil. Mag., 1852, p. 161, and 1853, p. 346.

the so-called herapathite require great manipulative skill for their production. If these could be readily obtained of sufficient size, they would be invaluable as analysers.

This opinion is supported by the existence of an inconvenience which attends every form of analysing prism. It is frequently, and especially in projecting apparatus, required to be placed at the focus of a system of lenses, so that the rays may cross in the interior of the prism. This is an unfavourable position for a prismatic analyser, and in the case of a powerful beam of light, such as that from the electric arc, the crossing of the rays within the prism is not unattended with danger to the cementing substance, and to the surfaces in contact with it.

Abbe's Analysing Eye-piece.—This (fig. 74), devised by Prof. Abbe, consists of a Huyghenian eye-piece with a doubly refracting prism P (a calc-spar prism achromatized by two suitable glass prisms) inserted between the eye-lens O and field-lens C, and over the diaphragm at B. The rays polarized parallel to the refracting edge pass through the prisms without deviation, whilst those polarized at right angles are strongly deflected, and are stopped off by a diaphragm over the eye-lens. The field of view remains undiminished.

Fig. 74.



Measurement of the Curvature of Lenses.*—With very small lenses the spherometer cannot be used, and Prof. R. B. Clifton's method is based on the Newton's rings formed between the lens and a plane surface, or a curved surface of known radius. From the wave-length of the light employed in observing and the diameter of a ring the radius of curvature can be determined. He places the lens on a plane or curved surface under a Microscope, and lights it by the sodium flame —wave-length 5892×10^{-7}—measures the approximate diameters of two rings a distance apart (in practice the tenth and twentieth rings are found convenient), takes the difference of their squares, and divides it by the wave-length and the number of rings in the gap between to find the radius of the lens. The formula is :—

$$\rho^1 m\lambda = (x^2{}_{m+n} - x^2{}_n)$$

where x_{m+n} and x_n are the diameters of the nth and $(m+n)$th rings ; λ is the wave-length of the light, and ρ^1 the radius of curvature of the lens. The method with proper care gives accurate results. Prof. Clifton has also used it to determine the refractive index of liquids in

* 'Nature,' xxix. (1883) p. 143.

small quantities; Mr. Richardson having found it for water = 1·3335 by this method, which is usually correct to two places of decimals. It can also be used to determine if the lens is uniformly curved and spherical.

New Microscopical Journals. — Two new Journals have made their appearance. The first is the quarterly 'Zeitschrift für wissenschaftliche Mikroskopie und für mikroskopische Technik,' published at Brunswick, and edited by Drs. L. Dippel, M. Flesch, A. Wichmann, and W. J. Behrens. It embraces "Microscopy" in its widest sense, and includes original articles, abstracts and reviews, and a bibliography of microscopical literature. It may be recommended to all microscopists who read German. The other is the bi-monthly 'Microscopical Bulletin,' published by Queen and Co., of Philadelphia, which, though unpretentious, gives useful information on microscopical subjects.

Bausch, E.—A new Condenser. [*Post.*] *The Microscope*, IV. (1884) pp. 105–6.

„ „ Eye-pieces and Objectives.
[General explanations.] *The Microscope*, IV. (1884) pp. 107–12.

Bausch and Lomb Optical Co.'s Improved "Investigator" Stand.
[Cf. I. (1881) p. 100. Mirror and substage now swing independently, position of body-rack changed, &c.]
Amer. Mon. Micr. Journ., V. (1884) p. 84 (1 fig.).

Bohn, C.—Ueber die Berichtigung des vereinfachten Ablese-Mikroskopes für Theilungen. (On the rectification of the simplified reading Microscopes for graduations. [*Supra*, p. 436.]
Zeitschr. f. Instrumentenk., IV. (1884) pp. 87–8.

Bond, G. M.—Standards of Length and their Subdivision.
[Describes the Saxton Yard-dividing Comparator, the Rogers-Bond Universal Comparator, and a Comparator made by the Ballon Manufacturing Company for Professor Anthony.]
Journ. Franklin Institute, CXVII. (1884) pp. 281–95, 357–67 (5 figs.).

Bradbury, W.—The Achromatic Object-glass. XXXII.–V.
Engl. Mech., XXXIX. (1884) pp. 93–4, 159–60, 246–7, 272 (6 figs.).

"Calculus."—Polarizer for the Microscope.
[Simple contrivance to fit on tail-piece.]
Engl. Mech., XXXIX. (1884) p. 215 (1 fig.).

Congdon, E. A.—Microscopy one hundred and fifty years ago.
[Notes on 'Baker on the Microscope,' 1740.]
The Microscope, IV. (1884) pp. 74–6.

D., E. T.—Graphic Microscopy.
IV. Pollen of Mallow. V. Peristome of *Fumaria hygrometrica*.
Sci.-Gossip, 1884, pp. 73–4 (1 pl.), 97–8 (1 pl.).

Davis, G. E.—[Leitz's] Oil-immersion Objectives.
Micr. News, IV. (1884) pp. 131–2.

„ „ Evenings with the Microscope. I.
[Measuring magnifying power of objectives and eye-pieces, and testing corrections of objectives.]
Micr. News, IV. (1884) pp. 132–5.

„ „ Microscopy. *Sci. Monthly*, I. (1883) p. 26.

Flesch, M.—Welche Aussichten bietet die Einführung des elektrischen Lichtes in die Mikroskopie? (What prospect does the introduction of the electric light afford in Microscopy?) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 175–81.

Hansen, E. C.—Ueber das Zählen mikroskopischer Gegenstände in der Botanik. (On the counting of microscopic objects in Botany.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 191–210 (6 figs.).

Hazlewood, F. T.—A home-made revolving Table. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) p. 94.

Hitchcock, R.—Neglected Opportunities.
[Exhortation to investigate the microscopic life of the country.]
Amer. Mon. Micr. Journ., V. (1884) pp. 95–6.

„ „ A New Microscopical Society.
[Sarcastic comment on the announcement of the establishment of the Ladies' Microscopical Society at San Francisco having been first sent to England. "Trusting the members will learn that, although they may look to foreign lands for styles and methods of personal adornment, when they come to such a serious subject as microscopy, their wants can be as well met and their fame as well appreciated in their own country."]
Amer. Mon. Micr. Journ., V. (1884) p. 97.

Jadanza, N.—Sui sistemi diottrici compositi. (On compound dioptric systems.)
Atti R. Accad. Sci. Torino, XIX. (1883) pp. 99–117.

Jung, H.—Ueber ein neues Compressorium. (On a new Compressor.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 248–50 (2 figs.).

Lancaster, W. J.—Lantern Microscope.
[Directions for making. "You may make a lantern Microscope in half a dozen different ways, and the method to work upon will depend entirely upon the illumination you have. You state in query that you have the lime-light; you could not have anything better. Fit up your Microscope in any form you like, and for object-lenses get three sets of lenses, A, two 1½ in. focus, both plano, one 1/2 in., the other 3/4 in. diameter; B, two lenses both 1 in. focus, one 3/8 in. diameter, the other 5/8 in. diameter; C, two lenses 3/4 in. focus, one 1/4 in., the other 1/2 in. diameter; and D, two lenses 1/2 in. focus, one 3/16 in., the other 3/8 in. diameter. Mount them in separate tubes in each case, both convex surfaces together, at the following distances apart:—A 1 in., B 2/3 in., C 1/2 in., D 5/16 in.; then a stop must be placed in front of each of the smallest lenses, the larger lens going towards object. The sizes of stops and their distances from small lenses are as follows:—A, 1/8 in. diameter, 1/2 in. in front; B, 3/32 in., 5/16 in.; C., 1/12 in., 3/16 in.; D, 1/16 in., 1/8 in."]
Engl. Mech., XXXIX. (1884) p. 152.

Lommel, E.—Spectroskop mit phosphorescirendem Ocular. (Spectroscope with phosphorescent eye-piece.) [*Post.*]
SB. K. Akad. Wiss. München, 1883, p. 408.

Magnifying Powers, Table of, with Note. *Micr. Bulletin*, I. (1884) p. 23.

McCalla, A.—The "Congress" Nose-piece.
[Reply to Mr. Bulloch, *ante*, p. 300, with woodcuts of his original design.]
Amer. Mon. Micr. Journ., V. (1884) pp. 64–5 (3 figs.), 78–9.
The Microscope, IV. (1884) pp. 101–2.

Mercer, F. W.—A New Photomicrographic Camera. [*Post.*]
Photography (Chicago), I. (1884) pp. 9–10 (1 fig.).

Mitchell, G. O.—A Focusing Glass for Photo-micrography. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) p. 80 (1 fig.).

Nelson, E. M.—On the selection and use of Microscopical Apparatus.
[*Ante*, p. 302, repeated here to give the following note:—(1) The Ross is decidedly to be preferred to the Jackson form, mainly on the ground of

the superiority of the long lever fine-adjustment over any other. (2) No Microscope is worthy to be called a scientific instrument unless it has a centering substage. (3) Choice and Aperture of Objectives, *supra*, p. 447. (4) Eye-pieces. (5) Daylight, artificial light, and incandescence lamp, *supra*, p. 447. (6) Condensers (Powell's the most effective for powers beyond 1/4). (7) Paraboloids, Lieberkuhns (*post*), Vertical Illuminator, and Micrometers. (8) Polarization. (9) Diffraction and the difficulties of interpretation with objects requiring high magnification.]

Engl. Mech., XXXIX. (1884) p. 48.

Noe, L. H.—Homogeneous immersion.

["It seems to me that to make a lens which shall work through different thicknesses of cover-glass equally well and without adjustment, the immersion medium should correspond with the cover-glass, so that the combined thickness of glass and immersion fluid would always be the same (although the thickness of each varied) for an object in contact with the under side of the cover."]

Amer. Mon. Micr. Journ., V. (1884) p. 79.

"Not an Optician."—Theory of the Achromatic Object-glass.

[Comments on O. V.'s articles.]

Eng. Mech., XXXIX. (1884) p. 210.

"Orderic Vital."—The Dialyte and Plate Glass.

Engl. Mech., XXXIX. (1884) p. 215.

Orth, J.—Cursus der normalen Histologie zur Einführung in den Gebrauch des Mikroskopes sowie in das practische Studium der Gewerbelehre. (Course of normal Histology as an introduction to the use of the Microscope as well as to the practical study of Histology.) 3rd ed., xii. and 340 pp., 108 figs. 8vo, Berlin, 1884.

Peaucellier.—Note sur la déformation des images réfractées et sur l'aplanatisme d'un système de lentilles. (Note on the distortion of refracted images and on the aplanatism of a system of lenses.)

Mém. Soc. Sci. Bordeaux, V. (1883) pp. 327–34 (1 pl.).

Peragallo, H.—Histoire sommaire du Microscope composé et de ses récents perfectionnements. (Compendious history of the compound Microscope and its recent improvements.) 8vo, Toulouse, 1883.

Plehn, F.—Apparat zur Prüfung der Brennweite des Auges oder anderer optischer Systeme. (Apparatus for testing the focal length of the eye or other optical systems.)

Title only of German Patent, Cl. 42, No. 1894, Feb. 1884.

"Prismatique."—Plate Glass for Optical Purposes.

Engl. Mech., XXXIX. (1884) pp. 191–2, 281.

Proctor, R. A.—Review of Poulsen and Trelease's 'Botanical Micro-chemistry,' in which the invention of the achromatic microscope-objective is attributed to J. J. Lister in 1829! *Knowledge*, V. (1884) p. 231.

Puscher & Wiederhold.—Cementing Brass on Glass.

[Puscher recommends a resin soap for this purpose, made by boiling 1 part of caustic soda, 3 parts of colophonium (resin) in 5 parts of water and kneading into it half the quantity of plaster of Paris. This cement is useful for fastening the brass tops on glass lamps, as it is very strong, is not acted upon by petroleum, bears heat very well, and hardens in one-half or three-quarters of an hour. By substituting zinc white, white lead, or air-slaked lime for plaster of Paris, it hardens more slowly. Water only attacks the surface of this cement. Wiederhold recommends, for the same purpose, a fusible metal composed of 4 parts of lead, 2 parts tin, and 2½ parts bismuth, which melts at 212° Fahr. The melted metal is poured into the capsule, the glass pressed into it and then allowed to cool slowly in a warm place.]

Polyt. Notizblatt. See *Engl. Mech.*, XXXIX. (1884) p. 119.

Reichert, C.—Anleitung zum Gebrauche des Mikroskops. (Introduction to the use of the Microscope.) 14 pp. (2 figs.), 8vo, Wien, 1883.

Scott, G. B.—Polarizer for the Microscope.

[Analyser mounted in a tube on a swivel just over the nose-piece so that it can be "pushed over to one side out of the way by a lever" when not in use. Polarizer also mounted on a short arm beneath the stage. Microscopes with narrow tubes must have a recess into which the analyser can go.]

Engl. Mech., XXXIX. (1884) p. 173 (2 figs.).

Stein, T.—Die Verwendung des elektrischen Glühlichtes zu mikroskopischen Untersuchungen und mikrophotographischen Darstellungen. (The application of the electric incandescence light for microscopical investigations and photomicrography.) [*Post.*]

Zeitschr. f. Wiss. Mikr., I. (1884) pp. 161–74 (7 figs.).

Stowell, C. H.—Our third Annual Soirée. *The Microscope*, IV. (1884) pp. 63–4.

" " An Editor's Life.

[Letter from a microscopist who "finds the working of the Microscope very pleasant employment for the evening of life."]

The Microscope, IV. (1884) p. 105.

Swammerdam, John, Sketch of his Life and Researches.

Journ. of Sci., VI. (1884) pp. 198–206.

Tait, P. G.—Light. viii. and 276 pp. and 49 figs. [Microscope, pp. 113–6.] 8vo, Edinburgh, 1884.

Vogel, J.—Das Mikroskop und die wissenschaftliche Methode der mikroskopischen Untersuchung in ihrer verschiedener Anwendung. 4th ed. By O. Zacharias. Lfg. 1. Leipzig, 1884.

Wanschaff, J.—Ueber eine neue Methode zur Anfertigung sehr langer Mikrometer-schrauben. (On a new method of constructing very long micrometer screws. [*Post.*] *Zeitschr. f. Instrumentenk.*, IV. (1884) pp. 166–9.

Ward, R. H.—An Eye-shade for Monocular Microscopes. [*Post.*]

Amer. Mon. Micr. Journ., V. (1884) pp. 82–3 (1 fig.).

Wassell, H. A.—Plate Glass for Optical Purposes.

Engl. Mech., XXXIX. (1884) pp. 170–1.

Wiederhold.—See Puscher.

Zacharias, O.—See Vogel, J.

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

Dissection of Aphides.*—G. B. Buckton says that "in the dissection of Aphides much assistance may be often got by a selection of liquids. Some of these are best suited for the purpose of hardening the tissues, so that they may bear separation and tearing asunder without their destruction. Others are used for colouring the transparent organs, so as to make them more visible. These organs of Aphides are so delicate that pure water will in a great measure destroy them. In such cases a weak solution of common salt, or very dilute glycerine, or sugar and water, or albumen and water, all of which should nearly approach the density of the juices of the insect, will be found a considerable help.

Some Aphides are so large, so full of liquid, and so charged with oil-globules that some treatment is necessary to reduce their bulk, and to allow of a sufficiently thin stratum of balsam for mounting.

In such cases the Aphides may be placed in spirits of turpentine, and just raised to the boiling-point in a small test-tube. After soaking in the turpentine for a few hours, all the oil-globules will be removed,

* 'Monograph of the British Aphides,' iv. (1883) pp. 193–5.

and the insect by this treatment will have become transparent, and the aqueous parts will not then chill the balsam.

To prepare Aphides for dissection, liquids may be divided into those used for hardening the tissues and those employed for colouring the same. For hardening, a digestion for several hours in weak alcohol will be of advantage. The alcohol must not be too strong, or the albuminous portions will be coagulated and become too opaque.

Weak acetic acid will render some portions tough, and the same action is also well effected by a weak solution of phosphoric or of nitric acid.

The action of ordinary ether upon Aphides is not well understood. Their bodies are speedily destroyed by plunging them into the liquid. At the same time a considerable stream of air-bubbles contained in the tracheæ is expelled, and of such a volume as would lead to the supposition that much of this air must be in some state of solution in the body-juices.

The reaction of weak potash has been before noted. As a rule, the germinal matter resists its action for a considerable time. Simultaneously this reagent usually stains it a bright gamboge yellow. In some genera (notably *Sachuus* and *Dryobius*) potash deepens very markedly the violet dye natural to these Aphides. In other cases I have found potash to evoke the violet shade from specimens otherwise colourless. This dye is fugitive, and if discharged by an acid, cannot be again recovered by the action of an alkali. Soda and ammonia also bring out this colour.

Advantage may be taken of the fact that there is a certain order in which the tissues resist the intrusion of a foreign matter such as a dye. Thus the germinal and most vitally endowed organs reject dyeing by carmine, logwood, and such coal-colours as magenta; whilst the portions in process of exfoliation and decay absorb it the most readily. For such purposes, weak alcohol may be made slightly alkaline by ammonia, and tinged with a little carmine or cochineal solution. Dilute chromic acid both tinges the tissues yellow and renders them tough. Solutions of osmic acid also may be used with advantage, and, in short, the usual reagents employed for conducting minute anatomy may be taken with due circumspection and tenderness.

For labelling specimens, paste will be found much more adherent than gum. The former may be preserved for some months in a well-closed bottle, if a little aqueous solution of corrosive sublimate be stirred into it."

Transmission, Preservation, and Mounting of Aphides.*—G. B. Buckton gives the results of his experience as to the best mode of transmitting living Aphides, and also the best method for killing and preserving such-like insects for future examination.

As to transmission, the chief thing to be guarded against is desiccation, and no plan seems to be so successful as their inclosure in ordinary quills stopped by plugs of cork or pellets of beeswax. The substance of the quill is sufficiently porous to prevent mildew on the

* 'Monograph of the British Aphides,' iv. (1883) pp. 188–93.

one hand and a rapid evaporation on the other. In this way small insects may be sent through the post, and in a far better condition than can be secured in any tin boxes, even though they be filled with leaves. If a slip of some succulent leaf be rolled round each quill, to retain moisture, a bundle will conveniently pass through the post.

For preservation (other than on a slide) the best plan is to drop the insects into small flattened glass tubes partially filled with a suitable liquid, then draw the tube to a fine point, break the end off, and warm the empty space (or, better, expel the air by a pump), and the tube can be entirely filled with liquid, and then sealed with the blowpipe.

For mounting microscopically, five or a dozen spots of fluid Canada balsam should be dotted on a slide from the head of a pin, and by means of a hair pencil as many living insects transferred to them. "The specimens at once adhere, and if the spots are small the insects spread out their limbs naturally, with a view to escape. They may be fixed on their backs or otherwise, according to the views desired.

A very thin glass cover, or, if very high magnifying powers are wanted, a small disk of clear mica, is laid over the insects, and then one or more drops of the fluid balsam are delivered from a glass rod at one of the sides of these covers. The balsam runs slowly under by capillarity, and it drives all the air before it, the small weight of the cover assisting it to spread, until the whole area is filled. No pressure is to be used, or the elastic bodies of the Aphides will change shape; and besides this, the juices will be forced through the cornicles and pores. If the balsam is thick, a very gentle heat, hardly exceeding that of the cheek, may be applied, but as a rule the temperature of a room is better than that which exceeds it. The insects die immediately they are cut off from air, and in almost every case their position will be good for examination. To spread the wings of a small insect, the above-mentioned small dots may be made in a row. The belly of the specimen is applied to the middle spot, and by a bristle one wing may be applied to the dot on the one side, and the other wing to the third dot. The cover is then placed as before, and when the balsam runs in it will not disturb the position of the spread wings.

It will be noticed that very soon after live insects have been mounted in a resinous substance that will not mix with water, a white cloudiness forms around each specimen. This is caused by the watery juices of the insect, which 'chill' the medium and make it opaque.

This cloudiness, however, entirely disappears after perhaps a month, the moisture being carried slowly outwards. The same is to be said of stray air-bubbles. The oxygen of the air unites with the balsam, and thus hardens it; but what combination is effected with the nitrogen is not so clear. However, air-bubbles in balsam disappear in time, provided the former is not in too hard a condition.

In cases when the above small pressure is undesirable, small circles, cut by round punches of different sizes out of very thin sheet

lead, will be found more convenient to insert between the glass slip and its cover than circles of card, which are sometimes recommended. The thin sheet lead from the Chinese tea-chests is very suitable for punching, and as it is not porous like card, it yields no air-bubbles by heat.

D. Von Schlechtendal has* described a method by which it would appear that all the characters of form and colour (?) may be preserved in Aphides and other insects. The method consists of a rapid death and drying of the insect by means of a current of heated air. The *Aphis*, previously attached to some suitable support, is suddenly and momentarily subjected to the heat of a spirit or other flame, by which it is immediately killed and caused to retain its natural position. Several examples are then carefully roasted in a current of hot air, such as that passing through an inclined glass tube duly made hot, or dried on a sheet of paper moved over a heated metal plate.

When dry, the specimens are mounted on card by attachment with gum tragacanth; or, as Mr. T. W. Douglas suggests, more conveniently on mica, called 'talc,' in the shops, which, as it is incombustible, is well suited for a support both before and after drying.

This method is vouched for as good by Drs. Giebel, Taschenburg, Mayr, and Rudow.

I have not tried this roasting process, but it must require some address to prevent the shrivelling of wings in such delicately-formed insects, and to provide against the bursting action of the boiling juices.

A more complete history of the process than the foregoing was given by Mr. Douglas in 1878.†

M. Lichtenstein has many times been good enough to forward in letters to me preparations of Aphides which have been secured between two films of mica. The insects, he explains, are immersed in a solution of resin in turpentine, 'a natural amber,' and, when all are in due position, the mica films are placed over apertures in card, and then gummed papers, similarly perforated, are pressed upon them. This arrangement secures all in their places.

Methods and operations in science, like events in history, repeat themselves. Fifty years ago films of mica were used to cover objects for the Microscope, and before the manufacture of the thin glass now so commonly used, it admirably answered its purpose. Under deep magnifying powers, such as 1/12 in., it will be found even now of great service. The mineral may be split by the lancet into films much thinner than glass can be blown in a flat state. Small unscratched pieces may be selected which are perfectly transparent, and their cost is quite trifling.

On account of the high refracting power of Canada balsam, the colours of recently-immersed Aphides show themselves very brightly; and it sometimes happens that tints, quite lost through irradiation or glance on the surfaces, become distinct by treatment with this resin.

The bright colours and markings of some species are due to the

* Entomol. Nachrich., iv. p. 155.

† Entomol. Mon. Mag., xv. p. 164.

hue of the internal juices of the insects. These cannot be preserved by balsam, but it is otherwise with the pigments which stain the somewhat horny coverings of the thorax and abdomen. These colours are persistent."

Breckenfeld's Method of Mounting Hydræ.*—A. H. Breckenfeld describes the following process as accomplishing the desired end more perfectly than any other published.

Have in readiness a slide upon which a well-dried cell of sufficient depth has been turned. Then, from a gathering of *Hydra*, transfer a sufficient number of individuals (the more fully developed the better) very carefully, by means of a camel's hair brush or a pipette, to a drop of water spread near the end of a plain glass slide, and place the latter upon a table in such a way that the end with the drop projects about two inches over the edge. This is easily done by placing a weight upon the opposite end. After allowing the slide to remain perfectly undisturbed for three or four minutes, hold a lighted coal-oil lamp so that the top of its chimney is very near the slide, but a trifle above it. The *Hydræ* will then appear brightly illuminated, and it can easily be determined by the unaided eye whether or not their tentacles are fully extended. If they are, quickly move the lamp directly under the drop, with the top of the chimney about an inch beneath the slide, and hold it in that position for about 3–5 seconds, the exact time depending principally upon the intensity of the heat. Then quickly remove the slide and place it upon a slab of marble or metal. When cool, pour the drop containing the zoophytes into the prepared cell on the slide which has been held in readiness, add a drop or two of a suitable preservative fluid, arrange the animals, if necessary, by means of a needle or camel's hair brush (using very great care, however, as the tentacles will be destroyed by the least rough handling), cover with thin glass, and finish as in the case of any fluid mount.

This "hot water" process seems to succeed peculiarly well with the brown *Hydra* (*H. vulgaris*).

Cell-sap Crystals.†—Crystals of the colouring material present in the petals and other portions of plants are by no means common or, as a rule, easy to obtain; and G. Pim thinks it may therefore interest some to know that the rich violet-coloured cell-sap in the flower of *Justicia speciosa*, a common and easily-grown stove-plant, crystallizes very easily into minute slender prisms. To obtain them it is only necessary to mount a fragment of the flower-stamen for choice, in dilute glycerine jelly, not too hot, without any previous treatment; after a few hours the colouring material collects into a few cells, in the form of the crystals above mentioned, forming a very pretty and interesting object for a 1/4 in. objective.

Staining for Microscopic Purposes.‡—H. Gierke contributes a paper on this subject. In the first part, after an excellent introduc-

* Amer. Mon. Micr. Journ., v. (1884) pp. 49–50.

† Journ. of Bot., xxii. (1884) p. 124.

‡ Zeitschr. f. Wiss. Mikroskopie, i. (1884) pp. 62–100. See Bot. Centralbl., xviii. (1884) p. 52.

tion, the writer gives an historical review of the application of microchemical methods of staining, giving special attention to the carmine-pigments. The earliest experiments on microscopic staining with carmine for the purpose of a ready differentiation of tissues were made by Goeppert and Cohn. More extended investigations on the capability of the various elements of vegetable tissues to fix carmine shortly followed by R. Hartig. In animal histology, carmine staining was first employed by Gerlach (1858). Further contributions to its application were made especially by Maschke, Thiersch, Beale, Rollen, Gwancher, Hoyer, Czokor, Ranvier, and others. Reference is further made to the cultivation of cochineal, and to the most convenient methods of obtaining carmine for technological purposes, and its application as a staining material in the form of ammonium carminate, and carmine acetate. The author convinced himself by experiments that old preparations of ammonium carminate, which contain a certain quantity of ammonium carbonate, stain better than fresh solutions. Finally, a shorter reference is made to the aniline-dyes, hæmatoxylin, indigo-carmine, and picro-carmine.

The second part includes a chronological and tabular account of the literature of the subject, especially with regard to the following staining materials:—(1) carmine; (2) hæmatoxylin; (3) ammonium molybdate; (4) alizarin and purpurin; (5) alcanna and lakmus; (6) sodium indigo-sulphate (indigo-carmine).

Mode of announcing new Methods of Reaction and Staining.* —E. Giltay calls attention to the fact that the publication of new methods of reaction is often made without sufficient precision for others to be able readily to form a judgment on their applicability for the special purpose. In the description of the application of a reagent, at least one mode of preparing it ought to be accurately described, such expressions as "somewhat," "a little," "a short time," and such like, should be avoided, and replaced by exact statements of weight and time. In the case of little known substances, the chemical formula—intelligible in all languages—should be appended. The descriptions of colours should be as correct as possible, with reference to all influencing circumstances, and should be based on some definite colour-scale, such as that of Chevreul's 'Des Couleurs.'

Pure Carminic Acid for Staining.†—G. Dimmock has often wondered why naturalists use carmine solutions in which water, with some caustic or destructive material added, is the principal solvent. Carmine of commerce, it is true, is not readily soluble, even in water, until ammonia, borax, or some other aid to solution is added; but carminic acid, the basis of the colouring matter of carmine, has long been stated in the leading chemical dictionaries and handbooks to be readily soluble in water and in alcohol. Watts (Dict. Chem., 1872, 1st suppl., p. 413) says of carminic acid:—"This acid forms a purple

* Zeitschr. f. Wiss. Mikroskopie, i. (1884) pp. 101–2.
† Amer. Natural., xviii. (1884) pp. 324-7.

mass, fusible and soluble in all proportions in water and in alcohol. Sulphuric and hydrochloric acid dissolve it without alteration. It bears a heat of 136° C. without decomposition." Earlier still Watts (Dict. Chem., i. 1863, p. 804) says:—"The fine red pigment known in commerce as carmine is prepared by treating a solution of cochineal with cream of tartar, alum, or acid oxalate of potassium. The fatty and albuminous matters then coagulate and carry down the colouring matter with them." Now in preparing most carmine solutions this precipitation takes place, and the carmine, having greater cohesive (not chemical) affinity for impurities of animal origin than for alcohol, its solution is not readily accomplished by that medium, nor indeed by water. In preparing carmine solution for histological purposes by some of the published recipes, more than one-half of the colouring matter of the carmine is lost in the refuse left upon the filter paper.

There are two ways commonly in use for preparing carminic acid. The first mode is that of De la Rue, which Watts (Dict. Chem., i. 1863, p. 804) gives as follows:—"To separate carminic acid, cochineal is exhausted with boiling water; the extract is precipitated by subacetate of lead slightly acidulated, care being taken not to add the lead-solution in excess; the precipitate is washed with distilled water till the wash-water no longer gives a precipitate with a solution of mercuric chloride, then decomposed by sulphuretted hydrogen; the filtrate is evaporated to a syrupy consistence and dried over the water-bath; and the dark purple product thus obtained is treated with alcohol, which extracts the carminic acid." The second mode is that of C. Schaller and is given by Watts (Dict. Chem., 1st suppl., 1872, p. 413) as follows:—"Schaller prepares this acid by precipitating the aqueous extract of cochineal with neutral lead acetate slightly acidulated with acetic acid; decomposing the washed precipitate with sulphuric acid; again precipitating the filtrate with lead acetate, and decomposing the precipitate with hydrogen sulphide. The filtered solution is evaporated to dryness; the residue dissolved in absolute alcohol; the crystalline nodules of carminic acid obtained on leaving this solution to evaporate are freed from a yellow substance by washing with cold water, which dissolves only the carminic acid; and the residue left on evaporating the aqueous solution is recrystallized from absolute alcohol or from ether."

Schaller's mode of preparation gives purer carminic acid than De la Rue's, but either kind is sufficiently pure for histological purposes. The precipitation by lead acetate and the dissolving in alcohol free the carminic acid from animal impurities, and the consequence is a purer form of pigment than can be extracted by any process hitherto employed for the preparation of carmine for histological purposes.

It is unnecessary to explain to naturalists the advantages of alcoholic solutions of carmine over aqueous ones. The alcoholic solution colours preparations much quicker than the aqueous solution does; for colouring sections, the author employs a solution of 0·25 gr. carminic acid to 100 gr. of 80 per cent. alcohol, and leaves sections in the

solution from two to five minutes. A solution of equal carmine strength but in absolute alcohol can be employed; it has, however, no special advantages, since with the 80 per cent. alcoholic solution the sections can be washed directly in absolute alcohol, and then put into oil of cloves or turpentine. Colouring in the piece before sectioning never takes as long with alcoholic carminic acid as it does with ordinary carmine solutions, and if it did take long the strong alcohol would preserve the tissue from maceration. In colouring pieces of mollusca, or of other equally slimy animals, the slime should be removed beforehand, or the staining will be unsatisfactory, because the slime congealing in the alcohol takes up the colouring matter, forming an almost impervious coloured layer on the outside and leaving the inside of the piece nearly uncoloured.

Some preparations coloured in alcoholic carminic acid and then put up in glycerine lost their colour in a few months, the colour seeming to be entirely diffused in the glycerine, while similar preparations mounted in Canada balsam retained their colour perfectly. The author does not know if this fading would occur with preparations coloured with alcoholic ammonic carminate, or even if this diffusion was not due to some impurity of the glycerine (of the purity of which he was doubtful); time to test this matter further failed.

An alcoholic ammonic carminate, or ammonia carmine, can be prepared, at a moment's notice, from alcoholic carminic acid, by adding ammonia drop by drop, and stirring until the entire solution changes from its bright red to purple red. By this mode pure alcoholic ammonic carminate can be produced with no excess of ammonia, and at any time. As the carminic acid can be preserved dry without decomposition, and dissolves quickly in alcohol, one can carry the ingredients of a carmine solution in the vest pocket without inconvenience.

In making and using alcoholic carminic acid pure alcohol and distilled water give the best results, because a portion of the carminic acid is converted to carminates by the salts of impure water. In making alcoholic ammonic carminate this precaution is not as necessary, because the colour of the carminates produced by the impurities of the water is so nearly like that of ammonic carminate.

Alcoholic carminic acid may be used, as Grenacher's carmine solution is used, to colour sections from which the colour is to be afterwards partly extracted by very dilute hydrochloric acid, leaving nuclei red. Another way to use carmine solutions, which is especially applicable to alcoholic carminic acid, is to precipitate the carmine in the tissues by some salt, the carminate of the base of which gives a desired coloration. For example, specimens hardened for a moment under the cover-glass with an alcoholic solution of corrosive sublimate (mercuric chloride) and, after washing with alcohol, coloured in alcoholic carminic acid, take a fine colour of mercuric carminate. So, too, specimens coloured in alcoholic carminic acid can be changed by a few moments' treatment with a very dilute alcoholic solution of lead acetate or cobalt nitrate to a beautiful purple. Sometimes salts in the

tissues of the animals change portions of the carminic acid to purple carminates, giving a double coloration without further treatment.

Picric acid added to alcoholic carminic acid in extremely small quantities (best in a dilute alcoholic solution, testing the solution on specimens after each addition) makes a double alcoholic colouring fluid (a so-called picro-carmine). The author has been unable thus far to determine the proportion of picric acid required for this solution, having in every case added an excess. All different kinds of carmine solutions can be made from carminic acid with the advantage of having always uniform strength, of being definite mixtures, and of not spoiling as readily as those made directly from cochineal.

Incompatible reagents with carminic acid are, of course, all alkaline solutions and nearly all metallic salts; with ammonic carminate, are naturally all acids; with all carmine solutions, are bromine and chlorine.

Hoyer's Picro-Carmine, Carmine Solution, and Carmine Powder and Paste.*—Hoyer proposed † an improved picro-carmine made by dissolving his carmine powder in a concentrated solution of neutral picrate of ammonia. P. Francotte points out that picrate of ammonia is a substance which it is not possible to have constantly at hand, and he has therefore modified Hoyer's preparation in the following manner:—Dissolve 1 gr. of carmine in from 5 to 7 c.cm. of concentrated ammonia, diluted with the same amount of water; in 50 c.cm. of distilled water dissolve (warm) 1/2 gr. of picric acid; mix the two solutions and dilute so as to make 100 c.cm. Then add to the liquid thus obtained 1 gr. of chloral hydrate. If any free ammonia remains, gently warm in a water-bath to drive away the excess, or allow the alkali to volatilize by exposing the liquid to the open air. This solution lasts a long time without changing.

M. Francotte also supplements Prof. Hoyer's description of his process for obtaining carmine solution. ‡ The latter directs chloral hydrate to be added to the neutral liquid to keep it, but does not state the quantity to be used. M. Francotte forms a carmine solution of 10 c.cm. by the addition of distilled water, to which is added 1 gr. of chloral hydrate.

If a paste is required instead of a powder, Prof. Hoyer directs it to be made with alcohol, glycerine, and chloral, but does not give the quantities. M. Francotte uses to 1 gr. of carmine, 2 c.cm. of alcohol, 2 c.cm. of glycerine, and 1 gr. of chloral.

Dry Injection-masses.—Prof. H. Fol writes that the red gelatine vermicelli mentioned at p. 312 (carmine emulsions) should be pressed out into slightly acidulated water (1 part acetic acid to 1000 parts water). The carmine will otherwise be washed out.

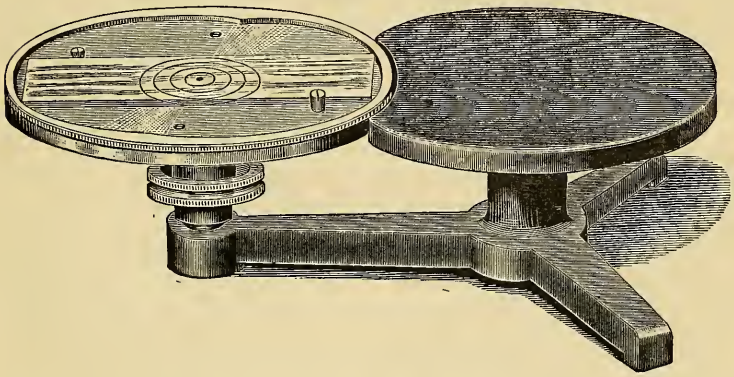
Imbedding Diatoms.§—R. Hitchcock suggests a plan for imbedding diatoms from fresh gatherings. It is to prepare an artificial

* Bull. Soc. Belg. Micr., x. (1884) pp. 75–7.
† See this Journal, iii. (1883) p. 142.
‡ Ibid., p. 141.
§ Amer. Mon. Micr. Journ., v. (1884) pp. 54–5.

calcareous rock from a mixture of finely-ground lime and clay, making a kind of hydraulic cement, with which the diatoms may be mingled. When this hardens, the sections may be cut, and isolated by treatment with diluted hydrochloric acid. The large *Pinnularia* is a good species to begin with.

Zentmayer's New Centering Turn-table.*—The turn-table represented in fig. 75 is the invention of Mr. J. Zentmayer. The plan of centering the slide is, it is claimed, quite original and perfect in its

Fig. 75.



results. The slide is placed so that its edges are in contact with the two pins projecting from the face of the plate. A ring with an oval inner edge is fitted to the periphery of the disk, in such a way that by turning it the slide is grasped at the diagonally opposite corners by the inner edge of the ring, and is thus centered longitudinally. The two pins centre it the other way. The ring may be easily removed, and spring clips substituted when desirable.

Phosphorus Mounts.—It was recently stated † that diatoms mounted in phosphorus solution cannot be kept for any time. This is not so. Mr. J. W. Stephenson has slides mounted several years ago (one in 1873), which are as good now as at first. All that is necessary is to avoid long exposure to daylight which turns the diatoms an opaque red.

Styrax.—On testing this medium (as supplied by Allen and Hanbury) with the refractometer, its refractive index is found to be 1·585 very nearly. It has so much colour that it is difficult to determine the third decimal with accuracy.

If we take the index of diatomaceous silex to be 1·43, and of Canada balsam 1·52, it is seen that styrax gives a marked increase of visibility over balsam, for while balsam is only 9, styrax is more than 15.

* Amer. Mon. Micr. Journ., v. (1884) p. 23 (1 fig.).
† Engl. Mech., xxxix. (1884) p. 149.

A. C. Cole * considers gum-styrax to be a "*perfect* substitute for balsam," that it "yields the best possible results," and that it "may be considered absolutely permanent and unalterable." The styrax solution is "even easier to work with than balsam, and air-bubbles are not produced in it by the application of heat."

Smith's New Mounting Media.†—Prof. H. L. Smith has been experimenting with various substances to find satisfactory media of high refractive index for the mounting of diatoms, &c. The desiderata at which he has aimed are: 1st, high refractive index; 2nd, a substance to be used in a fluid or semi-fluid state in the process of mounting; 3rd, the property of hardening on the slide, so as to make a permanent mount; and, 4th, a proper cement, to protect it from decomposition if the material is in danger from that cause by reason of exposure to the air or to immersion fluids.

Professor Smith is now assured that he has succeeded in his efforts, and has produced two media, both of combinations entirely new and heretofore unnoticed in chemistry. He has also devised a cement for rings upon the slides to protect the media, which is also new, and makes attractive mounts.

His first medium is a transparent, colourless substance, in the form of a thick fluid, which hardens by heat applied in the same way as in mounting in balsam. The heat expels the fluid part of the mixture, and leaves a solid which is a permanent mount, and requiring no more care in subsequent handling or packing of slides than balsam. The index of refraction of this medium when solidified is 2·00.

The second medium is a yellow-tinted, thick fluid, similar in handling to the last, and to be used and treated in the same manner, but having an index of 2·25 ± when solidified. A perceptible brownish-yellow tint remains in this medium, similar to that of pretty old balsam which has been a little overheated. This medium would naturally be used for special examinations of particularly difficult objects, and the colour is not enough to be objectionable, though the first medium, with its absolute transparency, would be preferred for more common use. Used in a fluid state, the denser medium has scarcely any colour, but its refractive index is of course lowered a little.

In either of them the resolution of *Amphipleura pellucida* is made with surprising ease and strength, and with light of very small obliquity compared with that which has been necessary in dry or balsam mounts. In short, it gives all the results which the high refractive index would lead us to expect, and with none of the objections for cabinet use which belong to the solution of phosphorus and other mixtures.

The cement for ringing is specially devised to avoid any danger of its attacking or decomposing the mounting medium.

The following is a copy ‡ of the report made to the State Microscopical Society of Illinois by a committee to whom were referred some slides of Diatomaceæ mounted in the new media.

* Methods of Micr. Research, Part x. (1884) p. lvii.

† Amer. Mon. Micr. Journ., v. (1884) p. 71.

‡ 'The Microscope,' iv. (1884) pp. 77–8.

"Your committee carefully examined the slides submitted to them, but gave special attention to the slides of *Amphipleura pellucida* mounted in a nearly white or colourless medium, whose refractive index is stated to be 2 —.

A new Bulloch Professional stand, with a 10-inch tube, was used. It was fitted with a condenser made on the Abbe pattern by Mr. Bulloch, the numerical aperture of which was stated by the maker to be 1·23. The condenser was used with a homogeneous-immersion fluid (cadmium chloride in glycerine). The illumination was furnished by a kerosine lamp with a flat wick turned edgewise toward the mirror, and the light was reflected through the condenser by the concave mirror.

The objectives used were, first, a dry 1/6 of Bausch and Lomb, said to be of 140° air angle, with a Beck No. 3 eye-piece, which gives a supra-amplification of 13·88. The angle of light from the condenser was as high as could be used by the objectives and fully illuminate the object, and with these appliances the lines showed with great distinctness.

We then used a homogeneous-immersion Zeiss 1/18, 1·28 N.A., with the following eye-pieces: Beck No. 1, supra-amplification 5; Beck No. 2, supra-amplification 8·33; Tolles 1 in., supra-amplification 10; Beck No. 3, supra-amplification 13·88; Tolles 1/2 in., supra-amplification 20·83. The illumination was the same, except that the angle of light was as oblique as the condenser could give. With all of these eye-pieces the *beads* showed very strongly.

The slide mounted in a yellowish medium with a refractive index said to be 2·3, did not seem to present any marked superiority over the other.

Your committee would expect these media, particularly the colourless one, to be of great value if they keep well. Their advantage in the study of diatoms is obvious. We would also expect them to be even more useful in histology if preparations can be transferred to them without injury. They may also be of great service in the study of bacteria.

By the process of staining, now necessary in the study of these structures, they are shrivelled and perhaps changed in other ways, and we may hope to learn much more about them than is now known if they can be studied in these media in a more natural condition." (Signed by B. W. Thomas, Lester Curtis, H. A. Johnson, H. W. Fuller, and H. J. Detmers.)

Wilks's Cell.—Mr. E. Ward supplies cells for mounting without pressure in Canada balsam made on a plan suggested by Mr. Wilks and shown in fig. 76.

Fig. 76.

The cell is made of soft metal and, as will be seen from the figure, has four elevations alternating with depressions, the cover-glass

resting on the upper points of the curves. By leaving an excess of balsam round the cell and cover-glass, air-bubbles ultimately escape through the spaces, and loss by evaporation of essential oil in the balsam is provided for. If the cell is too deep for the object it can be pressed between two glass slips until shallow enough.

Closing Glycerine Cells.—Mr. W. M. Bale writes: "I see by one or two remarks in the Journal that some manipulators still find a difficulty in securely closing glycerine cells. I have found the following plan obviate all liability to leakage. Use a cell of firm material, such as glass or ebonite, and a cover-glass of larger size, so that when in position it projects outside the cell for 1/12 in. or 1/8 in. all round. Fill the cell and press down the cover-glass, forcing out the superfluous glycerine; then (if on examination under the Microscope the object is found to be properly displayed) put on a spring clip to keep the cover close down, and with a fine syringe wash away the whole of the glycerine which may have exuded from the cell. The space below the projecting margin of the cover-glass will now be filled with water instead of glycerine, and by applying a piece of blotting-paper the water may be absorbed; the slide must then be allowed to stand for a minute or two till the outside of the cell is quite dry, when a little tenacious fluid cement may be applied at the margin of the cover, and allowed to fill the circular space outside the cell. Unless an excess of cement be placed on the slide there will be no tendency whatever to 'run in,' provided that the cell be quite flat, so that the cover can come into close contact with it all round, and that it be deep enough for the object. I formerly recommended this plan for mounting in fluids which would evaporate,* and I since find that it is equally applicable to a dense medium like glycerine, provided that the latter be syringed away from the outside of the cell, as directed. I have young *Hippocampi* preserved in ebonite cells in this manner, but I may add that it is not uncommon to find ebonite cells more or less bent, and such are useless for the purpose, it being essential that the cover should fit closely to the cell, as otherwise the water used in washing would enter it."

Getschmann's Arranged Diatoms.—Whether diatoms ought or ought not to be "arranged" is a question which is more often answered in the negative, and in calling attention to the slides prepared by R. Getschmann of Berlin, we have no intention of objecting to the general verdict. We simply record the fact of the existence of the slides, and that they much surpass any of the previous efforts with which we are acquainted. With the diatoms are included Lepidoptera scales, Echinoderm spines, &c.

Classification of Slides.†—Dr. C. S. Minot suggests a scheme of arrangement of microscopical (and especially histological) slides based on embryology. The foundation of the system is primarily the germ-layers and then the order of development of the various organs.

* See this Journal, iii. (1880) p. 864.
† 'Science Record,' ii. (1884) p. 65.

The first division embraces the ectoderm and its derivatives. Here would be placed in order the skin, nerves, glands, teeth, membranes, bones, and organs of sense, and all other organs derived from the outer germ-layer in as nearly as possible the order of their appearance in the embryo.

To the second division belong the endodermal structures, the lining of the alimentary tract, the liver, respiratory organs of vertebrates, endostyle of Tunicates and the thyroid and thymus glands, pancreas, spleen, and stomach.

The mesoblastic tissues may be divided into two great groups: the first, those of the mesenchyma, embraces the spicules of sponges and the skeleton of Echinoderms, smooth muscles, connective tissue, fat-cells, blood, blood-vessels, heart, lymphatics; and, lastly, cartilage and bone. To the other division, to which the term mesothelial tissues may be applied, belong the peritoneum of the vertebrates and its homologues in other groups, striated muscle, and its modification, electric organs, the segmental organs of the lower forms, and the excretory organs of the higher forms, sexual organs, then the stomodeum and its glands, and the proctodeum and its appendages.

The position of the mouth of vertebrates and its accessories is uncertain, as doubts exist whether it is comparable to a portion of the stomodeum of the lower forms or is a superadded feature.

In the case of compound organs the preparations should be placed with their most characteristic elements. Thus the liver should be placed with the hypoblastic tissues, the nerves and skin with the ectodermal, &c. In cases of series of sections of one animal, they of course should be kept together.

Dr. Dimmock adopts a different plan. Each of his slides is numbered in the order of preparation, and then two card catalogues are made, one by organs, the other systematic, each card referring by a number to the corresponding slide. On these cards can be entered full accounts of the specimen, its mode of preparation, the special features presented, &c., and thus with a slight additional amount of labour, the advantages of each system of arrangement may be obtained.

Blackham's Object-Boxes.*—Dr. G. E. Blackham takes the common rack-boxes for twenty-four slides, and putting on the cover, pastes a piece of stout twilled muslin on the back and lapping over on to the cover. This forms a hinge, and gives the boxes a uniform look. Each box is devoted to a special series or class of objects, and properly labelled, and stands up on end in a revolving book-case. The slides lie flat, and the whole collection is in reach from the working table, without getting out of the chair. For indexing each box Dr. Blackham, with an electric pen, makes a label covering the inner side of the cover, the name of each slide is written on this, on the line opposite the slide itself as it stands in the box. These boxes are cheap, convenient and portable, and are, he considers, preferable to the more elaborate and costly cabinets of drawers.

* Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 236–7.

Stillson's Object Cabinet.*—Dr. J. O. Stillson's cabinet consists of a number of trays made of thick pasteboard. They are 9 in. wide and 16 in. long. There are two rows of slides in each tray and 10 or 12 in each row according to the partitions, which can be removed or left in. The depth of the tray is equal to the thickness of the thickest slides, so that when they are in place, each lying flat, they fill the apartment. There is a lid to each tray, also made of pasteboard but stiffened, and made heavier by the addition of a strip of wood, such as is used in making cigar boxes. This strip extends all around the margin of the lid, and there is another across the middle the long way.

Two long openings are cut through the lid, about 2 in. wide, so that when the lid is closed it will press the slides down in their places firmly, but at the same time not touch the cover-glasses. High, dry and opaque mounts can be placed alongside of the thinnest balsam or diatoms, and when it is desired to look for a slide the whole tray can be surveyed with the eye at a glance, and the names of twenty or twenty-four specimens can be read without opening the tray. When the trays are all in the box, the lid holds them firmly in place suitable for shipping. He has borders for the labels printed on fancy coloured paper, and writes in pencil on the wrong side of the label such a history as he desires and pastes it on the slide. Then the name labels are cut with a circular No. 8 punch, and pasted on the border paper. There is plenty of room to write in front the English and Latin names, date and number; by turning the slide round one can read from the back through the glass the history and mode of preparation.

Pillsbury's (or Bradley's) and Cole's Mailing Cases. — This "mailing case," the design of J. H. Pillsbury, is intended to supply a demand for some safe and cheap means of packing one or more slides for sending through the post. The entire device comprises three differently shaped pieces of wood (tops, bottoms, and centres) so formed that two, three, or more may be put together as shown in

Fig. 77.

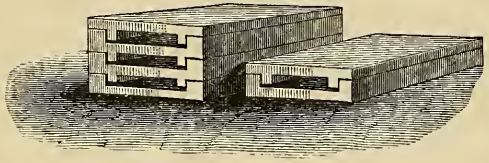


Fig. 78.

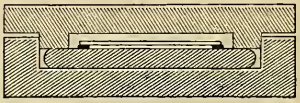


fig. 77. For one slide the top and bottom pieces are used, for two slides the centre pieces also, and so on to any convenient number.

The cross section fig. 78 shows the relation of the parts of the case to the slide. The pinching of the wooden lips on the margin

* Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883.

of the glass outside the mounting serves to hold the slide securely in place, and to protect the mounting from possible injury.

Every dozen tops and bottoms is accompanied with twenty-four strips of gummed paper which may be used on the edges to secure the pieces before wrapping for mailing. If one slide is to be sent the strips may be gummed lengthwise on the edges. If centres are used for more slides the strips may be used to pass around on to top and bottom. The slight shrinking of the moistened paper in drying pinches the slide sufficiently to hold it securely.

Fig. 79.

A. C. Cole uses the boxes shown in fig. 79. They consist of a piece of wood $3\frac{1}{8}$ in. × $1\frac{5}{8}$ in. and 1/2 in. thick in which a coarse saw-cut has been made nearly through it as shown in the figure. The slide is placed in the groove thus formed with a little cotton wool and the open side is filled up with a strip of wood about 3/16 in. section.

Adams, J. M.—How to keep [send] living Infusoria.
[Dr. A. C. Stokes uses *Lemna* plants which keep the water sweet and supply oxygen while in transit.]
The Microscope, IV. (1884) p. 64.

B., W.—Microscopical. [Mounting Cuticle of Leaf.]
Engl. Mech., XXXIX. (1884) p. 132.

Behrens, W.—See Boecker, W. E.

Blochmann, F.—Ueber Einbettungsmethoden. (On imbedding methods.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 218–33 (2 figs.).

Boecker, W. E.—Ueber ein neues Mikrotom mit Gefriereinrichtung, automatischer Messerfuhrung und selbstthätiger Hebung des Objectes. (On a new Microtome with freezing apparatus, automatic knife-guide, and automatic raising of the object). [*Post.*]
Zeitschr. f. Instrumentenk., IV. (1884) pp. 125–7 (2 figs.).
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 244–8 (by W. Behrens).

Booth, M. A.—Mailing packages of Diatoms.
[Inquiring how to send small exchanges to foreign countries.]
Amer. Mon. Micr. Journ., V. (1884) p. 100.

Born, G.—Die Plattenmodellirmethode. (The method of modelling by [wax] plates.) [*Post.*]
Arch. f. Mikr. Anat., XXII. (1883) pp. 584–99.
Amer. Natural., XVIII. (1884) pp. 446–8.

Buchka, K.—Ueber Hæmatoxylin und Brasilin. (On Hæmatoxylin and Brasilin.)
Nachr. K. Gesell. Wiss. Göttingen, 1883, pp. 60–66.

Buckton, G. B.—Monograph of the British Aphides. Vol. iv. ix. and 228 pp. (27 pls.). 8vo, London, 1883.
[Contains "The preservation and mounting of Aphides for the Microscope," "The preservation of Aphides for the Museum," and "The dissection of Aphides." *Supra*, p. 466.]

Burrill's (T. J.) Staining fluid, directions for use of.
Micr. Bulletin, I. (1884) pp. 21–2.

Cattaneo, G.—Fissazione, Colorazione e Conservazione degli Infusorii. (Fixing, colouring, and preserving Infusoria.) *Concld.*
Bollett. Scientif., V. (1883) pp. 122–8.

Cleaning Slides and Covers—Letter by J. C. Lathrop. [See also *ante*, p. 323.]
Amer. Mon. Micr. Journ., V. (1884) p. 79.

Coale, R. D.—Preparation of the Ethyl Ether of Gallic Acid.
[Cf. III. (1883) p. 931.]
Amer. Mon. Micr. Journ., V. (1884) p. 82.

Cole, A. C.—Studies in Microscopical Science.
Vol. II. No. 15. Sec. I. No. 8. Adipose Tissue, pp. 29–32. Plate 8 × 250.
No. 16. Sec. II. No. 8. pp. 29–34. Epidermal Tissue. Plate 8. T. S. of aërial root of *Dendrobium* × 130.
No. 17. Sec. I. No. 9. Development of Bone, pp. 33–6. Plate 9. Ossification of Cartilage (Quain) × 300.
No. 18. Sec. II. No. 9. pp. 35–8. Vasicular Tissue. Plate 9. Bast, Sieve Tubes and Liber Cells.
" " Methods of Microscopical Research.
Part IX. pp. xlix.–lii. Mounting (*continued*). Description of Materials.
Part X. pp. liii.–vii. Mounting (*continued*). The Preparation of Diatomaceæ.
" " Popular Microscopical Studies. No. VII. A Grain of Wheat (*concluded*), pp. 25–8.—The Common Bulrush (*Typha*), pp. 29–31. Plate 7. T. S. of Stem, double stained, × 75.
No. VIII. The Intestine, pp. 33–7. Plate 8. T. S. Ileum of Cat injected × 50.

Collins' (C.) Series of 48 Fish Scales. *Micr. News*, IV. (1884) p. 109.

Cornil, —.—Sur le mode de conservation des pièces anatomiques destinées à être examinées au Microscope. (On the mode of preserving anatomical objects required to be examined with the Microscope.
[Brief note only of original paper. The best preserving liquid is 90 per cent. alcohol using a volume at least 20 times as great as that of the piece to be preserved, which should if possible be reduced to 1/2–1 cm. cube.]
Journ. de Micr., VIII. (1884) p. 189, from *Progrès Médical*.

Cox, J. D.—[Prof. H. L. Smith's] New Mounting Media. [*Supra*, p. 476.]
Amer. Mon. Micr. Journ., V. (1884) p. 71.

Coze and Simon, P.—Recherches de pathologie et de thérapeutique experimentales sur la Tuberculose. (Experimental pathological and therapeutical observations on Tuberculosis.)
[Contains I. Technique.]
Journ. de Microgr., VIII. (1884) pp. 235–9, from *Bull. Gén. de Thérapeutique*.

Creese, E. J. E.—An inexpensive Turn-table.
["A home-made turn-table which any one with ordinary knack can make for himself at the cost of a shilling."]
Journ. of Micr., III. (1884) pp. 106–7 (3 figs.).

Deby, J.—Notes diatomiques. (Notes on Diatoms).
[I. On MM. Prinz and Van Ermengem's work on the structure of the valves of diatoms (*post*). II. Discovery of *Terpsinoë musica* in Spain. III. Special slides of diatoms by Möller (*post*).]
Journ. de Microgr., VIII. (1884) pp. 228–31.

Dippel, L.—Die Anwendung des polarisirten Lichtes in der Pflanzenhistologie. (The use of polarized light in vegetable histology.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 210–7 (5 figs.).
" " Kalium-Quecksilberjodid als Quellungsmittel. (Biniodide of mercury and potassium as a swelling agent.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 251–3.

Durkee, R. P. H.—Mounting in balsam in cells. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) pp. 84–85.

Edinger, L.—Notiz, betreffend die Behandlung von Präparaten des Centralnervensystems, welche zur Projection mit dem Scioptikon dienen sollen. (Note on the treatment of preparations of the central nerve-system intended for projection with the Sciopticon.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 250–1.

Elsner, F.—Mikroskopische Atlas. Ein illustrirtes Sammelwerk zum Gebrauche für Gesundheitsbeamte, Apotheker, Drogisten, Kaufleute und Gebildete Laien. (Microscopical Atlas. An illustrated compendium for the use of officers of health, apothecaries, druggists, merchants, and well-informed laymen.) Part I. 9 pp. and 2 pls. of 27 photomicrographs. 4to, Halle, 1884.
[Contains Coffee and Coffee-surrogate. Tea and Tea-surrogate.]

FERGUS, S. T.—Double staining sections of Buds. *Micr. Bull.*, I. (1884) p. 18.

FLESCH, M.—Notiz über die Anwendung des Farbstoffes des Rothkols in der Histologie. (Note on the use of the colouring matter of the red cabbage in Histology.) [*Post.*]

Zeitschr. f. Wiss. Mikr., I. (1884) p. 253–4.

FRENZEL, J.—Ueber die Mitteldarmdrüse der Crustaceen.

[Contains "Methods of studying the so-called liver of the Crustacea." *Amer. Natural.*, XVIII. (1884) p. 556–7. *Post.*]

MT. Zool. Stat. Neapel, V. (1884) p. 51.

GAGE, S. H.—Notes on the use of the Freezing Microtome. [*Post.*]

Science Record, II. (1884) pp. 134–5.

GILTAY, E.—L'Hématoxyline comme réactif spécifique des membranes cellulosiques non lignifiées et non subérifiées. (Hæmatoxylin as a reagent for non-lignified and non-suberose cellulose membraues.) [*Post.*]

Arch. Néerl. Sci. Exact. et Nat., XVIII. (1883) pp. 437–52.

GRANT, F.—Microscopic Mounting. IX. Mounting Media. 1. Phosphorus and monobromide. 2. Advantages as to the absence of contraction and as to visibility. 3. Thin aqueous fluids. 4. Advantages of different media with respect to granulation. 5. Thick aqueous media: advantages as to staining and pressure.

[Sec. II. requires considerable correction. *Inter alia*, the refractive index of diatoms is put at "about 1·5," and balsam at 1·528, or a visibility of ·028! Diatoms are stated to be more visible in air than in phosphorus. The disadvantages of air-mounting are not referred to its inapplicability for fine markings, but to a "dulness or mist which gathers inside," &c.]

Engl. Mech., XXXIX. (1884) pp. 148–50.

GRAVIS, A.—Procédés techniques usités à la Station Zoologique de Naples en 1883. (Technical methods used at the Naples Zoological Station in 1883.)

[Summary of various methods previously published, and *post.*]

Bull. Soc. Belg. Micr., X. (1884) pp. 104–27, 132–3.

HAACKE, W.—Entwässerungsapparate für Macro- und Microscopische Präparation. (Dehydrating Apparatus for Macroscopic and Microscopic Preparations.) [*Post.*] *Zool. Anzeig.*, VII. (1884) pp. 252–6 (1 fig.).

HARTZELL.—A method of staining the Bacillus [of tubercle.] [*Post.*]

Amer. Mon. Micr. Journ., V. (1884) p. 76–7, from *Medical Times.*

HAZLEWOOD, F. T.—Blue Staining.

[The stain—described III. (1883) p. 733—"gives surprisingly fine results with micrococci, bacteria, bacilli, &c." Method of suspending the slides in the water.]

Amer. Mon. Micr. Journ., V. (1884) pp. 83–4.

HEITZMANN, C.—Mikroskopische Morphologie des Thierkörpers im gesunden und kranken Zustande. (Microscopical morphology of the animal body in health and disease.) xvi. and 876 pp. (380 figs.). 8vo, Wien, 1883. Also 8vo, New York, 1884.

HITCHCOCK, R.—Styrax and Liquidambar as substitutes for Canada Balsam.

[Recommendation of Styrax.]

Amer. Mon. Micr. Journ., V. (1884) pp. 69–71.

„ „ Crystals of Arsenic.

[Select a small tube about 1 in. in length, and fit it in a holder made of a thin strip of copper, brass, or other metal having a hole bored through it to receive the tube. Let the mouth of the tube project slightly above the metal, and support the latter in some convenient way over a spirit lamp. Place a small quantity of white arsenic in the tube, and apply heat slowly until a white powder begins to collect about the mouth. Then warm a glass slip, and hold it over the top of the tube until bright crystalline particles appear on its under surface. Then remove the lamp and let the tube cool.]

Amer. Mon. Micr. Journ., V. (1884) p. 71–2.

„ „ Cleaning Polycystina. „ „ „ „ pp. 72–3.

HITCHCOCK, R.—Microscopical Technic. III, IV. Mounting Objects Dry. *Amer. Mon. Micr. Journ.*, V. (1884) pp. 73–4, 91–4.

„ „ Spring Collections. „ „ „ „ pp. 77–8.

HOEHNEL, F. v.—Ueber eine Methode zur raschen Herstellung von brauchbaren Schliffpräparaten von harten organisirten Objecten. (On a method for the rapid preparation of useful sections of hard organized objects.) [*Post.*] *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 234–7.

HOFFMANN, F. W.—Einfacher Einbettungsapparat. (Simple imbedding apparatus.) [*Post.*] *Zool. Anzeig.*, VII. (1884) pp. 230–2 (1 fig.).

HOLZNER, G.—Zur Geschichte der Tinctionen. (On the history of Staining.) [*Post.*] *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 254–6.

JACKSON, E. E.—How to Mount Casts.

[After allowing urine to settle, pour off and wash sediment repeatedly with clean water, the object being to get rid of the albumen. The white sediment consists of casts and epithelia. Have ready a solution of eosin, 5 grs. to 1 oz. (water 3, alcohol 1), pour it on sediment, allow to stand 30 minutes, then wash repeatedly as long as colour comes freely. Allow to settle, place a drop on cover, when dry enough to adhere, rinse off with alcohol to get rid of water; dry. Wet with spirits of turpentine and mount as usual in balsam.]

The Microscope, IV. (1884) pp. 78–9.

„ „ Mounting Desmids.

[A dip was put in a cell, the water absorbed by blotting-paper, then a drop of mixture of carbolated mucilage of gum arabic and solution of borax was put on the desmids and they were covered and ringed. It remains to be seen whether the medium has bleaching or shrinking properties.]

The Microscope, IV. (1884) p. 117.

KINGSLEY, J. S.—Microscopical Methods. II.

[Elementary instruction.] *Science Record*, II. (1884) pp. 124–7.

L., V. A.—To Harden Animal Tissues. *Sci.-Gossip*, 1884, p. 89.

LAGERHEIM, G.—Eine Präparirmethode für trockene mikroskopische Pflanzen. (A method for preparing dried microscopical plants.) [*Post.*] *Bot. Centralbl.*, XVIII. (1884) pp. 183–4.

LATHROP, J. C.—See Cleaning.

LINDT, O.—Ueber den mikrochemischen Nachweis von Brucin und Strychnin. (On the microchemical analysis of Brucine and Strychnine.) *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 237–40.

MEYER, H. V.—Fernere Mittheilung über die Kleisterinjection. (Further communication on paste injection.)

[Further experience of his modification of Pansch's method has proved its value. Remarks on the use of fuchsin and vermilion.]

Arch. f. Anat. u. Physiol.—Anat. Abtheil., 1883, pp. 277–8.

MICHAEL, A. D.—British Oribatidæ. Vol. i. xi. and 336 pp. (31 pls.). 8vo, London, 1884.

[Contains description of cells used for observing the development and immature stages, pp. 68–70 (glass rings made from thinnish 3/4 or 7/8 in. tubing and 3/8 in. deep). Collecting and preservation, pp. 99–109. Drawing, pp. 191–5. *Post.*]

MOELLER, J.—Das neue Patent-Schlittenmikrotom von C. Reichert. (The new patent sliding Microtome of C. Reichert.) [*Post.*] *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 241–4 (1 fig.).

PIM, G.—Cell-sap Crystals.

[*Supra*, p. 470.] *Journ. of Bot.*, XXII. (1884) p. 124.

PRAY, T., junr.—Cotton-fibre and its structure.

[Refers to the "importance of examining cotton by the Microscope," and the "advantages which manufacturing corporations would gain by selecting their stock in this way."]

Science, III. (1884) p. 583 (*Proc. Soc. of Arts. Mass. Inst. of Technol.*, April 10).

RATABOUL, J.—Les Diatomées. Récolte et préparation. (The Diatomaceæ. Collection and preparation. *Contd.*) *Journ. de Microgr.*, VIII. (1884) pp. 115, 173–6, 231–4.

Rindfleisch.—Bacilli of Tubercle.

[They are best stained by fuchsin, soluble in alcohol but not in water. Two or three drops of a concentrated solution in 2–3 cm. of anilin-oil water are sufficient. The staining is especially good at 40° C. The bacilli are uniformly stained if a few drops of fuchsin are added to a mixture of equal parts of alcohol, water, and nitric acid.]

The Microscope, IV. (1884) p. 91.

Sharp, B.—On Semper's method of making dried preparations. [*Post.*]

Proc. Acad. Nat. Sci. Philad., 1884, pp. 24–7.

Sharp, H.—On the Mounting of Objects in cells with Canada Balsam medium.

Journ. Roy. Soc. N.S. Wales, XVI. (1883 for 1882) pp. 286–8.

Simon, P.—See Coze.

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

[Spiral vessels of rhubarb, &c.—Oxalate of Lime in Wood Sorrel] [Fish scales] [Proboscis of Ophideres] [Wings of Insects].

Knowledge, V. (1884) pp. 240, 282–3 (3 figs.), 330–1 (2 figs.), 371–2 (1 fig.).

Smith's (H. L.) New Mounting Medium. [*Supra*, p. 476.]

[See also Cox, J. D.] *The Microscope*, IV. (1884) pp. 77–8.

Amer. Mon. Micr. Journ., V. (1884) p. 80.

Stowell, C. H.—Studies in Histology. Lesson I. Injecting. II. Hardening, Softening, Dissociating and Normal Fluids.

The Microscope, IV. (1884) pp. 49–56, 80–6.

„ „ The Measurement of Blood-corpuscles.

[Discussion of recent articles. He considers the relative size of the red blood-corpuscles as given by Gulliver incorrect.]

The Microscope, IV. (1884) pp. 60–1.

„ „ White Zinc Cement.

[Commendation of it when properly put on, in opposition to R. Hitchcock's view that it will run in and spoil the mounts.]

The Microscope, IV. (1884) p. 62.

Walmsley & Co.'s Circular on Bacillus Staining. [Vol. III. (1883) p. 310.]

The Microscope, IV. (1884) pp. 79–80.

West, T.—Naphthaline.

["It is considered by Prof. Williamson of Manchester, to furnish the very best of all substances for imbedding delicate microscopic subjects in previous to cutting sections."]

Journ. of Microscopy, III. (1884) pp. 113–4. See also p. 119.

Wills, —.—Mounting Desmidieæ.

[Plain water—gold size.]

Proc. Manch. Lit. and Phil. Soc., XXI. (1882) pp. 38–40.

Wilson, C. B.—The mesenterial filaments of the Alcyonaria.

[Contains "Methods of preparing the Alcyonaria." *Amer. Nat.*, XVIII. (1884) p. 558. *Post.*]

MT. Zool. Stat. Neapel, V. (1884) p. 3.

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CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

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1884.

XII.—*On a New Microtome.*

By C. Hilton Golding-Bird.

(*Read* 14*th May*, 1884.)

The necessity for providing some instrument which offered the advantages of modern microtomes and yet was within the reach of those whose work being of intermittent character did not warrant their employing the somewhat elaborate instruments that are found in laboratories, made me originate the instrument shown in figs. 83 and 84.

The microtome is intended to be held in the hand during use, and is of two forms—one for ice and salt, the other for ether. The former (fig. 83) consists of a cylindrical vulcanite chamber closed at the bottom by a brass screw-lid, and at the top by a

Fig. 83.

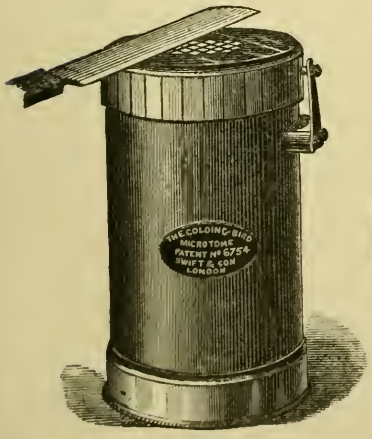


Fig. 84.

disk of vulcanite, having in the centre a plate of brass (freezing plate) 7/8 in. in diameter, and terminating in the chamber by a rod of brass. A metal cap surmounted by a glass plate and pierced in the centre to allow the freezing plate to project, screws over the upper end of the cylinder, the outer surface of which bears a male screw of hard metal on which the cap turns. As the cap is turned round a spring catch clicks at given intervals; these are so arranged that as the cap rotates from left to right each click shows that it has sunk on to the cylinder 1/1000 in.; hence any tissue fixed on the freezing plate projects, at each click, 1/1000 in. through the hole in the glass plate of the cap, and a

razor now passed over the latter cuts off a section of the same thickness. By turning the cap through half an interval, sections of half that thickness may be obtained. To fix the specimen it is only necessary to fill the cylinder with ice and salt, the specimen being previously prepared in gum, according to the general rule when freezing is employed as the means of imbedding.

The form in which ether is the freezing agent employed (fig. 84) differs mainly in the fact, that the lower half of the cylinder is a chamber for holding the ether, with the two nozzles that give the necessary jet. The freezing plate, cap, and regulating apparatus are the same as in the ice and salt machine. Mr. Swift (to whose skill and ingenuity the details of manufacture are due) has introduced a very ingenious but yet simple means whereby some of the ether can be saved from the spray; much must of course escape, but much also falls back on to the jets again (since the spray is a vertical one); this portion impinges on to a funnel-shaped diaphragm, which acts as a lid to the ether chamber, and through which, by means of a minute opening, it again finds its way back to the ether chamber.

For those who, like myself, have to work for a large histological class, there is nothing equal to the Groves-Williams ether microtome in the laboratory: but for intermittent and home work I believe that the form of instrument that I present to-night, leaves scarcely anything to be desired in accuracy of work, simplicity, convenience, and portability.

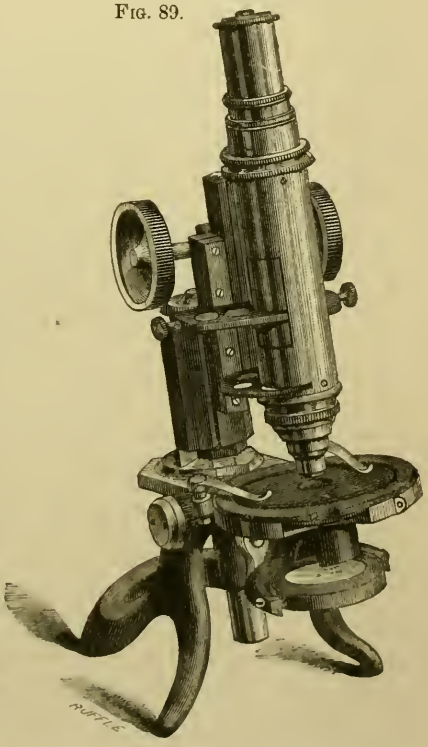
Diatomaceæ from the Island of Socotra.*—F. Kitton gives a list of twenty-two fresh-water species from the Island of Socotra. Amongst these are a new species of *Cerataulus* (*C. Soctrensis*), which is the first fresh-water representative of the genus, and *Fragilaria Ungeriana* Grun., which has previously been found in only two localities—Cyprus and Belgaum (India).

MICROSCOPY.

a. Instruments, Accessories, &c.

Microscope with Amplifiers.—Fig. 89 shows two methods of applying a series of amplifiers to the Microscope:—(1) A disk containing four apertures is mounted above the nose-piece to rotate so as to bring the apertures successively into the optic axis. One aperture is blank for normal examinations; and the others are provided with biconcave lenses of 3 in., 4 in., and 5 in. negative focus respectively. This application of amplifiers was exhibited at the Society several years ago, but we have not succeeded in tracing the name of the exhibitor. (2) Mr. J. Mayall, jun., suggests that the amplifiers should be mounted in a plate (shown in the fig.) sliding through the body-tube, and with means of raising or lowering it within the body-tube so that the best position with each objective may be found experimentally.

Fig. 89.



The use of such amplifiers involves a slight deterioration of the quality of the image, but in many cases this would be more than compensated by the increase in the magnification and in the working distance.

Bausch's Binocular Microscope.†—The following is E. Bausch's specification of his "Binocular Microscope":—

"My invention relates to the class of Microscopes in which part of the rays of light emanating from the object and passing through

* Journ. Linn. Soc. Lond.—Bot., xx. (1884) pp. 513–5 (1 pl.).

† Specification of U.S.A. Patent No. 293,217, dated February 12th, 1881.

the objective are divided by a doubly reflecting prism, known as the 'Wenham prism,' so that one-half of the rays pass to an auxiliary eye-piece mounted in a branch tube applied to the side of the main tube.

In Microscopes of this class the prism has heretofore been mounted in a box arranged to slide laterally in the lower part of the Microscope-body, so that it could be moved into and out of its place by sliding the box, and any imperfection in the bearings of the box, which are necessarily narrow, allowed the box to move laterally, thereby impairing the effectiveness of the instrument. Another serious objection to the common method of mounting the prism is, that the size of tubes in Microscopes being limited, and the box being contained entirely in the tube or nose-piece, the movement of the box and size of the prism are correspondingly limited. This being the case, a large proportion of the rays which are transmitted by modern objectives are prevented from passing to the eye-piece, so that it has frequently been found necessary to remove the nose-piece containing the ordinary prism-box and replace it by another nose-piece which had no obstruction when the full effectiveness of the objective was desired.

My invention is designed to obviate these difficulties by providing a prism-holder with a long cylindrical bearing, which is readily made and practically indestructible by wear, and which admits of either binocular or monocular arrangement of the Microscope with the full effect of either method of vision.

It consists of a prism-carrying arm fixed to the end of a spindle extending through a sleeve passing through the side of the Microscope-body, the spindle being provided with a milled head, by which it is turned, and with a stop-pin, for limiting its motion.

Fig. 90 is a vertical section on the line *x x* in fig. 91 of a portion of a Microscope-body, showing my improvement applied. Fig. 91 is a plan view, partly in section.

The body of the Microscope is provided with a nose-piece A, threaded in the usual way at its lower end to receive an objective, and having sufficient depth to contain the prism-holder B. The prism-holder B consists of a metallic plate *a*, bent twice at right angles, and receiving between its parallel sides *b c* the prism C. The side *c* of the holder B is prolonged, forming an arm *c'* which is secured in any suitable manner to the end of a spindle D. In the present case it is fitted to a shoulder on the spindle and fastened by means of a small nut *d* fitted to the threaded end of the spindle. The spindle D is fitted to a sleeve E, passing through the side of the nose-piece A, so that it may turn therein without lateral or longitudinal motion. To insure the perfect bearing of the spindle D in the sleeve E the sleeve has a longitudinal slit *e*, which permits it to adapt itself to the spindle by springing and to create the small amount of friction necessary to retain the prism-holder in any position. The outer end of the spindle D is provided with a milled head F, by which the prism may be moved into or out of the field, and a pin *f*, projecting from the spindle through a slot *g* in the sleeve E, limits the motion of the prism-holder in either direction. The prism-holder B is arranged relative to the main and auxiliary tubes of the Microscope

so that it will swing in a plane lying in the axes of the two tubes, and when it is swung down into the position shown in full lines in the drawings the prism intercepts one-half of the rays passing through the objective and diverts them to the auxiliary tube. When

Fig. 90.

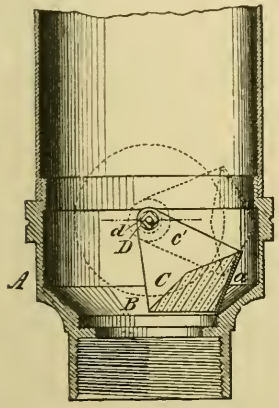
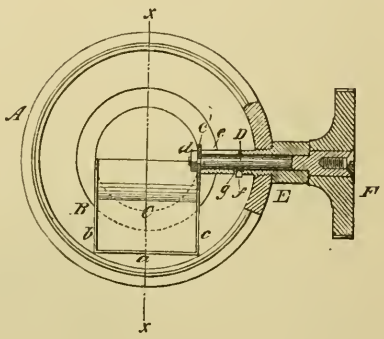


Fig. 91.



the Microscope is used for monocular vision, the prism is turned out of the field, as indicated by dotted lines in fig. 90.

Having thus described my invention, what I claim as new, and desire to secure by letters patent, is—

1. In a binocular Microscope, a swinging prism-holder adapted to support the prism within the body of the Microscope either in or out of the field of vision, as herein specified.

2. The combination, with the doubly reflecting prism of a binocular Microscope, of a prism-supporting arm and spindle attached thereto, and extending outward through the Microscope-body, as described.

3. The combination, in a binocular Microscope, of the prism C, prism-holder B, spindle D, provided with the stop-pin *f*, and the slotted sleeve E, as herein specified."

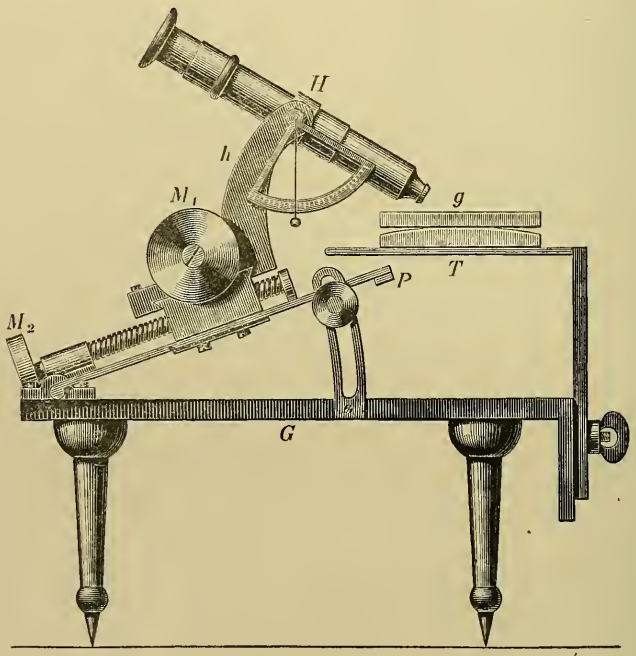
Sohncke's Microscope for Observing Newton's Rings.*—This instrument (fig. 92) is a device of Dr. L. Sohncke for examining Newton's rings, and it is claimed that it fulfils all the conditions in regard to variety of movements (and their measurement) necessary in such an instrument.

The microscope-tube (provided with cross threads and magnifying 20 to 25 times) slides in a short socket H, the former having a scale in half-millimetres (with a nonius on H) for allowing the exact position to be read off. The socket, with the Microscope, can be turned on a horizontal axis, fixed in the front part of two brass

* Zeitschr. f. Instrumentenk., i. (1881) pp. 55-8 (1 fig.).

shoulders *h*, rising from a common base plate. On one side the axis carries a quadrant turning with the Microscope, and having one arm parallel with the optic axis of the Microscope. A plumb line gives the angle on the quadrant. On the other side of the axis is a screw-nut to clamp it in any desired position. The brass base plate to which the shoulders *h* are attached, slides by means of a screw M_1 in a second piece shown in the figure. The motion is at right angles to the plane of incidence of the light falling on the object, i. e. from right to left (or *vice versâ*) as the observer would stand in using the instrument. The second piece is again part of another slide, which

Fig. 92.



is moved backwards and forwards by the screw M_2; the motion here is at right angles to that of the first slide, and therefore parallel to the plane of incidence. The extent of these two movements is read off on two millimetre scales on the guides of the slides, and the screw heads are divided for reading fractional parts of mm. The heavy iron base G of the whole instrument rests upon three feet, and the plane and convex glasses *g* are laid upon a small stage T attached to the front of the instrument, and capable of being raised and lowered above G as required.

Although the apparatus in this form may be thought to fulfil all requirements, Dr. Sohncke considered it especially necessary to add an additional contrivance for indicating, without further measurement, the most characteristic phenomenon in the position of Newton's rings, viz. that those ring-points which are in the plane of incidence passing through the centre of the rings, all lie in a straight line which rises obliquely towards the light. The greatest inclination of this "fundamental line" towards the horizon is 19° 28′. If we have an arrangement by which the Microscope with any angle of incidence can be given a movement parallel to the "fundamental line," then when any one ring (in the central plane of incidence) is clearly seen by proper focusing of the Microscope, all the rings in succession will also be clearly seen by the movement in question; whilst if the Microscope were moved horizontally, they would very soon be out of focus. This requirement is carried out in the present instrument by the guides of the lower slide being fixed, not upon the horizontal base G, but upon the plate P, which is movable on an axis at right angles to the plane of incidence, and can be fixed at any required inclination between 0° and 20°. That the object may not be disturbed by the inclination of the plate, it is cut out somewhat in the shape of a horse-shoe. To use this arrangement the plate P must be placed at the angle ω of the "fundamental line" for the particular angle of incidence θ. The value of ω is obtained from the formula:—

$$tg\,\omega = \frac{\sin\theta \,.\, \cos\theta}{1 + \cos^2\theta}.$$

The Microscope is then to be placed at the required angle of incidence. In order to do this direct, a plumb line, instead of an index, is used for reading off the "angle" on the quadrant, as an index would join in the inclination of the plane P. The lower slide has now only to be moved parallel to the plane of incidence, by means of the screw M_2, in order to see all the rings pass across the field in complete distinctness.

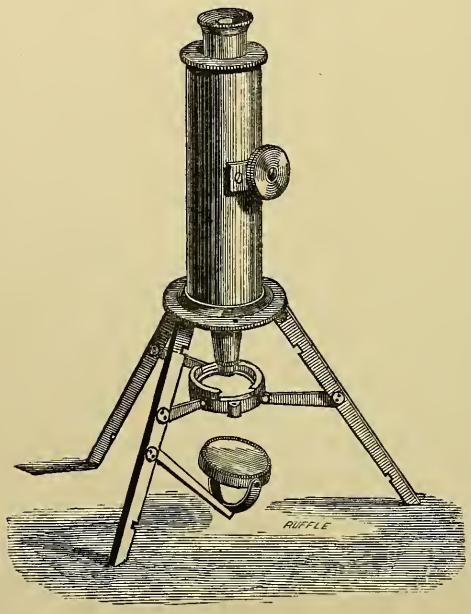
Dr. J. H. L. Flögel describes* a method of determining the thickness of diatoms by the examination of the Newton rings formed when they are illuminated by reflected light from a Lieberkühn. It consists simply in tilting the slide at an angle, the light being admitted to the Lieberkühn through a small excentric aperture in the diaphragm, reaching the objective only after reflection from the preparation.

Harris & Son's Portable Microscope.—This (figs. 93 and 94) is a somewhat ancient form, probably fifty years old, but is arranged on an ingenious plan to secure portability. When set up for use it takes the form shown in fig. 93. By unscrewing the tube, and screwing it into the lower side of the ring which holds it, and closing the tripod legs together, it is reduced to the form shown in fig. 94.

* Arch. f. Mikr. Anat., vi. (1870) pp. 472-514.

The subsidiary leg, which carries the mirror, folds against the leg of the tripod to which it is attached. The stage is removable, leaving

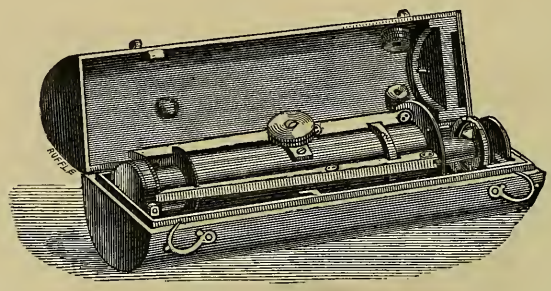
Fig. 93.



a ring, which is attached by three supports to the tripod, and rises and falls somewhat as the tripod legs are shut or opened.

The instrument is hardly so convenient as the modern forms which

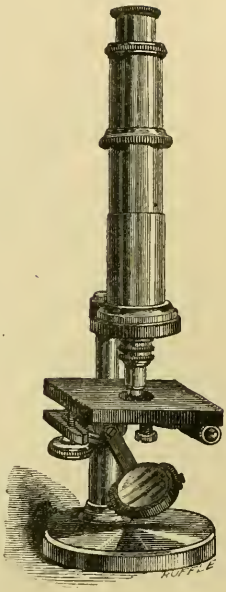
Fig. 94.



have been devised in such profusion, but it is interesting as being a very early progenitor of this class of instrument.

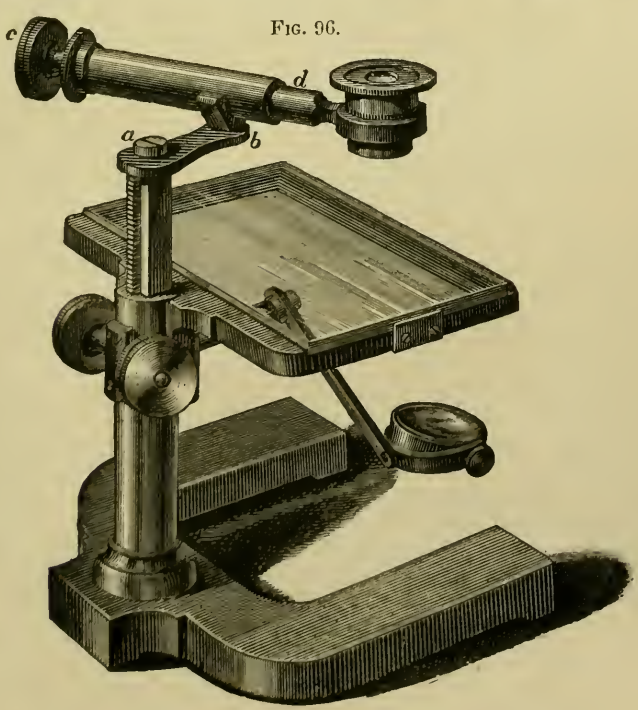
Seibert's No. 8 Microscope.—The Microscope No. 8 in Seibert and Kraft's Catalogue (fig. 95) has a fine adjustment similar in principle to those described Vol. III. (1880) p. 882, though carried out in a different manner. Here the stage is supported on a horse-shoe-shaped frame, and is pivoted to one of the projecting arms. A screw passing through the opposite arm raises the stage at the end and as the screw is withdrawn a spiral spring presses the stage back again.

Fig. 95.



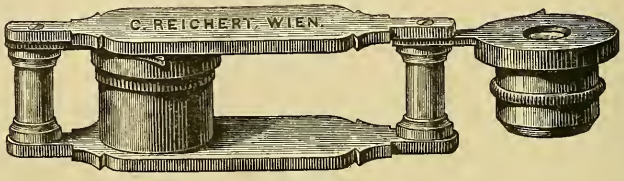
Reichert's Large Dissecting Microscope and Hand Magnifiers.—C. Reichert's large dissecting Microscope (fig. 96) is of exceptional size for the examination of sections of brain and similar large objects. The stage is entirely of glass, and is 11·5 cm. wide and 18 cm. long. The mirror can be moved forwards and to both sides. The preparation is intended to be fixed while the lens is capable of being moved over it in all directions. The arm *a b* can be rotated on *a*, and the lens-carrier *c d* can also be rotated at *b*. By turning the milled head *c* the inner tube *d* which carries the lens is pushed forward or withdrawn again.

Fig. 96.



Herr Reichert also mounts two doublets of 10 and 20 power in a nickelled frame (fig. 97, natural size). When not in use they are

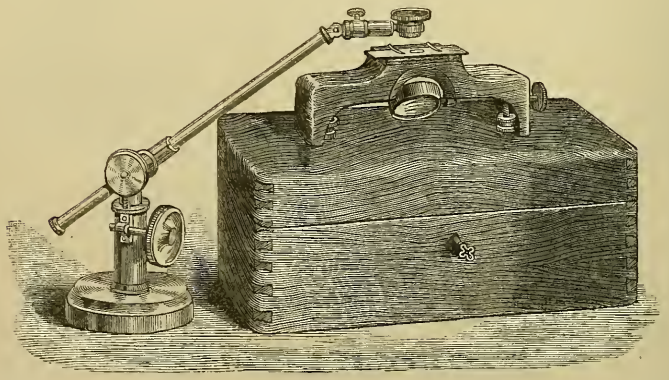
Fig. 97.



turned back within the frame, or for examining an object, brought out as shown in the fig.

Geneva Company's Dissecting Microscope.—This, fig. 98, consists of two parts, a support for the lenses and a stage and mirror.

Fig. 98.



The two are quite separate, a plan which gives more freedom of action than can be obtained in the ordinary form of dissecting Microscope.

The lens-support can be raised by a pinion acting on a rack on an inner tubular pillar. It can also be rotated in a horizontal plane on the top of the latter or in a vertical plane on the pivot clamped by the second (upper) milled-head.

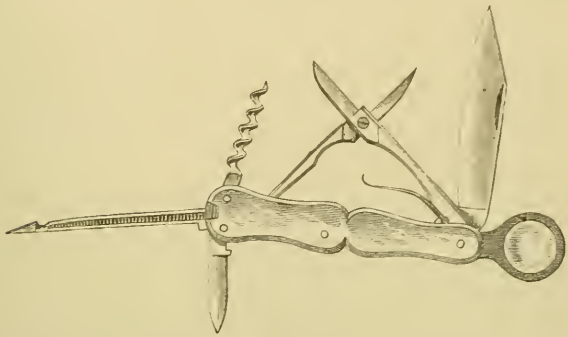
The stage has side rests for the hands and can be screwed to the top of the box holding the instrument. The mirror is rotated on its axis by the milled-head shown on the right. On one side there is an ordinary concave mirror and on the other a plane one of opal glass.

Drallim and Oliver's Microscope Knife.—The following is taken from the advertisement of this knife (fig. 99):—

"It comprises a great variety of articles including a large dagger-blade, small penknife, pair of folding scissors, corkscrew, nail-trimmer and file, tortoise-shell toothpick and ear-scoop, nickel silver tweezers,

and last, but by no means least, a very powerful Microscope. We are not aware of any other knife manufactured which contains a Microscope of any description, and we anticipate an enormous demand in consequence. An ordinary pocket handkerchief submitted to the

Fig. 99.



lens of this powerful glass, the texture appears nearly as coarse as a sack. Scientific students and merchants will find this invaluable to them, as the knife is of convenient size to be carried in the waistcoat pocket."

Ward's Eye-shade.*—Dr. R. H. Ward's device consists (fig. 100) of a circular disk of hard rubber or blackened metal, about 1½ in. in diameter, an extension of which in the form of a band 1/2 in. wide crosses in front of the nose of the observer, but quite out of the way, and encircles the top of the draw-tube or compound body just below the ocular. As now used, this shade is made of hard rubber, which is of light weight, and suitably dark colour, is less likely than metal to scratch the brasswork with which it comes in contact, and is so elastic as to be applicable to a considerable variety of tubes. The same shade, for instance, can be used on tubes of from 1 to 1¼ in., or from 1/8 to 1⅜, the best fit being of a size midway between the two extremes. Besides this easy range of adaptation, this eye-shade differs from those hitherto in use in its attachment to the body instead of the ocular, by which it is brought to an advantageous distance from the face, and is retained in position as long as the instrument is in use, instead of being removed with the ocular and requiring a fresh application every time that is changed. It is reversible by simply turning it over, and can thus be instantly transferred from the left

Fig. 100.

* Amer. Mon. Micr. Journ., v. (1884) pp. 82-3 (1 fig.).

to the right eye, according to the observer's custom of using either eye habitually or both in succession. It is equally applicable to stands whose construction does not admit of its being slipped over the tube from the top; the spring ring at the right of the figure being in such cases made partly open so as to spring on from the side.

Endomersion Objectives.*—Prof. K. W. Zenger claims to have found that perfect achromatism of telescope and Microscope objectives is possible by using a mixture of ethereal and fatty oils, the dispersive power of which for the different rays of the spectrum increases regularly. The disadvantages of the use of fluids are obviated by mixing with suitable salts of the fatty acid series by which nearly hard or gelatinous, vitreous, homogeneous, colourless, and transparent substances are obtained.

The following are extracts from two papers published by the author:—

The construction of achromatic objectives for telescopes, Microscopes, and photography has, from the beginning, presented great difficulties theoretically as well as practically. The dioptrical formulæ which give the equations for the achromatism and aplanatism of the objectives are so complicated that, up to the time of Fraunhofer and the younger Herschel, opticians were content with developing the conditions of achromatism and aplanatism in the axis. In this way, however, a perfect objective was theoretically not to be obtained, and therefore the best makers of that time were obliged to confine themselves to experimental trials.

Herschel and Fraunhofer first showed the way to a more accurate determination of the direction of the rays, and the former has given us a complete theory of telescope objectives, but for the much more difficult computation of Microscope objectives almost nothing has been done, and we to-day still look for a theory of these objectives.

The principal practical difficulty for all kinds of objectives lies in procuring suitable refracting media, because the flint and crown glass, hitherto exclusively used, deviate greatly from the conditions of perfect achromatism. Blair, at the end of the last century, showed the possibility of getting rid of all colour by the use of at least three refracting media, crown glass, oil of turpentine, and naphtha, which give contrary secondary spectra, the dispersive power of one being greater in the red, and of another in the violet part of the spectrum. In this way he succeeded in making an absolutely achromatic objective, the aperture of which was particularly large, namely, one-third of the focal length.

After Blair the matter was lost sight of until the second decade of the present century, when Barlow made an objective of crown glass and a biconcave lens filled with bisulphide of carbon on the dialytic principle. The achromatism of this was not, however, perfect, Blair's use of more than one fluid not having been attended to, and the question again fell into oblivion.

* SB. K. Böhm. Gesell. Wiss. Prag, 1881, pp. 479–92, 467–79 (reversed in order).

Prof. Zenger, in view of Blair's experiments, determined to see whether it would not be possible to find fluids which in combination with crown glass, would produce achromatic objectives. The conditions for absolute achromatism require that the partial dispersions should maintain the same relation in all parts of the spectrum for the two refracting media. Now mixtures of aromatic and fatty substances possess this property to a high degree of approximation, so that when combined as lenses with crown glass (a biconvex crown and a plano-concave fluid) all the different rays of the spectrum will be united and a perfection of achromatism will be produced not hitherto attained.

The question of course arises whether the fluids in consequence of striæ-formations, through rapid changes of temperature, may not originate a new element of optical imperfection. This is opposed to the author's experience of fluid achromatics in sunlight, either with the telescope or Microscope. He has succeeded in converting the ethereal and fatty oils which serve for the production of the refracting media, into the condition of vitreous bodies, or into a kind of gelatine in which striæ-formation is not as easily possible as in very mobile fluids.

By solutions of stearic, oleic, or palmitic acid, or mixtures of these, we can change benzol, castor-oil, poppy-oil and other similar ethereal and fatty oils into transparent gelatine, which is amorphous like glass, perfectly clear and does not flow out of the vessel if inverted. These substances are already used in the arts.

An immense scope for combination is thus opened in order, so to say, to produce kinds of glass of any desired refraction and dispersion, and consequently the optician is saved the trouble of undertaking changes of radius at great expense and loss of time. It is sufficient to make a suitable selection of the gelatine substance which is to be inclosed between a plane parallel plate and the biconvex lens, in order to solve the hitherto difficult problem of a perfect achromatic and aplanatic lens-combination.

The closing up of the fluid must be as hermetical as possible, in order to prevent any evaporation and chemical change in the course of time. There are ethereal and fatty oils which are transparent and very little changeable.

The problems as to lenses for telescopes, Microscopes, and photographic objectives are therefore, it is claimed, extraordinarily simplified through the use of "endomersion" objectives, which are thus named by the author in analogy with immersion objectives, because the fluid is between the lenses. On account of the fact that three radii are equal, while the fourth is infinitely great, he also calls them "symmetrical" endomersion objectives, a quality which embraces the most favourable conditions for brightness, sharpness, and flatness of field of view.

Formulæ and tables are given for the construction of endomersion objectives, and after considering more particularly the case of telescope objectives, those for the Microscope are dealt with, in which case the plane side of the concave fluid lens should be turned to the object.

Such an objective is then somewhat over-corrected, and thus exactly suited for a Microscope objective, because in the case of a single lens the over-correction can be removed by the Huyghenian ocular, while with doublets and triplets, the lens can be corrected or over-corrected to the desired amount, the residue being removed by the ocular as is commonly done by the Lister method.

When the necessary calculation for a given mean refractive and dispersive relation, such as from quartz to a fluid, is once made for a fixed large angle of aperture and a given thickness of the lens, it is easily seen what alterations a change in the refraction of the less refracting lens requires, according to the crown glass used, and we can correct the objective accordingly.

An objective, composed of three achromatics, whose curves were calculated for parallel rays (according to the formulæ and tables of the author) gave such satisfactory results that further detailed calculation is only required for exceptionally large angles of aperture.

The performance of a triplet of 8 mm. equivalent focus composed of three symmetrical endomersion lenses consisting of crown glass and a mixture of fatty and aromatic substances, gave perfect achromatism, for when achromatic eye-pieces (by Schröder) were used which magnified 9, 18, 36, and 72 times, there was even with the last, in bright lamplight and sunlight, scarcely a trace of colour on diatoms or on a Zeiss's silver grating, whilst all the objectives at hand * showed all the colours of the spectrum with such enormous eye-piece power.

With some of these objectives, however, the aplanatism was more perfect than others, which can probably be accounted for by slightly imperfect centering of the three lenses, and also by the defective quality of the plane-parallel plates, in place of which, later on, concave lenses of great focal length were used.

In direct light, with an angle of aperture of only 56°, all the more easy diatoms of Möller's plates were resolved, and of the more difficult the following:—*Rhabdonema arcuatum* and *R. adriaticum*, *Achnanthes subsessilis*, *Scoliopleura convexa* (the images appear black upon white).

With oblique light:—*Nitzschia circumsata*, *Navicula divergens*, *N. minor*, *Gomphonema geminatum*, *Melosira Borrerii*, *Symbolophora Trinitatis*, *Odontodiscus subtilis*, *Hyalodiscus stelliger*, and *H. subtilis* could not be quite resolved, as they were on the limits of the unresolvable with the aperture. *Grammatophora marina* and *Pleurosigma angulatum* were not resolved.

A double symmetrical endomersion objective, combined after the manner of Steinheil's "Symmetric Aplanaten," gave no trace of a difference of the chemical and visual foci, and therefore such an objective, which can be constructed from quartz and a very transparent fluid, is of practical importance for photography.

The usual contrivance is not necessary for obtaining sharp photographs of diatoms, which will even bear well a power of 30 times as

* Objectives by Schneider of Berlin, 1″ to $\frac{1}{9}$″ dry, and $\frac{1}{6}$–$\frac{1}{11}$, (*sic*) immersion, by Zeiss 1 *n* (A) and Hartnack, as well as Reichert of Vienna.

microscopic objects, furnishing the best proof of the coincidence of the optic and actinic foci. The eye-piece is removed and the camera placed in position, without having to make use in any way of coloured or subdued light for the illumination.

In an abstract* of Prof. Zenger's papers by G. Fischer, he expresses the apprehension that the unavoidable changes of temperature to which the lenses would necessarily be subject would be likely to impair their efficiency, and adheres to his own view that absolute achromatism will in all probability only be obtained by the discovery of more favourable kinds of glass.

Prof. Zenger subsequently wrote† to Herr Fischer that Merz's crown glass is still much wanting as regards refraction and dispersion; in his view crown and flint never give a rational dispersion, although flint containing different quantities of lead approximates to it. Incomparably better is the achromatism obtained by his fluid lenses, which are as much in advance of the best achromatics of the present time as these latter are in advance of the non-achromatics. The analogy of the eye, which formerly led to the discovery of partial achromatism, prompted him to try and obtain *absolute* achromatism by imitation of the gelatinous fluids of the eye, that is by mixing two, three, and four different fluids. In this he has succeeded; two or three fluids, oil and balsam mixed, give, compared with crown glass or quartz, quite rational spectra; that is constant ratio of the partial dispersions. A constant dispersion-quotient can be obtained for the whole length of the spectrum within 0·002 to 0·004, therefore much better achromatism than with the best of Merz's systems, in which the quotients differ from 0·004 to 0·026.

Finally he points out that the experiences of photography suffice to show how much the best productions of the first modern opticians fail in collecting all the rays to one focus. He, on the contrary, is able with his fluid system to obtain micro- and astrophotographs without the interposition of coloured glasses or adjustment-correction, just as if his lenses were mirrors; consequently, all rays, chemical and optical, are united in one focal point.

Prof. Safarik has pointed out‡ to Herr Fischer that whilst with Zenger's objectives perfect achromatism is undoubtedly almost attainable, yet it is very doubtful whether *aplanatism* (removal of spherical aberration) is also attainable. With Merz the diminution of the dispersion-relation necessarily entails a lengthening of the focus, the reverse of what opticians have hitherto striven to obtain. "Whether," adds Herr Fischer, "Zenger's system, the three-lens system (Merz's), the improved Herschel-Fraunhofer system with more perfect kinds of glass, Plössl-Littrow's, or an entirely new system, attains the desired end, this much may, I consider, be confidently expected, that sooner or later a considerable improvement of the achromatism, and with it of the optical capacity of the Microscope and telescope, will be assured. In conclusion, I gladly avail myself of the opportunity of bringing

* Central-Ztg. f. Optik u. Mech., iv. (1883) pp. 254–6.
† Ibid., p. 267.
‡ Ibid.

forward the opinion of so competent a judge as Dr. L. Dippel,* against that of Prof. Merkel, who has objected to Merz's object-glasses that they get dim from being too soft. Dr. Dippel writes: 'I have lately become more closely acquainted with Merz's objectives, 1/3, 1/9, 1/12, 1/18, and 1/24 in., and have convinced myself that the objection made to them by Prof. Merkel of their being affected by the air is not well founded.'"

Selection of a Series of Objectives.—At p. 449 (last line but one) a misprint occurs of 200° instead of 120° as in Dr. Carpenter's original text.

Correction-Adjustment for Homogeneous-Immersion Objectives.† —Dr. W. B. Carpenter's views on this somewhat vexed question are explained in his article "Microscope' in the 'Encyclopædia Britannica.'

After pointing out that with homogeneous-immersion objectives the microscopist can feel assured that he has such a view of his object as only the most perfect correction of an air-objective can afford, Dr. Carpenter continues as follows: "This is a matter of no small importance, for while in looking at a known object the practised microscopist can so adjust his air-objective to the thickness of its cover-glass as to bring out its best performance, he cannot be sure, in regard to an unknown object, what appearance it ought to present, and may be led by improper cover-correction to an erroneous conception of its structure.

"It has been recently argued that, as the slightest variation in the refractive index of either the immersion fluid or the cover-glass, a change of eye-pieces, or the least alteration in the length of the body—in a word, any circumstances differing in the slightest degree from those under which the objective was corrected—must affect the performance of homogeneous-immersion objectives of the highest class, they should still be made adjustable. The truth of this contention can, no doubt, be proved, not only theoretically, but practically, the introduction of the adjustment enabling an experienced manipulator to attain the highest degree of perfection in the exhibition of many mounted objects, which cannot be so well shown with objectives in fixed settings. But it may well be questioned whether it is likely to do the same service in the hands of an ordinary working histologist, and whether the scientific investigator will not find it preferable, when using these objectives, to accept what their maker has fixed as their point of best performance. The principal source of error in his employment of them lies in the thickness of the optical section of the object; for the rays proceeding from its deeper plane, having to pass through a medium intervening between that plane and the cover-glass, whose refractive and dispersive indices differ from those of the glass and immersion fluid, cannot be brought to so accurate a focus as those proceeding from the plane immediately beneath the cover-glass. The remedy for this, however, seems to be rather in

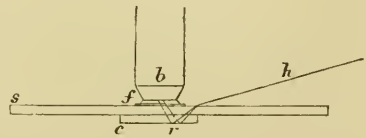
* 'Das Mikroskop,' 2nd ed., 1883, p. 460.

† Encyclopædia Britannica, 9th ed., xvi. (1883) p. 265.

making the preparation as thin as possible than in the introduction of what is likely, in any but the most skilful and experienced hands, to prove a new source of error. Every one who has examined muscular fibre, for example, under a dry objective of very high power and large aperture, well knows that so great an alteration is produced in its aspect by the slightest change in either the focal adjustment or the cover-correction that it is impossible to say with certainty what are the appearances which give the most correct optical expression of its structure. This being a matter of judgment on the part of each observer, it seems obvious that the nearest approach to a correct view will be probably given by the focal adjustment of the best homogeneous immersion-objectives, in fixed settings, to the plane of the preparation immediately beneath the cover-glass."

Lighton's Immersion Illuminator.*—This device of W. Lighton (fig. 101) consists of a small disk of silvered plate-glass *c*, about 1/8 in. thick, which is cemented by glycerin or some homogeneous-immersion medium to the under surface of the glass slide *s*, *r* being the silvered surface of the disk, *b* the immersion objective, and *f* the thin glass cover. The ray *h* from the mirror or condenser above the stage will enter the slide, and thence be refracted to the silvered surface of the illuminator *r*, whence it is reflected at a corresponding angle to the object in the focus of the objective. A shield to prevent unnecessary light from entering the objective can be made of any material at hand by taking a strip 1 in. long and 3/4 in. wide, and turning up one end. A hole of not more than 3/16 in. in diameter should be made at the angle. The shield should be placed on the upper surface of the slide so that the hole will cover the point where the light from the mirror enters the glass. "With this illuminator Möller's balsam test-plate is resolved with ease, with suitable objectives. Diatoms mounted dry are shown in a manner far surpassing that by the usual arrangement of mirror, particularly with large angle dry objectives."

Fig. 101.



Illumination by Daylight and Artificial Light—Paraboloids and Lieberkühns.†—E. M. Nelson finds daylight effective for low powers up to 2/3 in., and with condenser up to 1/6 in. Direct sunlight involves the use of a heliostat, otherwise the continued adjustment of the mirror is irksome. Where strong resolving power is needed, oblique pencils of sunlight from the heliostat outrival any other illumination; but much care is necessary not to injure the sight, and on the whole, he cannot recommend its general use except for photographing. Diffused daylight is too uncertain and too variable for accurate testing of objectives. It is not possible to get with diffused daylight the absolutely best image that an objective will produce.

* Amer. Mon. Micr. Journ., v. (1884) pp. 102-3 (1 fig.).
† Engl. Mech., xxxix. (1884) p. 48.

A really critical image could only be seen with artificial light, and with a good condenser and diaphragms. He does not mean to say that no good work can be done with diffused daylight, for excellent work is done with low or medium powers; but he insists that it is not possible to do any such critical work as testing objectives by daylight as thoroughly as it can be done by artificial light. With daylight and mirror only there is milkiness and "glaze." The milkiness can be got rid of by a diaphragm, and the "glaze" by using a ground glass behind the object. Unless a condenser is used there will always be found a falling off in the quality of the image with all powers higher than 2/3 in. From long experience in working with the Microscope, he feels justified in asserting that on the whole daylight is more trying to the sight than lamplight.

The oxy-hydrogen light may be serviceable for resolving such tests as Nobert's lines, but the incandescence lamp he regards as entirely a failure for microscopical purposes. "This is at once obvious upon the consideration that the finest images seen are got by viewing objects, as it were, *in the image of the source of light.* All critical images of transparent objects viewed by direct transmitted light require first that the source of light should be pictured by the condenser exactly in the plane of the object, the object then serves to interrupt the image of the source of light. The observer has simply to arrange the lamp, condenser, and diaphragms so as to produce the most perfect image of the source of light of the required size in the plane of the object, the objective will then have fair play. The size of the image of the lamp flame can be controlled by distancing the lamp. There is no other secret in the matter. With the incandescent lamp the image produced by the condenser represents the mere carbon thread, on which no object could be seen projected; in order to obtain some extent of brightly luminous field, the condenser must be put out of focus, then the intensity of the light is so reduced that the observer would simply discard the incandescence, finding it far less serviceable than a shilling paraffin lamp."

He entirely condemns the use of paraboloids for dark-ground illumination, as properly adjusted central stops with the condenser will give by far the best dark-ground illumination. For opaque objects he considers nothing has been devised so good as Lieberkühns, and objects ought as far as practicable to be mounted for use with Lieberkühns, and not covered up with paper. If the side illuminator is used it should be attached to a fixed part of the stand, not to the body-tube or stage.

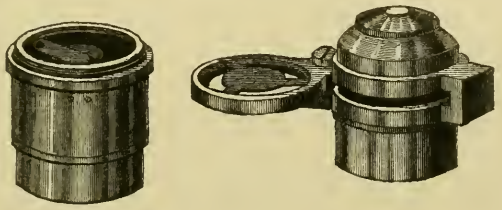
With the preceding remarks may be contrasted the view of Prof. Abbe (*in litt.*) that it is quite immaterial, from a theoretical point of view, whether an illuminator has or has not spherical aberration. The effect of illumination does not depend upon the projection of a *sharp image* of the source of light upon the object, nor even on the projection of any image at all. The only object of projecting an image of the source of light *approximately* at the plane of the object is in order that a uniform illumination of a given area

of the object (the field of vision) may be obtained by means of a small source of light. This object is attained notwithstanding considerable aberrations, and it is the better obtained the greater the focal length of the illuminating system. A lens of 3/4 in. curvature is therefore less advantageous than one of 1 in.

The general view of English microscopists is undoubtedly in favour of the superiority of an achromatic condenser over any non-achromatic arrangement. With the latter, confused pencils of light are produced by the spherical aberration, which seriously impair the images of fine structures, whilst with the former, "the most delicate objects are seen with a clearness and sharpness of detail quite unknown to those microscopists whose experience has been confined to the use of non-achromatic condensers." *

Bausch's New Condenser.†—E. Bausch describes a new condenser (figs. 102 and 103), similar to that of Prof. Abbe, the formula upon

Fig. 102. Fig. 103.



which it is constructed being, however, a modification of that used in Bausch's Immersion Illuminator. The posterior system is as large as the substage-ring will allow, and will transmit and condense all the rays which pass through this from the mirror. Its numerical aperture is about 1·42.

There are two styles of mounting, fig. 103 shows the substage adapter and condenser with a swinging diaphragm ring between them. This ring receives the various stops, which may be changed without disturbing the condenser. Fig. 102 is intended to give the different degrees of oblique illumination, from central to that of the utmost possible limit. It is provided with a circular opening, 1/4 in. in diameter, which may be decreased if desired, and which is caused to move slowly from the centre to the edge of the mounting by turning the outside milled edge.

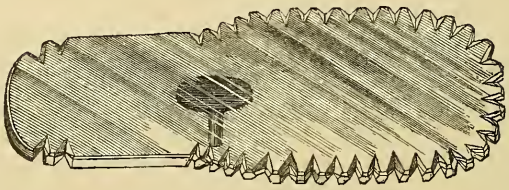
Both of these mountings are adapted to substages attached either to the substage bar, or fixed to the bottom of the stage. The condenser is also furnished with plain substage adapter only.

Glass Frog-plate.—This (fig. 104, designer unknown) is a simplification of the ordinary frog-plate. The general form of the

* Swift's 'The Microscope,' 1883, p. 43.
† The Microscope, iv. (1884) pp. 105-6 (2 figs.).

old brass plates is retained, but in place of brass glass is used, the edges of which are serrated for the string. The brass pin is at

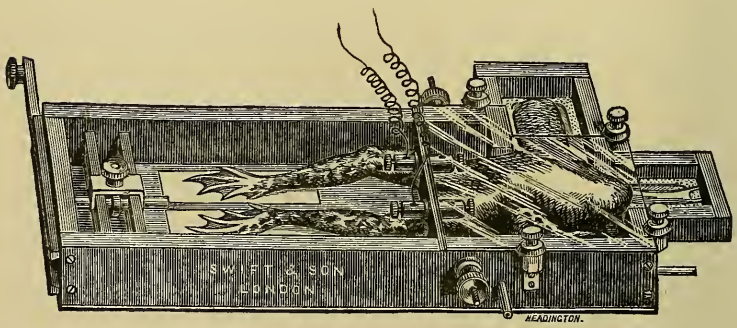
Fig. 104.



present only cemented to the plate; it would be better if it passed through it.

Groves and Cash's Frog-trough for Microscopical and Physiological Observations.—Some years since Mr. J. W. Groves devised a simple guttapercha trough, in which circulation in the webs of frogs could be observed for a considerable time without the web becoming dry. This was effected by keeping the feet of the frog entirely covered with water, into which the objective (protected by a watertight cap closed below by a piece of thin glass) could be lowered after the fashion of Mr. Stephenson's submersion objective. This contrivance he and Dr. Theodore Cash have considerably improved. The trough (fig. 105) is long enough to admit a full-sized frog; in

Fig. 105.



the bottom, which is lined with cork, are two windows of glass, through which light may be transmitted to the webs of the feet. At the anterior end is a projection, with a cork bottom and glass window for the examination of the tongue, and another similar projection at the side for the observation of the mesentery or lungs. The trough is made of vulcanite, and is watertight, but at the posterior end is a sliding piece by which that end can be opened and a thread passed through to the lever of a myograph. In convenient situations are binding screws for the connection of wires from a coil or battery.

Either or both of the projecting portions of the trough can be shut off from the main receptacle by sliding hatches (not shown in the fig.) if necessary, and the part containing the body of the frog can be covered with glass or a vulcanite lid. Should it be desired to observe the effect of gases or of heat or cold, the required gases or warm or cool air may be conducted through the body chamber by means of the two small tubes seen projecting from the front and sides respectively.

The frog to be observed is placed either ventrally or dorsally as may be required, and is held by means of loops of thread passed round the arms and then led through screw-eyes and clamped up. The thighs are held by a pair of stocks, which, by means of a sliding upper half, can be adjusted accurately to the limbs without causing constriction; and the webs are spread out by pinning loops of thread tied to the toes.

Visibility of Ruled Lines.*—C. Fasoldt writes, in regard to the note by Professor W. A. Rogers, which appears at p. 439 of vol. iii. (1883), that "there are some statements which do not agree with my experience. I find that lines properly ruled on glass are similar to graven lines; they are smooth, clean cut, having a definite shape and depth. Such lines are always visible in the Microscope, and central or oblique light will show the bottom of each cut as a dark or coloured line, plainly visible, and requiring no graphite or other foreign substance to indicate it. The Microscope is the test for a properly ruled line. The mechanical elements (pressure, &c.) entering into the process of ruling are not at all evidences that lines have been properly ruled. The slightest accident to the point of the cutter, or the surface of the glass not being perfectly clean, will spoil a line; that is, produce a scratch which cannot be satisfactorily illuminated in any light. Well-ruled bands of lines, 70,000 or 80,000 to the inch, are visible in the Microscope with central light; and with a Smith vertical illuminator (giving central light), I have seen 100,000 lines to the inch. As these individual lines have a width of about 1/200,000 of an inch only, it follows that the difficulty is not to see such a narrow line, but to eliminate the diffractions which tend to blur the image in the Microscope, and so prevent the resolution or separation of the lines in a band of them."

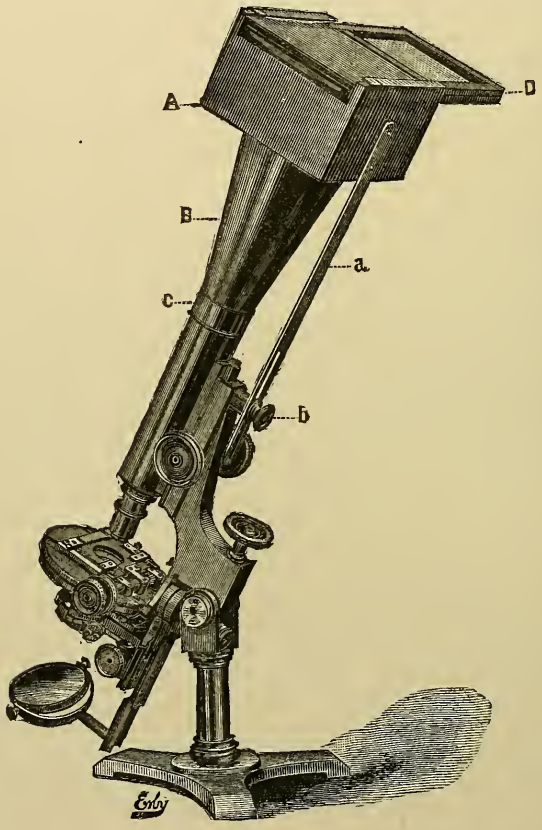
Mercer's Photomicrographic Camera.†—Dr. F. W. Mercer has devised the camera shown in fig. 106. It consists of a box of light wood A, a cone of light metal B, a tube which takes the place of the ordinary draw-tube of the Microscope, C, and the frame carrying the ground glass and plate-holder, D. The tube C is fitted to the cone B, so that it may be withdrawn for the insertion of an eye-piece or amplifier. To the box A is attached a brass strap *a*, the lower end being slotted to admit the passage of a binding screw secured to a button *b*, fastened to the arm of the stand. As soon as the object is coarsely focused upon the ground glass the cone and its tube are

* Scientific American, xlviii. (1883) p. 341.

† 'Photography' (Chicago), i. (1881) pp. 9–10 (1 fig.).

raised slightly, say about a quarter of an inch from the body of the Microscope, and the binding screw is then tightened, securing the weight of the camera, &c., upon the arm of the instrument, thus removing any undue pressure upon the rack and pinion, or fine movement of the tube, during future manipulation. The fine focusing

Fig. 106.



when completed leaves nothing to be done but to push the ground-glass frame on till it is replaced by the plate-holder, when the picture may be made.

The features claimed for this apparatus are: "Its great portability, measuring when the draw-tube has been removed from the cone, $4\frac{1}{4} \times 4\frac{1}{4} \times 9$ in.; its ready application to the Microscope in any position from the vertical to the horizontal, requiring but a few minutes for its adjustment without changing the position or light, at least for moderate powers; its special fitness for the amateur, being

moderate in first cost and inexpensive in use from the size of the plate used. Though the plate is small, $3\frac{1}{4} \times 4$ in. (lantern size), it is very useful and will meet most of the needs of the amateur workers for whose convenience the instrument is intended.

There is a class of work of which this little camera is incapable, and in introducing it to the notice of microscopists, it is not intended to convey the impression that it will supersede other means where skilled hands and elaborate apparatus are absolutely necessary. To those who have but an hour or two of an evening for observation with the Microscope, this camera may prove of service in securing a photograph quickly at the work-table.

The box above the cone might be dispensed with, and the slide carrying the ground glass attached directly to the large end of the cone. The advantage in having the box is the shutter, which may be fitted to its interior for excluding light from the plate at the moment of completing the exposure, a preferable means to that of placing a piece of black paper between the objective and the source of light. Instead of having the ground glass and plate-carrier in one frame, it might be desirable for some to have them separate, having more than one plate-holder. The apparatus can at a trifling cost be attached to most stands, and when properly made should not exceed, including ground glass and plate-holder, seven or eight ounces in weight."

Photographing Bacillus tuberculosis.*—M. Defrenne describes the process which he adopts to photograph this *Bacillus* with a Tolles' 1/10 in. (hom. imm.), without eye-piece, using extra rapid bromo-gelatine plates, developed with ferro-oxalate, a petroleum lamp being employed for illumination.

If, he says, the determination of the actinic focus of objectives constitutes, so to say, the chief difficulty in photographing ordinary microscopic preparations, it is no longer so when we deal with organisms so infinitesimally small as the bacilli of tuberculosis. Here arises a difficulty of quite another kind, which at first seemed insurmountable: the staining of the bacilli by means of fuchsin. This agent, even when it is employed in thick layers, is somewhat actinic, and it becomes the more so as the object stained is smaller or more transparent. These two circumstances are combined in the highest degree in the organisms in question. Thus at the beginning the plates exposed were either uniformly acted on or the image was so faint and so little differentiated after development that they were worthless for proofs on glass or on paper.

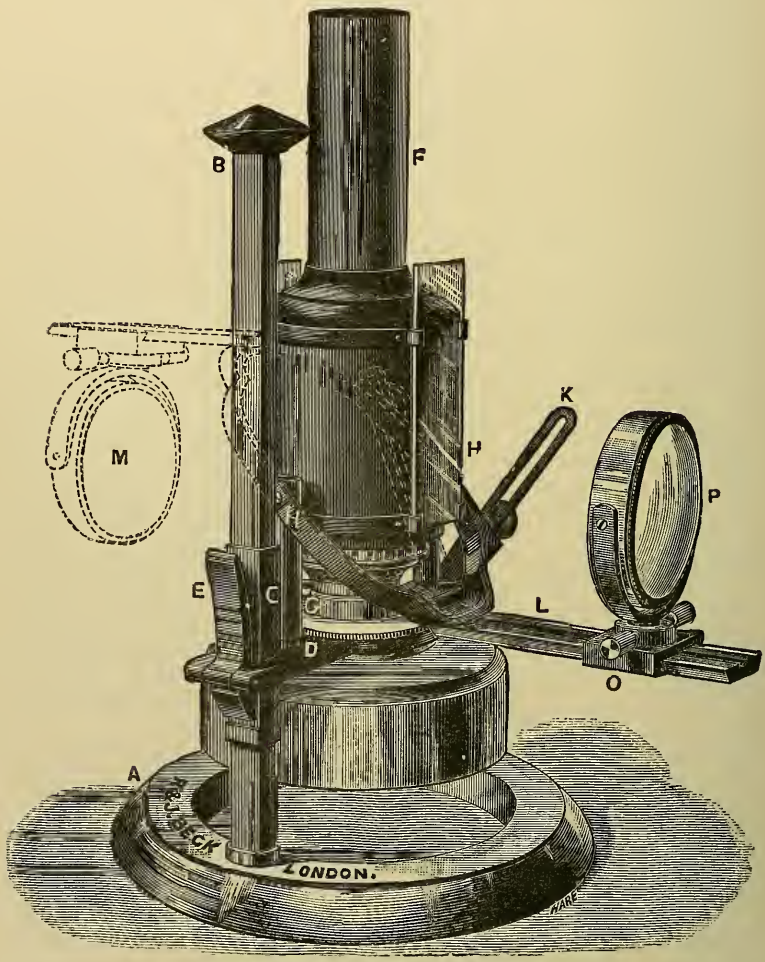
These negative results suggested the abandonment of the attempt, when the idea was suggested of having recourse to the use of a *compensating glass* of a colour complementary to red (that is green), placed between the objective and the sensitized plate. By thus filtering the image formed by the objective, the red rays, the only ones passing through the bacilli, are absorbed, if not wholly, at least in great part. The microbes therefore appear nearly black on the plate, and make

* Bull. Soc. Belg. Micr., x. (1884) pp. 128–32.

a much slower impression than the rest of the preparation, which gives free passage to all the green rays. More contrast is thus obtained and a very distinct photograph produced.

Beck's "Complete" Lamp.—For pathological and physiological investigation, as also for many other branches of microscopical

Fig. 107.



research, a lamp more delicate in its adjustments and giving a greater control over the light than those ordinarily in use is requisite, and Messrs. Beck have therefore constructed a lamp whereby more

perfect illumination of both opaque and transparent objects can be obtained.

The base A (fig. 107) consists of a heavy ring, into which a square brass rod B is screwed. The square rod carries a socket C with an arm D, to which the lamp is attached. This socket fits the square rod loosely, but is kept in any position by a lever E, which is pressed firmly against the square rod by a strong spring. If the lever and the opposite side of the socket are taken between the thumb and finger, the pressure of the lever on the bar is removed, and the lamp can be raised or lowered to the desired position, when by releasing the hold the lamp is at once clamped.

On each side of the burner, and attached to the arm D, is an upright rod G, to one of which the chimney is fixed, independent of the reservoir of the lamp, but fitting closely over the burner, thus enabling the observer to revolve the burner and reservoir, and obtain either a thin intense light or a broad and diffused one, without altering the position of the chimney. The chimney F is made of thin brass, with two openings opposite to each other, into which slide 3×1 glass slips of either white, blue, or opal glass, the latter serving as a reflector.

The reservoir, although holding enough oil to burn for several hours, is made very flat, and drops into the annular base, thereby bringing the flame of the lamp within 3 inches of the table, rendering it much more serviceable for direct illumination (without the mirror) and for other purposes.

A semicircle swings from the two uprights G, to which it is attached by the pins H, placed level with the middle of the flame; to this semicircle is fixed a dovetailed bar L, carrying a sliding fitting O, which bears a Herschel condenser P.

This condenser, swinging with the middle of the flame as a centre, is always at the same distance from it; and thus, when once focused, needs no further alteration for any change in the inclination of the beam of light. The condenser is fixed at any inclination by a milled head working in a slotted piece of brass K, fixed to the arm D.

When used for transparent illumination, the condenser is not required below the horizontal position; but when the lamp is required for the illumination of opaque objects, the chimney having been temporarily removed and the milled head fixing the condenser arm having been loosened, the arm with the condenser can be thrown over the lamp, as shown in the illustration at M, and the chimney being replaced, the light, which now comes through the opposite opening of the chimney, can be condensed at a large angle below the horizontal.

James' 'Aids to Practical Physiology.'*—It is beyond our comprehension how this extraordinary book could ever have been written by an author entitled to add M.R.C.S. to his name, or published as a volume of 'Students' Aids Series' by such publishers as those whose

* J. Brindley James, M.R.C.S., 'Aids to Practical Physiology,' 8vo, London (Baillière, Tindall, & Cox), 1884, viii. and 60 pp.

names are attached to the title-page, which moreover bears the motto "Mens sana in corpore sano." That we do not criticize it without reason will be seen by the following extract which is prefaced by the statement that it contains a "few practical hints which we trust may "powerfully tend to facilitate the young experimentalist's labours." (The italics are ours.)

"The Microscrope (sic).—You cannot expect to get one of any valuable power (!) under five guineas. It should be of two powers, enabling you to use inch and quarter-inch glasses (!) The hole in the stage should have its *axis diametrically consistent (!) with that of the tube* of the instrument. *A stand is also needed* (!!) Object-glasses, denoted as one-fourth, one-fifth, one-sixth, are used for high powers, *one-half to two-fifths* (!) for low. An oil-immersion lens is now-a-days a necessary complement, and should be about one-twelfth. The simpler it is the better for a beginner (!) The same may be said of the eye-piece (!!) With respect to such other adjuncts as achromatic condensers, special stands, &c., these concern the accomplished microscopist rather than the tyro."

As it was obvious that the author was not at home in the optical branch of his subject, we turned to the description of a piece of apparatus with which the practical physiologist should necessarily be intimately acquainted—the Microtome. Will it be believed that it is described not as an instrument for cutting sections, but for freezing specimens! The author's own words are as follows: "The Micro-"tome. This useful device for freezing specimens is susceptible of "various forms of construction."

After these extracts it is superfluous to refer to the other minor blunders which disfigure the book, such as the description of Dr. Klein as "Kleän," the indiscriminate use of "bichromate of potash," "potass" and "potassium," and "potassic bichromate" for the same substance.

Postal Microscopical Society.—This society is now forming a section specially devoted to members of the medical profession (including students).

"A President."—Suggestion for making the 'Journal of Microscopy' the Journal of provincial and other Microscopical Societies.
Journ. of Micr., III. (1884) pp. 194–5.

"Amateur."—Bacteria and the Microscope.
[Elementary Inquiries.] *Engl. Mech.*, XXXIX. (1884) pp. 465–6.

American Society of Microscopists, Session of 1884.—Circulars of President J. D. Cox, and E. H. Griffith. *Micr. Bull.*, I. (1884) pp. 25 and 28.
Amer. Mon. Micr. Journ., V. (1884) pp. 117–8.
The Microscope, IV. (1884) p. 133.

Belfield, W. T.—Photo-micrography in Legal Cases. [*Post.*]
Photography (Chicago), I. (1884) pp. 54–9 (7 figs.).

Bradbury, W.—Papers relative to the theory of the Object-glass.
[Note introducing paper by Dr. C. S. Hastings, from 'Amer. Journ. Sci.,' detailing the method used by him to determine the optical properties of various kinds of glass and the alterations in the properties when the glass was subjected to different temperatures.]
Engl. Mech., XXXIX. (1884) pp. 420–1.

Bulloch, W. H.—The Congress Nose-piece.
[Further rejoinder to Prof. McCalla's claim of priority.]
Amer. Mon. Micr. Journ., V. (1884) pp. 119–20.

Carnoy, J. B.—La Biologie Cellulaire. Etude comparée de la cellule dans les deux Règnes. (Cellular Biology; a comparative study of the cell in the two kingdoms.) Fasc. I. 271 pp. and 141 figs. 8vo, Lierre, 1884.
[Part I. Microscopical Technics (pp. 37–167, 24 figs.). 1. On instruments and the laboratory of the microscopist or cytologist. 2. On objects and their preparation. 3. On the method to be followed in microscopical observations and cytological researches.]

Carpenter, W. B.—Article "Microscope" in the 'Encyclopædia Britannica,' 9th ed., XVI. 4to, Edinburgh, 1883. [*Cf. ante*, pp. 448 and 620.]

Cox, J. D.—See American.

,, ,, Photographs showing the structure of Diatom shells.
Amer. Mon. Micr. Journ., V. (1884) p. 112.

D., E. T.—Graphic Microscopy. VI. Pupa of Locust, one day old. VII. Cluster Cups: *Æcidium quadrifidum*.
Sci.-Gossip, 1884, pp. 121–2 (1 pl.), 145–6 (1 pl.).

Defrenne.—Présentation d'une Microphotographie du *Bacillus tuberculosis*. (Exhibition of a photomicrograph of *Bacillus tuberculosis*.) With remarks by E. van Ermengem. [*Supra*, p. 627.]
Bull. Soc. Belg. Micr., X. (1884) pp. 128–32.

Dudley, Prof.—Microscopic Photography:
[Response to a toast.] *Photography* (Chicago), I. (1884) pp. 71–2.

Ermengem, E.—See Defrenne.

F.R.A.S.—Optical Recreations.
[Containing a note on the convex lens used as a magnifying glass.]
Knowledge, VI. (1884) pp. 46–7 (4 figs.).

Francotte, P.—Aspirateurs pour tenir constamment saturée d'air l'eau des récipients où l'on observe les animaux et les plantes aquatiques. (Aspirators for keeping saturated with air the water of receptacles for observing aquatic animals and plants.) [*Post.*] *Bull. Soc. Belg. Micr.*, X. (1884) pp. 141–3.

Giant Electric Microscope.
[Criticism of its defects.] *Journ. of Sci.*, VI. (1884) p. 370.

Gill, D.—Article "Micrometer" in 'Encyclopædia Britannica,' 9th ed., XVI., p. 248. 4to, Edinburgh, 1883.
[Contains "How to web a filar micrometer." *Post.*]

Gowen, F. H.—Resolution of *Amphipleura*.
[Direct sunlight above the stage. "The Microscope should be so placed that the light may fall on the circumference of the stratum of immersion fluid obliquely to the upper surface of the slide, and care should be taken to have one end of the frustule point towards the sun."]
Amer. Mon. Micr. Journ., V. (1884) p. 118.

,, ,, Resolution by Central Light.
[Resolution of *A. pellucida* in balsam by sunlight with the mirror in a strictly central position. "The resolution was effected by light reflected within the slide from one of its convex edges, and that instead of being central the light was very oblique."]
Amer. Mon. Micr. Journ., V. (1884) pp. 118–9.

Griffith, E. H.—See American.

Hardy, J. D.—Microscopical drawing.
[Report of demonstration.] *Journ. Quek. Micr. Club*, I. (1884) pp. 360–1.

Hastings, C. S.—See Bradbury, W.

Hazlewood, F. T.—A home-made revolving table.
["I got a second-hand sewing-machine table . . . Then I took another table-top which was raised about 2 in. from the other by a moulding. On the top of the first table I put a piece of pine board 1 in. thick. Into this I put three small castors upside down. I bored three holes in the top of the other table, on radii, from a common centre. Then I put top No. 2 over top No. 1, so that the castors came over the surface about 1/4 in.

Through the centre of both tables I bored another hole. Then I took a steel saw-plate into which the teeth had not been cut. I had a hole bored in its centre, and two brass handles or pins put in opposite each other near the circumference. This plate is fastened by a pin with nuts on the table over the three castors. The table is perfect. I painted the steel plate. The drawer of the first table on the side serves for accessories. The whole thing cost less than five dollars. The finished table looks as though made for this purpose, and not for a sewing-machine."]

Amer. Mon. Micr. Journ., V. (1884) p. 94.

Herrick, S. B.—The Wonders of Plant Life under the Microscope. 248 pp. and 85 figs. 8vo, London, 1884.

Hertwig, O. — Die Verwendung des Sciopticons als eines Anatomischen Unterrichtsmittels. (The employment of the Sciopticon for anatomical instruction.)

[Exhibition of glass photograms and sections.]

SB. Jenaisch. Gesell. Med. & Naturwiss., 1883, p. 17.

Heurck, H. Van—[Protest against the review of his "Lumière électrique," by Stein, in 'Zeitschr. f. Wiss. Mikr.']

Journ. de Microgr., VIII. (1884) pp. 273–7.

Hitchcock, R.—The Postal Microscopical Club.

[Exhortation to put better slides in the boxes.]

Amer. Mon. Micr. Journ., V. (1884) pp. 113–4.

James, F. L.—The St. Louis Microscopical Society.

[Notification of its formation.] *The Microscope*, IV. (1884) pp. 129–30.

James, J. B.—Aids to Practical Physiology. viii. and 60 pp. 8vo, London, 1884. [*Supra*, p. 629.]

Lighton, W.—Immersion Illuminator. [*Supra*, p. 621.]

Amer. Mon. Micr. Journ., V. (1884) pp. 102–3 (1 fig.).

Möbius, K.—Rathschläge für den Bau und die innere Einrichtung zoologischer Museen. (Advice on the construction and internal arrangement of Zoological Museums.)

[Contains a reference to the "Microscopirzimmer."]

Zool. Anzeig., VII. (1884) pp. 378–83.

Müller, P.—Insectenfänger mit Lupe. (Insect-catcher with lens. *Post.*) German Patent No. 25,806, 6th June, 1883. See *Zeitschr. f. Instrumentenk.*, IV. (1884) pp. 259 (1 fig.).

Nelson, E. M.—How to Work with the Microscope.

[Report of demonstration. See *ante*, pp. 447 and 464. The view originally expressed as to the decided preference to be given to the Ross form over the Jackson is modified. "In point of steadiness he did not think there was much to choose between them in first-class stands."]

Journ. Quek. Micr. Club, I. (1884) pp. 375–9.

" " The Health Exhibition.

[Description of Microscopes, Apparatus, &c., exhibited.]

Engl. Mech., XXXIX. (1884) pp. 437–9.

Rogers, W. A.—On a practical solution of the perfect screw problem.

[Describes the method by which it is claimed a perfect screw can be made on a common lathe, including a Microscope provided with Tolles' opaque illuminator attached to the carriage moved by the leading screw of the lathe.]

Engl. Mech., XXXIX. (1884) pp. 341–2.

Royal Microscopical Society: Notes as to the admission of ladies and rearrangement of the Cabinet. *Journ. of Sci.*, VI. (1884) p. 437.

Schneider, E.—Ueber eine Justirvorrichtung an einem Krystallgoniometer. (On an adjusting arrangement for a Crystal Goniometer.)

[Differential screw.]

Zeitschr. f. Instrumentenk., IV. (1884) pp. 242–4 (1 fig.).

Stein, S. T.—Das Mikroskop und die mikrographische Technik zum Zwecke photographischer Darstellung. (The Microscope and Microscopical Technic in Photographic representation.) Part II. of 'Das Licht im Dienste wissenschaftlicher Forschung,' 2nd ed., pp. i.–ix. and 151–322, figs. 168–302, pls. iii–vi. 8vo, Halle a. S., 1884.

Stowell, C. H.—Rochester meeting [of American Society of Microscopists]. *The Microscope*, IV. (1884) pp. 131–2.

Strasburger, E.—Das botanische Practicum. Anleitung zum Selbststudium der mikroskopischen Botanik für Anfänger und Fortgeschrittnen. (Practical Botany. Guide to the study of microscopical Botany for beginners and advanced students.) xxxvi. and 664 pp., and 182 figs. 8vo, Jena, 1884.

Talbot, R.—Das Scioptikon, Vervollkommneter Projectionsapparat für den Unterricht. 7th ed., vi. and 82 pp. 8vo, Berlin, 1884.
[Mainly a Catalogue of Photograms and microscopical preparations.]

Thurston, E.—The Microscope: its Construction and Manipulation. *Micr. News*, IV. (1884) pp. 150–2.

Waters, W. H.—Histological Notes for the use of Medical Students. vi. and 65 pp. 8vo, Manchester and London, 1884.
[The body-tube of the Microscope is (not aptly) styled the "telescope-tube"! and the concave mirror the "curved mirror."]

Wenham Button.
[To keep the Wenham button or the common hemispherical lens in position while examining temporary mounts, fix it with glycerin or immersion fluid to that surface of a slide on which has been turned a wax or an asphalt ring, the internal diameter of which corresponds to the diameter of the lens. Invert the slide, and it is ready for use.]
The Microscope, IV. (1884) p. 134.

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

Methods of Investigating Animal Cells.*—Dr. A. Brass has devoted several years of close study to the structure and life of animal cells, and gives a detailed account of his methods. The following are some of the more important of these methods:—

1. *Protozoa.*—As most Protozoa move very rapidly when hungry, it is well to feed them before attempting to study them with the Microscope. If well fed with powdered pieces of plants, &c., they usually remain quiet after a short time, and begin to assimilate the food-material which they have appropriated. In this condition of comparative quiet they can be easily examined with high powers. For this purpose they may be placed under a cover-glass with a considerable quantity of water and a number of small green algæ to keep the water supplied with oxygen.

For higher powers Abbe's illuminating apparatus is extremely useful. In some cases it is desirable to have a completely one-sided illumination, and this is best effected by inserting beneath the illuminating apparatus a circular diaphragm-plate perforated with a slit 3 mm. wide that runs parallel to the edge of the plate. It is best to leave about 2 mm. between the slit and the edge of the

* Zeitschr. f. Wiss. Mikr., i. (1884) pp. 39–51. Cf. Amer. Natural., xviii. (1884) pp. 650–1.

plate. Several diaphragm-plates should be prepared in which the slit varies in extent from a half to a whole of a quadrant or more.

The following mixture, which is Meckel's fluid with the addition of a little acetic acid, is recommended above all other reagents as a preservative medium:

Chromic acid	1 part.
Platinum chloride	1 „
Acetic acid	1 „
Water	400–1000 parts.

Unicellular animals die very slowly in this mixture, and suffer very much less alteration in structure than when killed in osmic acid or picro-sulphuric acid.

A special method is required for Protozoa filled with opaque food-material. In many cases the nucleus and the structure of the cell-body are completely obscured by foreign bodies. The method adopted in such cases is as follows:—

(1) Placed in picro-sulphuric acid 3–4 minutes.

(2) Transferred to boiling hot water for a short time.

(3) Placed in water and a little ammonia added; this causes the contracted object to swell up to its original size and form.

(4) Neutralize the ammonia with a little acetic acid, and then

(5) Colour with borax-carmine or ammonia-carmine.

(6) Wash and examine in dilute glycerin.

The picro-sulphuric acid destroys the nutritive material; the ammonia dissolves any particles of fat that may be present; and thus the object becomes transparent as far as possible.

A concentrated solution of corrosive sublimate may also be used with success for killing Protozoa; but care must be taken to wash thoroughly.

Dr. Brass has obtained his best results without reagents or dyes.

Born's Method of Reconstructing Objects from Microscopic Sections.*—Dr. G. Born describes in detail a very ingenious method of constructing models of objects from serial sections. By the aid of the camera the outlines of the sections are transferred to wax plates, which are then cut out so as to correspond in outlines as well as dimensions to the sections equally magnified in all three directions. With plates thus prepared, it is only necessary to put them together in the proper order to obtain a complete model. The method is simple and extremely useful, especially in investigating objects with complex internal cavities. Born has made use of the method in studying different parts of the vertebrate head; Swirski, in elucidating the development of the shoulder-girdle of the pike; Stöhr, in tracing the development of the skull of Amphibia and Teleostei; and Uskow, in studying the development of the body-cavity, the diaphragm, &c.

* Arch. f. Mikr. Anat., xxii. (1883) pp. 584–99. Cf. Science, ii. (1883) p. 802, and Amer. Natural., xviii. (1884) pp. 446–8.

Born makes use of three rectangular tin boxes of equal sizes, each measuring 270 mm. × 230 mm. × 2½ mm. Sections should be made about 1/25 mm. thick (never thinner than 1/50 mm.). If we desire to construct a model of an object from serial sections 1/30 mm. thick, which shall be magnified 60 diameters, then the wax plates must be made 60 times as thick as the sections, i. e. 2 mm. thick.

The surface of a plate that could be made in a box of the above-named dimensions, contains 62,100 sq. mm.; and the volume of such a plate 2 mm. thick would therefore be 124·2 c.cm. The specific gravity of common raw beeswax amounts to ·96–·97. For use, it requires only to be melted and a little turpentine added to make it more flexible. Thus prepared, its specific gravity is about ·95; and this number has been found sufficiently accurate in all cases. The weight of the wax required to make one plate of the above size, will accordingly be 117·99 gr., or, in round numbers, 118 gr. The wax having been weighed and melted, the tin box is first filled 1½ cm. deep with boiling water, and then the melted wax poured upon the water. If the water and the wax are quite hot, the wax will generally spread evenly over the surface; if gaps remain, they can be filled out by the aid of a glass slide drawn over the wax. As soon as the plate has stiffened, and while it is still soft, it is well to cut it free from the walls of the tin box, as further cooling of the water and the box might cause it to split. By the time the water becomes tepid, the plate can be removed from the water to some flat support, and left till completely stiffened. Half a hundred plates may thus be prepared in the course of a few hours.

The outlines of the section are transferred to the plate in the following manner: a piece of blue paper is placed on the plate with the blue side turned towards the wax, and above this is placed a sheet of ordinary drawing paper. The outlines are drawn on the latter by the aid of a camera, and at the same time blue outlines are traced on the wax plate. The plate can then be laid on soft wood and cut out by the aid of a small knife. Thus a drawing and a model of each section are prepared. The plates thus prepared can be put together in the proper order, and fastened by the aid of a hot spatula applied to the edges.

Shrinking Back of Legs of Oribatidæ in Mounting.*—A. D. Michael suggests a mode of getting over the difficulty of the shrinking back, during the process of mounting, of the legs of species of *Oribata* and other genera which have special cavities for the reception of the legs. The process requires careful manipulation, but if well done is very successful. Place a very thin layer of balsam upon the slide upon which the specimen is to be soaked in oil of cloves; when this layer becomes sticky the specimen is placed upon it, dorsal surface downwards. The mounter must then extend the legs and stick them to the balsam, if they rise up they should be pressed down again with a hair; when they are all fast the body should be brushed over with the smallest possible quantity of oil of cloves to prevent its drying,

* 'British Oribatidæ' (Ray Society) 1884, pp. 104–5.

but without touching the legs. This brushing with oil of cloves must be repeated from time to time as it sinks into the body. When a creature is ready, which can only be learned by experience, a large drop of oil of cloves, not benzole, may be put on; when this has *thoroughly* dissolved the balsam, but not before, the specimen may be moved and mounted, or further soaked in oil of cloves.

Preparing the Liver of the Crustacea.*—For the study of fresh tissues J. Frenzel places a small piece of the organ on the slide, *in the blood of the individual from which it was taken;* or, *in sea-water diluted until the salt contained amounts to about* 1½–2 *per cent.* (one part distilled water and one part sea-water from the Bay of Naples). The so-called "physiological salt-solution" (3/4 per cent.) worked unfavourably, causing maceration.

Various fluids were employed for killing and hardening, partly for determining the effect of different reagents on the nuclei and the protoplasm, and partly for finding the best means of preparing the object for sectioning.

Very good preparations were obtained with *warm* alcohol from 70–90 per cent.; while direct immersion in absolute alcohol did not prove advantageous. This treatment gave good results for the cell-protoplasm, but destroyed the structure of the nuclei. Still better results were obtained for the cells (not for the nuclei) by adding a few drops of iodine to 70 per cent. alcohol.

The most satisfactory results were reached by immersing the object in a saturated aqueous solution of corrosive sublimate from ten to thirty minutes, then washing with water, and finally replacing the water gradually with alcohol.

Perenyi's fluid gave best results when combined with corrosive sublimate. The object was left from five to ten minutes in the first-named fluid, then transferred to the second and left for the same time.

While these methods were good for the Decapods, Amphipods, and Phronimidæ, the Isopods required a different treatment. With these, Kleinenberg's picro-sulphuric acid, diluted with an equal volume of water, and allowed to act 15–20 minutes, gave much better preparations than the sublimate solution.

Preparing Alcyonaria.†—In studying the mesenterial filaments of the Alcyonaria, E. B. Wilson obtained the best results in the following manner.

The animals were suddenly killed by momentary immersion in a mixture of 1 part strong acetic acid and 2 parts of a concentrated solution of corrosive sublimate in fresh water. After being quickly washed, they were transferred to a concentrated solution of sublimate in fresh water and left two or three hours; the internal cavities being injected with the solution, where this was possible. They were then thoroughly washed in running sea-water, then in distilled

* MT. Zool. Stat. Neapel, v. (1884) p. 51. Amer. Natural., xviii. (1884) pp. 556–7.

† MT. Zool. Stat. Neapel, v. (1884) p. 3.

water, and finally preserved in successive grades of alcohol. A weak solution of iodine in alcohol and sea-water also gives beautiful results, but is less certain in its action. For staining he used Grenacher's alum-carmine, borax-carmine, picro-carmine, and Kleinenberg's hæmatoxylin. Much the best results are obtained by the use of alum-carmine, but it must be used as quickly as possible, since the gelatinous tissue of the mesoderm is apt to shrink if the object be left too long in aqueous fluid. The tissues were decalcified with very weak nitric or hydrochloric acid in 90 per cent. alcohol. For maceration, the Hertwigs' well-known mixture of osmic and acetic acid gives good results.

Semper's Method of making Dried Preparations.*—B. Sharp redescribes this process.†

After hardening in chromic acid solution ($\frac{1}{4}$–1 per cent.) and being repeatedly washed, the object is placed in alcohol, 30-40, 60–70, and 90–95 per cent. successively, and finally in absolute alcohol.

This stage of absolute alcohol is the most critical part of the whole process. *Absolutely* every particle of the water must be removed, and the secret of the whole process depends on this one point. If any water be left in the tissue, it will become spotted and eventually spoil. After all the water has been withdrawn by the absolute alcohol, by remaining in it for three days to a week, the object is placed in turpentine, the best that can be procured. In this it is allowed to remain until it becomes thoroughly saturated: with large objects it is best to change the turpentine once. Two or three days are required for this stage. When saturated, the object is quite stiff, and when the process is successful little or no contraction has taken place. The object is then placed in the air and protected carefully from the dust, and the turpentine allowed to evaporate. The object then soon presents a very beautiful appearance; it becomes white, resembling the whitest kid. It is light, stiff, and, on account of the resin it contains, is perfectly insect-proof. In annelids the iridescence is perfectly kept; hair and feather retain their original colours.

Method of Detecting the Continuity of Protoplasm in Vegetable Structures.‡—W. Gardiner makes the following observations on the various methods for observing the protoplasmic threads which pass from cell to cell.

During the earlier part of his work he used sulphuric acid in combination with Hoffmann's violet. This latter reagent, at the time of staining, colours equally protoplasm and cell-wall. If, however, the section be treated for some time with dilute glycerin, the staining of the cell-wall is removed, and the protoplasm alone remains clearly stained. A very useful reagent for the demonstration of sieve-tubes may be made by dissolving Hoffmann's violet in strong sulphuric acid. After treatment with this solution the sieve-tubes are well brought into view, and all lignified tissue assumes the usual

* Proc. Acad. Nat. Sci. Philad., 1884, pp. 24–7.
† See this Journal, i. (1881) p. 706.
‡ Arbeit. Bot. Inst. Würzburg, iii. (1884) pp. 53–60 (English).

gold-yellow tint, as after treatment with aniline chloride and hydrochloric acid.

In working with sulphuric acid the fresh material is first cut in water. A section having been taken up with a platinum spatula, and the excess of water removed by blotting-paper, a drop of strong sulphuric acid is placed upon it, and allowed to act for a short time, usually a few seconds. The section is then plunged into water and rapidly washed. After several washings it may be stained and mounted. As a staining reagent, either Hoffmann's violet or preferably Hoffmann's blue may be used. In the former case the section is quickly stained, washed in water, and then placed for twenty-four hours or more in dilute glycerin, which dissolves out a great portion of the dye from the stained cell-wall, and at the same time removes the peculiar staining of the pits, which, if allowed to remain, is apt to lead to very delusive results. The section is finally mounted in glycerin. When Hoffmann's blue is used, a moderate quantity of the dye is dissolved in a 50 per cent. solution of alcohol to which have been added a few drops of acetic acid. After staining, the sections are washed with water and mounted in glycerin. Or a sufficient quantity of the dye may be dissolved in a 50 per cent. solution of alcohol which has been saturated with picric acid, until the solution assumes a dark greenish-blue tint. To this solution Gardiner gives the name picric-Hoffmann's-blue. After staining, the sections are washed with water and mounted in glycerin as before; or, after treatment with alcohol, they may be cleared with oil of cloves and mounted in Canada balsam.

In Tangl's method, sections of endosperm were stained with iodine and mounted in chlor-zinc-iod. In such dry tissue as ripe endosperm cells the cell-walls do not turn blue, but merely remain stained with the ordinary yellow-brown due to iodine. The protoplasm, on the other hand, assumes a very dark brown coloration, and after some time there comes into view a series of striæ traversing the thickened cell-wall, which, from their coloration, and from the fact that their depth of staining varies *pari passu* with that of the protoplasm, are taken to be essentially protoplasmic in character. Although in cases where it can be applied this method is of great value, it is attended also with some disadvantages. Firstly, in tissues containing a higher percentage of water the walls assume the ordinary cellulose blue, which at once prevents the threads from being seen; and, secondly, on account of the extensive and varied staining properties of the iodine, the results obtained by it alone cannot be taken as entirely conclusive. But, where practicable, Tangl's method is of great use in giving at least an idea of the existence of the protoplasmic threads, and the staining of the threads with iodine is much more distinct than with any other reagent.

To obviate these difficulties Gardiner adopted the modification already described of dissolving Hoffmann's blue in a 50 per cent. solution of alcohol saturated with picric acid; and, on washing out, the threads were found to be well stained, the picric acid bodily carrying, as it were, the solution of the dye into the fine protoplasmic

strands. Picric acid has also another valuable property in tending to prevent the staining of cellulose by dyes which, although possessing an especial affinity for protoplasm, will stain the cell-wall also unless some such restraining reagent be used. The sections are first stained with iodine and mounted in chlor-zinc-iod. If the material is favourable, something may then be seen of the threads. After being exposed to the action of the chlor-zinc-iod for about 12 hours, the sections are well washed, stained with picric-Hoffmann's-blue, washed again in water, and finally mounted in glycerin, or, better still, placed in alcohol, first dilute and at length absolute, cleared with oil of cloves, and mounted in Canada balsam. In those cases where the tissue swells rapidly under the action of the reagent, as in the endosperm of *Strychnos nux-vomica*, *Bauhinia*, and *Tamus*, the action need not be so prolonged, and the excessive swelling must be prevented by the use of alcoholic iodine at the outset, and in a similar manner it may be washed with alcohol instead of with water, otherwise the threads will be so displaced or altered as to be almost or entirely invisible.

As regards the management of the reagents, and the length of time they must be allowed to act to obtain a satisfactory result, the manipulation must be varied to a certain extent to suit the requirements of the various kinds of tissue, according as it is thick- or thin-walled, easily swollen or only with difficulty. The use of sulphuric acid is attended with a much greater amount of difficulty; for if it is allowed to act for too short a time, the cell-wall will not be sufficiently swollen; while if the treatment is prolonged, the middle lamellæ of the walls are liable to swell and at the same time stain, and will then hinder all successful observation of the threads which may traverse their substance. Upon still further action the protoplasm itself commences to be attacked. With chlor-zinc-iod, on the other hand, where the action is much more regulated and gradual, but little precaution as to length of time need be observed. Besides the difficulty of regulating its action, there are still other and grave objections to the use of sulphuric acid. One of these is that, no matter how carefully the acid is added to the tissue, and no matter how quickly the washing in water is accomplished, there will be a very considerable evolution of heat attending the hydration of the acid, which is liable to accelerate its action and to cause very grave changes in such delicate structures as fine protoplasmic threads traversing the cell-wall. The folding up and general displacement of the tissue consequent upon the action of such a violent reagent also greatly increases the already existing complications which attend all observations connected with minute histology.

For these reasons, while sulphuric acid is a very valuable reagent, both for swelling up resistent tissues on which chlor-zinc-iod has but little action, and for demonstrating in an unusually clear way the remarkable manner in which the apices of the protoplasmic processes, entering the pits, cling to the pit-closing membrane, it is, on the whole, the less satisfactory of the two, and the phenomena resulting from its action can only be rightly interpreted in the light of the more certain results obtained by the use of chlor-zinc-iod. For all

tissues which will swell sufficiently under its action, the chlor-zinc-iod method may be regarded as perfectly satisfactory; after treatment with picric-Hoffmann's-blue and subsequent washing with water, nothing but protoplasmic structures will be stained. In clear instances where a thick closing membrane is plainly traversed by threads, it can be demonstrated with ease that, while the individual threads are well stained, the substance of the pit-membrane itself undergoes no coloration, even when the section has been exposed to the action of the dye for a long time. When the pits are smaller and the threads less clearly defined, it is more difficult to observe that the substance of the pit-membrane is still free from coloration; and when, owing to the thinness of the closing membrane, all appearances even of striation cease to be recognizable, only an apparent staining of the entire membrane can be observed. Such staining points, however, in the opinion of the author, not to the coloration of the substance of the pit-membrane, but to the staining of protoplasmic threads traversing its structure.

Besides a platinum lifter, the author uses platinum needles, and is careful thoroughly to brush all the sections with a camel's-hair brush, both after the action of the acid or of chlor-zinc-iod and after staining.

To prove that the threads traversing the cell-wall are actually protoplasm, he employed with success a solution of molybdic acid in strong sulphuric acid, which has the advantage of swelling the cell-wall and at the same time colouring the protoplasm. The solution is colourless and gives a beautiful blue colour with alcohol and many other organic substances; and this reaction is extremely delicate. While not affecting the cell-wall for some time this reagent gives at once a fine blue coloration with protoplasm. If a section of some living endosperm, such as that of *Tamus*, is treated with it, the cell-wall will swell up, and it will commence to dissolve the protoplasm; the fine threads perforating the walls will remain for some time unaffected, but will soon be perceptibly coloured, while the main mass of protoplasm will assume an intense blue.

The pit-membrane itself possesses some properties different from those of the cell-wall. After staining with iodine and chlor-zinc-iod, while the cell-wall assumes the usual blue tint, the pit-membrane is but slightly coloured, and, when thin, appears as if not coloured at all, although the examination of a fine transverse section of the pit will prove that a definite staining has taken place. But the depth of the staining is less than might have been expected in proportion to the thickness of the membrane. Methylene blue stains both the wall and the pit-membranes a fine light blue, and, after the action of sulphuric acid, the swollen wall assumes a much lighter tint, owing to the fact that the quantity of the dye taken up by the cell-wall is now distributed over a larger space. If a section is cautiously treated with sulphuric acid, washed, and stained, it will be seen that, whereas the general swollen wall is coloured a light blue, the bottoms and the sides of the pit retain the darker blue colour of the unswollen cell-wall, and

will thus be clearly marked out. If, however, another section is treated for a longer time with acid, or the same section is a second time exposed to its action, no special coloration of the bottoms and sides of the pits takes place on staining, but the whole swollen wall is of a uniform light tint. This shows that the substance of the pit-closing membrane and of the layers immediately surrounding the pit-cavity are more resistent than the rest of the cell-wall; as indeed has already been pointed out by Strasburger.

Exactly the same phenomena are observed when a section, after cautious treatment with sulphuric acid, is stained with methyl-violet. In the case of methylene blue the protoplasm is not coloured, but when methyl-violet is used, a deep staining of that structure occurs, the tint of which is the same as that of the bottoms and sides of the pits; for, while the general cell-wall assumes a violet colour, the protoplasm, the pit-membranes and the sides of the pits appear of a deep purple. Now since protoplasmic processes from the main protoplasmic mass may project for some distance into the swollen pits, when such a stained section of pitted tissue is examined, it appears as if there were, in any two contiguous cells, threads of protoplasm of a purple colour traversing the thickness of the violet cell-wall by means of the pits, and thus establishing a direct continuity of the protoplasm from cell to cell. But after prolonged treatment with dilute glycerin, this purple colour dissolves from the pits, and the protoplasmic processes are left clearly seen, and may or may not be the means of establishing a continuity between the cells. As in the case of methylene blue, so also here, a more lengthy treatment of the tissue with acid will swell up the pit-membranes, and when in that condition the pits will assume the same colour as the rest of the cell-wall.

Method of Preparing Dry Microscopic Plants for the Microscope.*—G. Lagerheim has found the following method convenient for the examination of algæ or other plants which have already been dried.

A fluid is prepared of the following composition:—1 part fused potassium hydrate is dissolved in 5 parts water, and when the solution is complete 5·5 parts are added of glycerin of the consistency of a syrup. The dried desmids, Œdogoniaceæ or other algæ, are treated with water till they are thoroughly moist; a small piece of the material is then taken up with a pincette and placed upon the glass slide. One or two drops of the fluid are added, and the algæ distributed as evenly as possible with dissecting-needles. The glass slide is then warmed for a time over a spirit-lamp, and a cover-glass finally placed on. The potassium hydrate has now caused the previously shrunken algæ to swell and resume their original form. The addition of glycerin gives a consistency to the fluid, so that the algæ can easily be turned over by shifting the cover-glass, and thus observed on different sides, a point of great importance, for example, in the study of desmids.

* Bot. Centralbl., xviii. (1884) pp. 183-4.

The algæ prepared in this way can readily be drawn or measured. The cover-glass is carefully removed, and, if a low power or a dissecting Microscope is used, the object is taken up by a needle or stiff bristle, and again at once placed in potassium acetate or glycerin. If, on the contrary, the whole material thus prepared has to be got ready for drawing or measuring, a drop of acetic acid is added after removing the cover-glass. The algæ are in this way imbedded in potassium acetate and glycerin, fluids perhaps the best adapted of any for the preservation of algæ.

Dry mosses and fungi may also be prepared in the same way.

Chapman's Microtome.*—A. B. Chapman has devised a microtome, which has for its cutting surface two parallel glass-plates cemented to a block of mahogany, through which is inserted a brass cylinder at right-angles to the glass plates; in this cylinder (which forms the "well" of the microtome) an accurately fitted brass plug works, carrying on its top a flat-headed table-like piece which entirely prevents the imbedding agent from rising or turning round while the sections are being cut. The plug is moved up and down by a brass disk, which revolves between the block of mahogany and a similar block underneath. The brass disk is graduated on the edge of its upper surface, each graduation representing a movement of ·0005 in. of the plug. The microtome has a base-board which can be firmly clamped to a table, and the whole is so conveniently arranged that every operation or adjustment can be made at once, the whole being in view on the table.

Use of the Freezing Microtome.†—The tendency at the present time is to make all microscopic sections by the dry method after paraffin infiltration and imbedding; but no doubt there is a place, and an important one, for the freezing microtome in practical histology, and in this note S. H. Gage calls attention to what seem to him improvements in its use.

Disliking greatly the disagreeable mess made by ice and salt, it occurred to him to take advantage of the device of plumbers to thaw out water and gas pipes,—to use strong alcohol with the ice or snow instead of salt. By using snow or finely powdered ice and 95 per cent. alcohol, a temperature of 20 C. below zero is obtained within five minutes, and this temperature may be maintained with far less trouble than with ice and salt. The microtome used is the Rutherford pattern, modified by placing the drain near the top instead of in the bottom. A rubber tube passing from this drain to a jar preserves the overflow. It requires about 250 c.cm. of alcohol to freeze and keep frozen one tissue for cutting, but this is not lost, as little evaporation takes place, and the dilution does no harm for many purposes, hence the method is not wasteful, while it is much more pleasant and expeditious than with salt.

Ordinarily tissues are infiltrated with thick gum before freezing,

* Sci.-Gossip, 1884, p. 137.

† Science Record, ii. (1884) pp. 134–5.

and then the sections are soaked in a relatively large amount of water to remove the gum. Evidently while soaking, staining, and transferring the sections, especially if they be of such an organ as the lungs, there is every liability of their becoming folded or torn. This may be avoided by staining the tissue in the mass as for dry section-cutting, and then soaking in water to remove any alcohol, and finally completely infiltrating the tissue in a thick solution of very clean gum arabic.

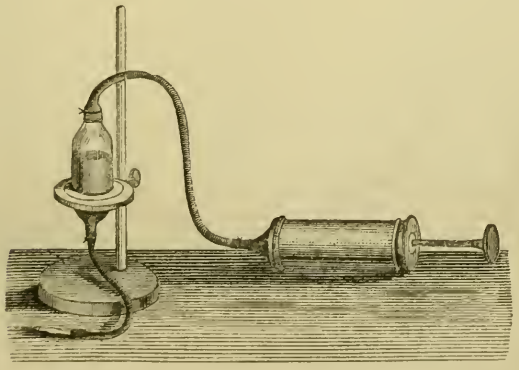
When ready to make the sections the well of the microtome is filled with the thick gum and the tissue introduced at the proper time as usual. Before cutting, the gum is cut away from the tissue as in sharpening very bluntly a lead pencil, then as the sections are cut they are transferred directly to the slide. After several slides are filled, a drop of glycerin is added to each section and the cover-glass applied. This is practically mounting in Farrant's solution.

Apparatus for Injection—Fearnley's Constant-Pressure Apparatus.—Very great variety exists in the forms of this class of apparatus. In the majority of them the leading principle is the compression of the air in an intermediate vessel by the entrance into it of a liquid falling from a greater or less height according to the pressure required, the air then acting on the injecting fluid in another bottle communicating with the first.

In the two following the intermediate vessel is dispensed with.

Ranvier's * (fig. 108) has a syringe connected by an indiarubber tube

Fig. 108.



with the bottle containing the injecting fluid, which is supported on a retort-stand. A second indiarubber tube terminates in the canula.

Ludwig's † (fig. 109) acts by the fall of quicksilver drop by drop into the vessel, A, containing the injecting fluid I.

* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, p. 187 (1 fig.).
† Ibid., p. 188 (1 fig.).

Toldt's * (fig. 110) is similar to the preceding, but in addition to the vessel containing the injecting fluid, a second air-vessel is introduced.

Thanhoffer's.† Prof. L. v. Thanhoffer uses the following apparatus (fig. 111). To the wall of the room and near the ceiling a board is fixed. This board carries a pulley, over which a cord is passed, having at one end a large glass vessel A, filled with water ; at the other end of the cord is a handle, by which the vessel can be drawn up and down as required. When the tap in A is open, water flows through the india-

Fig. 109.

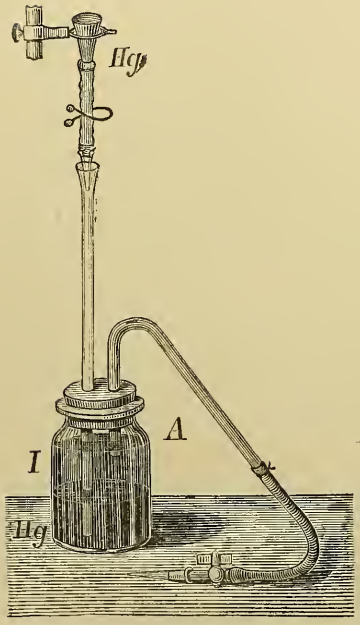
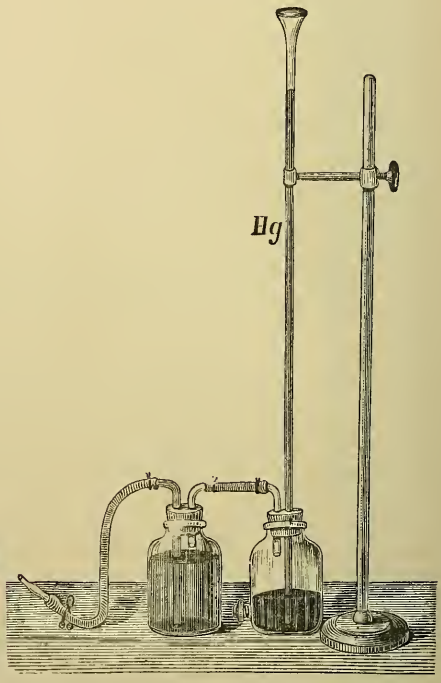


Fig. 110.



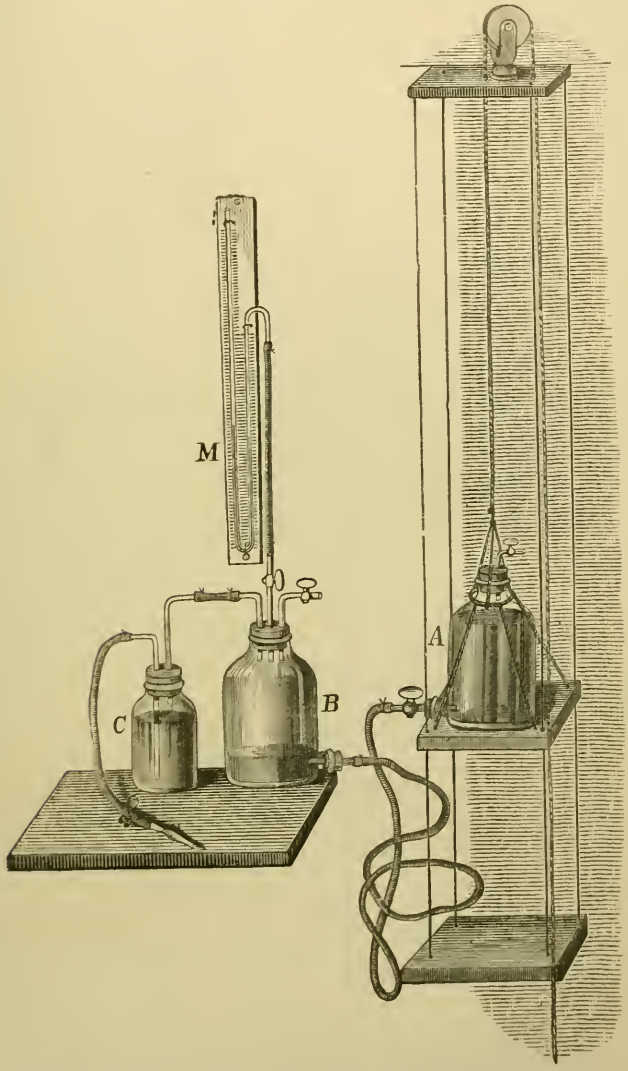
rubber tube into a second vessel B, which acts as an air-reservoir. The air compressed in B passes into C, which contains the injecting fluid, and forces it through the discharge pipes and thence into the vessels. The pressure is of course increased according as A is raised. The amount of pressure is denoted by the manometer M. Quicksilver may be substituted for water, and greater pressure thereby obtained,

* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, p. 189 (1 fig.).

† Ibid., pp. 190–2 (1 fig.).

but in injecting fine vessels this is quite unnecessary, for if the room be sufficiently lofty a pressure of from 300 to 400 mm. can be obtained

Fig. 111.



by drawing the vessel A to the ceiling, a pressure which is more than is required.

Ludwig's * (fig. 112) for quicksilver and small pressure, is substantially identical, and requires no explanation beyond the figure.

Fig. 112.

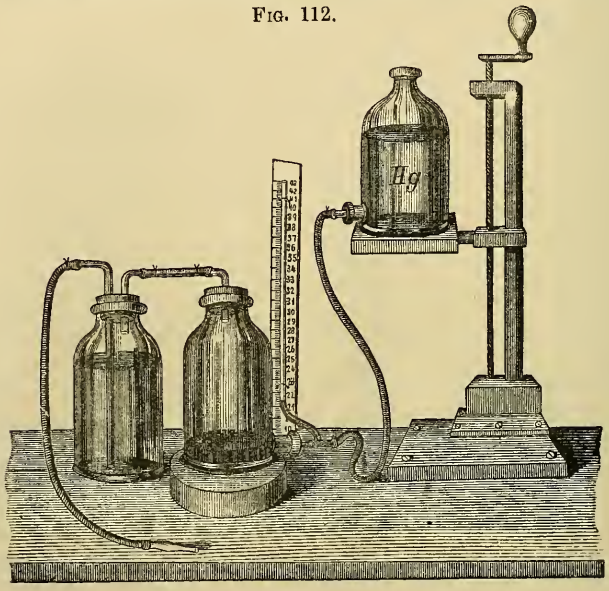
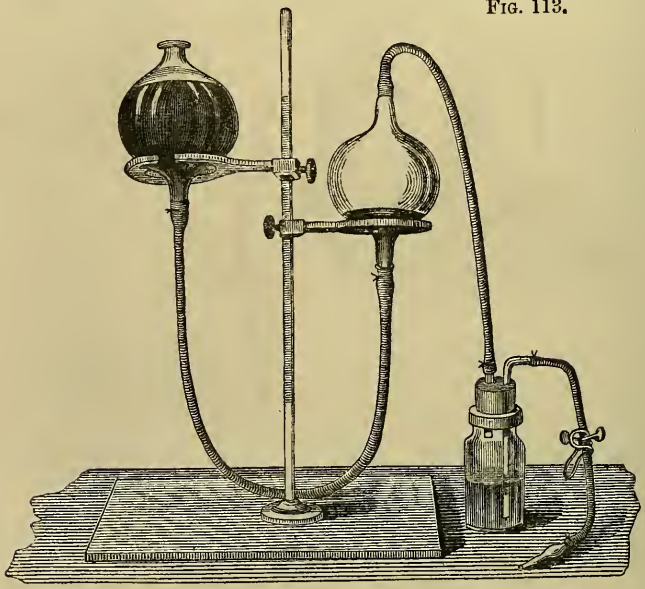


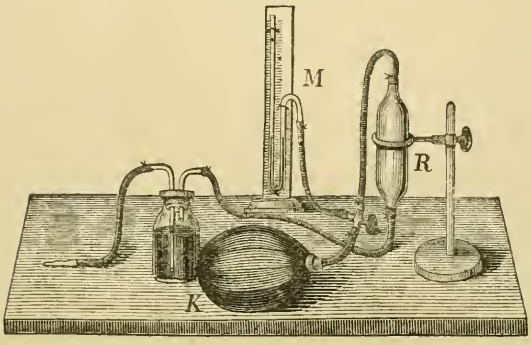
Fig. 113.



* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, pp. 192–3 (1 fig.).

Ranvier's * (fig. 113) consists of a glass vessel filled with quicksilver which can be raised and lowered on a retort-stand. The rise of the quicksilver in the intermediate vessel compresses the air which it contains as well as that in the bottle containing the injecting fluid, which is forced out as in the previous case. In another form (fig. 114)

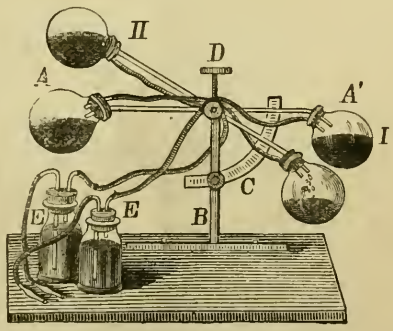
Fig. 114.



the pressure is obtained by compression of an indiarubber ball K communicating with an air-reservoir R (M being a manometer).

Hering's † (fig. 115) consists essentially of two glass bulbs, A A′, having a thin glass tube passing through the stoppers in their necks, and by which the bulbs communicate with each other. A flexible tube from each bulb passes into one or other of the bottles E E, containing the injecting fluid. The ends of the glass tubes are drawn out so fine that the quicksilver passes only a drop at a time from one to the other (even when the air is compressed). When the bulbs are turned on their axis, and instead of the horizontal position I., take the oblique one II., the quicksilver will flow from A to A′, and compress the air in the bulb A′, and act upon the injecting fluid in the vessel E. The nearer a vertical position is approached, the greater the pressure will be by which the injecting fluid is forced into the blood-vessels. The two bottles, E and E, are alternately used according as one or the other of the bulbs is uppermost.‡

Fig. 115.



* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, pp. 189–90, 187–8 (2 figs.).

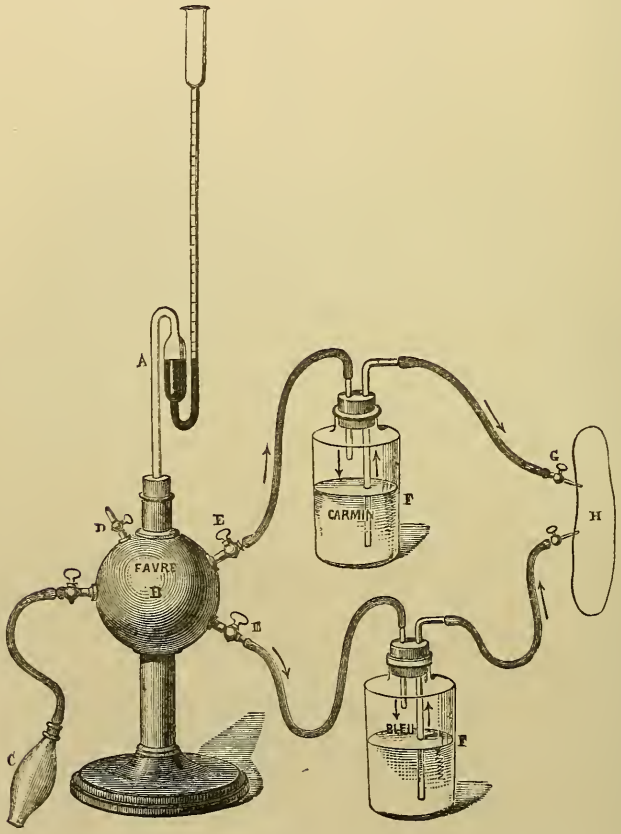
† Ibid., pp. 193–4 (1 fig.).

‡ The figure, which is a cliché of the original, should have indicated one of the two positions of the bulbs by dotted lines. As drawn, there appear to be four bulbs. B, C, and D are not explained but their function is obvious.

Other forms are described by Dr. P. Latteux in his 'Manuel de Technique Microscopique.'

Dr. Latteux's * (fig. 116) consists of a copper globe B, to hold the compressed air, having a tube at A with mercury serving as a manometer. Four taps are inserted in the globe of which one is the air

Fig. 116.



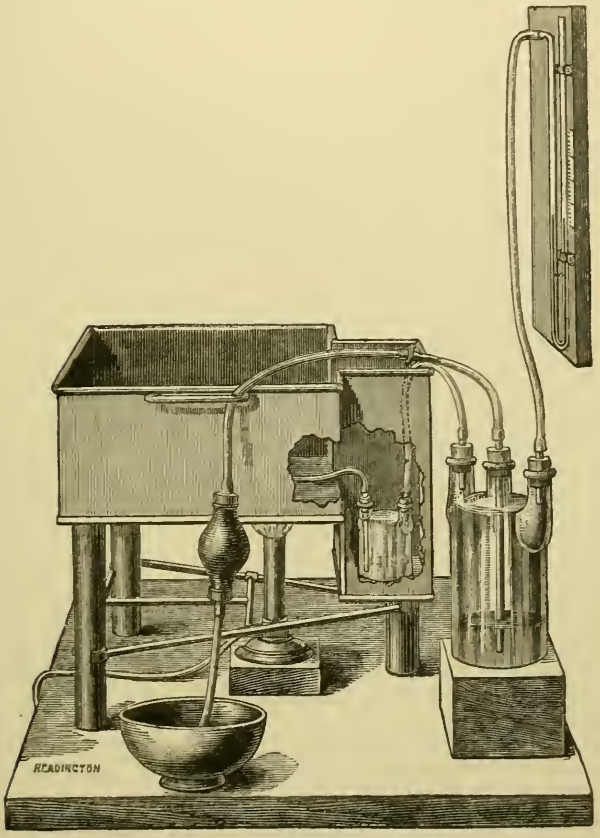
tube from the indiarubber ball C, another regulates the pressure, and the third and fourth E E communicate with two bottles F F containing carmine and blue, the exit tubes G H from these bottles terminating in canulæ for insertion in a vein and artery, or artery and gland duct.

* Latteux, P., 'Manuel de technique microscopique,' 2nd ed., 1883, pp. 110–12 (1 fig.).

The apparatus is sufficient to completely fill the finest vessels of the retina, spinal cord, &c.

*Fearnley's Constant-Pressure Apparatus.**—The method of Ludwig has always been acknowledged as superior to injecting by the syringe except for the one great obstacle—applying the necessary pressure, which had to be effected by elevating and depressing huge water-

Fig. 117.



bottles or by connecting the air-pressure bottle with a water-tap and regulating the pressure as best one could, thus rendering the pressure almost as uncertain and irregular as the thumb-pressure of the syringe. Mr. W. Fearnley's method is to apply the pressure with an ordinary Higginson's enema syringe (figs. 117 and 118).

No practice is required with this simple contrivance beyond introducing and tying in the nozzle in the aorta.

* Brit. Med. Journ., 1883, pp. 859–60 (2 figs.).

There is a bath, having a shallow part for the animal to lie in, and a deeper part for the Woulff's bottle, containing the injection-mass, to stand in. A large (40 ounce) Woulff's bottle, with three necks, is fitted with three perforated indiarubber stoppers. The middle stopper is perforated with a glass tube which goes to the bottom of the bottle. Each of the others is perforated with a glass tube, the depth of the stopper only, and standing above the stopper sufficiently to admit of a piece of indiarubber tubing being fixed upon it. The Woulff's bottle containing the mass has two necks, fitted with indiarubber stoppers. One neck admits a piece of glass tube, which goes quite to the bottom of the bottle; the other admits a short piece of tube the depth of the stopper only. Fig. 117 shows all further detail.

The mercurial manometer allows five inches rise of the mercury in the ascending arm—therefore five inches fall of the descending arm —though four inches will do.

"To inject an animal, a rabbit, for instance, proceed as follows:— Fill the bath with water, and heat the water with a Bunsen's burner to 100° Fahr. or so. The Woulff's bottle containing the mass should be filled and thoroughly stoppered. Then chloroform the rabbit and make an L-shaped incision into the thorax, so as to expose the heart and aorta. This is done by cutting up the middle line of the sternum (breast-bone) as far as the root of the neck nearly, then making a second incision at right angles to this to the rabbit's left. A triangular flap is thus made, and the heart inclosed in the pericardium exposed. Having cut through the pericardium, seize the apex of the heart with a pair of forceps and snip it off, then the heart's apex appears as in A, fig. 118. That is to say, the right and left ventricles are opened, and the animal instantly bleeds to death. Mr. Fearnley uses a nozzle, as in B, Fig. 118, which has an elastic collar *e c*, which is plugged by a nozzle, as here shown.

The opening in the right ventricle leading to the pulmonary artery has a crescent shape or slit-like appearance; whilst the opening in the left ventricle, leading to the aorta, is round. Therefore, if we wish to inject the entire arterial system, we insert our nozzle into the round hole; but if we wish to inject the pulmonary system only, we choose the crescentic slit.

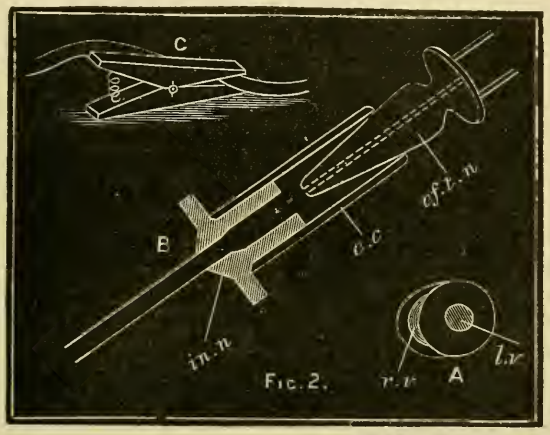
Either glass nozzles,* or those shown in fig. 118, are to be inserted into one or other of the two holes (usually the round one for injecting the entire arterial system with carmine and gelatine mass). We can now either tie the artery only, or we can tie the whole heart substance. In either case a ligature of floss silk is to be passed round (the artery or the entire heart) and tightly tied and secured. Before proceeding further, we wash out the cavity of the thorax of all blood to keep our bath water clean, then we lift the animal into the bath and there let it remain ten minutes or so to get well warmed. It is a good plan to slit open the entire abdomen in the middle line, so as to allow the

* Mr. Fearnley informs us that he now uses glass nozzles with tube connections, which answer quite as well as those figured, and are cheaper.

warm water to freely get round the abdominal contents: the mass thus gets into every organ and into every part of an organ evenly.

We now connect the pressure bottle with the manometer and with the Higginson's syringe, as shown in fig. 117, also with the mass bottle. The tube of the mass bottle, which is to convey the mass away from the bottle, is now clamped, as shown at C, fig. 118, and must never for an instant be allowed to get out of the warm water into the cold air.

Fig. 118.



Having our small basin full of water, we now squeeze the Higginson's syringe, watching the manometer, to raise the mercury half an inch. This done, we remove the clamp from the efflux tube, and the red fluid after driving out a few air-bubbles begins to flow out; we at once make the connection, and all quicksands are passed if we have tied in our nozzles properly into the artery and the connecting part, and fastened in our stoppers thoroughly into our Woulff's bottles.

Our task is easy now: all we do is to seize the head of the animal, which should be to our left, with our left hand, to watch the pale gums, tongue, and eyelids become suffused with a pale blush which gradually deepens, whilst we gently squeeze and relax the barrel of the syringe and glance at the mercury from time to time. When the mercury has risen four, or at most five inches, the whole animal will be completely injected: the visible mucous membranes and bowels will be dark-red and much swollen.

We now remove the animal, and place it in ice-cold water under a common water-tap for an hour or two, and divide it into parts as required. This method of applying pressure is wonderfully delicate; thus, whilst we can raise the mercury in the manometer almost imperceptibly, one entire compression of the barrel raises the mercury one inch."

Myrtillus for Staining Animal and Vegetable Tissues.*—Dr. M. Lavdowsky (in furtherance of the modern fashion of recommending every conceivable substance which by any chance will furnish a stain) recommends the berries of *Vaccinum myrtillus*, as an excellent staining agent for the nuclei of all cells and the cellulose walls of plant-cells. The karyokinetic figures are shown very plainly.

The fresh berries should be well washed in water, the juice squeezed out and mixed with two volumes of distilled water, to which some alcohol (90 per cent.) has been added. It is then heated for a short time, and filtered warm. For use, a small quantity of the fluid should be diluted with two or three times its bulk of distilled water.

The stain gives a red (carmine) colour with fresh neutral objects, or lilac (hæmatoxylin) when the acid of the fluid is neutralized by an alkali or neutral salt. The latter is the more durable. A double stain is obtained by placing the object in a solution of eosin after treatment with the lilac stain. Directions are given for applying the fluid, but it does not appear to us, from the author's own showing, to be a valuable or even useful addition to the already long list of staining agents.

Hartzell's Method of Staining Bacillus tuberculosis.†—A small quantity of sputum is spread as thinly and evenly as possible upon a slide, and allowed to dry, and is then passed slowly several times through the flame of an alcohol lamp or Bunsen burner. One or two drops of the fuchsin solution recommended by Gradle (prepared as follows: carbolic acid 15 minims, distilled water 1/2 fluid oz., dissolve, and add saturated alcoholic solution of fuchsin 1/2 fluid dr.) are placed upon the sputum, and allowed to remain from three to five minutes. The slide is now washed thoroughly with distilled water, to remove the excess of fuchsin, and the stained sputum completely decolorized by a saturated solution of oxalic acid. It is again thoroughly washed in distilled water, and allowed to dry; it is now ready to be mounted in glycerin or balsam for examination. With a power of 500 or 600 the bacilli will appear as brilliant red rods, no staining of the background being necessary.

One chief advantage claimed over other methods is that in the latter the decolorizing agent employed is dilute nitric acid; but this, besides being disagreeable to handle because of its corrosive and staining properties, is apt to remove the colour from the bacilli too, unless great care is taken. Oxalic acid, however, seems to leave the dye untouched in them.

Safranin Staining for Pathological Specimens.‡—For staining tumours, Dr. V. Babes(in) recommends that fine sections of tissue hardened in alcohol or chromic acid should be steeped either in a solution of safranin which has been dissolved in warm water, or in a mixture of equal parts of concentrated watery and concentrated

* Arch. f. Mikr. Anat., xxiii. (1884) pp. 506–8.
† Amer. Mon. Micr. Journ., v. (1884) pp. 76–7, from 'Medical Times.'
‡ Arch. f. Mikr. Anat., xxii. (1883) pp. 356–65.

alcoholic safranin solution for half an hour; they should be washed slightly in water, and then dehydrated as quickly as possible by absolute alcohol, then transferred to turpentine and mounted in balsam. Some tissues which are not so readily decolorized may be clarified with oil of cloves. Although they appear scarcely red, yet such sections show the following structures: viz. nucleoli of white blood-corpuscles; granules in the same and in most cells of rapidly proliferating granulating tissues; periphery of red blood-corpuscles; filamentous bodies occurring in connection with blood-vessels in process of formation; nuclei of giant-cells and nucleoli of all large-celled sarcomata and carcinomatous tumours.

As the inactive, skeletal part of the nucleus is not stained by the safranin, it is easy to follow by its means the part which the nucleolus plays in cell-division. In large-celled, malignant tumours a great variety of forms are thus brought out in the nucleus, while the spindles and the fibrils connecting them remain uncoloured. In melanosarcoma the fission-stages of the cells, which remain concealed under every other treatment, are well brought out, and in rapidly growing small-celled tumours, e. g. lymphosarcomata, the appearance of universal staining is imparted to the cell by a series of delicate nuclear markings which almost fill the cell.

Secondly, for investigating the structure of the cell and of other histological elements a super-saturated solution should be employed; it is warmed to 60°, and filtered in this state; the sections are placed in a small quantity of the liquid in a watch-glass, which is then warmed * for a few seconds over a spirit-lamp until the precipitating crystals are redissolved; the sections are left for a minute, then washed in water, and treated as in the former case. Tissues which do not stain readily should be warmed again and again. The nuclear network comes out well under this treatment. It is especially adapted for delicate structures and for bacteria; every micrococcus appears brownish-red, while the surrounding tissues assume a fine rose-red; the bacilli of tuberculosis and lepra are not thus stained.

Thirdly, the sections may be left for 12 to 24 hours in the solution (either concentrated watery or alcoholic, or a mixture of the two). Sections thus coloured may be left, if necessary, somewhat longer in alcohol, turpentine, oil of cloves, or, better, origanum; a large number of details are thus brought out, and a similar effect is produced by longer action of a watery solution; the method is especially adapted to tumours of the brain or spinal cord.

The finest representations of the changes undergone by nuclei in fission were produced by rapidly staining with safranin, followed by eosin, and mounting in balsam. Safranin and hæmatoxylin bring out the nuclear skeleton violet and the nucleolus red. Preparations made according to these methods have proved durable. Some points are better seen by mounting in glycerin, but the colour disappears more or less in time, and acetate of potash is preferable both on the grounds of permanency and clearness.

* Cf. this Journal, iii. (1883) p. 918.

Preparations which show only the muscular fibre and the elastic tissue may be made by staining small fragments with a mixture, half and half each, of oil of cloves or origanum and concentrated alcoholic solution of safranin and placing for an hour under the air-pump: sections may then be made at once, or, better, uncoloured sections may be transferred from alcohol to the oily solution; the sections are washed with solutions of caustic potash in alcohol, and mounted in acetate of potash. By putting sections stained with safranin into 30 to 40 per cent. solution of caustic potash the colour is fixed, and the elements come out very distinctly; they should be mounted in acetate of potash.

Collodion as a Fixative for Sections.*—Sections fixed by means of a solution of collodion in clove oil, as suggested by Schällibaum,† may be coloured on the slide. S. H. Gage, who had begun to experiment with collodion before Schällibaum's method was published, recommends that the collodion and clove oil be applied separately.

"A solution of collodion is prepared by adding to 2 gr. of gun-cotton (that used by photographers is good) 54 cc. of sulphuric ether and 18 cc. of 95 per cent. alcohol. After the gun-cotton is entirely dissolved the solution should be filtered through filter-paper or absorbent cotton. The slides are coated by pouring the collodion on one end, allowing it to flow quickly over the slide, and off the other end into the bottle. The prepared slides should be kept free from dust. As the collodion will not deteriorate after drying on the slide, any number of slides may be prepared at the same time. Before using a slide it should be dusted with a camel's-hair brush, and with another brush the collodionized surface of the slide should be thinly painted with clove oil. . . . . The sections are arranged as in the shellac method. The slide is warmed over an alcohol lamp, and then heated in a warm chamber, so as to drive off the clove oil. After cooling, it may be placed in a wide-mouthed vial of turpentine, chloroform, xylol, or refined naphtha, to remove the paraffin. Naphtha is very cheap, and is the best agent we have yet tried for dissolving the imbedding mass. The sections are usually freed from imbedding mass within half an hour, though the slide may remain in any of the solvents mentioned for two or three days, or perhaps indefinitely, without loosening the sections. When the slide is removed from the naphtha, the sections are washed with 95 per cent. alcohol by means of a medicine dropper, or by immersing the slide in alcohol. If the sections are to be stained in Kleinenberg's hæmatoxylin, or in any other stain containing 50 per cent. or more alcohol, the slide is transferred directly from the alcohol used for rinsing to the staining agent; otherwise it should be first transferred to 50 per cent. alcohol, and from that to the staining agent. Whenever the sections are sufficiently stained, they may be mounted in any desired mounting medium. In case Canada balsam is to be used, the slide must be immersed in alcohol to wash away the stain, and finally in

* Medical Student (N. Y.), i. (1883) pp. 14–6.
† See this Journal, iii. (1883) p. 736.

95 per cent. alcohol to completely anhydrate the sections. They are cleared with a mixture of carbolic acid 1 part, turpentine 4 parts. The balsam to be used is prepared by mixing 25 gr. of pure Canada balsam with 2 cc. of chloroform and 2 cc. of olive oil. The latter very soon removes any cloudiness that may have appeared in the collodion film."

Piffard's Slides.—Mr. B. Piffard has patented a slide which is made by forming with a diamond a round recess in an ordinary slide. In this the object is placed, and covered with thin glass. The upper surface of the slide is thus perfectly smooth, the cover-glass being even with the slide. There is no danger of the cover-glass and object being knocked off; and the recess causes a very beautiful diffusion of light.

Mounting in Balsam in Cells.*—R. P. H. Durkee describes the following process:—A curtain-ring, flattened by pressure, is placed upon a clean slide and the slide placed on the hot table. Drop in the centre a small portion of balsam, enough to fill the cell, and heat till the air-bubbles rise and permit of breaking with the needle; at the same time gently moving the ring about, and pressing it down to insure contact with the slide. Place the object in the balsam, taking care to see that it is completely covered; warm the cover and place it in position, in doing so holding it in the forceps parallel with the surface of the slide, so as to expel the air all round. Weight down with a bullet, and apply heat as may be necessary to harden the balsam.

What the author considers a feature is that there would seem to be no possibility of varnish running in, the channel in the top of the ring receiving the excess of balsam when pressed out by the cover, and thus forming a barrier to the influx of the varnish used in ringing. For flattening the rings he used two plates of brass, 2½ in. square by 1/8 in. thick. Place the rings, six or more at a time, between the plates, and press in a lever stamp. This method of mounting seems to him to have the following desirable features, viz. no previous preparation and drying of cells, rapidity and neatness of finish, and no running in of varnish.

Styrax, Liquidambar, Smith's and van Heurck's Media.—Dr. H. van Heurck writes that styrax, when prepared by exposing the raw product to the air and light, dissolving and filtering, is no longer of a dark colour, and that its index is higher than 1·585, as given on p. 475. The purified styrax of commerce is always darker and of lower refractive index. Preparations become completely colourless at the end of a few months, especially if brought into the light occasionally, and the index rises a little.

Liquidambar can be obtained of Lamman and Kemp, William and Cedar Streets, New York. It must be heated to reduce its brittleness, and dissolved by means of the water-bath in a mixture of

* Amer. Mon. Micr. Journ., v. (1884) pp. 84-5.

alcohol and benzine, and filtered. This is also the best solvent for styrax.

Styrax and liquidambar, purified and prepared according to Dr. van Heurck's directions, can be obtained of Messrs. Rousseau, 42–44, Rue des Ecoles, Paris.

Prof. Smith's medium, while most excellent for difficult diatoms of delicate structure, is not better than styrax for ordinary diatoms and preparations of histology or of insects.

Dr. van Heurck also announces that he has discovered a colourless medium analogous to that of Prof. Smith, but with an index higher than liquidambar.

Grouping Diatoms.*—J. Deby calls attention to some slides prepared for him by Möller, each containing many species of the same genus arranged in several lines. Thus there are 72 species or varieties of *Triceratium*, 60 of *Nitzschia*, 45 of *Surirella*, 38 of *Epithemia*, &c. Such slides have, Mr. Deby considers, enormous advantages over the "type-plates" from the point of view of the comparative study of the species of a genus. Equally to be recommended, from a scientific point of view, is, he thinks, the plan by which as many species as possible from the same gathering are united in one slide.

Quantitative Analysis of Minute Aerial Organisms.†—In the reports of the Imperial German Board of Health is a paper on this subject by Dr. Hesse. He employed an apparatus, which in all essentials so corresponds with the portable aëroscope of Dr. Maddox described in this Journal, III. (1883) p. 338, that it is necessary to note the fact, as no reference is made to it by Dr. Hesse. Instead, however, of drawing the air direct into an aëroscope and on to a thin cover-glass smeared with a glutinous substance for examination of the deposited matter by the Microscope, a long tube lined with a layer of gelatine is used. The air is allowed to enter by an aperture at one end, that most suitable being of like diameter with that of the exit tube, and as it traverses the tube slowly it deposits the organisms in its passage.

According to the nature of the deposits, small colonies are developed in the gelatine at different parts of the tube. By employing a long tube and slow traverse of air, the bacteria are deposited before reaching the exit, while the fungi—mildew and spores—appeared more abundant at the exit end than at the entrance. That bacteria are rapidly deposited in tranquil spaces was long since shown by Professor Tyndall.

Microscopical Evidence of the Antiquity of Articles of Stone.‡—An action has recently been pending in New York as to the genuineness of the collection of antiquities brought from Cyprus by Count Di Cesnola and sold to the city.

Mr. B. Braman, President of the New York Microscopical Society,

* Journ. de Microgr., viii. (1884) pp. 230–1.

† MT. aus dem K. Gesundheitsamte, ii. Berlin, 1884.

‡ Amer. Mon. Micr. Journ., v. (1884) pp. 14–5, from New York *Times*, 22nd Dec., 1883.

was examined as a witness and detailed the result of his examination with the Microscope of the surfaces of the statues in the collection.

"The Cypriote stone whereof these statues are sculptured is a cellular calcareous tufa. The cells are minute and crowded. There are about 1500 to the square inch. They are spherical in shape, and about 1/100 in. in diameter. When freshly cut, it will be found that the walls of some cells are harder than the walls of others. The hard walls resist the effects of the atmosphere with more success than the softer ones. During exposure these soft spaces sink first, and leave the hard ones standing, like craters on the face of the moon. The soft spaces sink into dome-like shapes, and small orifices indicate that the atmosphere has begun to affect them. Then the cups thus formed are carried away, the hard projections roll off in small globes, and the process recommences. Each process occupies several centuries. In the case of buried objects in Cyprus, the water filtering through the ground makes a deposit on them, more or less thick, of carbonate of lime. I have given seven or eight hours to the microscopical examination of the statuette of Venus, and it is susceptible of scientific demonstration that the surface of the so-called mirror and the surrounding surface are ancient. On the mirror are eight stipples of carbonate of lime, deposited in the way I have stated, which are an integral part of the ancient surface, and would not appear on a freshly cut surface. These evidences of antiquity could not be taken away without breaking the stone. They fill the cavities whereof I have spoken. They appear on the surface of the drapery within 3/16 in. of the mirror's outline. My Microscope would have disclosed cement 1/1000 in. in thickness."

"B.Sc."—Carbolic Acid and Cement.

[Fresh-water Algæ mounted three years ago in a weak carbolic-acid solution with asphaltum for the cement are still perfectly good.]

Sci.-Gossip, 1884, p. 137.

Briant, T. J.—Notes on putting up Microscopic Objects.

Rep. South Lond. Micr. and Nat. Hist. Club, 1884, p. 13.

Chapman's (A. B.) New Microtome.

[*Supra*, p. 642.] *Sci.-Gossip*, 1884, p. 137.

Cole, A. C.—Methods of Microscopical Research.

Part XI. Mounting (*continued*). pp. lvii.–lxi. (Mounting the Diatomaceæ. Cleaning and Mounting Polycystina. Preparation and Mounting of Insects. Preparation of Vegetable Sections. To Double Stain Vegetable Sections.)

Part XII. pp. lxiii.–lxxii. On Microscopical Drawing and Painting (by E. T. D.).

,, ,, Popular Microscopical Studies. IX. pp. 39–42. The Crane Fly (*Tipula Oleracea*). Plate 9 × 40.

No. X. pp. 43–6. Sponge. Plate 10.

No. XI. pp. 47–52. Starch. Plate 11 (*Sarsaparilla officinalis* × 400).

,, ,, Studies in Microscopical Science.

Vol. II. No. 19. Sec. I. No. 10. pp. 37–40. Nerve of Horse. Plate 10. T. S. × 150.

No. 20. Sec. II. No. 10. pp. 39–42. Vascular Tissue (*continued*). Plate 10. Wood Vessels and Cells.

Vol. II. No. 21. Sec. I. No. 11. pp. 41–4. Human Cerebellum. Plate 11. T. S. × 150.

No. 22. Sec. II. No. 11. pp. 43–6. Fundamental Tissue. Plate 11. T. S. Petiole of *Limnanthemum* × 75.

D., E. T.—See Cole, A. C.

Decker, F.—Ein neuer Schnittstrecker. (A new section-smoother.) [*Post.*]
Arch. f. Mikr. Anat., XXIII. (1884) pp. 537–43 (2 figs.).

Francotte, P.—Description des différentes méthodes employées pour ranger les coupes et les diatomées en séries sur le porte-objet. (Description of the different methods adopted for mounting sections and diatoms in series on the slide.) *Continued.* *Bull. Soc. Belg. Micr.*, X. (1884) pp. 137–41.

„ „ Petit instrument qui permet de repasser sur le cuir les grands rasoirs du Microtome de Thoma. (Small apparatus for sharpening on the strop the large razors of Thoma's Microtome.) [*Post.*]
Bull. Soc. Belg. Micr., X. (1884) pp. 151–2.

Friedländer, C.—Microscopische Technik zum Gebrauch bei medicinischen und pathologisch - anatomischen Untersuchungen. (Microscopical Technic in medical and pathological-anatomical researches.) viii. and 123 pp. and 1 pl. 2nd ed. 8vo, Berlin, 1884.

Griffin, A. W.—On the Collection and Preparation of the Diatomaceæ. Part I. Collection.
["An attempt to gather together some of the ideas of the best authorities on the question, for the benefit of those whose want of leisure precludes them from searching out these facts for themselves."]
Journ. of Micr., III. (1884) pp. 138–46.

Hillhouse, W.—Preparing Schultze's Solution. [*Post.*]
Proc. Cambridge Phil. Soc., IV. (1883) p. 399.

Hitchcock, R.—Microscopical Technic. V. Mounting in gelatinous and resinous media. *Amer. Mon. Micr. Journ.*, V. (1884) pp. 109–12.

„ „ See Insects, catching small.

„ „ See Mounting, questions about.

Insects, catching small.
[Mounting needle bent into a hook and dipped in alcohol. Dip the needle into alcohol (or concentrated carbolic acid—R. Hitchcock) to free the insects.]
Amer. Mon. Micr. Journ., V. (1884) p. 118.

Jackson, E. E.—Mounting the Skin of a Silkworm.
[Soak in acetic acid for 10 days, then open carefully with scissors from anus to mouth and wash in water. Soak in weak and then strong alcohol, follow with oil of cloves, turpentine, and balsam.]
The Microscope, IV. (1884) p. 133.

Kidder, J. H.—An examination of the external air of Washington.
[Describes and figures an aëroscope in principle "not essentially different from those devised by Pouchet, Maddox, and Cunningham." By bending the tube of the funnel at right angles the glycerine is prevented running off, as is the case when the smeared glass is set vertically.]
Journ. of Micr., III. (1884) pp. 182–5 (1 pl.).

Kingsley, J. S.—Microscopic Methods. I.
[No. II. was given *ante*, p. 484, the Part containing I. having been lost in the post.]
III. Hardening and macerating.
Science Record, II. (1884) pp. 108–10, 155–60.

Lavdowsky, M.—Myrtillus, ein neues Tinctionsmittel für thierische und pflanzliche Gewebe. (Myrtillus, a new staining medium for animal and vegetable tissues.) [*Supra*, p. 652.]
Arch. f. Mikr. Anat., XXIII. (1884) pp. 506–8.

Loew, O.—Ueber den mikrochemischen Nachweis von Eiweissstoffen. (On the microchemical analysis of albuminous substances.) [*Post.*]
Bot. Ztg., XLII. (1884) p. 273.

Mounting, questions about.
[As to the cracking of the covers of Möller's slides; also as to bubbles, and note by R. Hitchcock. "Bubbles are occasionally left in fluid mounts, especially when the cells are deep, under the impression that the air they contain being very elastic prevents injury to the cell from internal pressure when the temperature rises. We confess to grave doubts if such bubbles are of any benefit whatever."]
Amer. Mon. Micr. Journ., V. (1884) p. 119.

NEGRI, A. F.—Coloration des Spores dans les Bacilles de la Tuberculose. (Staining the spores of the Bacilli of Tuberculosis.) [*Post.*]
Journ. de Microgr., VIII. (1884) pp. 349–51, from 'Lo Sperimentale.'

Piffard's (B.) Improved Microscopic Slides. [*Supra*, p. 655.]
Sci.-Gossip, 1884, p. 136.

POIGNAND, M.—The Microscope in Palæontology. [*Post.*]
Journ. of Micr., III. (1884) pp. 163–70 (1 pl.).

PRINZ, W.—Examen microscopique (1) d'une feuille de papier qui à servi à isoler les plaques du parafoudre de la station de Lebbeke; (2) des lames minces d'un morceau de poterie. (Microscopical examination (1) of a piece of paper used to isolate the lightning conductor of the station of Lebbeke; (2) of thin plates from a piece of pottery.)
Bull. Soc. Belg. Micr., X. (1884) pp. 152–4 (3 figs.).

RALPH, T. S.—Results of a Microscopical Investigation of the action of Ammonium Molybdate and other chemical agents on the vascular and cellular tissues of about 120 different plants. *Journ. of Micr.*, III. (1884) pp. 155–62.

RATABOUL, J.—Les Diatomées. Récolte et préparation. (The Diatomaceæ. Collection and preparation.) *Continued.*
Journ. de Microgr., VIII. (1884) pp. 342–5.

ROBSON, M. H.—Improvements in Microscopic Slides.
[Records his experiments of five years ago to make slides similar to Piffard's, *supra*.]
Sci.-Gossip, 1884, p. 162.

Section-smoother, a simple.
[Practically identical with P. Francotte's, *ante*, p. 315.]
Science Record, II. (1884) p. 112 (1 fig.).

SIDDALL, J. D.—The Microscopical Examination of Milk and Drinking Water.
Micr. News, IV. (1884) pp. 187–9.

SLACK, H. J.—Pleasant Hours with the Microscope.
[Examining flowers of Borage, Comfrey, &c.—Ixodes.]
Knowledge, V. (1884) pp. 430–1 (2 figs.), 472–3 (2 figs.).

STOWELL, C. H.—Studies in Histology. III. Section Cutting.
The Microscope, IV. (1884) pp. 123–7.

" " New Apparatus.
[Griffith's Turntable, *post*. German Microtome.]
The Microscope, IV. (1884) pp. 131–2.

TAYLOR, T.—Clearing fluid.
[About equal parts of Squibb's absolute alcohol and Eucalyptus oil forms a very good clearing fluid for animal or vegetable tissues. When the tissues are freshly cut, place them in commercial alcohol for a few minutes. Next transfer them to the clearing fluid, as above described, for a period of about ten minutes. They are next placed in pure Eucalyptus oil, which removes the alcohol; a few minutes' immersion will suffice. It is not well to keep tissues longer than necessary in the fluid. Vegetable tissues become hardened when kept several days in it.]
Amer. Mon. Micr. Journ., V. (1884) p. 119.

UNDERHILL, H. M. J.—Mounting Infusoria.
[Reports his failures with osmic acid, permanganate of potash, and "chromic oxydichloride" acid.]
Sci.-Gossip, 1884, p. 162.

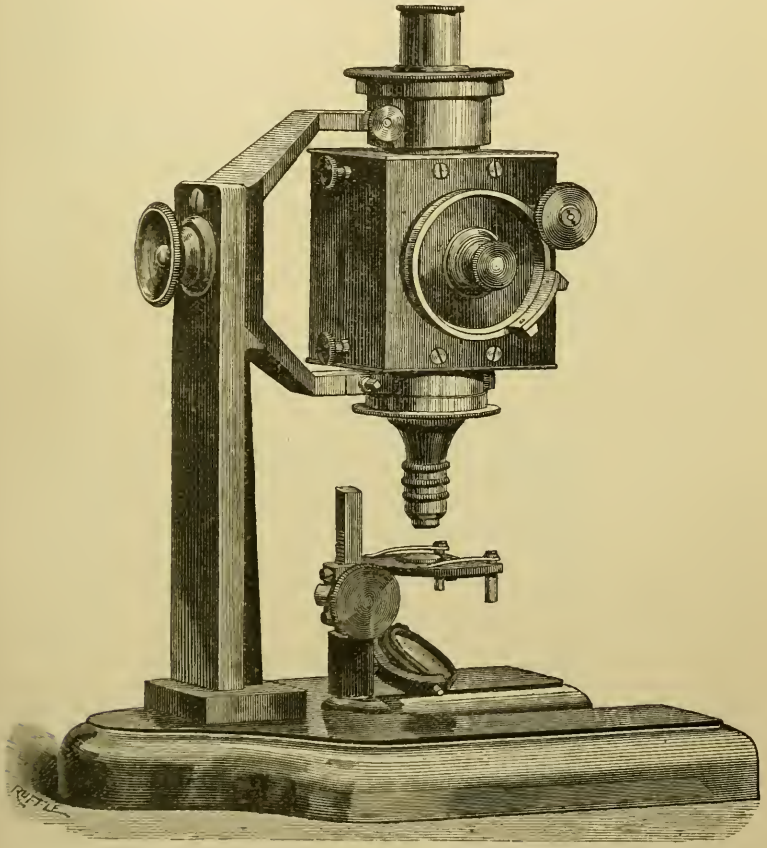
White Zinc Cement.
[Note on the difference of opinion between Mr. R. Hitchcock and Professor C. H. Stowell, *ante*, p. 485. "Perhaps they are not speaking of the same preparation of white zinc."]
Micr. Bull., I. (1884) pp. 28–9.

MICROSCOPY.

a. Instruments, Accessories, &c.

Albertotti's Micrometer Microscope.*—Dr. G. Albertotti, jun., has designed the instrument shown in fig. 123, for the purpose of measuring microscopic objects more satisfactorily than can be done with either eye-piece or stage micrometer.

Fig. 123.



If the diverging plates of Helmholtz's ophthalmometer are interposed between the eye-piece and objective of a compound Microscope in such a way that the axis of the plates is at right angles to the axis of the Microscope, the effect of the plates on the apparent

* Ann. di Ottalmologia, xi. (1882) pp. 29–30 (1 pl.).

position of an object seen through the Microscope will be the same as when they are used without a Microscope, i. e. so long as the plates are in one plane the image is unchanged in its position, but as soon as the plates cross at an angle it will be separated into two images of equal size, which are displaced in opposite directions. By turning the plates through a sufficient angle the displacement can be so arranged that the margins of the two images which are turned to each other shall coincide, and a compound image is formed which, in the direction of the displacement is twice as large as the original one. For the same eye objective and eye-piece and for a constant distance of both from the axis of the plates, the angle of inclination to be given to the plates, in order to double the image, bears a fixed relation to the size of the object and may therefore be used to measure it.

If a table is prepared showing the values in mm. of the angles of inclination of the plates, it is only necessary in measuring an object to turn the plates until the image is doubled and ascertain the angle between them, and the table will then give the dimensions.

In fig. 123 the square box between the eye-piece and objective holds the Helmholtz plates which are rotated by the outer milled head, the angles of inclination being read off on the large graduated drums on each side.

It is claimed that by the use of this instrument those errors are avoided which arise in the use of the eye-piece micrometer if the image of the object does not exactly fall in the plane of the micrometer divisions. The angles can moreover be read with greater precision than the micrometer divisions.

Baumann's Callipers with Movable Microscope and Fixed Micrometer.*—T. Baumann's instrument (fig. 124), in which the Microscope is movable and has a fixed micrometer in the eye-piece, is not intended for such minute measurements as the preceding, but was devised for cases for which a vernier is not sufficiently exact, while a screw micrometer is too fine or not sufficiently rapid. It will read to 0·04 mm. In a base plate A A, 200 mm. long, a central groove is cut, along which moves the cylinder *a*. The upper edges of the groove are bevelled off by a cylinder of the same diameter as *a*. The cylinder moves freely along these without attachment of any kind, to avoid errors of tension, &c. To one end of the cylinder is attached a glass plate C, another glass plate B being fixed exactly parallel at the end of A, the two plates forming the jaws of the callipers. The cylinder is moved by the ivory handle at *h*. A plate *u u* is attached to the former on one side, to which plate are fastened the two supports *g* which carry the socket of a compound Microscope *l o* (78 mm. high and magnifying 50–60 times). The supports *g* rest on the base plate. The socket is divided and the two halves are clamped by the milled head *m*. The inside of the socket has a worm so that by turning the ring *k* the Microscope is moved up or down for focusing.

The edge of the base plate is divided on silver for 150 mm. into

* Zeitschr. f. Instrumentenk., iv. (1884) pp. 149–52 (2 figs.).

0·2 mm. The centimetres are numbered with large figures and the millimetres by microscopic figures from 0 to 9. The approximate position of the Microscope is read off by a pointer. One of the smaller figures is always in the field of the view, which is 1·5 mm. in diameter. At *l* is a micrometer which can be rotated in azimuth.

Fig. 124.

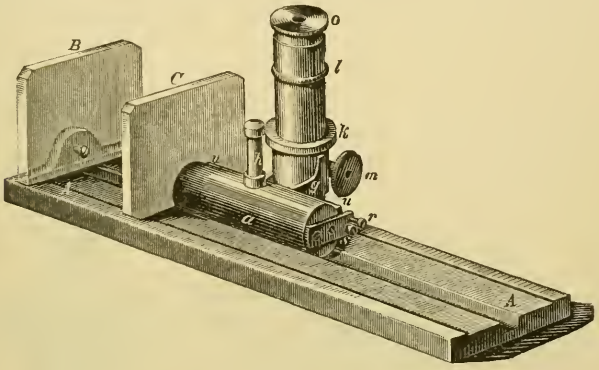


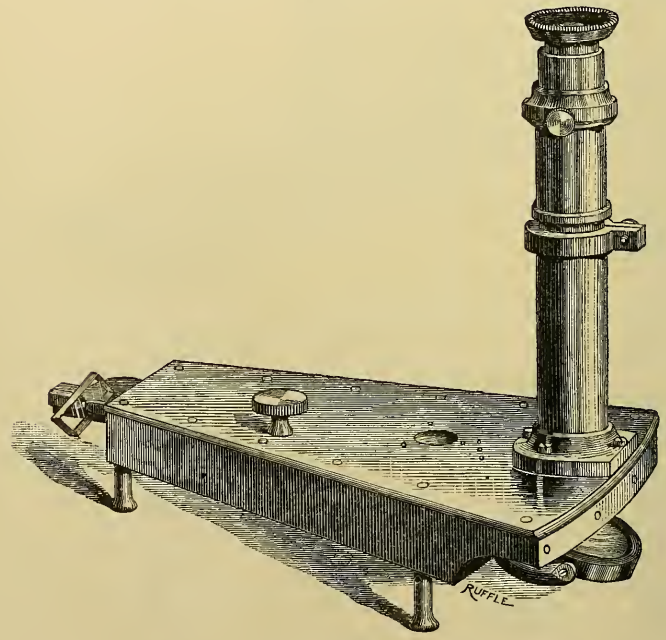
Fig. 125.

Its five divisions coincide with one of the scale as seen through the Microscope, and each is therefore equal to a fifth of 0·2 mm. or 0·04 mm. The divisions are preferably inclined, as shown in fig. 125. The reading in this case is 4·936 mm. as the last line of the micrometer (reading from right to left owing to the inversion of the image) is 3·4 divisions from the 4·8 mm. point of the scale. As each division is 0·04 mm., 3·4 of these divisions = 0·136 mm. The

coincidence of the 0 point of the scale with that of the micrometer is obtained by the screws *r* and *s* acting on the plate *u u*, which is not rigidly fixed to the cylinder *a*, but slightly movable.

Geneva Co.'s Microscope Callipers.—In the instrument, fig. 126, (made by the Société Genevoise pour la construction d'Instruments de Physique), a compound Microscope is made use of for measuring minute thicknesses such as cover-glass, &c. It consists essentially of a lever at one end of which are the jaws for holding the object to

Fig. 126.

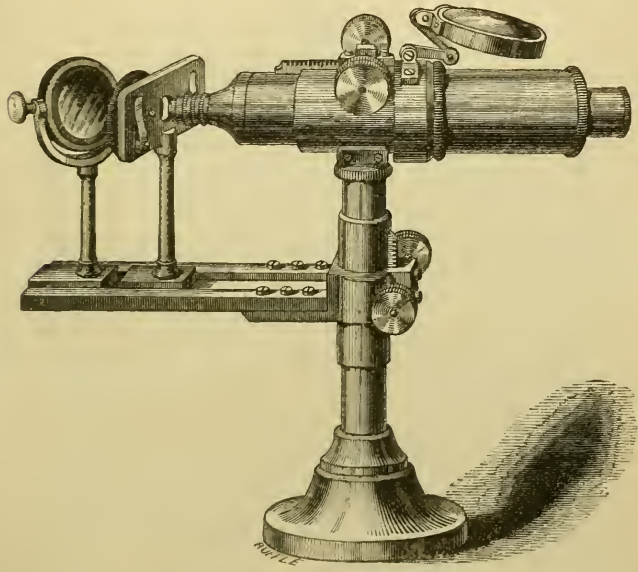


be measured (shown in the figure with a piece of glass between them), and the movement of which is amplified twelve times. At the other end the lever carries a glass plate ruled with 120 divisions, which is observed through a Microscope having a fixed micrometer in the eye-piece with 30 divisions. The jaws are opened by the milled head on the box, and the extent of movement is indicated by a scale with 120 divisions (corresponding to the glass plate), which passes under the aperture seen at the top of the box. By the eye-piece micrometer the principal divisions may be further subdivided. When open the jaws are 3 mm. apart; each of the principal divisions represents therefore 1/40 mm., and the subdivisions 1/1200 mm. The mirror illuminates the divisions of the glass plate.

Griffith's Club Microscope.—Mr. E. H. Griffith writes us that he has further improved the 'Griffith Club Microscope'* as follows: "The bar that holds the clips has a stiff spring over it. The front of the bar is flattened. The clips may be turned back out of the way, and when needed again the spring holds the clips down (or the bar in position). Some have been made with an arrangement to push the bar either way, letting the bar pass through the stage-holder but above it a nut gives the double clips a lateral motion and the spiral spring keeps the bar steady. The double clips clasp the slide and carry it with them. The lamp attachment has been improved also."

Nachet's Class Microscope.—This (fig. 127) was intended by M. A. Nachet to be passed round amongst the students in a class, being at the same time very steady on the table. It can only be used in a

Fig. 127.



horizontal position. The body-tube is focused by the rack and milled heads at the top, while the stage and mirror, which slide on the horizontal bar, are raised or lowered by the milled heads at the side of the standard. The shifting of the object from right to left is effected by the hands.

Nachet's Microscope with Large Field.†—A. Gravis describes a new Microscope by M. A. Nachet, of which the speciality appears to be that it affords a larger field of view than usual in Continental

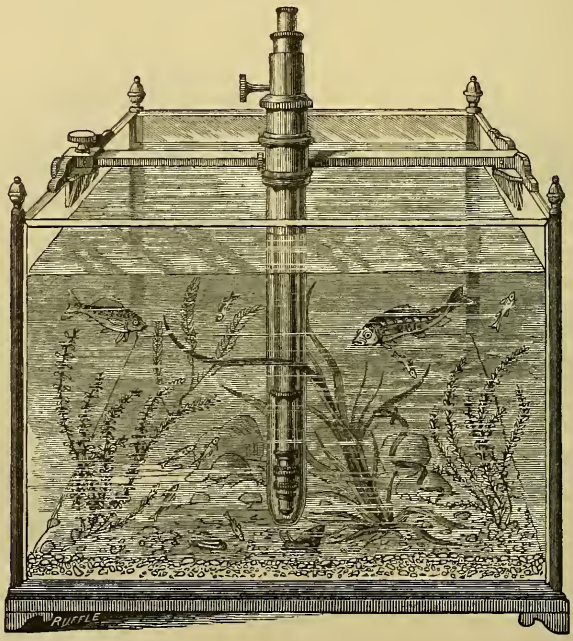
* See this Journal, iii. (1883) p. 113.

† Bull. Soc. Belg. Micr., x. (1884) pp. 194-7.

Microscopes, and is thus specially adapted for dissecting, examining large sections, &c. The tube has an interior diameter of 29 mm., and the apparent diameter of the field measured at a distance of 250 mm. by means of the camera lucida is 200 mm. With the ordinary Nachet No. 1 eye-piece this diameter is only 135 mm., and with No. 1 Prazmowski 110 mm. There is a variable objective, which when shortened gives a magnifying power of 15 with a working distance of 28 mm. and real diameter of 13 mm. When extended these figures are 23, 7 mm. and 8·5 mm. respectively.

Stephenson's Aquarium Microscope.—This Microscope (fig. 128) was designed by Mr. J. W. Stephenson for the examination of living objects in an aquarium.

Fig. 128.



A brass bar is laid across the aquarium, as shown in the woodcut. To adjust it to aquaria of different widths the support on the left is made to slide along the bar, and it can be clamped at any given point by the upper milled head. The milled head at the side, by pressing on a loose plate, fastens the bar securely to the aquarium.

Between the ends of the bar slides an arm carrying a sprung socket, and the arm can be clamped at any given point of the bar. Through the socket is passed a glass cylinder, cemented to a brass collar at the upper end and closed at the lower by a piece of cover-

glass. Into this cylinder is screwed the body-tube of the Microscope with eye-piece and objective, which are thus protected from the water of the aquarium. The Microscope is focused by rack and pinion (milled head just below the eye-piece), and in addition the objective is screwed to a draw tube so that its position in the cylinder may be approximately regulated.

The arm of the socket is hinged to allow of the Microscope being inclined in a plane parallel to the sides of the aquarium. The lower milled head clamps the hinge at any desired inclination. The socket also rotates on the arm so that the Microscope can be inclined in a plane parallel to the front of the aquarium. Thus any point of the aquarium can be reached.

Swift and Son's Oxyhydrogen Microscope. — This (fig. 129) is suitable for use with ordinary objectives from 4 in. to 1/4 in. The gas jet can be regulated for either parallel or convergent light without the necessity of opening the lantern, it being mounted on

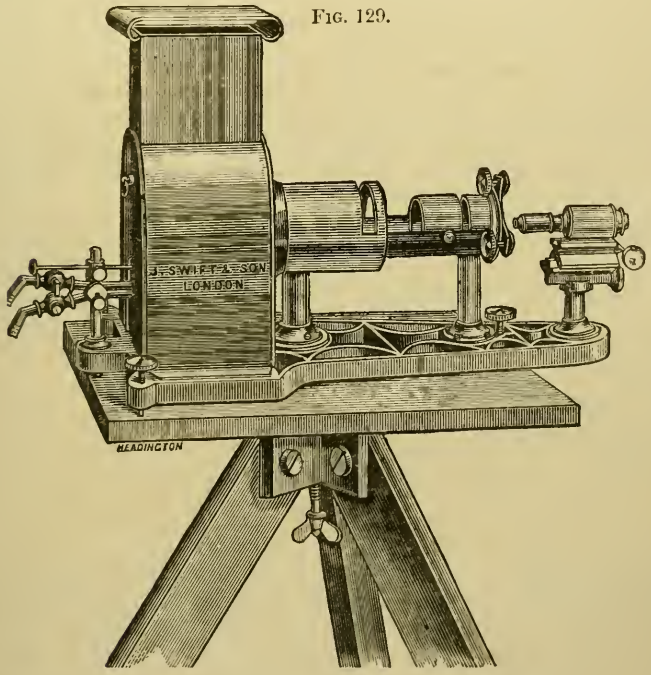


Fig. 129.

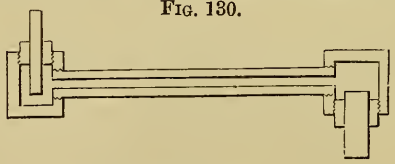
an independent pillar 2 in. from the back, and fitted to adjust to or from the condensing lenses as occasion may require. The perforated metal base renders it very light, and also allows the passage of a free current of air, so that the lantern is kept as cool as possible. There are three screws, upon which the whole is supported to finally adjust

the disk of light. The tube into which the convergent lenses, polariscope, and spot-lens fit, is cut open for the purpose of easily dropping these pieces into position; this opening is covered with a revolving segment of tube similar to the breech action of the Martini rifle.

The stage has rectangular motions by cams which are moved by the milled heads at the back of the stage, and the clip holding the object will equally clamp the thinnest slide or a thick zoophyte trough, the clip is lifted by turning the milled head. The coarse focusing is by rack and pinion, and the fine adjustment is similar in construction to that of the ordinary Hartnack Microscope. The alum trough for stopping the heat-rays can be used behind the condensers for convergent rays, or inserted in the opening in front when parallel light is required, the opening being covered by a revolving segment of tube when not used.

Nelson's Hydrostatic Fine Adjustment.*—E. M. Nelson considers that "the growing increase in the use of wide-angled object-glasses calls for an improvement in the fine adjustments of Microscopes. This is especially the case when it is remembered that depth of focus is inversely proportional to N.A. Also the Microscope is used in a far more scientific manner than the rough and ready way of former days. Among the best workers critical pictures are now the only ones accepted. A vast improvement has taken place in the construction of object-glasses, but the fine adjustments are pretty much the same as they were twenty-five years ago. The following diagrams illustrate a method that has occurred to me, and which, if adopted, would, I think, effect an improvement in this direction. It is simply an iron chamber filled with mercury, with a plunger and a ram. The fine adjustment screw works on the plunger, and the ram on a stud fixed to the nose-piece, which is kept pressed against it by a spring. Fig. 130 shows the arrangement as adapted to a bar movement. Here there are two chambers connected by a pipe, the

Fig. 130.



plunger being in one, the ram in the other. Fig. 131 shows the same thing adapted to a Jackson-Lister. It will be observed that the fine adjustment screw may be on either side or behind the bar. Fig. 132 shows it as arranged for the Continental or medical student's model, which has the direct-acting, non-geared-down, screw fine adjustment. The application of this contrivance to these Microscopes would be invaluable, as their present fine adjustments preclude the possibility of any fine work being done with them. As drawn, the

* Paper read at Quek. Micr. Club. Cf. Engl. Mech., xxxix. (1884) p. 576 (3 figs.).

apparatus gears down 1 : 4, but by varying the relative diameters of the plunger and the ram the ratio could be reduced almost to any extent—e g. a plunger of 1/12 in. and a ram 1/2 in. would gear down

Fig. 131.

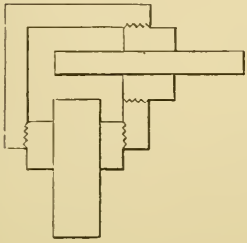
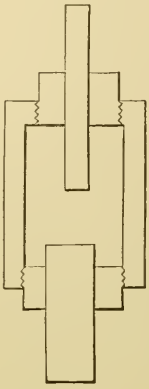


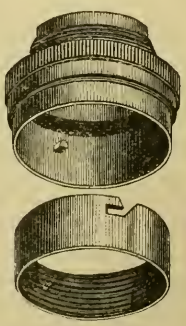
Fig. 132.



in the ratio of 1 : 36, so that one revolution of a 50-thread screw would only make a movement of 1/1800 of an inch in the objective."

Griffith's Nose-piece.—Mr. E. H. Griffith suggests yet another form of nose-piece as shown in fig. 133. The adapter has a short pin fitted on the inner surface of the cylinder, while the ring for the objective has a bayonet slot. The ring is as deep as the Society-screw to the objective, allowing it to be put into the box with the latter. This device was employed by Chevalier many years ago.

Fig. 133.



Kellner Eye-piece with additional Lens as a Condenser.—At the closing meeting of the last Session, after Dr. Wallich had pointed out the advantages of his new form of condenser, Dr. R. L. Maddox explained the plan he had used for some time, especially when photographing minute objects, such as bacteria. Instead of the usual pin-hole in the cap of a Kellner eye-piece, he substituted a movable diaphragm, with a small deep lens of 1/12 in. radius and of some thickness. The diaphragm, with lens duly centered, slides by friction in the cap of the eye-piece, and is pushed up close to the ordinary opening; the cap is then closed down upon the eye-lens to the best position for the purpose required. Single lenses of other radii can also be tried. The whole is used as a substage condenser, and with or without the usual diaphragm wheel.

The advantage claimed for this form is its inexpensive addition to what is ordinarily part of the apparatus of the microscopist. It can be used as an ordinary or immersion condenser, and when employed for photo-micrography, on looking along the path of the illumination from behind, a ring of light is observed round the edge of the field lens, equally divided by a narrow vertical image of the flame, if all the parts be correctly centered.

Osborne's Diatomescope.*—Lord S. G. Osborne calls attention to a little instrument he has invented, which he thinks "may, when once known, be of great service to those observers who, like myself, take great interest in the study of the beautiful forms found in the diatom class of objects.

I have now, for a very long time, worked patiently in an endeavour to procure the means of viewing these objects by oblique light. I possess many of the modern inventions for the purpose; with all I could get much good result; but I yet failed with them to arrive at my chief aim—to possess means of a simple character, easy to use, capable of being put into the market at small cost, which should give with all powers, from 1 in. to 1/4 in., a perfectly black background, the objects under observation brilliantly illuminated.

I have now done this, and the rough models made by my own hands have been seen in use by some well-skilled observers, who have all admitted that my purpose has been fully achieved.

It was my first intention to have simply published in your columns the formula for the construction of the instrument; but having had to make a great many with my own hands, experience taught me that it would be far better to employ skilled labour to act in the first instance under my own supervision to secure accuracy, than to risk the disappointment in the case of those who, wanting my practical experience, might well fail to get all the nicety of adjustment necessary for success.

I therefore have gladly availed myself of the offer of Mr. Ernest Hinton, who has had much experience in connection with the mounting of diatoms, to aid me in getting the little apparatus accurately made. . . .

The instrument is applicable to the stage of any stand which has the usual lateral and vertical movements, and if there is a clamp to keep the slides *in situ*, nothing more is wanted; failing the existence of a clamp, two small pegs fixed to the instrument to drop into two holes in the sides of the stage will answer equally well. If, as in some of the small stands, the aperture in the stage is circular, no clamp is necessary, as the instrument can be set in a piece of tubing to drop into this, with a narrow thin flange to prevent its falling through.

In whatever way it is applied to the stage, the method of use is very simple. The stage being set central, the diatomescope is either laid on it, or, as above, dropped into it. It is well to have a pilot slide. I always use the '*Orthosiren*.' Place this in the springs,

* Engl. Mech., xxxix. (1884) p. 561.

focus the mirror so as to throw light through the slide; with very little manipulation of stage and mirror you will find there is a position of the field in which, with 1-in. power, the centre of the slide has the objects illuminated on dark ground. A very little practice will effect this. You can now change for any object of the class you wish, not moving either mirror or stage; but you will find that if you now put on, say, a 1/4-in. objective, you may have to move the stage a very little to get the full effect; you will also find that by using lateral movement only you will get with the high powers at the edge of the dark field a pearl-coloured light, giving most beautiful definition.

From some that I have constructed with very small lenses I have been astonished to find the comparatively large field I obtain. I get by the above means a result such as I had never conceived possible—effects most beautiful; good slides of *P. angulatum* (Möller's) with 1/4 in. are lit up as with electrical light, on what I may well call perfect black background, and this with wonderful definition. The way all the beautiful markings of all the coarser diatoms are brought out is most satisfactory. The *Podura* and other scales I certainly never had really seen before as I can now see them. With a Zeiss 1/14 I get beautiful definition of everything short of *A. pellucida*.

What I chiefly claim for the invention is, however, not simply the results thus obtained, but that they can be so obtained with scarce any trouble by a simple apparatus of small cost, thus giving to those who cannot afford the more or less costly affairs now in use equal means of enjoying the study of this class of objects.

I have fitted some to the substage of my large stand with advantage; but these would be more costly, as they require a different position of the parts of the instrument, and are not so readily applied.

I have arrived at one fact in experimenting, which I have not the scientific knowledge to explain. Say that I have some *P. angulatum* well shown with high power, and that the background is very black; strange (to me) to say, by shutting in the binocular prism it makes this ground even darker still. . . . I use no condenser to throw light on the mirror, only a common reading-lamp with small flame; either this, or the white cloud of daylight, answers every purpose. The apparatus is constructed to work with the source of light on the left hand."

S. C. S. says * that the above "leaves microscopists no wiser than they were before," and "hopes, if his lordship really wishes to benefit his fellow-workers with the Microscope, he will publish his formula for the construction of the Diatomescope," but this his lordship objects to do.†

Hardy's Collecting Bottle.‡—Mr. J. D. Hardy devised this apparatus for collecting and examining aquatic specimens whilst out on excursions. It consists of two plates of glass with a narrow strip

* Engl. Mech., xl. (1884) p. 18. † Ibid., p. 38.
‡ Journ. Quek. Micr. Club, ii. (1884) pp. 55-6.

of thick indiarubber cemented between them on three sides, the fourth side being left open, and thus forming a very convenient flat bottle for the side coat-pocket. The space between the glasses is sufficient to allow of *Anacharis* 5 in. long being inserted without pressure, at the same time enabling the collector to bring all parts of the weed into good focus. By the insertion of an indiarubber flat cork the bottle is rendered water-tight, and can be used as a slide on the stage, so as to obviate the necessity of disturbing the weed should any object of interest be observed when collecting.

Mr. Hardy also proposes a simple and effective method of straining the water poured into or out of an ordinary wide-mouthed collecting bottle, viz. by means of a small cylinder of copper wire gauze, which extends above the neck of the bottle.

Eye-piece Amplification.—Prof. Abbe points out that his view as to the comparatively low eye-pieces which the best Microscope objectives of the present day will usefully bear * is supported by the recognized rules for telescopes.

"The essential principle for a valid comparison of the telescope and the Microscope is that every Microscope involves in its action that of a given telescope. The effect of the Microscope cannot in any case extend farther than the effectiveness of such telescope. Now the most trustworthy power of eye-piece for a telescope is approximately 40 per inch of the diameter of the objective, i. e. 1/4 in. focal length for every telescope in which the proportion of focal length to aperture is 1 : 10. This relation of eye-piece to objective in the telescope is exactly paralleled in the Microscope when to a 1/8 in. dry objective of maximum aperture is applied (with a 10-in. tube) a 1 in. eye-piece, or a 3/4 in. eye-piece with a homogeneous immersion 1/8 in. of 1·33 N.A.

If therefore it is contended that Microscope objectives can usefully bear the application of a 1/4 in. eye-piece, it must at the same time be contended that a telescope will bear a useful power of 120 per in. aperture!"

Illumination and Focusing in Photo-Micrography.†—Dr. R. A. Hayes, after considerable experience with electric (arc) magnesium, lime, gas, and oil-lamp lights, finds that only the lime-light and the oil-lamp fulfil the necessary conditions required in the case of a source of artificial light for photo-micrography which shall at the same time have light-illuminating power, be perfectly steady, possess very active actinic properties, and be easily produced and maintained. The use of the oil-lamp being confined to cases where the magnifying power does not exceed 50–100 diameters; or in other words, to the 1 in. or 1/2 in. objective. The difficulty as to the intensity of the light is not so much in reference to the exposure of the plate, as to

* "Usefully" that is in the sense defined in Prof. Abbe's paper, Vol. III. (1883) p. 790, and not merely "useful" for an amusing exhibition of the diffraction phenomena.

† Proc. R. Irish Acad. (Sci.) iv. (1884) pp. 59-61.

the impossibility of getting the image focused in a satisfactory manner, the great rapidity of the dry gelatine plates now in use making the time of exposure quite a secondary matter.

The arrangement for making the photographs is as follows:—In front of the condenser of the lime-light lantern is fixed a tube 10 in. in length, at the further end of which is placed a plano-convex lens, of about 2 in. focal length, mounted in a sliding tube movable by rack and pinion, the beam of light passing through which comes to a focus, and then while only slightly divergent falls on the achromatic condenser fixed in the substage of the Microscope. This arrangement gets rid of most of the heat-rays; the beam passing through the condenser traverses the object to be photographed, the image of which is projected directly on the screen by the object-glass, no eye-piece being used. For focusing, a sheet of glazed white paper is used pasted on a glass plate placed in the dark slide. By focusing in this manner as one sits in front of the screen the various adjustments of the Microscope and condensers are easily made, while keeping a distinct view of the image.

As regards the details of focusing the image, he adopts the following method:—

The object having been brought into the desired position and roughly focused, it is then by means of the mechanical stage removed from the field, and the diaphragm aperture which is intended to be used in the particular case having been placed in position, the achromatic condenser and light are manipulated until the field is evenly illuminated; the diaphragm plate is then revolved until the full opening is reached; the object is then brought back into position, and the best possible image obtained by means of the fine adjustment; the diaphragm plate is then again returned to its former position; the image, of course, gains much in sharpness, and although quite sufficiently bright to produce an impression on a rapid plate, is not at all in as satisfactory a condition for accurate focusing as when presenting a brighter appearance.

When all the adjustments have been made, the sleeve suspended from the frame is placed in position, one end of it being attached to the sliding front of the camera, and the other end to a pasteboard cylinder, which fits on to the back of a narrow box, containing a sliding shutter by which the exposure is made. To the front of this box the body of the Microscope is attached by a small black velvet sleeve which completes the camera. The large sleeve is made of mackintosh cloth, with three hoops fastened inside to prevent its collapsing.

Mitchell's Focusing Glass for Photo-Micrography.*—G. O. Mitchell, finding that no matter how finely the focusing screen was ground, it would not allow the finer details of objects to be seen, made use of a Huyghenian eye-piece in the following manner. A narrow strip of thin board, 15 × 2 × 3/8 in., had a circular hole cut in its centre through which the eye-piece could be just forced with con-

* Amer. Mon. Micr. Journ., v. (1884) p. 81 (1 fig.).

siderable pressure and a screwing motion. Throwing back the ground-glass screen and allowing the projecting ends of the strip to rest upon the edges of the camera, as clear and distinct an image was obtained as in looking through a Microscope.

To adjust the glass to the position occupied by the plate during exposure, focus with the ground-glass screen upon a printed text placed at some distance from the camera, using an ordinary view lens and getting the edges of the letters as sharp as possible. Then throwing back the screen and being careful not to change the position of the bellows, apply the eye-piece with its carrier resting against the edges of the box, and screw it in or out till the sharpest and clearest focus is obtained, making a mark upon the eye-piece to serve in case of accident.

When an objective is used which is not well adapted to photographic work, owing to the difference between the focus for vision and that for actinic rays, the eye-piece can be so adjusted, by experiment, that when the image is sharp as seen in the eye-piece the actinic rays will be focused on the plate.

Photo-Micrography in Legal Cases.*—Dr. W. T. Belfield points out that among the numerous applications of photography, none is more satisfactory to the operator than photography with the Microscope in legal cases, it being indeed the only way for conveying to judge or jury absolutely accurate and faithful conceptions of the microscopic appearances upon which the expert microscopist bases his evidence.

It is naturally and notoriously difficult to present technical evidence clearly to a jury; and this difficulty arises not necessarily from any lack of intelligence on the part of the jury, but simply from their lack of technical knowledge of the subject in question. The difficulty is especially great in presenting facts obtained through the Microscope. The actual exhibition of such objects as blood-corpuscles in court cannot be satisfactorily accomplished, and while drawings made with the Microscope are admissible as means of general *illustration*, they are totally inadmissible as *representations* of absolute accuracy and fidelity to nature.

The photograph is the only method which we at present possess whereby accurate and faithful representations of microscopic objects can be presented to individuals who are not familiar with the instrument.

The author then relates a case coming within his own experience of the application of photo-micrography to the determination of a legal question.

"I was induced to submit hairpins to microscopic examination some months ago under the following circumstances:—In the pocket of Zura Burns, found murdered at Lincoln last October, was found a single hairpin; in the buggy of O. A. Carpenter, suspected of having perpetrated the murder, were found two pins, one of which appeared to be the exact counterpart of the pin found in the girl's pocket.

* 'Photography' (Chicago), i. (1884) pp. 54–9 (7 figs.).

The prosecuting attorney inquired of me whether or not the Microscope would reveal additional proofs of the similarity of the two pins. I had at that time never made a critical examination of hairpins with the Microscope, and was not aware that such examination had been made by others; I so informed him. I was commissioned to investigate the subject.

The two pins were of the pattern known as the 'crimped' or curvilinear hairpin; I therefore directed my investigation to the structure of these pins and the mode of their manufacture. I found that these 'crimps' are made by a punch which bends the wire; and it became evident that the pins made in the same machine would probably exhibit the same punch marks or indentations at the curves. An examination of numerous packages of crimped hairpins showed that such was actually the case; all the pins from a given package as bought in the store, showed precisely the same marks at the same points on the pin. Pins of different manufacture, even though similar to the naked eye, showed different punch marks, corresponding to their production in different machines. Nos. 1 and 2, Fig. 134, are specimen punch marks, the two pins photographed having been obtained from different packages. Of course merely a small fragment of the pin is represented.

Fig. 134.

All the hairpins contained in the package from which No. 1 was taken, exhibit the same indentation at the same point on the pin; all of those in the package from which the second hairpin was taken, exhibit the same mark as is pictured in No. 2. However close the resemblance to the naked eye, therefore, such pins can be readily identified or distinguished with the aid of the Microscope by means of these marks.

The two hairpins already mentioned in connection with the Carpenter case were sent by express to my address; one of them—that found in the girl's pocket—was unfortunately lost *en route*. Upon examining the other with the Microscope, I found that it presented four distinct machine marks, the most prominent of which is represented in No. 3. The loss of the other hairpin seemed at first to vitiate the value of the information which might probably be derived from a comparison of the two. However, it was ascertained that on the morning of her departure from home (in St. Elmo) for Lincoln, the girl's father had purchased for her at a country store a package of pins, some of which she had used in making her toilet, the remainder being placed in her pocket. The prosecuting attorney forthwith bought all the hairpins in stock at the store where this purchase had been made. The stock was found to consist of the one variety of pin from which a small packet had been sold to the girl's father. Microscopic examination of these pins showed precisely the same machine markings as were exhibited by the pin found in Carpenter's buggy. A photograph of the indentation on one of these

pins from the St. Elmo store is copied in No. 4. I was thus enabled to assert that the pin found in Carpenter's buggy must have been made in the same machine as those used by the girl just before the murder.

These pins were, moreover, of a peculiar pattern; among eighty packages purchased in Chicago and in Lincoln, and some twenty odd hairpins obtained at random, I did not discover a single pin exhibiting the same markings. The scarcity of pins of this pattern was afterwards explained by the fact that the factory in which they had been made was closed eleven years ago. The rarity of hairpins made in this particular machine combined with the presence of one of them found in Carpenter's buggy, rendered it highly probable at least that the girl had ridden in this buggy."

American Society of Microscopists.—The deputation (Dr. Dallinger and Mr. A. W. Bennett *) appointed to represent our Society at the Rochester, N.Y., meeting of the American Society have not yet returned from America, so that we are not in a position to give any authentic report of the proceedings of the meeting, but we understand from private sources that nothing could exceed the courtesy and warmth with which the deputation were received by our American brother microscopists, everything being done to testify to the friendly feeling entertained for our Society on the other side of the Atlantic. We are sure that Dr. Dallinger and Mr. Bennett did not leave unacknowledged at the time the courtesies extended to them, but the appreciation of the Society at large will remain to be expressed at the ensuing meeting, by which time it is anticipated that the deputation will have returned.

The toast of "The Royal Microscopical Society" was proposed at a supper given to the American Society, and Dr. Dallinger was elected an Honorary Fellow.

Health Exhibition. — The connection of this exhibition with health is, as is generally recognized, one of a very slender kind, and it is to be regretted that such a department as the Biological Laboratory, which in a true "health" exhibition would have occupied a prominent place, is relegated to the comparative obscurity of the topmost rooms of the lofty City and Guilds Institute.

The laboratory is under the charge of Mr. W. Watson Cheyne, M.B., who exhibits a large series of microbes of various kinds, isolated and growing in the media suited to them. The laboratory contains examples of fungi injurious to animals or plants, or altogether innocuous; and it is well equipped with apparatus and appliances, including incubators, sterilizers by steam and dry air, aspirometers, and Microscopes; there are also 36 photo-micrographs and some diagrams, among the latter of which are those that illustrate the excellent influences of vaccination and re-vaccination, and show that in later years no German soldier has died of small-pox, and that in some years only 2·12 in 100,000 have been ill of it. Many of the

* Mr. Glaisher was unfortunately prevented from attending.

specimens and most of the diagrams have their origin in Dr. Koch's laboratory. On Thursday afternoons microscopical preparations are exhibited, and at 4 P.M. on that day Mr. Cheyne gives a demonstration.

Microscopes and apparatus are exhibited by Messrs. Beck, Powell, Swift, Watson, and other makers.

American Society of Microscopists.
[Further Notes as to the Rochester Meeting by G. E. Davis, R. Hitchcock, C. H. Stowell, D. S. Kellicott, E. H. Griffith, and E. Bausch.]
Micr. News, IV. (1884) pp. 195–6.
Amer. Mon. Micr. Journ., V. (1884) pp. 136–7, 139.
The Microscope, IV. (1884) pp. 160–1, 162–3, 163–4, and 164–5.

Baumann, T.—Ueber einen Scalen-Taster mit festem Mikrometer im Mikroskop. (On Callipers with fixed Micrometer in the Microscope.) [*Supra*, p. 794.]
Zeitschr. f. Instrumentenk., IV. (1884) pp. 149–52 (2 figs.).

Bausch and Lomb Optical Co.'s New Illuminator. [*Ante*, p. 623.]
Amer. Mon. Micr. Journ., V. (1884) p. 126 (1 fig.).

Behrens, W.—Eine neue Construction des Abbe'schen Beleuchtungsapparates. (A new Construction of Abbe's Illuminating Apparatus.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 409–12 (1 fig.).

Blandy, H.—Culpepper's Microscope.
[Description of one.] *Engl. Mech.*, XL. (1884) p. 97.

Bottone, S.—See Wright, L.

Bulloch, W. H.—"Falsus in uno, falsus in omnibus."
[Further reply to Prof. McCalla in regard to the Congress Nose-piece.]
The Microscope, IV. (1884) p. 163.

Cooke, M. C.—The President's Address (1884).
[To "serve as a caution to some of our younger members, and at least convince them that an old microscopist of 40 years' experience believes it to be his duty to warn them of one of the vices of the age, and to put them on their guard against exaggeration."]
19*th Report Quekett Micr. Club*, 1884, pp. 9–18.

D., E. T.—Graphic Microscopy. VIII. Spiracle of Breeze Fly (*Œstrus equi*). IX. Polypidom of *Lepralia nitida*.
Sci.-Gossip, 1884, pp. 169–70 (1 pl.), 193–4 (1 pl.).

Dallinger, W. H.—The Lowest and Smallest Forms of Life as revealed by the Modern Microscope.
[Some of the principal passages of lecture at the Montreal Meeting of the British Association. *Supra*, p. 721.]
Times, 2nd September, 1884.
Engl. Mech., XL. (1884) pp. 10–1.

Davis, G. E.—Objective Changers.
["We have never found the so-called instantaneous changers to enable more work to be done, and we have even discarded the double nose-piece in ordinary work."]
Micr. News, IV. (1884) p. 218.
„ „ Proceedings of Provincial Societies.
Micr. News, IV. (1884) p. 218 and p. 215.

Dudley, P. H.—[Exhibition of Photo-micrographs of sections of American timber-trees taken with ordinary lamp-light and enlarged 100 diameters.]
Bull. Torrey Bot. Club, XI. (1884). p. 84.

Ermengem, E. Van.—Microphotographies obtenues à l'aide des plaques isochromatiques préparées par Clayton et Attout-Tailfer. (Micro-photographs made with the isochromatic plates of Clayton and Attout-Tailfer.) [*Post.*]
Bull. Soc. Belg. Micr., X. (1884) pp. 170–2.

GIACOMINI.—Nuovo Microscopio per l'esame delle sezioni dell'intero encefalo umano adulto. (New Microscope for the examination of sections of the entire human adult brain.) [*Post.*]
Giorn. R. Accad. Med. Torino, 1883 (1 fig.).
Gazz. delle Clin., 1883, p. 528. Cf. *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 427–9 (2 figs.).

GRAVIS, A.—Microscope à grand champ de A. Nachet. (Microscope with large field of view, by A. Nachet.) [*Supra*, p. 797.]
Bull. Soc. Belg. Mikr., X. (1884) pp. 194–7.

GROVE, W. B.—A Synopsis of the Bacteria and Yeast Fungi and Allied Species. (Schizomycetes and Saccharomycetes.) [Contains Appendix A, pp. 101–2, "On the Unit of Micrographical Measurement" [*post*], and Appendix B, pp. 103–4, "On the staining of '*Bacillus tuberculosis*,'" describing Koch's, Ehrlich's, Gibbes', and Prideaux's methods (*supra*, p. 787).] vi. and 112 pp. (87 figs.), 8vo, London, 1884.

GUÉBHARD, A.—Puissance et grossissement des appareils dioptriques. (Magnifying power of dioptric instruments.) [*Post.*]
Rev. Scientifique, XXXI. (1883) pp. 804–11 (5 figs.).
Transl. *Centralztg. f. Optik. u. Mech.*, V. (1884) pp. 183–8 (6 figs.), 194–7.

HANAUSEK, E.—Eine zweckmässige Mikroskopierlampe. (An effective microscopical lamp.)
[A petroleum lamp made by Rob. Rühe, at Landsberg a. W. Over the glass chimney is placed a metal structure of white composition, consisting of a conical tube inclosing the glass chimney, to which is attached a fixed metal cylinder placed obliquely. This latter is closed at the lower end by a convex lens of small curvature, and permits the application of a blue glass plate.]
Fachztg. f. Warenkunde, 1883, No. 6, p. 32.
Cf. *Bot. Centralbl.*, XVIII. (1884) p. 53.

HAYES, R. A.—Notes on Microphotographic methods. [*Supra*, p. 804.]
Proc. R. Irish. Acad. (Sci.), IV. (1884) pp. 59–51.

HEURCK, H. VAN.—Entgegnung auf den Artikel des Herrn Stein: Die Verwendung des elektrischen Glühlichtes zu mikroskopischen Untersuchungen, &c. (Reply to Stein's paper, "The application of the electric incandescence light to microscopical investigations, &c.)
[Same as the French protest, *ante*, p. 632.]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 419–22.

HITCHCOCK, R.—The Electric Light in Microscopy. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) pp. 138–9.

„ „ Growing Slides, or Microscopical Vivaria.
[Charters White's, and J. D. Hardy's, I. (1881) p. 671.]
Amer. Mon. Micr. Journ., V. (1884) p. 141 (1 fig.).

HOLLEY, G. W.—Suggestions for improvement in the manufacture of glass. . . .
[Proposal "to improve the quality of glass by introducing silver into its composition."]
Journ. Frankl. Institute, CXVIII. (1884) pp. 132–8.

JANNEY, R.—Simple Solar Microscope. [*Post.*]
Scientific American, L. (1884) p. 276 (1 fig.).

KORITSKA, F.—Norme pratiche per l'uso del Microscopio. (Practical rules for the use of the Microscope.) 14 pp. 32mo, Milano, 1883.

LIMONT, W.—Notes on Modern Forms of the Microscope.
["When it can possibly be afforded, an English skeleton Microscope on the American (Jackson-Zentmayer) model should be got by students and others. . . . In no case is it a good investment to buy a foreign first-class instrument, and in most cases a first-class English 'skeleton' Microscope should be got in preference to a third-class Microscope, either English or foreign."]
Proc. Phil. Soc. Glasgow, XV. (1883–4) p. 118.

MERCER, F. W.—Incandescent Lamps and Accumulators in Photo-micrography.
[Describes Swan and Edison lamps, and a "small and very portable accumulator made on the Faure principle," with practical directions.]
Photography, I. (1884) pp. 147–9 (4 figs.).

M'Intosh, L. D.—Lanterns for Projection.
[Includes microscopic projections.]
Photography, I. (1884) pp. 131–4 (6 figs.).

Moeller, J.—Ein neues Präparirmikroskop. (A new dissecting Microscope.) [*Ante*, p. 613.]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 412–3.

Moore, A. Y.—Beck's Vertical Illuminator and Immersion Objectives.
[Description and directions for use. Also as to coating diatoms with silver, *infra*, p. 829.]
The Microscope, IV. (1884) pp. 157–9, 165.

" " The Fakir's Secret.
[*À propos* of F. L. James's account of the exhibition of paste eels as animalcules in water, *ante*, p. 146. The secret is probably the use of a few drops of cider vinegar, which promotes the growth of the eels.]
The Microscope, IV. (1884) pp. 170–1.

Nelson, E. M.—A hydrostatic fine adjustment. [*Supra*, p. 800.]
Engl. Mech., XXXIX. (1884) p. 576 (3 figs.).

" " Microscope Tube-length.
[Reply to query. "Place an object on the stage accurately centered and focused to the objective whose back focus is to be measured. Centre the substage condenser, and focus by it the edge of a flame on the object. Remove the object out of the field, leaving slip and cover-glass between objective and condenser. Take out the eye-piece. Insert down the tube of the Microscope a smaller tube having its lower end closed by a diaphragm of paraffined tissue paper. Slide this up and down until the image of the flame is focused on it, which will give the solution to the first part of "B. C.'s" question. By pushing the tube further down until the smallest spot of light is found, the place where the rays cross can be determined."]
Engl. Mech., XXXIX. (1884) p. 589.

" " Plane Mirror for Microscope.
[Reply to query. "I find it difficult to write a complete answer to 'Mirror's' question within reasonable limits, there being so many combinations and varieties of methods of illumination, each of which demands a separate consideration before the reply could be termed exhaustive. 1. When using artificial transmitted light with substage condenser, I, if possible, dispense with the mirror altogether and work direct; but when this is not possible, I use the plane mirror. 2. With lamplight, but without a substage condenser, concave mirror. 3. Diffused daylight without substage condenser, concave mirror with high and medium powers, plane with low. 4. Diffused daylight with substage condenser, always plane mirror. 5. Dark ground with lamp-light and bull's-eye, always plane mirror."]
Engl. Mech., XXXIX. (1884) p. 593.

" " Illumination for the Microscope (*in part*). [*Post.*]
Engl. Mech., XL. (1884) p. 68 (2 figs.).

Osborne, S. G.—The Diatomescope. [*Supra*, p. 802.]
Engl. Mech., XXXIX. (1884) p. 561 and XL. (1884) p. 38.
Also letter by S. C. S., XL. (1884) p. 18, *supra*, p. 803.

Pease, J. L.—The Facility Nose-piece.
[Description of it. *Ante*, p. 425.] *The Microscope*, IV. (1884) p. 171.

Plehn, J.—Apparat zur Prüfung der Brennweite des Auges oder anderer optischer Systeme. (Apparatus for testing the focal length of the eye or other optical systems.)
German Patent, Kl. 42, No. 27,860, 27th January, 1884.

Purser, J. M.—See p. 839.

[Redding, T. B.]—The Microscope. Its uses and revelations.
Indianapolis Journal, 16th August, 1884, p. 10.

S., S. C.—See Osborne, S. G.

Schöffler und Smolarz.—Das elektrische Gewehr, elektrische Minenzündung, elektrische Distanzmesser und das Gastroskop. 8vo, Wien, 1884, pp. 93–109. (17 figs.). Extr. from 'Die Elektricität und der Magnetismus.'

[Describes the Gastroscope, III. (1883) p. 420.]

Sexton's (L. R.) retirement from business.

Amer. Mon. Micr. Journ., V. (1884) pp. 158–9.

St. Clair, G.—Note on a possible source of error in photographing Blood-corpuscles. [*Post.*]

Nature, XXX. (1884) p. 495.

Stein, T.—Die Verwendung des elektrischen Glühlichtes zum mikroskopischen Untersuchungen und mikrophotographischen Darstellungen. (The application of the electric incandescence light to microscopical investigations and photo-micrography.)

[Additions to his original paper, *ante* p. 466, describing the battery of five elements which he uses.]

Centralztg. f. Optik u. Mech., V. (1884) pp. 170–1 (1 fig.).

Stewart, C.—Polarized Light.

[Report of Demonstration.] *Journ. Quek. Micr. Club*, II. (1884) pp. 37–41.

St. Joseph (Mo.) Microscopical Society formed.

The Microscope, IV. (1884) p. 165.

St. Louis Society of Microscopists.

[Adoption of a rule requiring each member to furnish six slides annually to the Society's cabinet.]

Science Record, II. (1884) p. 233.

Stowell, C. H.—High angles or low angles?

[As to the superiority for a physician of a 1/4 in. objective of 75° over one of 100°.]

The Microscope, IV. (1884) p. 180.

" " Mr. Griffith's new box.

[Facetious anecdote of a person to whom Mr. Griffith exhibited his Microscope and who thought the box the "handsomest he ever saw."]

The Microscope, IV. (1884) pp. 180–1.

Tolman, H. T.—Photo-micrography with an Eye-piece.

[Directions for photo-micrography generally.]

Photography, I. (1884) pp. 124–6.

Viguier, C.—Note sur un nouveau Compresseur à verres mobiles. (Note on a new compressor with movable glasses.) [*Post.*]

Arch. Zool. Expér. et Gén., II. (1884) pp. xii.–xvi. (5 figs.).

Wales' (W.) High-power lens for use with the Binocular.

[Apparently the same as that described III. (1880) p. 1050.]

Amer. Mon. Micr. Journ., V. (1884) p. 139.

Wheeler's (E.) retirement from business. *Sci.-Gossip*, 1884, p. 184.

Woodward, J. J., death of. *Times*, 17th September, 1884.

Wormley, T. G.—Microscopic Science.

[Abstr. of an address to the Section of Histology and Microscopy of the Amer. Assoc. Adv. Sci.

[Describes the advantages and possibilities of two special applications of the Microscope: first, to the detection of very minute quantities of certain poisons, notably arsenic, by the examination of the sublimate; second, to the examination of blood stains. Also the limits within which identification of different animals, and the recognition of human blood, is feasible; he denied that human blood can be absolutely identified; he also stated that the result of prolonged experiments indicated that pure water is the best reagent for restoring the blood-corpuscles in a stain to their natural condition.]

Science, IV. (1884) p. 244.

Wright, L.—Micro-photography.
[Reply to inquiry as to photographing diatoms and diffraction-gratings. Also reply by S. Bottone.]
Engl. Mech., XXXIX. (1884) pp. 519-20.

Zenger, C. V.—Détermination des Indices de Réfraction par des Mesures linéaires. (Determination of indices of refraction by linear measures.)
[Simple method of strict determination to the 5th decimal by means of a divided rule with a small telescope sliding on the alidade which carries the vernier.]
Comptes Rendus, XCIX. (1884) pp. 377-80.

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

Killing Infusoria.*—J. P. McMurrich finds that for killing infusoria, provided only a temporary preparation is required, a saturated solution of corrosive sublimate in water is the most useful he has tried. A drop or two run under the cover-glass produces almost instant death without any of the shrinkage so annoying even with osmic acid. After this treatment staining with anilin blue, black, or Brunswick brown takes place very rapidly and very satisfactorily.

Perchloride of Iron.†—H. Fol has overcome some of the inconveniences of this reagent and has made it "really practical." The iron salt may be completely extracted from a preparation fixed by being for 1/2–1 hour in the perchloride, diluted with alcohol, by washing with an aqueous solution of oxalate of potash, or an alcoholic solution of oxalic acid. The tissues can then be preserved in weak alcohol and stained with success by the ordinary process, using carmine, hæmatoxylin, and anilin dyes.

The author adds "These preparations are only distinguishable from those obtained by the usual fixing agents by the extraordinarily faithful preservation of the vibratile cilia, the pseudopodia, and the nuclear filaments."

Mounting of Foraminifera—New Slide for Opaque Objects.‡—Dr. F. M. Hamlin considers that for the finest forms, and for calcareous sands, such as the famed Bermuda sand, there is no plan so satisfactory as to search through the material with the Microscope, to save time and labour separating the sand into grades by passing it through sieves of three different degrees of fineness. The shells from the last will exercise the skill nearly as much as diatoms. Having sifted the sand, it should be examined on a specially devised slide, made as follows:—A piece of pasteboard the size of an ordinary slide has a long slit cut in it, and is then fastened to a glass slide. The width of this slip is of importance, and is determined thus: Take a low power objective, say a three or four inch, which affords just sufficient power to see the shells well, and measure the width of its field. Make the slit or opening in the pasteboard just twice this distance. The slide being ready, a little pinch of sand is put on the glass, and a slight shake spreads it out in a single layer confined by

* Amer. Natural., xviii. (1884) p. 832.
† Arch. Zool. Expér. et Gén., ii. (1884) p. ix.
‡ Proc. Amer. Soc. Micr., 6th Ann. Meet., 1883, pp. 65–8.

the pasteboard. It is then placed under the Microscope, and moving it so that the edge of the pasteboard is just visible, pass up one side and down the other, and every particle of the sand is brought into view without loss of time in searching over the same portions many times, and perhaps entirely omitting other. It is surprising what a quantity of sand can thus be looked over in a short time by this systematised labour.

The shells may be picked up by a very fine needle dipped in turpentine, or a very small camel's hair brush.

Not being satisfied with the ordinary slides and cells for this class of objects, the author has devised a slide which he thinks serves the purpose admirably; it is made as follows:—The slide itself is of wood, of the ordinary size, and about 1/10 in. thick. Through its centre is bored a hole 1/2 in. in diameter. Over the back of this is pasted a strip of stout paper. The hole in the slide with the paper back constitutes the cell. In the bottom of the cell is pasted a disk of coloured paper, cut with a gun-wad punch, to serve as a background for the "mount." To give a neat finish, a brass curtain-ring which just fits in the hole is fastened in with a bit of cement. The edges of the slide are now bound or covered with coloured tissue paper. The shell may now be arranged in the cell, and the cover-glass dropped in upon the brass ring, the top of which has been covered with cement. A suitable label the whole size of the slide is now pasted on the front, and a plain one may be put on the back.

Should a shell be very rare, and it is desirable to show both sides, a piece of thin glass may be let into the back of the slide, and the curtain-ring placed upon this instead of the paper background. Such a slide would need a hole in the back as well as in the front label.

When these slides are finished with pretty and suitable labels they make a fine appearance, pack and carry as easily as so many slips of wood, and if made of white bass wood do not warp. The porosity of the wood prevents any accumulation of moisture upon the cover-glass.

Hæmatoxylin as a Reagent for Non-lignified and Non-suberized Cellulose Membranes.*—The reagent described by E. Giltay in this paper and which he finds to be very sensitive and preferable in most cases to those hitherto employed for the purpose, is prepared as follows:—

To 5 cc. of a solution of hæmatoxylin (7 grams of hæmatoxylin to 50 cc. of water) add 100 cc. of a solution of alum (3/4 per cent.). The mixture should be prepared two days before it is required, and as it speedily becomes turbid, a small amount is filtered each time before use. The sections to be stained are left in from 5 to 15 minutes, according to circumstances, and subsequently mounted in glycerine, oil of cloves, or Canada balsam. In the last, or in oil of cloves, the colours keep for a long time.

In general this reagent and that of Schultze have the same action

* Arch. Néerland. Sci. Exact. et Nat., xviii. (1883) pp. 437–52.

on vegetable tissues, and they both stain blue. The value of the hæmatoxylin consists, however, in the fact that it does not stain the membranes which are completely transformed into cork or wood. It is therefore well adapted to reveal the unaltered cellulose elements in cell-walls which are imperfectly lignified or suberized. With Schultze's solution, which colours the lignified and suberized parts yellow, the blue colour simultaneously developed in the cell-wall is not brought out sufficiently clearly to enable the extent of the lignification to be determined with certainty.

Canarine for Staining.*—L. Errera finds that canarine, a new colouring matter derived from sulphocyanide of potassium, is specially adapted for sections of stems, and the author adds that it "exercises its staining action in the presence of caustic potash, which will make it without doubt valuable for various researches in vegetable anatomy."

Cultivation of Bacteria upon the Slide. — Dr. Pierre Miquel writes us as follows:—

"The first efforts towards cultivation upon the slide whilst on the stage of the Microscope date far back, and have always attracted the attention of micro-botanists, anxious to follow the germination of microscopic spores, their growth, and fructification. De Bary, Woronin, Brefeld, and many others have carefully studied the arrangements necessary for these delicate cultivations. In France, Van Tieghem and Lemonnier have popularized a very convenient method from their memoir on which the following is derived.†

In the centre of an ordinary slide is fastened, by Canada balsam, a glass ring from 4–5 mm. thick, cut from a tube used for organic analysis, and the cut sides properly ground level. A thin cover-glass, round, and of a sufficient diameter to just cover the ring without overlapping the edge, is fixed on the upper side, by three very small drops of a greasy oil, to complete the cell. In order that the interior air may be always saturated by moisture a few drops of water are placed on the bottom of the cell. A small drop of nutritive liquid is suspended at the centre of the under surface of the thin cover. In this drop are sown the spores for cultivation. This plan allows us to follow, with great facility and without interruption, from hour to hour if required, all the details of the germination, characters of the mycelium, and all the phases of the different fructifications, in a word, the life-history of the plant, however long the time may occupy. It offers all the advantages of cultivation upon the slide as habitually practised without being liable to such errors as may otherwise happen from contamination by foreign germs falling into the nutritive fluid during the period of cultivation.

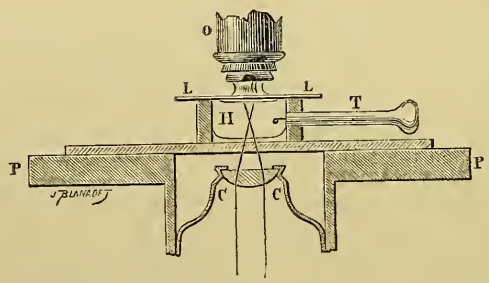
The cultivating liquids employed by these investigators, who were at that time specially occupied in the study of the Mucorini, were of different kinds, as orange-juice, boiled and filtered, or a decoction of

* Bull. Soc. Belg. Micr., x. (1884) p. 183.
† Ann. Sci. Nat., xviii. (1872).

horse-dung, both of which are abundantly provided with azotized principles, or of the so-called mineral liquids proposed by Pasteur and Cohn.

The moist chambers used by Van Tieghem and Lemonnier have during the last ten years undergone many modifications, more or less satisfactory; some investigators have pierced the sides of the little chamber with one or more square holes for the facility of introducing into the interior various reagents, as iodine or ammonia. It is nevertheless singular that these observers have overlooked the chance of these holes permitting the access of dust charged with germs. It is not, however, my purpose to give the history of these moist cells, but simply to describe a method of cultivating the bacteria upon the slide, free from these errors, and which I have employed for the study of the atmospheric Schizophytes. The same cell is made use of, pierced laterally by an opening which can be closed by a small glass rod stopper. Fig. 135 represents the same in section, where O is the immersion objective, L the thin cover with the droplet attached to the

Fig. 135.

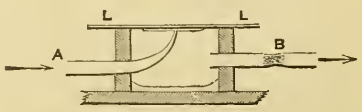


under side, H the moist chamber, T the small glass rod stopper, P the stage of the Microscope, and C the condensing lens. The cells and cover should be attached to the slide by a cement that will not be loosened by the heat used to sterilize the chamber. Afterwards, by the lateral opening, one or several drops of sterilized water for the purpose of keeping the air in the cell saturated with moisture, are placed in the little chamber. Then, by means of a pipette with a curved capillary point, the sterilized nutritive liquid—as blood serum, broth, urine, vegetable juices, &c.—is placed upon the under surface of the thin glass cover, whilst the sowing of the organisms, whose development is to be watched, is accomplished by the aid of a fine platinum wire slightly bent at the point. The small rod stopper is replaced, and the whole with the Microscope is placed in a warm chamber kept at 30° C. If immersion objectives be used, a little glycerine can be added to the water, or cedar oil used on the cover. Good dry objectives and the light from a paraffin lamp generally suffice for the observations, but I give the preference to the excellent No. 7 immersion objective of Nachet. It is not necessary that I

should further describe the precautions required to prevent contamination and the neglect of which may entirely nullify the value of the cultivation."

Another form used by M. Miquel is shown in fig. 136. By the tube A air is projected on the drop of nutritive liquid at the under side of the plate L L, and this having been done, the tube is withdrawn, and the hole closed with a piece of cork; the tube B, which contains some wadding, serves as the aspirator.

Fig. 136.



Dr. Koch describes the method adopted by Hesse for defining the exact quantity of air from which the spores originate. A glass tube 12 in. by $2\frac{3}{8}$ in. is closed at each end with indiarubber coverings, in one of which a glass pipe is inserted, while in the middle of the other is an opening about 3/8 in. in diameter. Gelatine is placed along the bottom of the tube, which is in a horizontal position. The smaller pipe is then placed in connection with an exhausting apparatus and a given quantity of air is forced through, the bacteria and spores falling on the gelatine.

Staining of Schizomycetes in Sections and Dry Preparations.* —C. Gram proposes the following method for producing an isolated staining of pneumonia-cocci, leaving the nuclei and other elements of the tissue uncoloured, the deep staining of the cocci usually found in the sweat-cells causing them to be much more readily found than in ordinary preparations. The method he considers applicable also to almost all examinations of Schizomycetes in sections and dry preparations.

He takes the ordinary Ehrlich's anilin-gentian-violet solution. The sections to be examined for Schizomycetes must be preserved in absolute alcohol and brought direct from it to the staining fluid; here they remain from 1–3 minutes (in the case of preparations of tubercular bacilli from 12–24 hours); then placed in an aqueous solution of potassium biniodide (1 part I, 2 parts KI, 300 parts water), without or after a slight washing with alcohol, where they remain again from 1–3 minutes. A precipitate takes place in the iodine solution, and the sections, previously a dark blue-violet, become a blackish purple-red. They are now laid in absolute alcohol until the colour is again entirely removed, the alcohol being renewed once or twice. They are then clarified in the ordinary way by clove-oil, the remainder of the pigment being given off to the oil. The nuclei and the fundamental tissue are now coloured light yellow by iodine, while the Schizomycetes, if present in the section, are of a conspicuous intense blue colour, often nearly black, the colour being much deeper than in any other mode of staining. After the application of alcohol, the sections may be placed for a moment in a weak

* Fortschr. d. Medicin, ii. (1884) No. 6. See Bot. Centralbl., xviii. (1884) p. 383.

solution of Bismarck brown or vesuvin in order to produce a double staining.

Permanent preparations have been kept for four months without change in Canada balsam, xylol, or gelatin-glycerin. The whole process takes a quarter of an hour, and the preparations may remain for some days in clove-oil without losing their colour. The method can also be applied to dry preparations, the cover-glass being treated as a section. The following diseases were tested for Schizomycetes by this method:—pneumonia cruposa, pyæmia, nephritis suppurativa, arthritis suppurativa after scarlatina, multiple brain diseases, osteomyelitis, typhus, liver abscesses, erysipelas, tuberculosis, cattle distemper, as well as the bacteria of putrefaction. After treatment with iodine the following Schizomycetes remained coloured in alcohol:—The cocci of crupose pneumonia, the Schizomycetes of pneumonia, the cocci of the liver abscesses after perityphlitis, the cocci and small bacilli in circumscribed infiltration of the lungs, the cocci of osteomyelitis, of arthritis suppurativa after scarlatina, of nephritis suppurativa after cystis, those of multiple brain abscesses, of erysipelas, the bacilli of tubercular cattle distemper, and the Schizomycetes of putrefaction. On the other hand, no staining was exhibited of the capsular cocci in a case of crupose pneumonia, or of the capsules without cocci in another case, or of the bacilli of typhus.

Staining Fluid for Sections of Tubercle-Bacilli.*—Dr. Klein recommends a staining fluid devised by Weigert as yielding the finest specimens of tubercle-bacilli in sections through tuberculous growths that he has seen. The sections may be either fresh or hardened.

The fluid is prepared as follows:—Take a 2 per cent. aqueous solution of gentian-violet 12 ccm., and of a saturated aqueous solution of anilin oil 100 ccm. Mix. This is used like an ordinary staining fluid for the first stain. For the second or contrast stain the following solution is used:—Bismarck brown, 1 gr.; spiritus vini rectificati (sp. gr. ·830), 10 ccm.; distilled water, 100 ccm. The sections remain in a few drops of this solution for fifteen minutes. Dr. Klein states that the results obtained by this method are very beautiful, the only drawback being the liability of the colour of the bacilli to fade.

Methods of Imbedding.†—Dr. J. Blochmann reviews the various methods of imbedding, describing in detail those that have come into general use, and pointing out the advantages and disadvantages of each.

In every method of imbedding the principle is the same, namely, to saturate objects with substances which not only fill out the larger internal cavities, but which also penetrate the tissues themselves,

* 'Practitioner,' xxxiii. (1884) p. 35. Sci. Monthly, ii. (1884) p. 92.

† Zeitschr. f. Wiss. Mikr., i. (1884) pp. 218–33 (2 figs.). The above taken from one of Dr. C. O. Whitman's excellent abstracts, Amer. Natural., xviii. (1884) pp. 842-4 (2 figs.).

rendering them (after cooling) sufficiently hard for the process of sectioning.

Glycerin and Gelatin.—Gelatin 1 part; distilled water 6 parts; glycerin 7 parts. For preservation a little carbolic acid (1 gram for 100 grams of the mixture) should be added. Objects are transferred directly from water to the melted mixture, and after complete saturation imbedded in paper boxes. After cooling the objects thus imbedded are hardened in alcohol, then sectioned and mounted in glycerin.*

Schiefferdecker's Method of Imbedding in Celloidin.—Schiefferdecker † uses two solutions, one of syrupy consistency, the other somewhat thinner. The celloidin plate is cut into small pieces and dissolved in absolute alcohol and ether (in equal parts). Objects are transferred from absolute alcohol,‡ first to the thinner solution, then to the thicker. After remaining a few hours (or days, according to the character of the object) in the latter, they are imbedded in paper boxes. As soon as a hardened film forms on the solution in the box, the whole is placed in 82 per cent. alcohol for 24–28 hours, and thus rendered sufficiently hard for cutting.

Blochmann recommends imbedding on a cork rather than in a paper box, as less celloidin is required, and as the cork is held more firmly in the holder. One end of the cork is made rough and surrounded by a strip of paper, which is made fast by a pin as shown in fig. 137. The roughened surface of the cork is wet with absolute alcohol, and then the object is imbedded in the usual manner. In order that this small box may sink in alcohol, in which it is placed for hardening the celloidin, it may be weighted with a small lead ball fastened to the cork by a needle.

Fig. 137.

In cutting, the knife is kept wet with alcohol (70 per cent.). The sections may be placed in water or in alcohol and afterwards stained with carmine or hæmatoxylin, in which the celloidin is only a little or not at all stained. Anilin dyes colour the celloidin, and therefore should not be used.

The sections can be mounted in glycerin or in balsam, but in the latter case they must be anhydrated with 95 per cent. alcohol, as absolute alcohol dissolves the celloidin. They should be clarified in bergamot-oil or origanum-oil (clove-oil dissolves the celloidin).

Objects imbedded in celloidin can be preserved ready for cutting for a long time in 70–80 per cent. alcohol.

Imbedding in Paraffin.—The object is transferred from absolute alcohol to chloroform, and left till the alcohol has been entirely replaced; it is next placed in a shallow vessel with a small quantity of chloroform and enough paraffin added in fine pieces to cover it

* This method was recommended by Kaiser, Bot. Centralbl., i. (1880) p. 25.

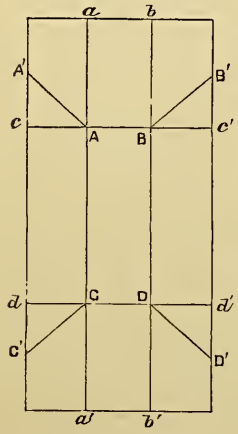
† Arch. f. Anat. u. Physiol. 1882, p. 199.

‡ If the objects are penetrated with difficulty they may be transferred from absolute alcohol to ether, then to the celloidin solution.

after the chloroform has evaporated. The vessel is then exposed to a temperature which corresponds to the melting point of the paraffin employed. The paraffin melts and the chloroform evaporates, so that the object is brought very gradually into pure melted paraffin. In this way the object becomes *completely* saturated with the paraffin.

It is essential that the mixture be kept at the proper temperature until *all* the chloroform has evaporated. A simple test is to place a hot wire in the paraffin, if no bubbles arise it is safe to conclude that the chloroform has entirely escaped.

Fig. 138.



After evaporation of the chloroform the object may be placed in any desired position, and the paraffin allowed to cool. After cooling the object can be cut out and fixed to a larger block of paraffin fitted for the holder of the microtome.

Boxes for imbedding may be made of rectangular pieces of paper, of the thickness of postal cards, in the following manner. The paper is first broken in the lines *a a'* and *b b'* (fig. 138), then *c c'* and *d d'* (by bending always towards the same side). Then in every corner a break (A A' B B' C C' D D') is made by bringing A *c* and A *a* together. The four sides of the box are next bent up, and the corners at the same time turned outwards and back behind the ends A B, *a b*, and C D *a' b'*. Finally the upper edge of these ends is bent down over the corners.

Bubbles around the object may be removed by means of a heated wire.

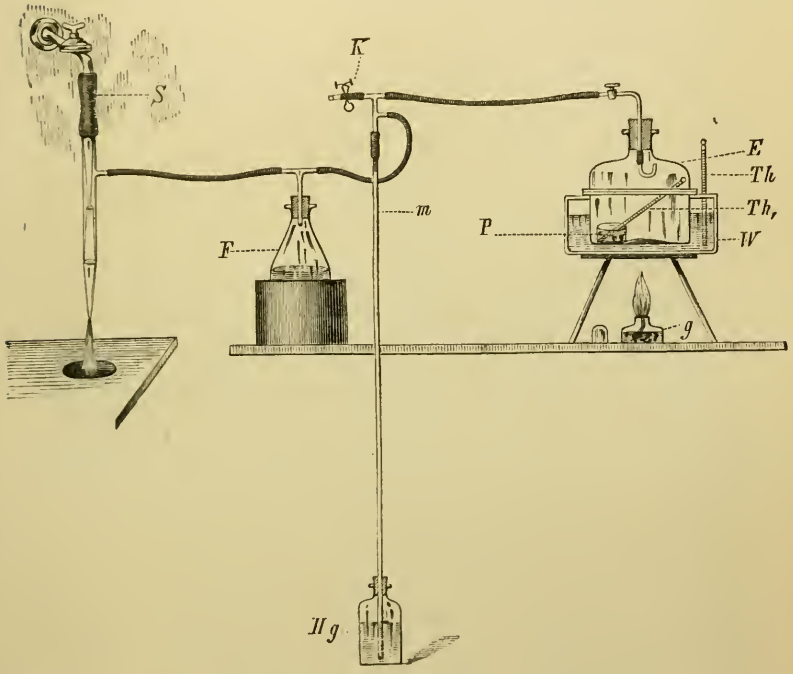
Hoffmann's Imbedding Apparatus.*—Dr. F. W. Hoffmann describes the apparatus he has devised for the more accurate imbedding of anatomical preparations, in which an air-pump is replaced by a suction-pump in connection with a water supply of sufficient pressure.

The suction pump S, which ought to have as free a discharge as possible, is connected with the exsiccator E by means of a strong non-compressible indiarubber tube (or one with a glass tube inside it). The exsiccator contains a few small bowls P, filled with paraffin. The whole is placed in a zinc vessel W, filled with water, and so arranged that the temperature remains constant. Between S and E is the flask F (with strong sides), which is connected with the indiarubber tube by a T piece. A glass tube *m* passes into a bottle of mercury *Hg*, and serves as a manometer. The object of the flask is to prevent the entrance of the water into E in case of any difference of pressure in the pipes. The manometer enables the pressure to be read directly, and enables one to judge whether the preparations are sufficiently penetrated with paraffin.

* Zool. Anzeig., vii. (1884) pp. 230–2 (1 fig.).

In using the apparatus, first heat the water-bath in which E is placed to a temperature of 60° C., then put the bowls containing the melted paraffin and the preparations to be imbedded into E and turn on the water. The two thermometers *Th* and *Th,* record the temperature in W and in the bowl P. The spirit- or gas-lamp *g* should be regulated so that the paraffin does not harden. When the mercury is at the highest point and no more air-bubbles form on the preparation, then the process is finished, and the air may be allowed to enter through K. Before this is done, however, the cock on the vessel E can be closed, so as to leave the preparation still longer in

Fig. 139.



the vacuum. The cock can then be carefully opened and the air allowed to enter. The small bent tube is for the purpose of preventing the scattering of the paraffin by the entrance of the air. Finally the object is taken out and put in a little box filled with liquid paraffin. With sufficient pressure (700–720 mm. *Hg*) every preparation, be it ever so difficult, provided that it is not too large, will be penetrated by the paraffin in about twenty minutes, so that a longer stay in the vacuum is only exceptionally necessary.

Preparations may be left imbedded in this way for weeks in the open air with unprotected cut surfaces without their undergoing any

change. As in other methods, the water must be previously entirely removed from the preparation, and then it is quite unimportant whether before putting it into paraffin it is placed in turpentine oil or oil of cloves, or, as the author does, into resinous turpentine saturated with paraffin, which must not be too thick.

Celloidin for Imbedding.*—The following is the manner of preparing and using this material practised in the laboratory of the Alumni Association of the College of Physicians and Surgeons at New York (as given by Dr. G. C. Freeborn).

A saturated solution of celloidin is made in a mixture of equal parts of ether and 97 per cent. alcohol. This requires about 24 hours with occasional agitation. The object to be imbedded is soaked in a mixture of ether and alcohol for some time, then transferred to the imbedding fluid and allowed to remain overnight.

One of two ways of imbedding may be adopted :—

1. Cover the smooth surface of a cork with a thick layer of celloidin solution and allow it to dry; place the specimen, which has previously been soaked in the imbedding fluid, on this, and cover it, layer by layer, with a solution of celloidin, allowing each layer to partially dry before applying another. When the specimen is completely covered immerse in alcohol of 80 per cent. for twenty-four hours when it will be ready to cut.

2. The specimens are imbedded in paper boxes in the usual way, or a cork is wrapped with one or two layers of thick writing paper, allowing it to project an inch or an inch and a half above the surface of the cork. By this procedure a round box with the cork for a bottom is obtained. Into this box pour a small quantity of the imbedding fluid, and allow it to dry. The specimen having been previously soaked in the celloidin solution, is now placed in the box, adjusted as to position and allowed to dry for five or ten minutes, so as to fix it; the box is now filled with the imbedding fluid. The boxes are exposed to the air until the imbedding mass has become semi-solid, and are then immersed in weak alcohol (alcohol 95 per cent. two parts, water one part) for twenty-four hours, when the specimen will be ready for cutting. If the specimen has been imbedded in a paper box and sections are to be cut with a sliding microtome, it is necessary to mount it on a cork. This is accomplished in the following manner :—Cover the surface of a smooth cork with a thick layer of celloidin solution, allow it to dry, and again cover with the same. Trim off the superfluous imbedding mass from around the specimen, cut the lower surface even, wet it with a drop or two of ether, and adapt it to the layer of celloidin on the cork. Dry for a few moments and place in dilute alcohol for a few hours, when the specimen will be ready for cutting. If the plan of imbedding in the boxes with a cork for the bottom is adopted, the specimen is imbedded and mounted on the cork at the same time.

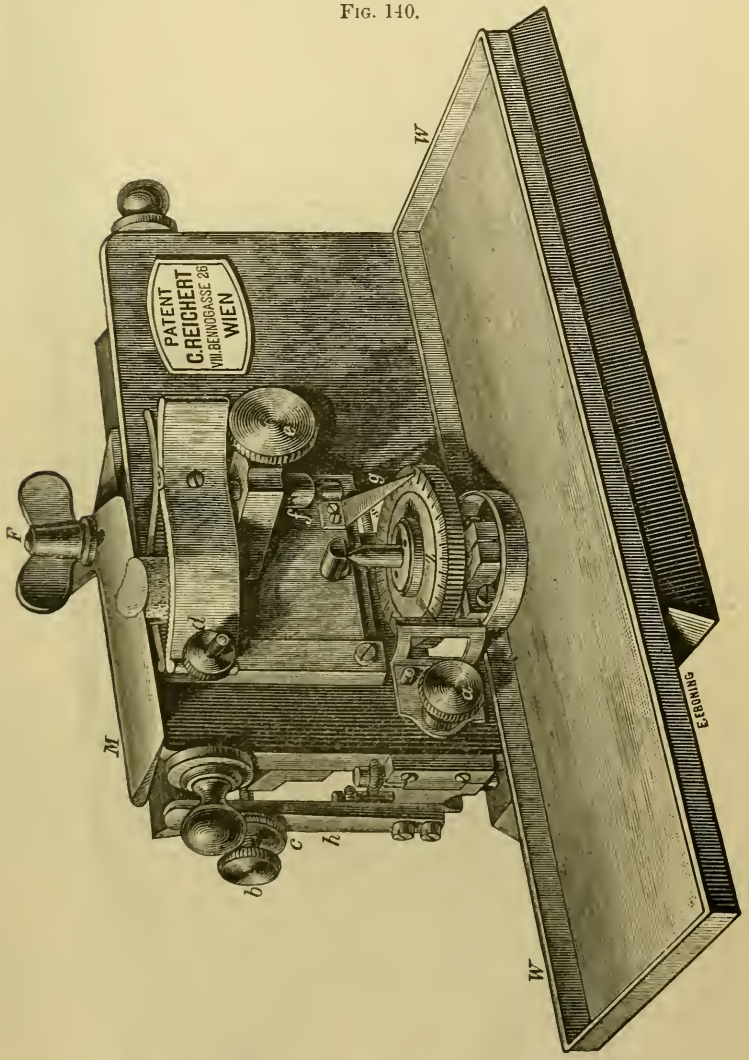
Sections may be stained with the different staining fluids and mounted in glycerine or other media. If mounted in Canada balsam

* Amer. Mon. Micr. Journ., v. (1884) pp. 127-8, from New York Med. Journ.

and the specimen is to be retained in the imbedding mass, absolute alcohol for dehydrating and oil of cloves for clearing are to be discarded, for they both dissolve the celloidin, and alcohol of 96 per cent. and oil of bergamot, oil of sanders, or oil of origanum used.

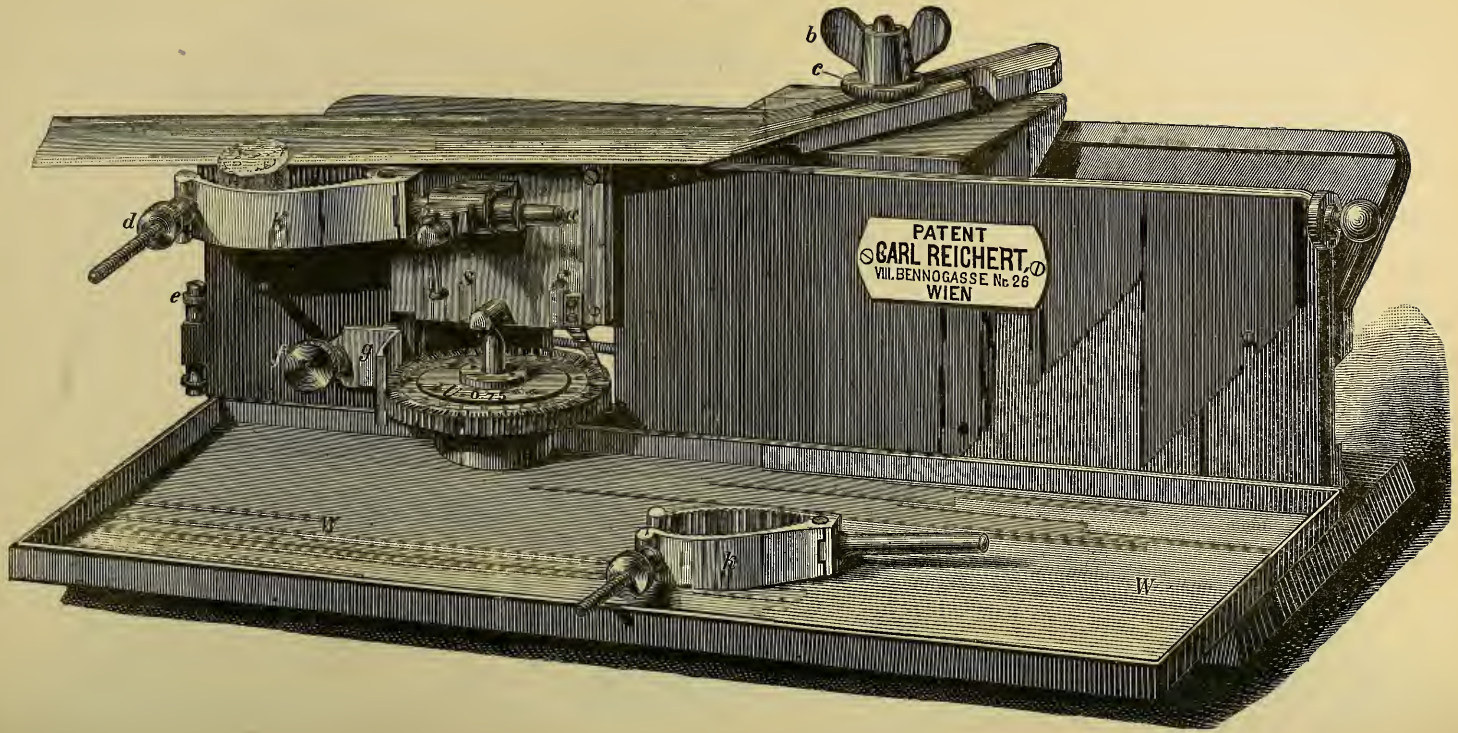
Reichert's Microtomes.—The essential feature of these Microtomes is that the object is automatically raised.

FIG. 140.



The carrier, to which the knife M is attached by the screw F, rests on six points, for greater exactness and for reducing friction.

Fig. 141.

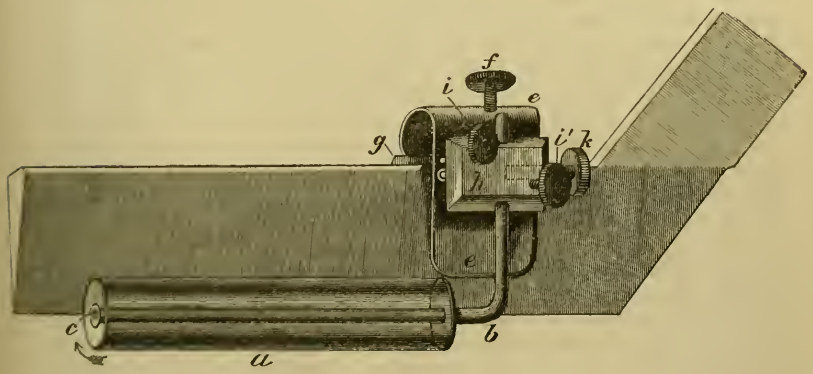


The vertical axis of the toothed wheel *z* on the top of which the object-carrier rests, ends below in a screw with a pitch of 0·75 mm. The knife-carrier at each cut pushes against the lever *h*, the horizontal arm of which catches in the wheel *z*, which has 100 teeth. At the commencement of each cut a spring *s* draws the lever back ready for the cut. The lever is regulated by *b c*, so that it will move the wheel *z* only one tooth forward or several teeth up to ten. The wheel is prevented from moving backwards by a catch attached to *a*. Sections of 0·0075–0·075 mm. can thus be cut. If sections thicker than 0·075 mm. are required the automatic apparatus is detached, the catch at *a* being removed and the spring *s* detached. The thickness of the section is now indicated by the pointer *g* and the graduations on the periphery of the wheel. So that the knife may not inadvertently cut against the object-carrier a contrivance is added which prevents the lever working in the wheel after a given height has been reached. The axis *f* of the object-clamp is fixed by the screw *e*, so that it can be raised or lowered. The jaws can be brought closer together by *d*. The tray W serves for catching spirit, &c.*

The instrument fig. 141 is a larger form of the previous instrument, 38 cm. long instead of 20 cm.

Decker's Section-smoother.†—Dr. F. Decker describes the apparatus shown in fig. 142. The essential principle consists in the application to the knife-blade of a glass cylinder *a*, which can rotate on an axis *b c*.

Fig. 142.

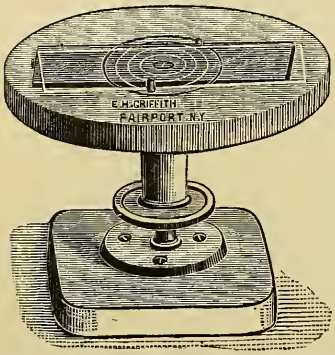


The knife has attached to it a steel bow *e e*. By turning the screw *f*, which acts on a long steel plate *g*, the bow is made to grip the knife tighter. The block *h* is attached by a hinge to *e* (its axis

* Cf. Zeitschr. f. Wiss. Mikr., i. (1884) pp. 241–4 (1 fig.).
† Arch. f. Mikr. Anat., xxiii. (1884) pp. 537–43.

being parallel to the knife-blade), and the bent arm of the axis of the glass cylinder passes into it and is clamped by the screw *k*. By the screws *i* and *i'* the block *h* can be raised at one end and depressed at the other, thereby raising or lowering the cylinder *a* above the knife-blade. The maximum length suggested for the cylinders is 5 cm. and the diameter 4, 6, and 9 mm.

Fig. 143.



Griffith's Turntable. — Mr. E. H. Griffith has devised the ingeniously simple turntable shown in fig. 143.

The centre of the table, marked with the circles, has a spiral spring attached to it beneath. The slide being placed between the two pins in this centre, is partially rotated against the spring and pushed forward, when the spring keys it between the two pins and a third fixed pin at the upper side of the slide (towards the left). The fourth pin, at the left end, is for length. The table rotates on a pointed spindle, and can be lifted off it as required.

Reversible Mounts.*—Of late years much attention has been given to the preparation of whole insects, without subjecting them to pressure, by using cells of vulcanite or other suitable substance affixed to the ordinary slides. T. J. Briant has in the same way put up *thick sections* of various parts of insects with very good results. Such preparations allow of the examination of the various parts as they are arranged in the body of the insect, and are comparatively easy to make, either by the ordinary section-cutter or by hand. It is, however, frequently found, both in the case of whole insects as well as that of the thick sections, that one wants to know the appearance from the opposite side. Of course the slide may be turned over, but the critical examination of an object through glass of the thickness of an ordinary slip is very difficult—practically impossible.

In order to overcome this difficulty take a vulcanite ring and fasten a thin cover as a bottom to it with any good cement; fill it with balsam, immerse the preparation, and cover with another thin cover. Then put this aside to dry, placing it on the top of a small cork fixed in a bottle, and thus preventing the superfluous balsam fastening the ring to the shelf or table. The ring with its cover and contents is then placed in a wooden slide, with a hole corresponding in size to that of the ring. Usually there is enough balsam around the edge to hold the ring in place, but if not the slip may be covered on both sides with paper. In the case of small objects, two glass covers may be used, kept apart by small pieces of thin glass cover;

* Thirteenth Ann. Rep. South London Micr. and Nat. Hist. Club, 1884, p. 13.

these can be fastened in the wooden slips by covering one side with paper, with of course, the necessary hole cut a smaller size than the hole in the wood slip, and while the gum is wet dropping the glass in place; then when dry covering the other side.

Mr. Briant has found immense advantage in being able to reverse the preparation in this way, many difficult points being easily solved upon examining both sides.

Hinman's Device for Mounting.*—G. C. Hinman's device consists of a perforated plate with the edges turned up so as to receive a glass slip, and hold it with the centre over the centre of the perforation, thus enabling the object to be placed centrally without difficulty. When the object is mounted this plate is placed upon another under a spring having three points in a plane parallel with the surface of the slip, which can be pressed down upon the cover-glass with any desired force, and thus bring the cover-glass into a plane parallel with the slip.

Mr. J. H. Pillsbury considers this by far the most convenient instrument for holding the cover-glass in place which he has ever seen.

Preparing Schultze's Solution.†—Prof. W. Hillhouse describes the following method of preparing Schultze's solution, a modification of that of Radlkofer. Pure granulated zinc is dissolved in hydrochloric acid at an ordinary temperature; the solution is evaporated at a temperature of about 70° or 80° C. and under contact with metallic zinc, to a syrup which does not get muddy on addition of much water, and has the specific gravity 2·0 This syrup is poured off and diluted with water to specific gravity 1·8—that is, twelve parts of water are added to every hundred of the syrup. In 100 parts of the resulting fluid dissolve at a gentle heat six parts of potassium iodide, and then dissolve in the whole as much iodine as it will take up. The solution will now have the consistence of concentrated sulphuric acid, is perfectly clear, of a bright golden-brown colour, slowly becoming somewhat darker on exposure to light. It can be brought to various degrees of dilution, as its action varies according to the strength. It is best kept in the dark.

Styrax and Liquidambar.‡—Dr. H. van Heurck has a further note on these substances, in which, after referring to the commendations of Cole, Dippel, Grunow, and Kitton, he quotes that of Strasburger in his 'Das Botanische Practicum,' who recommends it for making visible the details of the nucleus of plant-cells previously stained with hæmatoxylin. The cytoplasm is invisible, while the details of the nucleus are seen with the greatest clearness.

A "new quality" of styrax Dr. van Heurck finds to be, as mentioned *ante* p. 655, that instead of becoming coloured by time and

* Amer. Mon. Micr. Journ., v. (1884) p. 140.
† Proc. Camb. Phil. Soc., iv. (1883) p. 399.
‡ Bull. Soc. Belg. Micr., x. (1884) pp. 178–82.

light like Canada balsam, the preparation becomes absolutely colourless.

The solution should be used as follows:—Place the cover-glasses on a large glass plate, and put on each by a pipette a large drop of distilled water, and on this let fall gently a drop of the liquid containing the diatoms. Then cover them with a watch-glass and allow to evaporate spontaneously. When this is done the cover-glasses are separately heated to redness on platinum and transferred to the glass plate, and a drop of a very fluid solution of styrax or liquidambar put on them and the watch-glass replaced. In twenty-four hours the benzine is completely evaporated. The cover-glass is then put on the slide and slightly heated, preferably in a water-bath. A light pressure will drive out air-bubbles.

Preparing Shellac Cement.*—R. Hitchcock gives an easy method of preparing an excellent clear solution of shellac.

Obtain from a paint-shop a quantity of shellac spirit-varnish, or prepare it by dissolving common shellac in alcohol. It is well to use five or six ounces of the varnish, as there will be considerable shrinkage in volume during the process. Place the varnish in a bottle, which it should not more than two-thirds fill, and add to it about one-quarter of its volume of naphtha or "petroleum spirit." Put in the cork and shake well, to thoroughly mix the two liquids. Let the mixture stand a few minutes and shake it again, repeating the operation two or three times. Then let the bottle stand undisturbed for twelve hours, or as much longer as convenient. The naphtha will be found in a layer above the shellac containing the flocculent matter, which, being insoluble in cold alcohol, renders the ordinary solutions of shellac turbid, while the alcoholic solution beneath will be perfectly clear. By means of a siphon, extemporized by a rubber or glass tube, the clear shellac may be drawn off from beneath the naphtha.

The solution thus obtained will be too thin for microscopical use. It should therefore be placed in an evaporating dish and heated very gently—preferably over a water-bath in which the water is not allowed to boil—until it reaches a syrupy consistence. When cold it will be thicker than while warm, and it should be tested by placing a few drops on a cold slide and watching its behaviour. When it seems to be right the solution may be poured into a bottle and about three drops of castor-oil added for every ounce of solution. This causes it to flow smoothly from the brush.

In practice we have found it advisable to evaporate the solution, as above described, until it is too thick to flow from the brush, and then to thin it with strong alcohol. The reason is that during evaporation the alcohol of the original solution is driven off more rapidly than the water that is associated with it. Therefore, by the time the solution is reduced to one-fourth its original volume the alcohol has become much weaker than it should be, and the cement

* Amer. Mon. Micr. Journ., v. (1884) pp. 131–2.

dries slowly. By thinning the solution with strong alcohol the resulting cement becomes all that can be desired.

It is well to have two kinds of shellac cement always at hand—one so thick that it will just flow from the brush on the turntable, the other thinner. The first is useful for making cells, the second as a general cement to attach covers, &c.

Coating Diatoms with Silver.*—A. Y. Moore burns one side of a diatom to the cover-glass and then coats the other side with pure silver. The refractive index of silver according to Brewster is 3·27, and the visibility of a diatom so prepared is four times as great as when mounted dry, or more correctly, in the proportion of 1·84 to ·43. "The results obtained by giving such a visibility to the diatom and at the same time utilizing the full aperture of the objective, can hardly be imagined by one who has never seen it. The dots upon *Amphipleura pellucida* are shown in a way which would readily convince those who still deny their existence. Even *Rhizosolenia alata* yields transverse lines which, so far as I know, have never been seen by any other method."

Lyon's Mailing Case.†—H. N. Lyon takes two slips of wood 3 by 1 in. and 1/16 in. thick, and in the centre of one makes a hole a little larger than the cell. Paste a piece of stiff paper on one side of this slip, covering the hole. Lay the slide between the slips and along one side paste a piece of paper, not touching the glass slide however. A rubber band holds the package tight, and it may be sent as it is or first wrapped in paper. If two or more slides are to be sent the modus operandi is the same, except that the openings are alternately on opposite sides. In this case the middle slips need not be covered.

Action of Reagents in the discrimination of Vegetable Fibres.‡—V. Berthold classifies the more important vegetable fibres according to the action upon them of iodine and sulphuric acid, as follows:—

A. Coloured blue, violet, or green by iodine and sulphuric acid:—Flax, Chinese grass and ramie (*Boehmeria nivea*), roa (*Pipturus argenteus*), cotton, hemp, and sunn-hemp (*Crotalaria juncea*).

I. Transverse sections coloured blue or violet, but showing no yellow middle lamella; cell-cavity usually filled with a yellow mass.

a. Flax. Transverse sections occur either isolated or a small number in a group; the separate transverse sections are not contiguous; they are polygonal, bounded by straight lines, and have sharp edges. Lamination evident, blue or yellow; cell-cavity a yellow dot. Longitudinal distortions of the striæ indicated by darker lines which usually cross.

* The Microscope, iv. (1884) pp. 157–9 and 165.

† Ibid., p. 179.

‡ Zeitschr. f. Warenkunde, 1883, pp. 14–5, 17–8 (16 figs.). See Bot. Centralbl., xvi. (1883) p. 308.

b. Chinese grass and Ramie. Transverse sections isolated or a small number in a group; their connection very loose; they are polygonal or irregular, and very large. Lamination very evident; cell-cavity large and irregular, often filled with dark yellow masses; sometimes striated radially. In the longitudinal aspect some fibres appear very broad, but their breadth is very variable; distortions evident; the ends thickly rounded.

c. Roa-fibre. Transverse sections not many in a group, polyhedral, usually with straight or slightly curved sides and rounded edges; cell-cavity narrowly oblong, regular; contents sometimes yellow. Some transverse sections are surrounded by a thin greenish lamella, and show well-marked radial striæ or fissures and connective lamination; the separate lamellæ vary in depth of colour.

d. Cotton. Transverse sections always isolated, rounded, of various forms, usually reniform; cell-cavity narrow, linear, contents usually yellow. No lamination.

II. Transverse sections blue or violet, polyhedral, rounded or irregular, always surrounded by a yellow middle lamella.

a. Hemp. Transverse sections always in groups, contiguous, with rounded edges, surrounded by a thin yellow middle lamella, beautifully laminated concentrically; cell-cavity linear, simple or branched, irregular, sometimes broad, without contents.

b. Sunn-hemp. Transverse sections numerous in a group, closely contiguous, resembling hemp, often sickle-shaped, either polygonal or oval, with a small round cell-cavity, often with yellow contents. Surrounded by a broad yellow middle lamella, from which the inner laminæ are often detached.

B. Coloured yellow by iodine and sulphuric acid.

I. Dicotyledons. No vessels besides the bast-fibres; cell-cavity with constrictions.

1. Transverse sections in groups, polygonal, bounded by straight lines, with sharp edges; cell-cavity round or oval, smooth, empty, surrounded by a narrow middle lamella of the same colour.

a. Jute. Cell-cavity large, roundish, oval; middle lamella very narrow; no lamination; the ends always rounded, and almost always strongly thickened.

b. Abelmoschus. Transverse sections larger than *a*, bounded by straight lines, sharp-edged; cell-cavity a dot or line, oval, rarely angular, smaller than *a*. Fibres of uniform thickness; ends broad, rounded, often thickened; cell-cavity variable, often reduced to a line.

2. Transverse sections always in groups, polygonal, bounded by straight lines, with sharp or slightly rounded edges; cell-cavity empty. Middle lamella broad and decidedly

darker than the transverse sections; cell-cavity with constrictions, locally entirely absent.

a. *Hibiscus*. Edges sharp or rounded; in the first case the cell-cavity small, in the latter case broader and oval; middle lamella sometimes wanting; transverse sections only slightly and inconspicuously laminated. Fibres of very various thickness, not usually striated longitudinally; ends rounded, blunt and almost always thickened

b. *Urena sinuata*. Edges sharp; cell-cavity very small, a dot or narrow short line; middle lamella broad and very distinct; transverse sections not laminated. Fibres of uniform thickness; rarely striated longitudinally; ends rounded, rarely somewhat thickened.

II. Monocotyledons. Vessels in addition to bast-fibres; cell-cavity without constrictions.

1. Transverse sections usually rounded, rarely polygonal; cell-cavity always round; no middle lamellæ.

a. *New Zealand Flax* (*Phormium tenax*). Transverse sections small, usually round, closely contiguous, polygonal with rounded edges; cell-cavity empty. Fibres thin, uniform, smooth, rigid; cell-cavity small, of uniform breadth, without striation or distortion; ends sharp.

b. *Manila Hemp* (*Musa textilis*). Transverse sections polygonal with rounded edges, or roundish; cell-cavity large, roundish, sometimes with yellow contents. Fibres of uniform thickness, smooth, not striated; walls thin; ends sharp, or slightly rounded. After combustion siliceous skeletons remain behind in the form of strings.

2. Transverse sections evidently polygonal; cell-cavity polygonal, with one or more sharp edges, moderately large; no middle lamella.

a. *African Hemp* (*Sanseviera*). Transverse sections closely contiguous, not laminated. Fibres thin, smooth, with sharp ends.

b. *Aloe*. Transverse sections not very numerous in a group; edges slightly rounded; cell-cavity not very large, polygonal, often with rounded ends; large spiral vessels; fibres of uniform thickness, without structure; ends sharp or rounded.

c. *Agave*. Transverse sections polygonal, bounded by straight lines, closely contiguous; cell-cavity large, polygonal; its edges less sharp. Fibres rigid, considerably broader towards the middle; ends broad, thickened, sometimes split.

3. Transverse sections polygonal, closely contiguous, small, bounded by straight lines; edges very sharp; cell-cavity small, round or linear; middle lamella very evident. Fibres narrow, striated, with sharp ends:—*Yucca*.

Reagents for Tannins in Vegetable Cells.*—W. Gardiner specifies objections to all the micro-chemical reagents for tannins hitherto used. Iron sulphate he finds convenient when the products are blue and not green. He prefers to use a solution of ammonium molybdate in concentrated ammonium chloride; this gives with tannins a copious yellow precipitate. It can also be used for determining the presence of gallic acid, with which it produces only a red colour; the compound with gallic acid is soluble in ammonium chloride, while that with tannin is not.

The determination of tannins in tissues preserved in alcohol is facilitated by the fact that dead protoplasm gives a permanent precipitate with tannins.

The author regards the tannins as secondary products of metastasis, especially when this process is very active, and thinks that they have no further use. In the old leaves of a cutting of the cherry-laurel which had already put out roots and shoots, the quantity of tannin had considerably increased.

Microscopical Examination of Chestnut-meal.†—T. F. Hanausek gives the following microscopical characteristics of the various parts of the sweet chestnut. The testa of the chestnut consists of three layers. The cells of the outermost layer are polyhedral thick-walled plates with yellow or dark-brown angular flakes (tannin?). Many bear stiff cylindrical unicellular hairs, varying in thickness from 0·018 to 0·029 mm., and of variable length. Some have thin and others very thick walls; the former contain tannin. The middle layer is composed of tangentially elongated, thin-walled, bright-red parenchymatous cells, which swell up in potash to a broad elliptic form, and are coloured of a beautiful violet-blue by chloride of iron. It has also strong vascular bundles and large cavities. The innermost fibrous layer forms a narrow light-brown streak composed of thin-walled fibrous elements.

The two cotyledons consist of an amylaceous parenchyma. The outermost layer of cells are narrow five- or six-sided radially arranged prisms, with a diameter of 0·007–0·01 mm.; in the radial direction they are three or four times as long. The very small colourless protein-grains are only coloured pale yellow by iodine, on account of the envelope of oil which surrounds them. The amylaceous cells have a diameter from 0·055–0·075 mm., and contain, besides starch, a parietal layer of albuminoids and oil. The starch-grains are sometimes simple, sometimes double. The simple grains are extremely variable in form; the most characteristic forms are triangular, and one has an acute projecting appendage. Some resemble the cap-shaped partial grains of tapioca. The nucleus is central and difficult to detect; stratification is indicated in the largest by two or three inconspicuous lines. The polarization-cross is very conspicuous. The smaller spherical or ellipsoidal grains have a diameter of from 0·005–0·009 mm.; the

* Proc. Camb. Phil. Soc., iv. (1883) pp. 387–94.

† Zeitschr. f. Landwirtschaft. Gewerbe, 1883, pp. 3–5 (3 pls.). See Bot. Centralbl., xiv. (1883) p. 180.

largest observed measured 0·025 mm. in length and 0·016 mm. in breadth; the most common length was about 0·02 mm.

Microscopical Investigation of Dyed Cotton Fabrics.*—R. Meyer finds that cotton goods which have been dyed by means of the albumin process can easily be distinguished from articles which have been printed with soluble dyes, by means of the Microscope. For example, if a piece of cotton is first treated with a solution of lead acetate, and afterwards with a chromate, the fibres are uniformly coloured. But if the goods have been printed with a mixture of precipitated lead chromate and albumin, and the colour fixed by steaming, the fibres themselves appear colourless under the Microscope, but patches of coloured albumen are attached to the fibre.

Microscopical Examination of Water for Organic Impurities.†—J. Brautlecht produces a precipitate in the water by adding to 100 cc. 5 drops of a solution consisting of 1 part aluminium sulphate, 1 part hydrochloric acid, and 8 parts water, followed up by one to three drops of liquid ammonia. The precipitate settles readily, and after decanting off the clear solution, is collected upon a smooth filter, stroked off with a glass rod, and thus transferred to a test-tube, in which it is dissolved in ten to fifteen drops of dilute acetic acid. The clear solution is examined with the Microscope, at first alone, and then after the addition of a solution of saffranine. By adding one-half per cent. of gelatine permanent preparations may be obtained on Koch's principle.

A. Certes‡ summarizes in a very convenient form the procedure necessary for an effective microscopical examination of water. The more general observations of the first sixteen pages are followed by eleven of practical instructions, in which are dealt with the collection of the water, the employment of reagents and their formulæ, preservative liquids, colouring matters, &c.

For the ordinary examination of microbia the power ought not to be less than 250 or 300. For more extended study, powers of 700 to 800 are necessary.

"The use of staining reagents ought never to be neglected after direct examination, as they define much more distinctly the colours and certain details of structure, such as the vibratile cilia, flagella, nuclei, and nucleoli of the ciliate or flagellate infusoria. Especially important is the part which staining reagents will certainly play in the future in regard to the different elements of the protoplasm.§

* Journ. Chem. Soc.—Abstr., xliv. (1883) p. 751. Ber. Deutsch. Chem. Gesell., xvi. pp. 455–7.

† Rep. Anal. Chemie und Chem. Zeitung. Cf. Chemical News, xlviii. (1883) p. 180.

‡ Certes, A., 'Analyse micrographique des Eaux,' 8vo, Paris, 1883, 28 pp. and 2 pls.

§ The various colouring substances give very different reactions, according to the organisms with which they are brought in contact. Manufactured for the most part for commercial purposes, they are far from being homogeneous. Still more rarely are they chemically pure. Hence arise mistakes and uncertainty in their use.

Some organisms, morphologically alike so far as appears with our present means of investigation, behave very differently with the same staining agents. The chemical affinities are not always the same during life and after death, and there seems to be some relation between the diversity of constitution of the protoplasm, revealed to us by the diversity of the reactions, and the physiological or pathogenic *rôle* of certain microbia. In other terms, where there are no morphological species, reagents like inoculations show us distinct physiological species.

Is it not remarkable, for instance, that dahlia violet, methyl blue, and iodine green, which, managed carefully, only colour the nucleus of living infusoria, also colour, but always entirely, a great number of rods and bacterian filaments? We are thus led to consider the chromatic elements of the protoplasm as diffused in the microbia, whilst they are differentiated and condensed under the form of nucleus or nucleolus in the infusoria properly so called.

If, on the other hand, we consider that in the cells and infusoria the transformations of the nucleus and nucleolus always precede the phenomena of reproduction, however much they differ, and that generally these transformations largely modify the form of the nucleus and nucleolus, we are less surprised to see the same bacterian rod in process of development pass, as Cienkowski has shown, through phases corresponding with the very distinct forms from which morphological species have been made."

Dr. J. D. Macdonald has also issued a second edition of his 'Guide to the Microscopical Examination of Drinking Water,' in which he gives the following directions for collecting and examining sediments:—

When water is very turbid, from an obviously impure source, it is easy enough to obtain a sufficient amount of sedimentary matter for microscopical examination, and a just estimate of the unfitness of such water for drinking purposes may be thus readily formed. But it more frequently happens that the deposit, even after long standing, is but slight, and when this is the case, we must have recourse to special means, by which the whole or a large amount of the matters in suspension may be concentrated or collected together within a small compass. In the first place one of the tall glass vessels above described, should be filled with the water to be examined, and a circular disk of glass, resting on a horizontal loop at the end of a long aluminium wire lowered to the bottom, when the whole arrangement, lightly covered, must be set aside for 24 or 48 hours, as the case may be.

At the end of the specified time, the water should be siphoned off with a piece of indiarubber tubing, so as to leave only a thin stratum of the liquid over the glass disk. This should now be carefully raised and laid upon blotting-paper to dry its under surface and remove the surplus moisture, when it may be at once transferred to the Microscope, with a large piece of cover-glass so placed upon it as to exclude all air-bubbles. An ordinary watch-glass may in some cases be substituted for the disk alluded to, with advantage, as being less likely to permit the loss of sediment by overflow, which is certain to happen

with a plane surface. The operator must be cautioned not to use iron wire, which rusts so rapidly that it will soon throw down a flocculent precipitate. Another good plan, which is perhaps the better of the two, is to siphon off the water until only a sufficient quantity remains to permit the sediment to be shaken up with it, and poured into a tall conical glass, from which, after standing again for a short time, portions may be taken up by means of a pipette, and placed on slides for examination. If the subsidence is observed to be complete, it is rather an advantage to have a good body of water in the glass, or, at least, so much as will permit the pipette to be used with ease and facility. It may be observed here, that it is very inconvenient to have too much fluid at a time on a slide. The cover-glass will be unstable and liable to have its upper surface wetted, while the objects themselves will be tremulous, if they do not quite run out of the field. To obviate this, the pipette, when taken out of the water, should be held in a vertical position for some little time, until the suspended matters gravitate to the bottom of the tube, when a well-charged droplet might be placed on a number of separate slides and examined seriatim. This is, in fact, the only way in which a large sediment can be thoroughly inspected.

M. Balland also gives * a neat and easy method for examining water contaminated by the drainage of cesspools. Into a long tube he pours a few cubic centimetres of a solution of sodium hypobromide, and then fills it completely with the water to be examined. Placing the thumb on the tube, it is inverted and placed in a glass containing mercury. If urea is present, bubbles of nitrogen gradually rise in the tube and collect at the closed end.

J. W. Mallet describes † apparatus whereby the water to be examined may be evaporated under greatly reduced pressure and at a correspondingly low temperature, out of contact with the air. Under such conditions, the organic matter is altered much less than in the apparatus generally made use of. As test-materials, leucine and tyrosine were selected, as representing the more stable products of putrefaction liable to occur in natural water, and for which the combustion process in its natural form had been found to give results far from satisfactory.

Mr. G. E. Davis has also published ‡ two articles on 'Water, Water Analysis and the Microscope.'

Changing the Water in Aquaria containing Microscopical Organisms.§—F. Könike describes the following as the more convenient way for emptying aquaria without drawing away the minute organisms :—

Tie over a small flask or glass, with the widest possible mouth, a piece of fine muslin in such a manner as not to stretch it tight. Then put the end of an indiarubber tube through the middle of the muslin to the bottom of the glass. At the place through

* Journ. de Pharm. et de Chimie, 1883. Cf. 'Athenæum,' 24th Nov., 1883.
† Chem. News, xlvii. (1883) pp. 218–20, 232–3.
‡ Micr. News, iii. (1883) pp. 309–13 (7 figs.).
§ Zool. Anzeig., vi. (1883) pp. 638–9.

which the tube passes, fasten the muslin tightly with thread to the tube, and sink the glass to the bottom of the aquarium. On exhausting the tube the glass will fill with water, and the aquarium will in this way be emptied, the water passing through the muslin. If a stoppage should occur the cause will in most cases be some dirt having settled on the muslin. It is for this reason that a glass with a wide mouth is recommended.

Micro-chemical Test for Sodium.*—A. Streng proposes to employ uranium acetate as a test for sodium; by its action on any sodium solution, crystals of uranium sodium acetate are formed, which are but sparingly soluble in water. They appear in the form of tetrahedra and the minute yellow crystals cannot be mistaken for the rhombic crystals of uranium acetate, which separate out as the solution dries, on account of their action on polarized light. The reaction is very sharp, as the double salt contains a very low percentage of soda (6·6 per cent.).

Micro-chemical Reaction of Solanine.†—J. Schaarschmidt gives the following test for determining the presence of this alkaloid. The section is laid in a drop of nitric acid or of not too concentrated sulphuric acid, covered, and immediately placed under the Microscope. A rose-red colour supervenes after a few seconds, especially if nitric acid be employed. By this method the author found solanine in *Solanum tuberosum*, especially in the sub-peridermal cells of the tuber, and in the sub-epidermal cells of the stem and leaf-stalk; also in the collenchyma of *S. nigrum* and *Dulcamara*, *Capsicum annuum*, *Lycopersicum esculentum*, and *Mandragora officinalis*. The epidermis of the sepals of *Solanum nigrum* is especially rich in solanine.

Size of Atoms.‡—Sir W. Thomson gives an estimate of the size of atoms or molecules, founded on four lines of reasoning—(1) the undulatory theory of light, (2) the phenomena of contact electricity, (3) capillary attraction, and (4) the kinetic theory of gases—which all lead to substantially the same estimate of the dimensions of molecular structure. "Jointly they establish, with what we cannot but regard as a very high degree of probability, the conclusion that, in any ordinary liquid, transparent solid, or seemingly opaque solid, the mean distance between the centres of contiguous molecules is less than the 1-5,000,000th, and greater than the 1-1,000,000,000th of a centimetre.

"To form some conception of the degree of coarse-grainedness indicated by this conclusion, imagine a globe of water or glass, as large as a football, or say a globe of 16 centimetres diameter, to be magnified up to the size of the earth, each constituent molecule being magnified in the same proportion. The magnified structure would be more coarse-grained than a heap of small shot, but probably less coarse-grained than a heap of footballs."

* Jahrb. f. Mineral., ii. (1883) p. 365. See Journ. Chem. Soc.—Abstr., xlv. (1884) pp. 366-7.

† Zeitschr. f. Wiss. Mikroskopie, i. (1884) pp. 61-2.

‡ Proc. Roy. Inst., x. (1883) pp. 185-213 (11 figs.).

In an article on "Liquid Films and Molecular Magnitudes" * A. W. Reinold and A. W. Rücker give the results of their measurements of soap films in the last stage of tenuity, and in which, referring to Sir W. Thomson's lecture, they say: "If the size of the molecules of which the liquid is composed is between 2×10^{-6} and 1×10^{-8} mm. (the limits given by him) it follows that the thinnest film measured by us, which was $7 \cdot 2 \times 10^{-6}$ mm., must contain not less than 3 and not more than 720 molecules in its thickness. The smallness of the smaller of these numbers tends to show that the real size of the molecule is considerably below Sir W. Thomson's superior limit."

B. Sc.—Difficulties in Mounting.

[To avoid air-bubbles in glycerine cell-mounting. — Varnish twice at intervals of a couple of hours with a solution of shellac in alcohol and then finish off with ordinary bitumen.]

Sci.-Gossip, 1884, p. 212.

Baumgarten, P.—Ueber Untersuchungsmethoden zur Unterscheidung von Lepra- und Tuberkel bacillen. (On methods for distinguishing Leprosy and Tubercle Bacilli.) *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 367–71.

„ „ Ueber eine gute Färbungsmethode zur Untersuchung von Kerntheilungsfiguren. (On a good staining method for investigating the figures in the division of nuclei.) [*Post.*]

Zeitschr. f. Wiss. Mikr., I. (1884) pp. 415–7.

Beecher, C. E.—A New Design for a Microscope Cabinet. [*Post.*]

Amer. Mon. Micr. Journ., V. (1884) pp. 126–7 (1 fig.).

Bell, J.—The Chemistry of Foods.

[I. Tea, Coffee, Cocoa, Sugar, &c. II. Milk, Butter, Cheese, Cereal foods, &c.] 8vo, London, 1884.

Bonnet, R.—Kurzgefasste Anleitung zur mikroskopischen Untersuchung thierischer Gewebe für Anfänger in der histologischen Technik. (Condensed Guide for the Microscopical Investigation of Animal Tissues for Beginners in Histological Technic.) 8vo, München, 1884, 61 pp. and 2 figs.

Chase's (H. H.) *Amphipleura pellucida* and other test-objects mounted in a medium of refractive index 2·42. *Amer. Mon. Micr. Journ.*, V. (1884) p. 159.

Cole, A. C.—Methods of Microscopical Research. Part XIII. pp. lxxiii.–lxxxiii. On Photo-micrography. Plate of T. S. Spine of *Echinus* under (4) various conditions of illumination—1 fig.

„ „ Popular Microscopical Studies. No. XII. pp. 53–6. The Dodder-plant. Pl. 12. T. S. of Dodder (*Cuscuta*) in its host, double stained × 75.

„ „ Studies in Microscopical Science.

Cf. *Micr. News*, IV. (1884) p. 242.

Vol. II. No. 23. Sec. I. No. 12. pp. 45–8. Human Cerebrum. Plate 12. No. 24. Sec. II. No. 12. pp. 47–50. Secondary Tissue. Pl. 12. T. S. Stem of Maple showing annual rings × 50.

Cox, C. F.—Cement for Mounting.

[Correction as to the material he employs for his finishing cement.]

Amer. Mon. Micr. Journ., V. (1884) p. 140 (cf. also p. 132).

Davis, G. E.—The President's Address.

[Deals with "the use of the various processes in connection with microscopical manipulation which have been so universally employed during the past few years" and "the past history of the Microscope."]

Ann. Rep. Manchester Micr. Soc., 1883-4, pp. 60–72.

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* Nature, xxviii. (1883) pp. 389–93 (2 figs.). See also Proc. Roy. Soc., xxxv (1883) pp. 149–51.

DIPPEL, L.—J. D. Möller's Probeobjecte in Phosphorlösung. (J. D. Möller's test-objects in solution of Phosphorus.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 413–4.

E., H. L.—Mounting Infusoria.
[Reply to H. M. J. Underhill. Chromic Oxydichloride acid = Chlorochromic acid.]
Sci.-Gossip, 1884, p. 185.

EHRENBAUM, E.—Ueber eine Methode zur Anfertigung von Dünnschlitten zoologischer Objecte. (On a method of preparing thin sections of zoological objects.) [*Post.*] *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 414–5.

ERRERA, L.—Coupes de tiges colorées par la Canarine. (Sections of stems stained by Canarine.) [*Supra*, p. 815.]
Bull. Soc. Belg. Micr., X. (1884) p. 183.

„ „ Sur l'emploi de l'encre de Chine en Microscopie. (On the employment of Chinese Ink in Microscopy.) [*Post.*]
Bull. Soc. Belg. Micr., X. (1884) pp. 184–8.

FLEMMING, W.—Mittheilungen zur Färbetechnik. (Notes on Staining.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I (1884) pp. 349–61.

FOL, H.—Nouvelle Méthode pour le Transvasage de Bouillons stérilisés et le dosage des germes vivants contenus dans l'eau.
Arch. Sci. Phys. et Nat., XI. (1884) pp. 557–74 (1 pl.).

„ „ Remarques supplémentaires sur la technique du perchlorure de Fer. (Supplementary remarks on the technic of perchloride of Iron.) [*Supra*, p. 813.]
Arch. Zool. Expér. et Gén., II. (1884) p. xi.

„ „ Contribution à la technique des Injections. (Contribution to the technic of Injections.) [*Ante*, p. 312.]
Arch. Zool. Expér. et Gén., II. (1884) p. xii.

FRANCOTTE, P.—Exhibition of Thoma Microtome by Jung, with foot entirely of bronze, and so protected from the effects of sea-water or the moist and salt air of maritime laboratories. *Bull. Soc. Belg. Micr.*, X. (1884) pp. 157–8.

FREEBORN, G. C.—Celloidin for Imbedding. [*Supra*, p. 822.]
Amer. Mon. Micr. Journ., V. (1884) pp. 127–8.

GAGE, S. H.—A Starch Injection Mass. [*Post.*]
Amer. Natural., XVIII. (1884) pp. 958–60,
from the *New York Med. Journ.*, June 7th, 1884.

GERLACH, L.—Technische Notiz. (Technical Notes.) [*Post.*]
Untersuch. Anat. Inst. Erlangen, I. (1883).
Cf. *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 436–8.

GIERKE, H.—Färberei zu Mikroskopischen Zwecken. (Stains for Microscopical Purposes.) (*Contd.*) *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 372–408.

GOTTSCHAU, M.—Vorzüge und Nachtheile Verschiedener Mikrotome und ihrer Hilfsapparate. (Advantages and disadvantages of different Microtomes and their auxiliary apparatus.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 327–48 (12 figs.).

GRAM, C.—Ueber die isolirte Färbung der Schizomyceten in Schnitt- und Trockenpräparaten. (On the isolated staining of Schizomycetes in sections and dry preparations.) [*Supra*, p. 817.] *Fortschr. d. Medicin*, II. (1884) No. 6.
Bot. Centralbl., XVIII. (1884) p. 383.

GRANT, F.—Bacteria and the Microscope.
[Reply to "Amateur," *ante*, p. 630.]
Engl. Mech., XXXIX. (1884) pp. 490–1.

GRAY, E.—Glycerin in Mounting.
[Recommendation not to use an acid glycerin.]
Amer. Mon. Micr. Journ., V. (1884) p. 140.

Griffith's (E. H.) Turntable. [*Supra*, p. 826.]
Amer. Mon. Micr. Journ., V. (1884) p. 126 (1 fig.).

GROVE, W. B.—See p. 810.

HARDY, J. D.—Contrivance for collecting and examining aquatic specimens whilst out on excursions. [*Supra*, p. 803.]
Journ. Quek. Micr. Club, II. (1884) pp. 55–6.

Heurck, H. Van.—De l'emploi du Styrax et du liquidambar en remplacement du baume du Canada. (On the employment of Styrax and liquidambar in place of Canada Balsam.) [*Supra*, p. 827.]
Bull. Soc. Belg. Micr., X. (1884) pp. 178-82.

Hitchcock, R.—The preparation of Shellac Cement. [*Supra*, p. 828.]
Amer. Mon. Micr. Journ., V. (1884) pp. 131-2.

„ „ Microscopical Technic.
Amer. Mon. Micr. Journ., V. (1884) pp. 132-4, 147-9.

Ingpen, J. E.—Smith's Mounting Medium.
["He did not think he had ever seen a slide of *Amphipleura* so well shown as the one which Mr. Nelson exhibited, which was mounted by Prof. Smith. No doubt the objective and the manner of showing it had something to do with the matter, but there was also no doubt that something was due to the medium. He could only say that probably the exhibition had never been surpassed or equalled, and the fact was to be recorded as an era in the history of resolution."]
Journ. Quek. Micr. Club, II. (1884) p. 43.

Karop, G.—Section-cutting. *Abstr. Proc. Western Micr. Club*, 1883-4, p. 12.

Kesteven, W. B.—On Staining Fluids for Sections of Brain and Spinal Cord.
Sci. Monthly, II. (1884) p. 138.

Klein.—[Weigert's] Staining Fluid for Sections of Tubercle-Bacilli.
[*Supra*, p. 818.] *Practitioner*, XXXIII. (1884) p. 35.

Lyon, H. N.—A New Mailing Case. [*Supra*, p. 829.]
The Microscope, IV. (1884) p. 179.

Murray, F. W.—Celloidin for Imbedding.
[Similar to G. C. Freeborn's directions, *supra*, p. 822.]
Amer. Mon. Micr. Journ., V. (1884) p. 128.

Nealey, E. T.—A rapid method for making Bone and Teeth Sections. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) pp. 142-4.

Nelson, E. M.—Bacteria and the Microscope.
[Reply to "Amateur," *ante*, p. 630.]
Engl. Mech., XXXIX. (1884) p. 517.

Peirce's (J.) Slides.
["Intended to prevent the drying of specimens during several hours' continuous observation. A rather deep circular cut is ground in the middle of each slide about 1/2 in. in diameter, which is intended to hold a sufficient quantity of the water to prevent evaporation from under the cover within the cut. It is expected that physicians will find these slides useful."]
Amer. Mon. Micr. Journ., V. (1884) p. 139.

Pillsbury, J. H.—[Hinman's] Device for Mounting. [*Supra*, p. 827.]
Amer. Mon. Micr. Journ., V. (1884) p. 140.

Purser, J. M.—A Manual of Histology and of Histological Methods. viii. and 396 pp. 8vo, Dublin, 1884.
[Contains an Introduction (pp. 1-11) on the Microscope and its use, and an Appendix (pp. 339-86) on measuring, drawing, determining magnifying power, injecting, hardening, embedding, cutting, mounting, summary of reagents, &c. In the Introduction it is stated that "the image must always be formed for each eye-piece at a certain distance below the latter."]

Rataboul, J.—Les Diatomées. Récolte et preparation. (The Diatomaceæ. Collection and preparation.) *Concld.*
Journ. de Microgr., VIII. (1884) pp. 451-4.

Slack, H. J.—Pleasant Hours with the Microscope.
[Thrips—Fungi—Heaths.]
Knowledge, VI. (1884) pp. 125-6 (5 figs.), 179-80 (1 fig.), 230-1 (4 figs.).

Smith, W. D.—On Staining Vegetable Tissues.
[Report of Demonstration.]
Journ. Quek. Micr. Club, II. (1884) pp. 46-52.

Sorby, H. C.—On the detection of Sewage Contamination by the use of the Microscope, and on the purifying action of minute Animals and Plants.
[*Post.*] *Journ. Soc. Arts*, XXXII. (1884) pp. 929–30.

Stowell, C. H.—Studies in Histology. IV. Staining.
The Microscope, IV. (1884) pp. 149–53.

" " How to harden Balsam Mounts.
[Reply to inquiry how to harden balsam mounts quickly and safely. "We have never tried to hasten the drying or hardening of the balsam. Should we desire to have a mount become hard quickly we would use balsam of such a consistence that it was fluid only when warm and quite solid and firm when cold, or we could expose the mounted preparation to a low temperature; this could be accomplished by placing the mount in a drying oven or in a sand bath. Nearly all specimens, however, can be mounted in warm balsam without fear of injury, and then as soon as the balsam becomes cold it is firm and hard."]
The Microscope, IV. (1884) p. 159.

" " Studies in Histology. V.
[Metallic stains.—Mounting.]
The Microscope, IV. (1884) pp. 171–6.

" " A new solid Watch-glass. [*Post.*]
The Microscope, IV. (1884) pp. 176–7.

Sudduth, W. X.—Dento-embryonal Histology and Technology. 19 pp. and 12 figs. 8vo, Chicago, 1884.

W., A. W.—Mounting Fresh-water Algæ.
["After trying all sorts of media . . . . I came to the conclusion that none was so good as plain water with the least addition of camphor water to prevent fungoid growths." Also suggests to preserve the green colour (1) the use of water recently boiled and then closed up in a flask to minimise the amount of air dissolved in it; (2) to put the slide in the dark immediately after mounting.]
Micr. News, IV. (1884) p. 216.

Wagstaff, E. H.—Pond Life in Winter.
[List of objects found in one haul.]
Amer. Mon. Micr. Journ., V. (1884) pp. 144–5.

Whitman, C. O.—A simple Section-smoother.
[Kingsley's, *ante*, p. 659. "For use with the Sterling (well) Microtome it is evidently ill adapted, for the ends which come underneath the blade would interfere with the work."]
Amer. Natural., XVIII. (1884) p. 844 (1 fig.).

Wichmann, A.—Ueber eine Methode zur Isolirung von Mineralien behuf ihrer mikrochemischen Untersuchung. (On a method for isolating minerals for their investigation micro-chemically.) [*Post.*]
Zeitschr. f. Wiss. Mikr., I. (1884) pp. 417–9.

Wilder and Gage.—On the use of Vaseline to prevent the loss of Alcohol from specimen Jars.
[Used *inter alia* to prevent the sticking of the covers or stoppers of cement vials.]
Proc. Amer. Assoc. Adv. Sci., XXXII. p. 318.
Cf. *Amer. Natural.*, XVIII. (1884) p. 845.

Wolle, F.—Fresh-water Algæ.
[Directions for collecting.]
Amer. Mon. Micr. Journ., V. (1884) pp. 129–30, from 'Desmids of the United States.'

the deeper and shallower areolæ in this case is similar to that which has been described in *Navicula prætexta*, &c., and when they are covered by the lace-like veil of the finely dotted film we have the beautiful and changeable effect which has proved so puzzling to observers. In whole valves of *Heliopelta* the larger areolæ will often be found showing in the central part of the shell where the fine dotting of the upper film does not extend over them, and their character may there be pretty satisfactorily determined, even if the separated laminæ are not detected."

After referring to the similarity of structure in *Halionyx*, and dealing briefly with a few other forms, Dr. Cox concludes with the summary of his results which will be found *supra*, p. 853.

MICROSCOPY.

a. Instruments, Accessories, &c.

Japanese Microscope.—Fig. 145 shows a modern Microscope made in Japan and purchased last year in Tokio. The Japanese workman must have evidently had before him one of the old forms of "conical" Microscope which were current in this country in the last century.

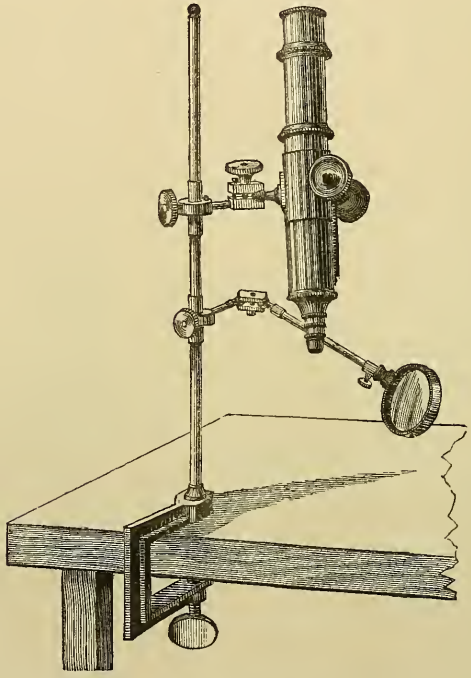
FIG. 145.

A special feature of the Microscope is its exceptional instability, the feet being made of thin and very springy pieces of metal, so that the whole instrument vibrates in every part at the least movement of the table. The four objects are inserted in a metal plate which slides from right to left in grooves in the stage. There is no provision, however, for shifting the plate from back to front, and so obtaining a view of different parts of an object in that direction. The body tube has 2 eye-piece lenses, and a single-lens objective of about 1/2 in. focal length. The metal of which the instrument is made is copper, coated with a black japan, the body tube being covered with leather figured in gilt. The plate immediately below the mirror can be rotated on the box beneath,

carrying with it the whole of the upper part of the instrument, the mirror remaining stationary. We imagine, however, that this movement is the result of defective workmanship, and was not designed as a means of providing oblique illumination.

Schieck's Corneal Microscope.—This (fig. 146) was designed by F. W. Schieck for the examination of the cornea. A steel standard (16 in. long) is secured to the table by a screw clamp. On it slide

FIG. 146.

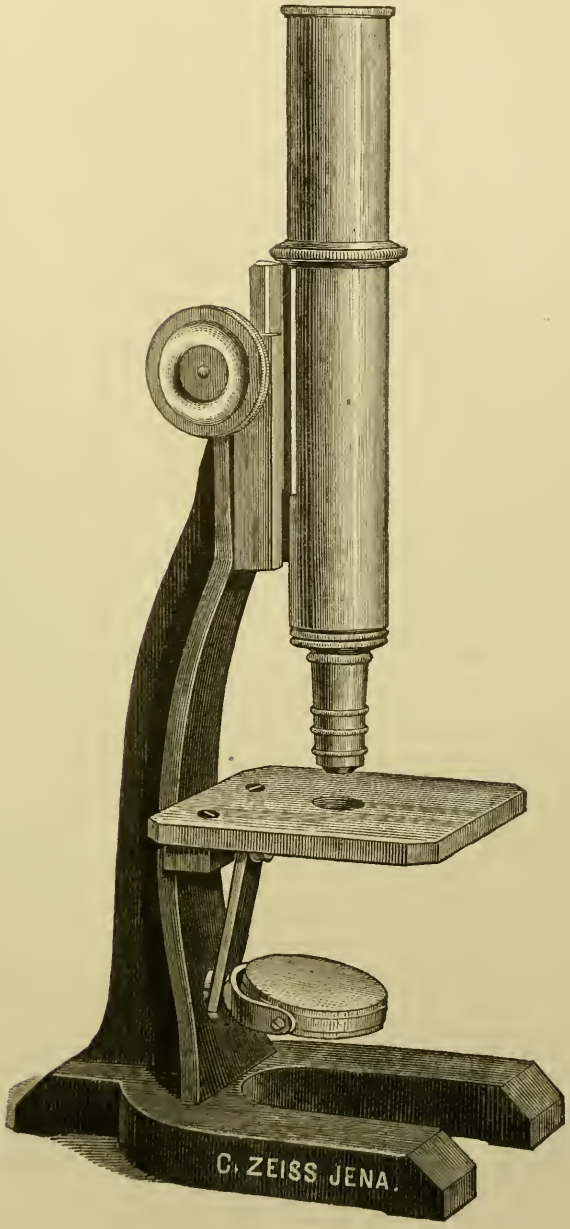


two arms which can be set at any required height by screws. The upper short arm carries the Microscope, which is connected with it by a ball and socket joint and clamp screw, so that great range of motion is obtained. A rack and pinion serves for focusing.

The lower arm carrying the condensing lens consists of two rods connected by a double ball and socket joint. The lens moves on a hinge and also rotates on the rod, a small screw, the point of which works in a groove encircling the end of the rod, preventing it from slipping off. For the lens a mirror having the same movements can be substituted.

Zeiss's No. X. Microscope.—This (fig. 147) is noticeable mainly for the manner in which the upright support is constructed. The limb is of the "Jackson" form, but is continued to the base, to which it is

Fig. 147.



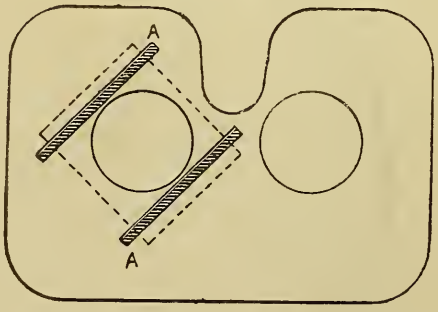
fixed. The stage is attached to the limb. The focusing is by means of rack and pinion only, without fine adjustment. The general design and construction are so simple that the instrument is issued at a very low price indeed.

Wray's Microscope Screen.*—L. Wray, jun., thinks that all who have ever used the Microscope must be painfully aware of the fatigue and distress which prolonged work with it causes to the eyes, and therefore describes a device which he has been trying with this object in view. When the eyes are exposed to a bright light, and one of them is then covered over, the pupil of the uncovered eye at once enlarges, and he believes this action of the iris to be the cause of the distress produced in the use of the Microscope, for the pupil of the working eye is unduly enlarged by the other eye being either shut or shaded by a black screen, consequently more light is admitted to the retina than it can comfortably bear, and the irises of both eyes are in a state of tension, the one tending to contract and the other to expand.

The way in which he counteracts this is by exposing both eyes to an equal light, by attaching to the eye-piece a cardboard screen, which has two holes cut in it, the one to fit on the eye-piece, and the other to allow a thin piece of even-grained white paper being presented before the eye that is not in use.

A back view of the screen is shown in fig. 148, with the paper removed. The two lines A A are intended to represent elastic

Fig. 148.



bands, by which the squares of paper are kept in place, as indicated by the dotted lines, one, two, or more thicknesses being used, according to the brightness of the field and translucency of the paper. The object being to illuminate both eyes equally, it will be found convenient to gum on one thickness of this paper, and to have two or three loose slips to adjust the amount of light.

The plan is one that any one can try for himself; but a more refined method of accomplishing the same thing is to have a ground

* Engl. Mech., xl. (1884) p. 180.

glass screen lighted with a small mirror, and a set of revolving diaphragms to adjust the amount of light.

At first it will seem strange to have a light before the eye not in use, but after a short time this will wear off, and it will then be found that far brighter illumination of the field can be borne when using this device than when closing one eye or employing a black screen.

Abbe's Micro-spectroscope.—This was described at p. 703 of Vol. III. (1880), with an outline diagram of its construction. Its special feature consists, it will be remembered, in the arrangement by which the position of the lines in the spectrum is determined by a direct reading of their wave-lengths on a scale in fractions of μ. The apparatus (half natural size) is shown in fig. 149, and the arrangement for widening the slit in fig. 150.

The tube J containing the prism moves on the excentric pin K so as to turn it away from the eye-piece when required for focusing the object. It is fixed in place by the catch L. The slit is in the

Fig. 149.

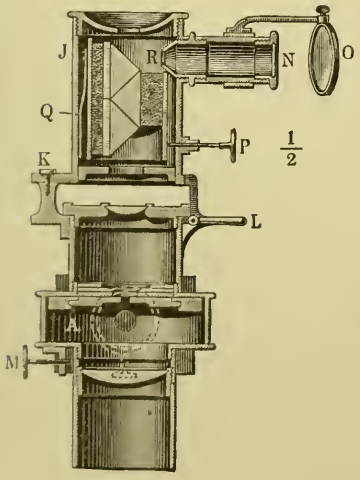
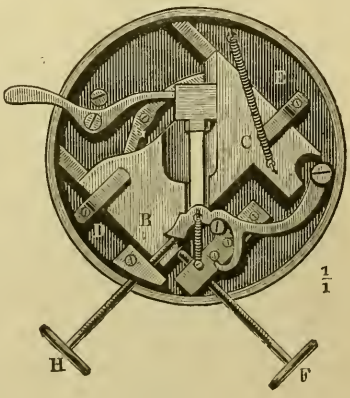


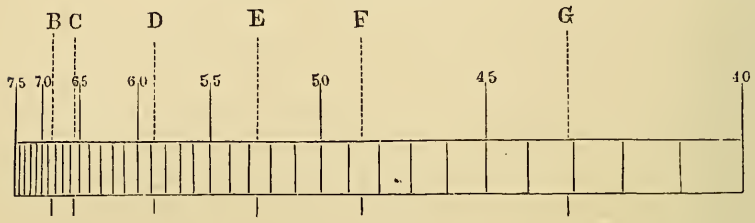
Fig. 150.



drum A, and is made wider or narrower by the action of F, which causes the plates B and C, connected by the lever-arm G and moving between the guides D and E, to approach each other symmetrically. H, on the other hand, regulates the length of the slit. The scale N (fig. 151) is illuminated by the mirror O, and its image is thrown on the spectrum by the objective at R. By the milled head P, which acts against the spring Q, it is set so that the Fraunhofer line D coincides with 0·589 of the scale. The screw M serves to secure the

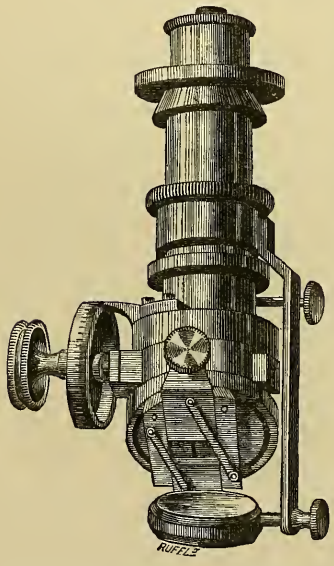
apparatus to the body-tube of the Microscope, into which it is slipped as far as the lower end of the drum A.

Fig. 151.



The comparison prism with its illuminating mirror is not shown, though the latter is indicated in fig. 149 by dotted lines. It is turned away from the slit by the lever-arm shown in fig. 150.

Fig. 152.



Engelmann's Micro-spectral Objective.*—This (fig. 152) was made by Dr. Zeiss for examinations by Prof. T. W. Engelmann's Bacteria-method.

It consists of a plane mirror, a slit, a collimator lens, and a direct-vision prism. The whole apparatus is 77 mm. long, and is applied beneath the stage, ordinary objectives according to the size of the spectrum desired being screwed on at the top to project a spectrum at the plane of the object under examination. Both sides of the slit are moved symmetrically by the screw with divided drum. This screw has two opposite threads on a common axis, so that the centre of the slit never changes its place. The drum gives the width of the slit in hundredths of mm. The smaller milled head moves outer slides to regulate the length of the slit.

In place of the prism a grating can be used, which would give an interference spectrum.

Mayall's "Stepped" Diagonal Rackwork.—Mr. J. Mayall, jun., has suggested the application to the coarse adjustment of a "stepped" diagonal rackwork for increasing the smoothness of the motion.

* See this Journal, ii. (1882) p. 661. Bot. Ztg., xv. (1882) pp. 419–26 (1 fig.). Pflüger's Arch. f. d. gesammt. Physiol., xxvii. (1882) p. 464, xxix. (1883) p. 415.

Fig. 153 shows the arrangement as first applied with three racks, the teeth of each part being set out of line to the extent of one-third their pitch and the spiral pinions being fitted to correspond with the racks. The effect is similar to what would be obtained by pitching the teeth of a single rack three times as finely, but at the same time retaining the strength due to the coarser pitch.

Mr. Mayall subsequently suggested that as the fitting of three

Fig. 153.

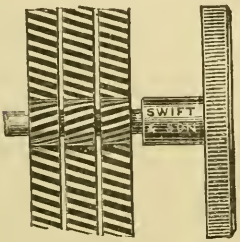
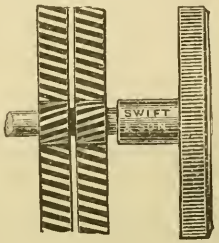


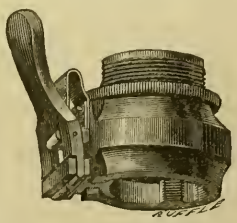
Fig. 154.



pinions on the same axis presented some difficulties of workmanship, these might be considerably reduced by using two racks instead of three, as shown in fig. 154, still retaining a considerable advantage over the ordinary single diagonal rack.

Fasoldt's Nose-piece.—Mr. C. Fasoldt's form of nose-piece (fig. 155) is somewhat similar in principle to that suggested by Mr. Curties.* The Society screw to receive the objective consists of three segments, one of which is on a movable piece which is acted on by a spring lever, a jam-nut enabling the lever always to be set at the most convenient point for working it, say in front of the body-tube. On pressing the lever the objective can be introduced, and if inserted so that the threads correspond, will not require any turning, but otherwise a fraction of a turn may be necessary. "The position of each objective when screwed up is readily found, and can then be marked so that it may always be inserted near this position."† The latter requirement would seem to introduce an element of difficulty, which it is the essential object of such contrivances to eliminate.

Fig. 155.



Spencer's Dust-protector for Objectives.‡—H. R. Spencer & Co. have patented a device to protect the interior and backs of objectives from dust. It consists of a thin piece of plate glass polished, and mounted in a ring screwed into the back of the objective. It is

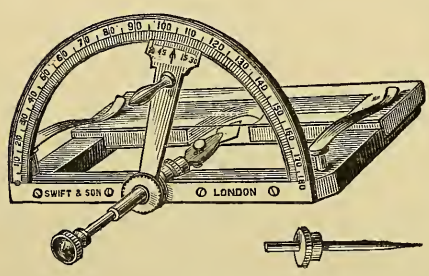
* See this Journal, iii. (1883) p. 572.
† Cf. Micr. Bulletin, i. (1884) pp. 42-3.
‡ Amer. Mon. Micr. Journ., v. (1884) p. 200.

claimed to be "a valuable addition to a lens, while not affecting the corrections or interfering with the performance of the objective in any way. The plan will especially commend itself to all workers who leave their objectives attached to the stands, as dust is sure to find its way to them, even under glass shades."

This device was adopted by the late F. A. Nobert many years since.

Swift and Son's Goniometer Stage.—This instrument (fig. 156) has been constructed by Messrs. Swift and Son for use with their petrological Microscope. It consists essentially of a pair of forceps attached to a pointer moving round a graduated semicircle. It is used as follows to determine the separation of the optic axes in biaxial crystals:—

FIG. 156.



A section of the mineral cleaved or cut perpendicularly to the first median line is placed in the forceps and the apparatus adjusted on the stage of the Microscope, so that the line joining the optic axes is inclined 45 per cent. to the crossed Nicols which are set parallel to the cross wires of the eye-piece, whilst the same line is at right angles to the direction in which the forceps point. The pointer is then turned till the darkest part of one of the "brushes" covers the intersection of the cross wires, when a reading of the scale is made. The pointer is afterwards turned in a contrary direction till the darkest part of the other brush covers the intersection of the cross wires, when a second reading of the scale is made. The difference between the two readings gives the apparent angle in air. The angle in oil or other liquid can be determined in the same way by setting the Microscope horizontally and adapting a small glass cell filled with oil or other liquid, but in this case it is requisite to use an eye-piece provided with a Nicol which rotates so as to allow of the polarizer and analyser being set at 45° to the vertical direction of the forceps.

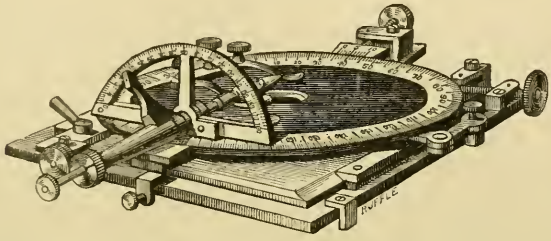
Very small sections of minerals may be attached by wax to the point of the forceps or to a needle fixed in their place.

Hartnack's Goniometer-stage.—The stage shown in fig. 157 has priority of date (by several years) over the preceding.

The base-plate lies on the stage of the Microscope, to which it is clamped by the small screw in the angle-piece below the semicircle, two other similar angle-pieces, but without screws, being fixed to the opposite and one of the remaining sides. On the base-plate are two slides moved by the milled heads at the back and right-hand side of the fig., giving lateral motions in two rectangular directions. The

upper circular plate can be rotated by the hand, or by turning the small handle shown on the left it is fixed, and then can only be rotated slowly by the adjacent tangent screw. The graduated semicircle and forceps are screwed to the upper plate, and can be removed

Fig. 157.

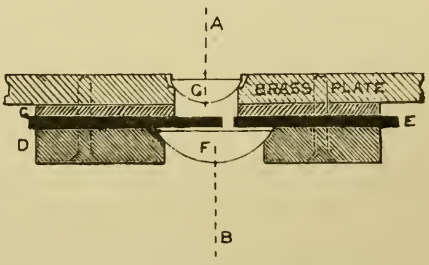


so as to leave the stage free. The movement of the index and forceps jointly is effected by the larger milled head on the axis of the forceps.

Osborne's Diatomescope.—Lord S. G. Osborne has forwarded to us his diatomescope, together with notes from which we have made the following description and diagram.

The apparatus (fig. 158) consists of a rectangular brass plate, 3 in. by $1\frac{3}{4}$ in., in the centre of which is a plano-convex lens G, with its plane face nearly flush with the upper surface of the plate. A thin metal disk C, having a central opening corresponding with the diameter of G, is placed beneath the plate to separate the upper from a second plano-convex lens F, which is mounted slightly out of the centre of the thick metal disk D, so that its axis B is a little at one side of the axis A of the lens G. The upper surface of D is grooved to permit a diaphragm-plate E, having a small square opening of 1/32 in., to traverse between the lenses.

Fig. 158.



The apparatus is placed upon the stage of the Microscope, and the slide is laid flat on the plate, with or without immersion-contact with G, and is held in position by two spring clips. A pencil of light suitably incident on F is refracted through the small opening in E to the curved surface of G, where it is again refracted, emerging from the plane surface more or less obliquely, according to the original incidence and to the position of the diaphragm.

We understand from Lord S. G. Osborne that the device has also been made to fit in an ordinary substage, where it is of course more serviceable than on the stage proper.

Mr. E. M. Nelson * somewhat severely criticizes the instrument. With it used dry, he can just get a dark field with an objective of 0·82 N.A., but the effect is far better with an objective of 0·8 N.A. "Therefore, as far as dark fields are concerned, it does all that is claimed for it. As regards the *quality* of the dark field, it fails, as every other illuminator, which only gives an oblique pencil in one azimuth, must fail. A diatom, to be shown critically on a dark ground, must be illuminated all round; one edge is always blurred when the illumination is from one side only. One will say then, that, if it is not good as a dark-ground illuminator, it must be a first-rate striæ resolver. This, however, is not the case. For an instrument to be a good striæ resolver it must be capable of varying the obliquity of the illuminating pencil. The strongest resolution is always obtained *just before* the field gets dark. Of course I am aware that the obliquity of the illuminating pencil may be varied to a small extent by dodging with the mirror; but that fidgety sort of business cannot be compared with the certain method of a central and focused condenser and a slot cut to a known depth. As mine is mounted, you can neither rotate the beam about the diatom, nor the diatom about the beam."

On this "F. R. M. S." says † that it "is unquestionable that the little device will do good service within the limits prescribed by its aperture. Mr. Nelson should not taboo it for not possessing powers beyond the scope of its designer. He would hardly consider it fair if the 'Nelson' Microscope-lamp were publicly condemned for not being provided with all the luxurious movements of the 'Dallinger' lamp. The construction of an illuminating apparatus of special convenience and efficiency is almost invariably a question of expense. Greater outlay would convert the 'Nelson' lamp into a 'Dallinger.' The 'Nelson' costs some five guineas; and yet is there any feat of microscopical illumination possible with it that could *not* be done with a sixpenny paraffin lamp and brown paper diaphragms in the hands of an expert—say, in the hands of Mr. Nelson himself?"

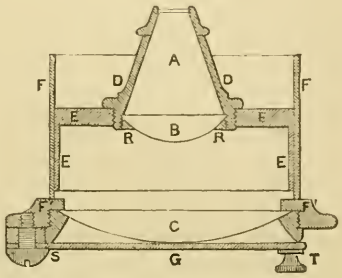
Lord S. G. Osborne replies ‡ to Mr. Nelson's criticism, and "still confidently recommends the instrument to the very many observers who have no substages, not for hypercritical study of diatoms, but as giving most lovely pictures of some of Nature's most beautiful work."

Wallich's Condenser.—Dr. G. C. Wallich has patented an improved condenser intended to obviate the difficulty which has hitherto been experienced in adequately illuminating objects having considerable depth, and more especially when examined in the binocular Microscope and with high-power objectives. It extends the range in depth through which more or less transparent objects may be distinctly seen; and, when used with the binocular, facilitates the production and increase of true stereoscopic effect. The speciality

* Eng. Mech., xl. (1884) p. 157. See also further remarks, p. 242.
† Ibid., p. 199, and see pp. 263-4 (1 fig.).
‡ Ibid., pp. 180-1.

of the improvement consists in the employment of a truncated cone of glass, in combination with one or more lenses capable of being adjusted with respect to one another. The conical surface is highly polished, so as to constitute an internally reflecting surface, the cone having such an angle as to produce total reflection.

Fig. 159.



In fig. 159 A is the cone mounted in a cell D and having a lens B attached to its larger end by transparent cement. C is a second larger lens, and mounted in suitable fittings E and F, by which its distance from B can be adjusted so as to produce various effects. As improved effects may in many instances be produced by preventing the admission of light into the condenser from one or other side of the lens C, a shutter G is added, pivoted at the circumference of the cylindrical fitting F^1 by a screw S, which shutter can be set in any required position by moving the knob T, or by rotating the entire condenser in or by its fittings.

For the purpose of producing various effects of illumination diaphragms are also used furnished with openings of various shapes and sizes, placed either between the lenses B and C, or in front of the smaller polished transmitting end of the catadioptric cone A.

Cells for Minute Organisms.*—In breeding Oribatidæ, Mr. A. D. Michael used glass cells each composed of an ordinary microscopical glass slip 3 × 1 in., having in the centre, fastened by marine glue or Canada balsam, a glass ring made of a transverse slice of glass tubing about 3/4 or 7/8 in. in diameter, the length of the tube, and consequently the depth of the cells, being usually about 3/8 in. The tubing should be of tolerably thin glass, if very thick it is opaque, and leaves little room inside the cell. Over this a thin glass cover, rather larger than the diameter of the tubing, was laid, either a circle or a square; the latter is often handy, as the projecting corners are convenient to take it on or off by, or sometimes a second slide or a broken piece of one is more serviceable. This cover was always quite loose, and simply held on by an ordinary brass-wire microscopical spring-clip; of course the upper edge of the slice of glass tube required to be smooth, so that the cover would lie flat upon it, and not allow the minute animals to escape.

A cell so prepared was carefully cleaned out, and examined under the Microscope, to see that it did not contain Acarina or ova. A small piece of thick white blotting-paper, not large enough to cover the whole bottom of the cell, was then placed in it and damped; a piece

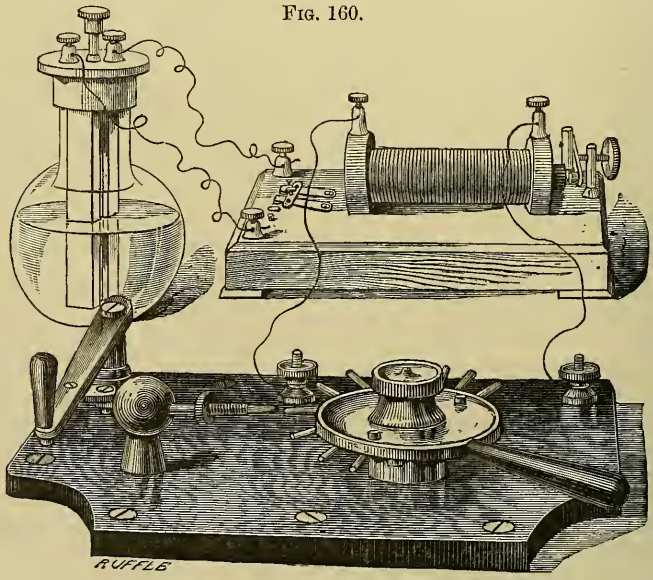
* British Oribatidæ, i. pp. 68–70.

or two of growing moss or fungus was then placed in the cell, having first been carefully examined under the Microscope to see that it also was free from Acarina and ova, and the cell was then ready for use. One or two specimens of the larva, nymph, or species to be observed, were placed in the cells; the cover was put on and fixed with the clip. By carefully attending to the hygrometric condition of the cell, damping the blotting-paper or removing the cover to give air as required, the animals throve well and got quite accustomed to the cells. When it was desired to observe the inmates, which was done at frequent intervals, the clip was removed and the cell transferred to the stage. If low powers were sufficient, the cover did not require to be removed if kept clean and if free from condensed moisture; if, however, higher powers were used it was found that usually the cover could be safely removed.

Mr. Michael found these simple cells answer better than any of the more elaborate apparatus. In particular he tried Mr. Macintyre's ingenious cork cells, but did not find them answer for Oribatidæ. In the first place, many species, being wood-borers, simply ate their way out or into the cork; in the next place, the very minute ones got lost in the interspaces of the cork and never reappeared; in the third place, the cells got dry too easily, and were apt to be too wet or too dry; the former of which was injurious, and the latter always fatal.

Stokes's Spark Apparatus.—Mr. A. W. Stokes has shown at the

Fig. 160.



conversazioni of this Society and of the Quekett Club the sparks of various metals under the Microscope, an exhibition which has proved

of great interest, and has always attracted much attention. The ingenious apparatus which he uses is shown in fig. 160 (drawn from an improved model made by Messrs. Watson and Sons.

The base-plate is of ebonite, and has at one end a small pillar, through which passes an arm carrying a piece of platinum. A similar support at the other end carries a double disk, between the plates of which are inserted the pieces of metal to be experimented on, viz. magnesium, tin, brass, steel, carbon, lead, iron, copper, platinum, and aluminium. The disk can be rotated by an ebonite arm so as to bring each metal successively in line with the platinum. The distance of the latter from the pieces of metal can be increased or reduced by moving the lever-arm with which the platinum holder is connected. A pint bichromate cell in connection with a small induction coil is sufficient to actuate the apparatus. A 1 in., 1/2 in., or 2/3 in. objective shows best. With a higher power than the 1/2 in. the spark is likely to pass to the brass of the objective.

The apparatus is adapted for use with the micro-spectroscope.

Bertrand's Polarizing Prism.*—E. Bertrand proposes a new form of polarizing prism as follows:—"The Nicol prism, the polarizing apparatus most generally employed, is attended with certain disadvantages: (1) the obliquity of the end-faces in relation to the axis of the prism; (2) the length of the prism, which is about four times its breadth; (3) the extent of the field, which is less than 30°; (4) the necessity of employing a very clear and somewhat large piece of Iceland spar, which is becoming more and more scarce and expensive.

Hartnack and Prazmowski † have improved this apparatus; the end-faces of their form of prism being perpendicular to the axis, the prism is shortened, and the field increased to 35°.

In the Nicol prism, and in that of Hartnack and Prazmowski, a luminous ray passing through the spar is divided in two: the ordinary ray undergoes total reflection at the film of Canada balsam or linseed oil, whilst the extraordinary ray is transmitted. By computation the field, within the spar, cannot exceed 26° 33′ 45″; on emerging into air the rays expand and the field attains 35°. It is impossible to exceed this exterior angle by utilizing the extraordinary ray; but if the ordinary ray were utilized, in consequence of its higher refractive index, the field would be increased to 44° 46′ 20″ in air.

To attain this result, I use a prism of flint glass of index 1·658 which I cut through a plane at an angle of 76° 43′ 8″ to the end-faces; the two section-faces thus produced are polished and between them is placed a cleavage plate of spar suitably oriented, the whole cemented together with a substance of refractive index equal to, or greater than 1·658.

A ray of light entering the prism normally cannot traverse the plate of spar without being divided into two rays, which are polarized at right angles. The ordinary ray, whose index is 1·658, will

* Comptes Rendus, xcix. (1884) pp. 538–40.

† See this Journal, iii. (1883) p. 428.

proceed without deviation, but the extraordinary ray, whose index is between 1·483 and 1·658, according to the direction of the ray, will not enter the spar if the angle of incidence is suitably regulated. My prism is devised to fulfil these conditions.

A polarizing prism is thus obtained about equal in length to that of Hartnack and Prazmowski, but the exterior field of view is 44° 46′ 20″. A large piece of spar is not required, a simple cleavage plate suffices; moreover, as the end-faces are of flint glass, they may be cleaned without injury.

This form of construction may be still further improved: the flint-glass prism may be cut in a plane forming an angle of 63° 26′ 15″ with the end-faces, and a cleavage plate of spar inserted between the section-faces as before. This prism is again cut in a plane symmetrical with the former in relation to the axis, and the two parts are cemented together, having between them another cleavage plate of spar placed symmetrically in relation to that in the first section. We thus obtain a polarizing prism half the length of Nicol's, with a field of view of 98° 41′ 30″."

Electric Illumination for Anatomical, Microscopical, and Spectroscopical Work.*—Dr. C. von Voit describes the result of some experiments as to the electric light, conducted by himself and Drs. Kühne, Kupffer, Rüdinger, and Bollinger.

The lamps used were an Edison incandescent lamp, of about 16 candle-power, a Müller, of about 24, and a Maxim of from 36 to 60, respectively.

In every instance the light was sufficient for the finest microscopical observations, and for the highest magnifying powers, free from the well-known disadvantages of other artificial illumination, such as the preponderance of the yellow-rays, and the heat with close approximation. When the light of the Maxim lamp was raised to about 60 candles, so that the M-form of the carbon filament was unrecognizable in consequence of the irradiation, the heat was scarcely perceptible, when the face was within 25 cm. of it.

The 16-candle lamp was effective at a distance of 1 m. For the arrangement of many Microscopes in a circle at a convenient distance round the source of light, the Müller lamp is most to be recommended, because the spiral form of the carbon produces equal effects in all directions.

The greatest intensity—of 60 candles—was equivalent to the best available diffused daylight, when the rays were made parallel by a condenser before falling upon the mirror.

In all the observations it was necessary for obtaining homogeneous images, unaffected by any reflex and interference phenomena, to insert immediately under the object a plate of ground-glass, or to place the preparation upon the polished side of a ground-glass slide.

* Central-Ztg. f. Optik u. Mechanik, iv. (1883) p. 206. Aus Die Elektro-Medicin in der Internat. Elektr.-Ausst. zu München im Jahre 1882 von Dr. R. Stintzing.

The objects examined were: fresh human blood, epithelium from the mouth, and saliva-corpuscles, numerous preparations (stained with colouring matters of all kinds) of muscle, nerves, epithelium, bones, skin, embryos, bacteria, "test objects" (*Pleurosigma angulatum*). Especially surprising was the faultless image of the red blood-corpuscles, an object which has hitherto for the most part withstood artificial illumination. Even with the weaker incandescent lamps, the faint hæmoglobin colour of the corpuscles showed a clearness beyond expectation.

A few more intense pigments, on the other hand, were considerably altered: in daylight saturated blue imbibitions, prepared with indigo-carmine, borax, and oxalic acid, were a dingy reddish-violet, with every kind of electric illumination, whilst objects coloured with anilin-blue were a more intense blue, and, when in thick sections, blackish blue. All coloured green with indigo and picric acid were of a decided saturated green.

A Crompton arc-lamp, of about 3000 candle-power, was found quite as advantageous as the incandescent lamps. The light, diminished (by about 15 per cent.) by an opal glass shade, and placed at a distance of 2·1 m. (in a horizontal direction) from the mirror of the Microscope, and raised 1·1 m. above it, was found the most convenient, whilst the plane mirror of Abbe's illuminating apparatus was adjusted, not on the brightest point, but on an adjoining portion of the globe. In this case the ground glass under the object was indispensable, and may always be reckoned an advantage. Where exceptionally such great brightness is requisite this illumination is to be recommended.

In order to see how far the excess of light promised advantage, the shade was removed, and the mirror adjusted on the carbons. Instead of the ground glass, which produced a field of view full of spots, a small piece of oiled tissue-paper was placed over the upper surface of the Abbe illuminating lens, and the smaller diaphragm inserted. An object, consisting of mouth-epithelium and saliva-corpuscles, observed with this illumination and Zeiss's oil-immersion 1/18 and a strong eye-piece, has perhaps given the most perfect microscopic image that has yet been seen. It was, indeed, attempted to obtain the same with direct sunlight, but with only partial success, as it was necessary to dim the sunlight by ammonio-oxide of copper.

Further to increase the illumination by a parabolic reflector appears impracticable, as the heat, which had never before been troublesome, became unbearable, even at a distance of several metres.

The whiteness of the electric light, resembling in this respect daylight, especially adapts it to the observation of such objects as are recognizable essentially by differences of colour. Fresh preparations of pathologically changed organs (cancerous and cirrhous liver), and fine shades of skin pigments of animals, were perfectly demonstrated by the incandescent lamps, and whilst enjoying the advantage of these almost non-heating lamps, by which the observer may be surrounded on all sides, there is no difficulty in undertaking the finest zootomical

preparations by its peaceful light, undisturbed by troublesome shadows of the hand and instrument.

As the spectrum of the incandescent lamp is not only continuous but incomparably more intense in the blue and violet than that of any other artificial light, the suitability of the light was tested for spectral absorption analysis. Complete success was obtained in recognizing in the blue and violet the absorption-bands of such colouring matters as had hitherto only been capable of investigation with sunlight; for instance, the three between F and H of the yellow colouring matter of the yolks of eggs, the alcoholic-ether extract being placed between the slit of the spectroscope and an Edison lamp.

Dr. M. Flesch also considers * the advantages of the electric light for microscopy.

The value of a light for microscopical purposes can be judged of by considering the causes which determine the maximum capacity of the Microscope. "The limit of resolution of the Microscope, which under present conditions cannot be extended, depends upon the illumination, and under the most favourable conditions it does not exceed with the most oblique light 3/8, or with perfectly central light 3/4, of a wave-length (about 0·55 μ) of white light. With homogeneous blue light of about 0·43 μ wave-length (Fraunhofer's line G), under the same circumstances, the above limits become reduced to about 3/10 and 6/10 respectively; that is, to about 0·15 μ and 30 μ." † The possibility of thus increasing the resolving power of the Microscope by the use of blue instead of white light, makes it desirable to introduce illuminating apparatus which will permit of the ready application of monochromatic light. It follows from the preceding that a good microscopic lamp must be rich in blue rays. This in the case of incandescent bodies is dependent upon the temperature. At 1500° C. bright blue rays are emitted, at 2000° violet rays. In the case of the electric light, the proportion of short-wave rays will vary with the strength of the current. O. E. Meyer ‡ gives the following table showing the brightness of the different lights, compared with that of the sun, the latter being reduced in intensity, through polarization, until the brightness of the yellow light was the same in each case.

	Arc Light.	Incandescent Light. (Edison's).	Gaslight.
Red	2·09	1·48	4·07
Yellow	1·00	1·00	1·00
Green	0·99	0·62	0·43
Blue-green ..	—	0·29	—
Blue	0·87	0·21	0·23
Violet	1·03	0·17	0·15
Extreme violet ..	1·21	—	—

The incandescent light contains, it will be seen, relatively, more of the blue rays than gaslight; and it will, therefore, much facilitate

* Zeitschr. f. Wiss. Mikr., i. (1884) pp. 175–81.
† Dippel's 'Das Mikroskop,' i. (1882) p. 324.
‡ Centralbl. f. Elektrotechnik, v. p. 457.

work with monochromatic light where the greater intensity compensates for the light absorbed. It also possesses the advantage of comparatively lower heat, as it can be brought very close to the object. It is also very pure, which proves useful with complicated stains, and it is very uniform.

Dr. Van Heurck, it will be remembered, has already published * the opinion that "the incandescent electric light supplies the illumination *par excellence* which the microscopist requires."

Clayton and Attout-Tailfer's Isochromatic Plates for Photomicrography.†—The different colours of the spectrum are, as is known, far from having the same reducing action on silver salts; there exists, in fact, an antagonism between their luminous intensity and photo-chemical action. It is thus that objects coloured yellow or orange (which are luminous colours) produce almost black images, whilst objects coloured blue or violet (which are dark colours) give pale and almost white tones.

Dr. E. Van Ermengem has obtained some excellent photo-micrographs by using the isochromatic plates of Clayton and Attout-Tailfer, of Paris, which in the reproduction of the Bacteria for instance do not necessitate any special device for illumination, or the use of coloured glass even when the objects are stained red with fuchsin.

According to Dr. Van Ermengem the scientific application of photography is likely to derive the best results from these plates. The methods of staining so much used at present in micrographic research have undoubtedly contributed to restrict the use of photography even where it would have been most useful. In bacteriological researches especially, it has been very difficult hitherto to get suitable images of certain bacteria, such as *B. tuberculosis*, which cannot be coloured with brown stains. The same was the case with preparations treated with methyl-blue or fuchsin, the most usual staining reagents. The isochromatic plates, however, enable excellent photographs of these different preparations to be obtained with equal facility. Their manipulation does not differ from that of the ordinary plates, and their sensitiveness is very great, though possibly less than that of the bromo-gelatin plates of Van Monckhoven. The sensitiveness of the plates to coloured light is due to the impregnation of the sensitized layer by a very weak solution of eosin. All the compounds do not, however, give good results, and what kind of eosin ought to be used is not yet decided.

Error in Photographing Blood-corpuscles.‡—A note on a possible source of error in photographing blood-corpuscles, by G. St. Clair, communicated to the Birmingham Philosophical Society, is a fruitless attempt to explain as an optical illusion Dr. Norris's asserted discovery by the aid of photography of a third kind of corpuscle in mammalian blood. The author invokes the principle of the forma-

* See this Journal, ii. (1882) p. 418.
† Bull. Soc. Belg. Micr., x. (1884) pp. 170-2.
‡ Nature, xxx. (1884) pp. 495 and 517.

tion of images by the passage of light through small apertures, and conceives that Dr. Norris's "colourless disks" are merely images at the end of the microscope-tube or the aperture of the eye-piece, and he seems to have taken some pains to obtain such images by placing under the Microscope a slide thickly strewn with small steel disks, and receiving the light on a screen beyond the eye-piece. Had he attempted to focus these ghosts and the real images of the disks *at the same time*, or considered a little more closely the elementary optical principles involved, we venture to say the note would never have been written.

The Tolles-Wenham Aperture Controversy.—The address * of Dr. J. D. Cox, the President of the American Society of Microscopists, is exclusively occupied with a review of the controversy between Mr. Wenham and Mr. Tolles on the aperture question, with extracts from the various papers published by them and others. Mr. Wenham was so fundamentally in the wrong throughout that controversy, not only on the merits of the question, but also in the manner in which his part of the controversy was conducted, that Dr. Cox may be, in part at least, forgiven for the relentless manner in which he recapitulates the strange optical errors which Mr. Wenham from time to time enunciated, not omitting the mishap by which—though in fact he had discovered, in 1855,† the great increase of distinctness of the more difficult diatoms when mounted in balsam and with a small hemisphere cemented over them with balsam—he after all missed the keystone of the aperture question and the important property of immersion objectives in consequence of having in some inexplicable way supposed that a glass hemisphere did not magnify the object at its centre because there was no refraction.‡

If, however, Dr. Cox, in demonstrating the correctness of the views of the American optician, felt himself obliged to deal so fully with the mistakes of his opponent, he does not shrink from paying a well-deserved tribute to Mr. Wenham in the following words:—"His authority was deservedly great. His improvements of the Microscope

* Proc. 7th Ann. Meeting Amer. Soc. Micr., 1884, pp. 5–39 (4 figs.).

† Quart. Journ. Micr. Sci., iii. (1855) p. 302.

‡ Ibid., and Mon. Micr. Journ., x. (1873) pp. 11–12. The text of Mr. Wenham's paper is as follows:—

"Now arose the question of a means of obtaining the full aperture on objects in balsam or fluid. It at once appeared that if the object was set in the centre of a sphere (or hemisphere) all rays from the central point must continue their course without deviation, and that in such a case neither the length of radius of the glass hemisphere or the refractive power of the material would influence the results. I therefore made a number of minute plano-convex lenses of various radii, some less than the 1/100th part of an inch. Such of these as turned out to be hemispheres were set exactly over a single selected diatom and balsam let in. *Before* the balsam was admitted for a well-known optical law, the object could not be seen. When a 1/5th or other object-glass was brought over this lens, the arrangement might be termed a four-system one, though the optical effect of the hemisphere as a lens was *nil*, simply because there was no refraction. The balsam object was not magnified. It occupied a like focal distance to the *dry* ones outside and the same adjustment served for either." Cf. also Mon. Micr. Journ., ix. (1873) p. 31.

and its accessories were so numerous, so beautiful, and so useful as to excite the enthusiasm of all who used the instrument. He had made himself an expert in the construction of object-glasses, and in every department of his activity he had with a noble disinterestedness made the world a free gift of his inventions."

We must take exception to one remark of Mr. Cox. It is not correct to say that Mr. Tolles "practically had to contend with the organized authority of the Royal Microscopical Society." The authority of the Society was never involved in the controversy, and the Fellows who saw the absurdity of the denial of the existence of an aperture in excess of that of 180° angular in air were at all times as numerous and influential, to say the least, as those who maintained the contrary view.

The only satisfactory point about this aperture question is that it is at last at rest, and that it is now no more incumbent upon microscopists to debate the question with objectors than it is for physicists to debate the rotundity of the earth or its rotation upon its axis.

Amphipleura pellucida resolved into "Beads." Nature of the Striæ of Diatoms.—Dr. H. Van Heurck writes to us as follows:—

The *A. pellucida* has a double system of striation, transverse and longitudinal, which has been known for some time, although the number of observers who have seen the longitudinal striæ is very limited.

Hitherto the "beads" on this diatom have not been clearly resolved, and the possibility of exhibiting them has been doubted. The matter is no longer doubtful, for I now adduce unmistakable proof—a photograph of the "beads."

In October 1883 I succeeded in producing a print on which the beads were fairly indicated, but the matter was not ripe for publication; I was proceeding with further experiments, when I was attacked by severe illness which prevented me from resuming my work during the whole of the winter.

I have recently taken up the subject again, and have succeeded in obtaining photographs, both by transmitted light and by the vertical illuminator, which suffice to clearly prove the existence of the beads, although as photographs they leave much to be desired.

If these beads are difficult to observe distinctly, they are far more difficult to photograph, so that I had almost despaired of obtaining a satisfactory print. We may, it is true, succeed in viewing the beads on the focusing screen of the photographic apparatus, and may see them distinctly, and yet on developing the image on the sensitized plate the whole appears foggy, indistinct, and valueless. Out of some fifty trials I hardly obtained one with tolerable success. I used some of the best known objectives, such as the 1/12 and 1/18 of Zeiss, the 1/10 of Tolles, and the 1/8 (1·47 N.A.) of Powell and Lealand, all homogeneous immersions, and, notwithstanding, the results were nearly always worthless. I attributed these failures to the "chemical" focus of the objectives, but I have since found that the real explanation was in the fact that the objectives were not equal to the task.

My success in photographing the beads has been due to the use

of the incandescent electric lamp; still, I hope to improve upon these results. Drummond's light in my hands was not satisfactory.

I send for comparison a print of *A. Lindheimeri* Grun., a species intimately allied to *A. pellucida*, differing only in being larger and in having bolder striation. The details shown on *A. Lindheimeri* will assist the interpretation of the print of *A. pellucida*.

It will be observed that in both species the longitudinal lines are not straight but wavy, which is due to the fact that the beads or alveoli are not opposite each other, but alternate irregularly. This is also observed in the photographs (*vide* photo. E, negative No. 789) produced by Dr. Woodward, of the *Rhomboides Van Heurckia* Bréb. This arrangement of the striation combined with the presence of the rudiment of the median nodule, which on my prints is well seen, confirms the opinion given by Mr. Kitton in a note on the text of my Synopsis, which he has been good enough to read, that the genus *Amphipleura* presents no essential generic character which would differentiate it from the genus *Van Heurckia* (the existence of the keels not being demonstrable and their notification appearing to him due to an error of observation), the species of the genus *Amphipleura* should therefore be comprised in the genus *Van Heurckia*.

I take advantage of this opportunity to explain my opinion on the nature of the striæ of diatoms, striæ which in many cases are only seen by the help of oblique condensers.

I cannot admit that these striæ are illusory.

The beads of the diatoms are really alveoli or cavities in the thickness of the valves; between the cavities are thickened parts, and it is these thickenings which appear as striæ. These striæ are stronger or weaker according to the separation of the alveoli, and also according as the siliceous bands between them are more or less thick.

I have explained this point in detail, as well as my other views on the structure of the valves, on pages 35–7 of the text of my Synopsis, which were printed early this summer and of which a copy is deposited with the Secretary of the Belgian Microscopical Society.

By way of summary of this note, I state: (1) that the *A. pellucida* as well as the *A. Lindheimeri* consist of alveoli arranged in series at right angles; the alveoli are arranged in regular transverse series and in wavy longitudinal series. (2) Our present objectives suffice to elucidate the structure of the diatom valves, provided we employ media of sufficiently high refraction, and suitable illumination. (3) The striæ exhibited by an improper illumination or by an objective whose aperture is too low to resolve the alveoli or the "beads" of *A. pellucida*, are due to the thickened parts of the valve, that is, to the parts situated between the beads and the alveoli.

The photographs I send herewith are:

(1) *A. pellucida* produced with Powell and Lealand's oil-imm. 1/8, illuminated by incandescent electric lamp,* and the vertical

* The illumination was obtained by means of the Nelson-Mayall-Van Heurck lamp,—thus I name the Nelson-Mayall lamp, in which I have replaced the lamp-wick by a Swan lamp of 6 volts. The great facility of movement provided in this lamp renders it of much service in these extremely delicate researches.

illuminator. The preparation silvered by Dr. A. Y. Moore's process.

A. Print from the original negative, 800 diam.

B. Print from negative enlarged to about 2850 diam.

C. Print magnified to 7000 diam., with Ross's Rapid Symmetrical, without diaphragm, by oxyhydrogen light.

(2) *A. Lindheimeri* Grun., medium of index 2·4, Zeiss's 1/18, incandescent electric light nearly axial, full aperture of Powell and Lealand's achromatic condenser.

A. Print from original negative.

B. An enlargement of the same.

American Association for the Advancement of Science.
[Report of the Philadelphia Meeting (probable abolition of the Section of Histology and Microscopy).]
Science Record, II. (1884) pp. 235–48.
Amer. Mon. Micr. Journ., V. (1884) pp. 175–6, 181–3 (Address of Prof. Wormley, V.P.).
Science, IV. (1884) pp. 342–3.
Micr. Bulletin, I. (1884) pp. 33–4, 46.
The Microscope, IV. (1884) pp. 237–8.

American Society of Microscopists.
[Report of Rochester Meeting—Remarks of Dr. Dallinger.]
Amer. Mon. Micr. Journ., V. (1884) pp. 161–73, 174–5.
Microscope, IV. (1884) pp. 193–5, 204–5, 206, 208, 209, 210, 228–31, 234–5 (under the headings "The Great Lights of the Past; where are they?" and "What our Friends say," "To See is to Believe," and "The Working Session").
Science Record, II. (1884) pp. 206–7, 248–9.
Micr. Bulletin, I. (1884) p. 41.

Atwood, F.—New Apparatus for Photo-micrography. [*Post.*]
Amer. Mon. Micr. Journ., V. (1884) p. 170.

Bausch, E.—Binocular Microscope. [*Ante*, p. 607.]
Specification of U.S.A. Patent, No. 293,217, 12th February, 1884.
„ „ The Society Screw. [*Post.*]
Micr. Bulletin, I. (1884) p. 40.

Bertrand, E.—Sur un nouveau prisme polarisateur. (On a new Polarising Prism.) [*Supra*, p. 965.] *Comptes Rendus*, XCIX. (1884) pp. 538–40.

Biological Laboratory at Health Exhibition. [*Ante*, p. 808.]
Sci.-Gossip (1884) p. 233.

Blackham, G. E.—Memoir of Robert B. Tolles.
Proc. 7th Ann. Meeting Amer. Soc. Micr., 1884, pp. 41–6.
Amer. Mon. Micr. Journ., V. (1884) pp. 167–8.
The Microscope, IV. (1884) pp. 202–4.

Bradbury, W.—The Achromatic Object-glass. XXXVI.
Engl. Mech., XL. (1884) pp. 232–3.

Brayley, E. B. H.—The Bristol Microscopical Society.
[In contradiction of the statement that there was no such Society.]
Engl. Mech., XL. (1884) p. 239.

Cox, J. D.—Annual Address of the President to the Rochester Meeting of the American Society of Microscopists. Robert B. Tolles and the Angular Aperture question. [*Supra*, p. 970.]
Proc. 7th Ann. Meeting Amer. Soc. Micr., 1884, pp. 5–39 (4 figs.).

D., E. T.—Graphic Microscopy. X. Eggs of House-fly. XI. Sori of Fern: *Marattia alata*. *Sci.-Gossip*, 1884, pp. 217–8 (1 pl.), 241–2 (1 pl.).

Dallinger, W. H.—Researches on the Origin and Life-histories of the least and lowest living things.

[The full lecture—abstract, *ante*, p. 721.]

Nature, XXX. (1884) pp. 619-22 (1 fig.), 645-8.

" " See American Society of Microscopists.

Davis, G. E.—To our Readers.

[Announcing the suspension of the 'Microscopical News.']

Micr. News, IV. (1884) pp. 267-8.

Engelmann, T. W.—Recherches sur les relations quantitatives entre l'absorption de la lumière et l'assimilation dans les cellules végétales. (Researches on the quantitative relations between the absorption of light and assimilation in plant cells.)

[Version in French of German paper noted *ante*, p. 301. Describes the "microspectral photometer, an apparatus for quantitative microspectral analysis."] [*Post.*]

Arch. Néerl. Sci. Exact. and Nat., XIX. (1884) pp. 186-206.

F. R. M. S.—The Diatomescope and Mr. E. M. Nelson—An oblique illuminator for the Microscope wanted. [*Supra*, p. 961.]

Engl. Mech., XL. (1884) pp. 198-9, 263-4 (1 fig.).

Findon, C. J. B.—The Diatomescope. *Engl. Mech.*, XL. (1884) p. 264.

Fischer, G.—See Guébhard, A.

"Grey Beard."—The Annual Proceedings [of the American Society of Microscopists].

[Deprecating complaints of delay in publication.]

The Microscope, IV. (1884) p. 223.

Guébhard's (A.) Artikel Ueber das Vergrösserungs-vermögen der optischen Instrumente, Anhang zu, aus französischen Quellen zuzammengestellt von G. Fischer. (Appendix to Guébhard's article, *ante*, p. 810, on the magnifying power of Optical Instruments. Compiled from French sources by G. Fischer.) [*Post.*]

Central-Ztg. f. Optik u. Mech., V. (1884) pp. 217-20 (3 figs.).

Gundlach, E.—Improvement in Objectives. [*Post.*]

Amer. Mon. Micr. Journ., V. (1884) pp. 168-70.

Haycraft, J. B.—A Model Lens for use in Class Demonstrations.

Nature, XXX. (1884) p. 543 (1 fig.).

Hitchcock, R.—Recent Studies on the theory of the Microscope, and their practical results as regards the use of the Microscope in scientific investigations.

Amer. Mon. Micr. Journ., V. (1884) pp. 191-6.

" " The Electric Light for the Microscope.

[Mr. Walmsley's exhibit at the Philadelphia Meeting of the Amer. Assoc. Adv. Sci., &c.]

Amer. Mon. Micr. Journ., V. (1884) p. 199.

Hofmeister, V.—See Siedamgrotzky, O.

James, F. L.—Instructions for making a neutral-tint Camera lucida.

[Round cover-glass and pill-box.]

Amer. Mon. Micr. Journ., V. (1884) p. 179, from 'National Druggist.'

Julien, A. A.—An Immersion Apparatus for the determination of the temperature of the critical point in the fluid cavities of minerals. [*Post.*]

Amer. Mon. Micr. Journ., V. (1884) pp. 189-90.

Science, IV. (1884) pp. 342-3.

Kingsley, J. S.—Journal of R. Microscopical Society.

Science Record, II. (1884) p. 187.

" " [Answer to question "Which is the best Microscope?"—the answer being Hartnack or Zeiss if price is taken into consideration. "Almost every American student who goes to Europe to study biology gets rid of his American stand, and comes back armed with instruments of one of the two makers named."]

Science Record, II. (1884) p. 210.

Kingsley, J. S.—Workers and their Instruments.
[List of 31 United States and Canadian working microscopists with the Microscopes they use, being German 24, American 11, and English 2. "It may be that these men who have chosen the despised instruments of Europe are fools, and that they are not capable of appreciating a good article when they see it; but if we are to judge by their published works, we have no evidence of any dementia or idiocy."
Science Record, II. (1884) pp. 261–2.
" " [Suspension of publication of the 'Science Record.']
Science Record, II. (1884) pp. 272–5.
'Lens,' proposed resuscitation of, by Illinois State Microscopical Society.
Science Record, II. (1884) p. 207.

Martius.—Eine Methode zur absoluten Frequenzbestimmung der Flimmerbewegung auf stroboskopischem Wege. (A method for determining the absolute frequency of the movement of the cilia by means of the stroboscope.) [*Post.*]
Arch. f. Anat. u. Physiol., 1884, *Physiol. Abtheil.*, pp. 456–60.

Miller, M. N.—Photographing Diatoms and diffraction gratings.
[Reply to query as to "how to successfully photograph a diatom its natural size, preserving if possible the detailed structure in the photo." Suggests first making a photomicrographic negative × 200–500, and then making a microphotographic positive from the negative, which with a lens would show the detail of the larger picture.]
Engl. Mech., XL. (1884) p. 158.

Nelson, E. M.—Illumination for the Microscope. II., III. [*Post.*]
Engl. Mech., XL. (1884) pp. 157–8 (3 figs.), 263 (6 figs.), (in part).
" " On a Hydrostatic Fine Adjustment. [*Ante*, p. 800.]
Journ. Quek. Micr. Club, II. (1884) pp. 57–8 (3 figs.), 84–5.
" " The Diatomescope. [*Supra*, p. 962.]
Engl. Mech., XL. (1884) pp. 157 and 242.
" " " [Rejoinder to F. R. M. S. Also remarks on oblique illuminators, which he thinks should "be consigned to the dust-bin."]
Engl. Mech., XL. (1884) p. 242.

Osborne, S. G.—The Diatomescope. [*Supra*, p. 961.]
Engl. Mech., XL. (1884) pp. 180–1.
" " " [Comment on "F. R. M. S.'s" letter, and that there is no difficulty in fitting the apparatus to a substage.]
Engl. Mech., XL. (1884) p. 221.

Queen, J. W.—Some recent devices for quickly changing objectives.
[All have appeared *ante*, except Fasoldt, *supra*, p. 959.]
Micr. Bulletin, I. (1884) pp. 34–6 (6 figs.), 42–3 (5 figs.).
Queen's (J. W. & Co.) New Dissecting Stand. [*Post.*]
Micr. Bulletin, I. (1884) p. 38 (1 fig.).
" " New Class Microscope.
[Described II. (1882) p. 398.]
Micr. Bulletin, I. (1884) p. 47 (1 fig.).

[Redding, T. B.].—The Microscope. II.
Indianopolis Journ., 12th October, 1884, p. 7.

Royston-Pigott, G. W.—Diatomescope experiments.
[Examples showing the capabilities of the instrument, with drawings of the appearance of *P. angulatum*.]
Engl. Mech., XL. (1884) p. 239 (2 figs.).

Siedamgrotzky, O., and V. Hofmeister.—Anleitung zur mikroskopischen und chemischen Diagnostik der Krankheiten der Hausthiere für Thierärzte und Landwirthe. (Guide to the microscopical and chemical diagnosis of the diseases of domestic animals, for veterinary surgeons and farmers.) 2nd ed.
[Contains general remarks on the use of the Microscope, pp. 4–16, and the principal impurities of microscopical preparations.]
iv. and 227 pp. (56 figs.), 8vo, Dresden, 1884.

Smith, J. Lawrence, Memoir of.
[Inventor of the Inverted Microscope.]
Proc. Amer. Acad. Arts and Sci., XIX. (1884) pp. 535–9.

Society Screw, Committee appointed by American Society of Microscopists as to. [*Post.*] *Amer. Mon. Micr. Journ.*, V. (1884) p. 172.

Spencer, C. A., and Tolles, R. B., Proposed Memorials to.
Amer. Mon. Micr. Journ., V. (1884) p. 171.

Spencer's (H. R. & Co.) Objective Protector. [*Supra*, p. 959.]
Amer. Mon. Micr. Journ., V. (1884) p. 200.

Stricker, S.—Ueber das elektrische Licht als Hülfsmittel für den mikroskopischen Unterricht. (On the electric light as an aid for microscopical instruction.)
Wiener Med. Jahrbücher, 1883, pp. 463–75.

Swift & Son's New 1-in. Objective, 40° Angle of Aperture, "constructed on an "entirely new optical principle, whereby extraordinary depth of focus and "flatness of field combined with resolving power is obtained. This objective "works beautifully with the Binocular Microscope, and owing to its large "angular aperture is rendered the best objective extant for use with the Lan-"tern-projecting Microscope." *Sci.-Gossip*, 1884, p. cxvi. (Advt.).

Taylor, J. E.—The Aquarium: its Inhabitants, Structure, and Management. New ed.
[Contains "The Aquarium as a Nursery for the Microscope," pp. 113–38.]
xvi. and 316 pp. (239 figs.), 8vo, London, 1884.

Tolles, R. B.—See Spencer, C. A.

Wallich, G. C.—An improved form of "Condenser" for the Microscope. [*Supra*, p. 962.] *Specification of Patent*, No. 7639, 13th May, 1884.

Watts, H.—[Postal Microscopical Society formed in Australia.]
Journ. of Micr., III. (1884) pp. 261–2.

West, T.—Blackground illumination [is a poor way of getting at the facts which a specimen may disclose; so also is polarizing . . . .]
Journ. of Microscopy, III. (1884) p. 247.

Wilson, W. L.—A cheap Microscope holder.
["It costs about a penny, and works as well as a guinea one with universal brass hinge. It consists of a turned American clothes-peg, held between two upright strips of wood, and these are bound at the top with an elastic band, which is passed three times round them. The bottom end of the strip is held by one screw to a block of wood. The clothes-peg thus has every motion, up and down between the strips of wood, round upon its own axis, and sideways on a hinge."]
Sci.-Gossip, 1884, p. 260.

Woodward, B. B.—The Microscope: how to make and how to use one.
Young England, 1884, pp. 213–5 (3 figs.).

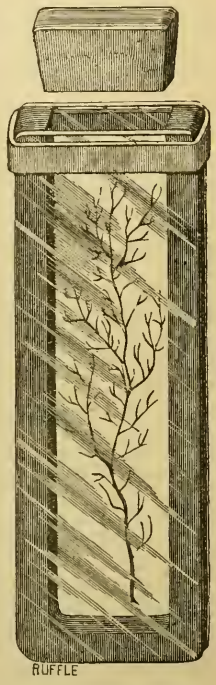
Woodward, J. J., death of. *Amer. Mon. Micr. Journ.*, V. (1884) pp. 173–4.
Cinc. Med. News, XVII. (1884) pp. 571–5.

Wray, L., Jun.—An Improved Microscope Screen. [*Supra*, p. 956.]
Engl. Mech., XL. (1884) p. 180 (1 fig.).

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

Hardy's Collecting Bottle.—We are now able to give a woodcut (fig. 161) of one of Mr. J. D. Hardy's bottles for collecting and examining aquatic specimens (6 in. × 2 in. × 3/8 in.) described *ante*, p. 803. At the October meeting of the Society, at which it was exhibited, the opinion was very generally expressed that the bottle was a most useful contrivance, and one that it was somewhat surprising had not been adopted long ago.

Fig. 161.



Collecting Desmids.*—The Rev. F. Wolle gives the following directions for collecting desmids:—

"The outfit need not consist of more than a nest of four or five tin cans (tomato or fruit), one within the other for convenience of carriage; ten or a dozen wide-mouthed vials, and a small ring-net made of fine muslin at the end of a rod about four feet in length. Should a boat be needed, it can usually be hired on the spot. After selecting what seems to be a good locality, drag the net a few feet among the grass and mosses, allow the bulk of the water to drain through the muslin, and then empty the residue into one of the cans; repeat this process as often as may be desirable. Ten or fifteen minutes after the cans have been filled, most of the surface-water may be poured off, and the remainder transferred to a glass vial, when the solid contents will gradually sink, and the superfluous water can be again poured off and the vessel filled up with deposits from other vials. In shallow places what is known as swamp-moss (*Sphagnum*), bladder-wort (*Utricularia*), water milfoil (*Myriophyllum*), or other finely cut-leaf water-plants are likely to abound; these should be lifted in the hand, and the water drained or squeezed from them into a tin can to be subsequently treated as already stated.

A few drops of carbolic acid in each vial, just enough to make its presence perceptible, will preserve the contents for months, and even years, from deterioration: the green colouring matter (chlorophyll) may fade, but this, in the case of desmids, is of little importance; nevertheless, when practicable, always examine the materials when fresh. When dried on paper for the herbarium, the specimens can still, after being moistened with water, be microscopically examined, but not with the best results, since the drying up is apt to collapse or otherwise distort the cells."

* Wolle, F., 'Desmids of the United States.' See this Journal, *ante*, p. 791.

Preparing Embryos.*—J. A. Ryder points out that in working with vertebrate materials, hardening and killing should be done in such a way as not to distort the axis of the embryos, in order that the knife may be adjusted so as to cut in any desired plane with accuracy. The imbedding must be as homogeneous as possible; for this purpose saturating the object with paraffin has been found to be the best, so that evenly thin sections may be produced. The methods of Bütschli, Plateau, Calberla, Duval, all serve this purpose, and their relative values are probably expressed in about the order in which they stand. Staining is best accomplished by dyeing the object as a whole; mounting should be done serially and with the ribbon method.

Method of Studying the Amphibian Brain.†—Prof. H. F. Osborn hardens the brain in Müller's fluid (bichromate of potash), the ventricles being fully injected. After the usual alcoholic treatment, the brain is placed for one week in a carmine solution, then for twenty-four hours in acetic acid.

The imbedding mass is prepared by shaking the contents of an egg with three drops of glycerin. After soaking in this mass, the brain is placed in position, and hardened in the vapour of boiling 80 per cent. alcohol. The mass is then placed for one week in absolute alcohol.

Sections are made under alcohol with a Jung's microtome, fifty or sixty sections collecting on the razor in alcohol are then floated at once, in order, upon the slide. To keep them in place, they are covered with old-fashioned blotting-paper (cigarette-paper was suggested as better by Dr. C. S. Minot) and treated with alcohol and oil of cloves through the papers, a device which may prove convenient in many cases.

Preparing Planarians and their Eggs.‡—In the preparation of Planarians for histological study, J. Jijima recommends corrosive sublimate as the only good preservative agent. The worms are placed in a shallow plate, *without water*, and a saturated solution of corrosive sublimate, heated almost to boiling, is poured over them. In this way they are killed so quickly that they do not have time to contract. They are left thirty minutes or less in the sublimate, then placed in water for an hour or more. The water should be changed several times, in order to remove all the sublimate; otherwise it forms needle-like crystals, which impair or ruin the preparation. Three grades of alcohol ("weak, strong, and absolute") are used in hardening, in each of which the object should be left at least forty-eight hours before staining. Borax-carmine (probably the alcoholic solution) is recommended as a staining agent; a dilute solution is used in preference to the full strength, and allowed to act from three

* Amer. Mon. Micr. Journ., v. (1884) pp. 190–1.

† Science, iv. (1884) p. 343. Abstract of paper read before the Philadelphia Meeting of the Amer. Assoc. Adv. Sci. Also Amer. Mon. Micr. Journ., v. (1884) p. 188.

‡ Zeitschr. f. Wiss. Zool., xl. (1884) pp. 359–464 (4 pls.). Amer. Natural., xviii. (1884) pp. 1068–9.

to four days. For preservation as museum specimens, they are killed with strong nitric acid (about 50 per cent.), in which they die fully extended.

Preparation of the Ova.—The egg-capsules of fresh-water Planarians are generally attached to water-plants by means of a white secretion. The ova are very small and few in number, and are scattered among an immense number of yolk-cells. The ova are completely naked, and a little smaller than the yolk-cells, and are not easily isolated. When cleavage begins, a large number of yolk-cells surround the ovum, and form with it a mass large enough to be seen with the naked eye. Jijima adopts the following mode of isolation and preparation:—By the aid of two sharp dissecting needles, the egg-capsule is opened on a slide in dilute acetic acid (2 per cent.). The contents flow out, and the empty capsule is then removed. The slide is next shaken, in order to isolate the ova so far as possible from the yolk-cells. This process detaches many of the yolk-cells, but not all; each ovum will still have yolk-cells adhering to it, and will now appear to the naked eye as a minute white mass. A cover-glass supported by wax feet or by slips of paper is now placed over them. After about thirty minutes the acetic acid is carefully removed by the aid of small pieces of blotting-paper placed at one side of the cover, and replaced by alcohol (70 per cent.). The withdrawal of the acetic acid must be as slow as possible, otherwise the ova will be lost. After an hour the alcohol is replaced by a stronger grade (90 per cent.), in which the ova should remain two hours. Finally, the alcohol is replaced by a mixture of glycerin and water in equal parts, and this in turn by pure glycerin. The preparation is now complete, and the cover-glass may be fixed in the usual way by means of lac.

In order to obtain sections of embryos which are too small to be treated individually, the contents of the capsule may be hardened *in toto* in chromic acid (1 per cent.), which renders them less brittle than corrosive sublimate.

The changes which take place in the ovum initiatory to cleavage are very difficult to trace, as they are generally completed before the cocoon is laid. In some cases ova were found in fresh laid capsules, which showed the germinal vesicle still unchanged; others were found to have two nuclei, supposed to be derivatives from the first cleavage nucleus. This stage of two nuclei was also found in some cocoons taken directly from the penial sheath, in which the cocoon formation takes place. It is therefore not quite certain when fecundation takes place, whether in the cocoon or before its formation.

Starch Injection Mass.*—Prof. S. H. Gage considers that a coarse injection mass which is cold-flowing, which may be forced nearly to the capillaries, rapidly hardening after injection and leaving the vessels flexible, which does not dull dissecting instruments, and is suitable for permanent dry or alcoholic preparations, being at the same time simple in its manipulation, cleanly and economical, is fully

* Amer. Natural., xviii. (1884) pp. 958-60, from 'New York Medical Journal,' 7th June, 1884.

realized in the starch mass introduced by A. Pansch, and since recommended, with various modifications, by Wikszemski, Dalla Rossa, Meyer, and Browning.*

As starch is insoluble in alcohol and cold water, it becomes hard when injected into the blood-vessels simply by the exudation of the liquid with which it is mixed. (That the starch-grains forming the mass remain entirely unchanged may be easily demonstrated by making a microscopic examination of the contents of an injected vessel.)

The mass originally recommended by Pansch consisted of wheat-flour and cold water, to which was added a sufficient quantity of the desired colouring matter. Later experiments have shown that pure starch is better than flour.

Mass for Ordinary Injections.—Dry starch ("laundry" is good), 1 vol.; 2½ per cent. aqueous solution of chloral hydrate, 1 vol.; 95 per cent. alcohol,† 1/4 vol.; colour, 1/4 vol. Since almost any animal injected may afford some organ worth preserving, it seems better to employ permanent colours for tinging the mass. Among those which are available, probably vermilion, red lead, ultramarine, chrome, orange, yellow or green are preferable.

Preparation of the Colour.—Dry colour, 1 vol.; glycerin, 1 vol.; 95 per cent. alcohol, 1 vol. To avoid lumps, which would clog the cannulæ, or small vessels, the colour is thoroughly ground with the liquid in a mortar. It is stored in a well-stoppered bottle, and is prepared for use simply by shaking.

Special Mass.—For the injection of brains, and, perhaps, for other rapidly perishing specimens, it seems best, as suggested by Wilder, to use strong preservatives in preparing the mass. Corn starch (that used for food), 1 vol.; 5 per cent. aqueous solution of chloral hydrate, 1/2 vol.; 95 per cent. alcohol, 3/4 vol.; colour, 1/4 vol. For convenience and economy, a considerable quantity of either of the masses described above may be prepared at once, and kept in a wide-mouthed specimen or fruit jar. A smooth stick in each jar is convenient for stirring the mass, which should always be done just before using. The syringe may be filled directly from the jar, and any mass remaining in the syringe after the injection is finished may be returned to the jar.

If it is desired to have the mass enter very fine vessels, some of the stock mass, as given above, diluted with an equal volume of water or chloral solution, may be injected first, and immediately followed by the undiluted mass, or for large animals, a mass containing twice the usual amount of starch. In whatever form the starch is used, it is necessary to work somewhat expeditiously, because the

* See A. Pansch, Arch. f. Anat. und Entwickl., 1877, pp. 480–2, and 1881, pp. 76–8; Wikszemski, ibid., 1880, pp. 232–4; Dalla Rossa, ibid., pp. 371–7; H. v. Meyer, ibid., 1882, pp. 60–1, and 1883, pp. 265–6; Browning, 'Annals of Anatomy and Surgery,' 1884, pp. 24–5.

† The chloral and alcohol prevent fermentation in the mass when it is kept in stock; the alcohol also increases the fluidity and likewise the more rapid hardening in the vessels; both, of course, act as a preservative upon the animal injected.

exudation of the liquid in the smaller vessels takes place so rapidly that the mass hardens very quickly in them. The larger the vessel the more slowly, of course, do the exudation and consequently the hardening take place. It sometimes happens that large vessels, like the aorta, are not fully distended after the exudation of the liquid. In this case some mass containing double the ordinary amount of starch can be advantageously injected in two hours or longer after the first injection.

Dry Preparations.—Finally, if vessels injected with the starch mass are dissected free, soaked a day or two in Wickersheimer's preservative, and then dried, they retain their form, and to a great degree their flexibility.

Imbedding in Sticks of Paraffin.*—J. S. Kingsley describes a convenient method of imbedding. Small sticks of paraffin, fitting the holder of the microtome, are cast in quantity in suitable paper moulds and are laid aside until wanted. When it is desired to imbed an object it is treated as for any paraffin imbedding. When thoroughly impregnated with paraffin, a bit of wire is heated and with it a hole is bored in one of the sticks of paraffin and the object is quickly inserted.

This method is especially adapted for cutting transverse sections of elongated objects such as tadpoles, and furthermore it obviates all danger of overheating the specimen. With objects of spherical shape, of which sections are desired in any particular plane, it affords no especial advantage.

"Microtomy."†—J. A. Ryder suggests the word "microtomy" for the "new art" which has within a very recent period been developed, including both the processes preliminary to the actual cutting of sections, and also those necessary for mounting.

Gray's Ether Freezing Microtome.—The improvements in this microtome, the design of the Rev. Metcalfe Gray, consist in the holder for the knife, and in the addition of guides, that the direction of the cuts may be uniform, while steadiness is secured.

All workers with tools know how important it is that they should be held at the proper angle to the work, in order to secure the best results, and the fault of many if not all section-cutters in which plane-irons or chisels are used is that there are no means whereby this object may be attained, the results in consequence depending upon knowledge and skill, which many to whom sections would be most valuable have no time to acquire.

To meet this difficulty an iron duplex plane has been altered by cutting away the connecting bar in front of the end slot, so that the iron is fixed firmly at the proper angle, and has the greater part of its front surface clear, up which the sections as they are cut may slide without obstruction. The cutting edge of the iron is ground level on a piece of plate glass with emery powder, and afterwards sharpened.

* Science Record, ii. (1884) p. 175.
† Amer. Mon. Micr. Journ., v. (1884) pp. 190–1.

The plane thus altered works upon two strips of plate glass, which can be adjusted to the width of the iron, and easily renewed if broken, being kept in position by wooden bars which act as guides to the plane.

The inside edges of the guides just allow the plane to work freely upon the glass, and the edges of the glass are adjusted carefully so as to allow the plane-iron to pass between without touching them.

The top of the table is roughened with a file, and not grooved, in order to secure more evenly and firmly the substance to be cut, and in the spray small brass nozzles are used which can be renewed when desired.

In use, the whole instrument is clamped to the left-hand corner of a table, with the side towards the operator. The cutting edge of the plane-iron being fixed about 3/16 in. above the top of the table, and the substance to be cut being frozen, the operator firmly grasps the plane with his right hand, and causes it to travel backwards and forwards between the guides, while he leans over the instrument, and with his left hand, before each cut, turns the large screw-head through one or more divisions, according to the thickness of the section desired. In turning the screw-head, the worker will be guided by the nick in the little brass screw in the end of the wooden base of the instrument.

Any advantages of a diagonal cut may be secured by placing the substance to be operated upon in a diagonal position upon the table.

Preparing Picrocarmine and Indigo-Carmine.*—Dr. F. L. James writes that whilst picrocarmine is one of the most valuable staining agents, the formula for preparing it, "for some unaccountable reason, is not given in any of the standard works on the subject, and microscopists are forced to purchase it from dealers at exorbitant prices," and he therefore gives the following as the process used in his laboratory for preparing a very satisfactory article.

"Dissolve 15 grains of the best carmine in the smallest quantity possible of strong water of ammonia, and add distilled water enough to make one ounce of the solution. In a separate vessel dissolve 75 grains of picric acid in the smallest amount of boiling distilled water, making a saturated solution. When cold pour the two solutions together, and let stand in a closely stoppered bottle for several days, giving it an occasional shake. At the expiration of four or five days filter the solution, and pour the filtrate into flat dishes; saucers or soup-plates will do. Cover with a plate of glass close enough to keep out dust, but not so closely as to prevent evaporation. Put in a moderately warm place, and let stand until the fluid has entirely evaporated, leaving a crop of fine brickdust-red crystals. These should be collected, thoroughly dried, and preserved. When required for use, dissolve in about fifty times their weight of distilled water, filter the solution, and keep in glass-stoppered vials. Do not make more than an ounce of the solution at once, as a little of it goes a long way."

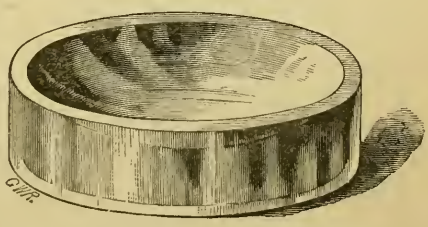
* Amer. Mon. Micr. Journ., v. (1884) pp. 178-9 and 199, from 'National Druggist.'

"Another stain that the histologist, and especially the student of micro-botany, frequently has occasion to use, is the so-called indigo-carmine, or sulph-indigotate of potash solution. Like the foregoing (picrocarmine) the text-books content themselves with recommending it, but giving no working formula for preparing it.

The following process gives a brilliant beautiful blue that works well with almost any kind of preparation, and is most useful in double staining of vegetable sections. Take of the best indigo, in lump, 30 grains. Powder in a capsule, and dry thoroughly in a water bath. When perfectly dry, add 2 drachms (by weight) of fuming (Nordhausen) sulphuric acid, adding it drop by drop, and stirring with a glass rod. As the indigo swells under this treatment, a large capsule is necessary. The whole of the acid having been added, stir well, cover, and let stand for twenty-four hours. Transfer to a tall flask, and add 3 ounces of distilled water. Let stand for four days, giving the flask an occasional shake. A magnificent blue colour is now obtained, but its acidity prevents its being used in this condition. The solution must now be neutralized by the addition of carbonate of potash (or soda) added cautiously, with frequent testings, as an excess of the alkali causes the separation of the indigo in a doughy mass (which can be redissolved, however). Filter the neutralized solution, and evaporate to dryness. For use, dissolve in fifty times its weight of distilled water."

Mercer's Solid Watch-glass.*—Dr. A. C. Mercer uses the "Syracuse Solid Watch-glass" (fig. 162) as a bath, or staining or dissecting dish for the histological laboratory. It rests solidly upon the table or stage, and is not liable to be overturned and its contents spilled. It is transparent and can be used over black, white, or coloured paper, enabling the student to use such backgrounds for his work as will permit him to watch its progress to the best advantage. Transparent tissues can be examined in it from time to time, or dissected and studied on the stage while in water, alcohol, oil of cloves, or other bath, enabling the student to reject unsatisfactory specimens at any step in the process of preparation.

Fig. 162.



When the top and bottom edges are cut, one watch-glass rests dust-tight upon another, and a piece of plate glass will fit accurately over it as a cover. In such a watch glass, covered, specimens may remain for long staining or soaking, without loss of fluid by evaporation. When the concave surfaces are polished, the watch-glass is as clear as a lens, and becomes a perfect receptacle for transparent dissecting material on the stage.

* The Microscope, iv. (1884) pp. 676-7.

Cheap method of making Absolute Alcohol.*—B. Sharp describes a cheap method of making absolute alcohol, from the strong (95 per cent.) spirit, used in Prof. Ranvier's laboratory in Paris.

A wide-mouthed bottle is taken, holding about a litre, and three-quarters filled with strong alcohol. A mass of pulverized cupric sulphate ($Cu\ SO_4 + 5\ Aq$) is heated to a red heat in order to drive off the water of crystallization. This is poured, when cool, into the alcohol, the mouth of the bottle quickly closed, and the whole shaken. The cupric sulphate is insoluble in alcohol, but has an affinity for the water contained in it, and the water is consequently taken up, and the cupric sulphate becomes bluish. When this has stood—with occasional shakings—for a day or so, decant, and repeat the operation, especially if there is very much of a bluish colour in the sediments. When finished a drop of alcohol can be mixed with a drop of turpentine on an object-glass, and if there be no particles of water to be seen under the Microscope, the alcohol is absolute enough for all practical purposes.

Arranging Sections and Diatoms in Series.†—P. Francotte has modified the method of Dr. Van Heurck ("to render it more practical") as follows:—

(1) Dissolve (warm) from 7–10 gr. of glue in 100 gr. of water (gelatin gives equally good results). A yellowish liquid is obtained which becomes perfectly clear on cooling; filter.

(2) Spread this solution on the slide, in the same way as with collodion or by means of a brush; arrange the sections on the glass while damp, and let it dry protected from the dust. To hasten evaporation the preparation may be placed in a water-bath, or better still, in an oven (at a temperature from 35° to 40° C.).

(3) When dry, warm gently over a lamp. The paraffin is removed by turpentine.

(4) Apply the cover-glass coated with liquid balsam.

The turpentine should be washed with absolute alcohol, and then the cover-glass coated with glycerin should be fixed if it is desired to preserve the preparation in the latter reagent. If the object has not been previously stained the sections can be very well stained by a reagent which is dissolved in alcohol (hæmatoxylin, eosin, aniliu dyes, &c.), alcohol not dissolving either glue or gelatin. It would not be possible to use a staining agent in an aqueous solution unless the sections were previously washed with tannic acid, which would disadvantageously complicate the process.

The method recommends itself to the author by the ease with which the fixing liquid can be obtained; the sections always adhere perfectly; no displacement is to be feared; in washing, ether, chloroform, and oil of cloves can be used; the mounting can be in balsam, glycerin, or any other reagent. The wrinkles made in cutting are effaced without difficulty. Sections obtained by imbedding in gum, albumen, soap, or celloidin, can also be arranged by this method, but

* Proc. Acad. Nat. Sci. Philad., 1884, p. 27.
† Bull. Soc. Belg. Micr., x. (1884) pp. 137–41.

in this case they must be previously passed through distilled water, and placed on the glass while still wet with the solution of glue; to avoid distortion of the tissues, evaporation must only be allowed until desiccation begins; then treat with strong alcohol, which precipitating the glue, produces perfect adherence between the sections and the glass.

A very simple method described by Dr. Flögel also deserves to be known, as it may be useful for arranging sections of objects imbedded in paraffin. The process is as follows:—5 gr. of gum arabic are dissolved in 100 gr. of water; this solution is poured over the entire surface of a perfectly clean glass slide, and the excess of liquid run off by holding the slide vertically.

The operation may then be conducted in two ways.

(1) The sections are arranged upon a perfectly dry surface; then by breathing upon it, the thin layer of gum is dissolved and the sections sink into it; it is again allowed to dry, which takes place rapidly. The paraffin is removed by benzol, and the cover-glass coated with balsam is put on as previously described.

(2) The sections are arranged on the wet slide to which they adhere as the water evaporates; the desiccation being complete they are finished as in the previous case.

For thin and delicate sections the first method is preferable. For sections of considerable size and thickness, the second should be employed.

Balsam of Tolu for Mounting.*—C. H. Kain recommends balsam of tolu for mounting, as having a higher index than styrax. It has some colour, but for such purposes as mounting diatoms, where only a thin layer of the medium is required, the slight discoloration will not prove very objectionable. It is perhaps possible to bleach the solution somewhat. To prepare the tolu for use it should be dissolved in either alcohol or chloroform (the latter is preferable for many reasons) and then well filtered. It will not dissolve in benzole. By a gentle heat the solvent can then be evaporated so as to leave the solution in any desired state of concentration.

The ordinary gum benzoin (or benjamin) is quite as good as styrax, if not better, but neither is so good as tolu. The gum benzoin should be prepared as directed for tolu.

Biniodide of Mercury and Iodide of Potassium and Phosphorus for Mounting.†—Mr. Kain also drops "a word or two of caution in regard to the use of the solution of biniodide of mercury and iodide of potassium as a mounting medium. On account of its great density and high refractive index it is valuable for many purposes, but immersion objectives should be used on such mounts with great caution. Even after the glass cover has been apparently thoroughly washed, enough of the mercurial solution often adheres to cause quite a deposit of mercury to accumulate on the front brasswork of the

* Micr. Bulletin, i. (1884) p. 36.
† Ibid., pp. 36-7.

objective. The writer came near ruining a valuable objective in this way. The solution is also a violent poison, and if the slightest drop touches a tender portion of the skin, as the lips for instance, it burns like fire, and leaves a bad blister.

Phosphorus mounts, too, are fraught with considerable danger. The beautiful slides of Möller mounted in this medium are evidently prepared with great care, but after a time the medium either acts upon the asphalt ring or penetrates it, so that the smell of phosphorus is plainly discernible, and in the dark the ring is luminous. A correspondent states that he had a bad fire in his cabinet from the spontaneous combustion of one of these mounts. For those who possess valuable cabinets it will be at least a wise precaution to avoid placing phosphorus mounts with their other slides. They should be kept in a cool, dark place, and in such a locality that other property will not be jeopardized if spontaneous combustion should ensue. Notwithstanding its very high index of refraction, it is not likely that phosphorus will ever become a general favourite as a mounting medium, partly on account of the danger in manipulating it, and partly because the preparations lack permanence, for even when carefully kept away from the light they deteriorate in the course of time."*

The statement of the correspondent as to the "bad fire" in his cabinet through the combustion of a phosphorus-mounted slide is, we fear, a little imaginative, or at least exaggerated, having regard to the very small quantity of phosphorus in a mount.

Chapman's Slide Centerer.†—This is a device of Mr. A. B. Chapman for mounting objects accurately in the centre of the glass slip, and for applying the thin cover-glass concentrically with the object. It has two revolving backgrounds to contrast with the colour of the object, one being black with white circles, the other white with black circles, and so arranged that, by simply turning a little knob, either can be used or both removed as desired without touching the slip, which can be finished entirely (except the ringing) before it is taken off the instrument. It is so simple that there is nothing to prevent any manipulation required in mounting the object.

Indian Ink for examining Microscopic Organisms.‡—L. Errera, after some general remarks on the principles involved in mounting in media of different refractive indices and in staining,§ points out that living organisms do not absorb the various colouring solutions. The exception to this rule pointed out by Brandt ‖ and Certes ¶ are only apparent exceptions. According to Brandt, the nucleus of living Protozoa can be dyed pale violet by a dilute solution of hæmatoxylin, and the fatty granules can be dyed brown by Bismarck brown.

* As to this, see this Journal, *ante*, p. 475.

† Sci.-Gossip, 1884, p. 260.

‡ Bull. Soc. Belg. Micr., x. (1884) pp. 184–8.

§ "In visiting the laboratories of microscopists one might often believe oneself to be in a dyer's workshop."

‖ See this Journal, i. (1881) p. 956.

¶ Ibid., pp. 527 and 694.

Certes found this last action also with cyanin or quinolein blue. But in all these experiments the protoplasm, properly so called, remains colourless, and the coloured solution always exercises an injurious action on the vitality of the organisms; so that it can only be used in an extremely dilute condition and for a very short time.

If, on the contrary, we try the converse method and place the living organisms in a somewhat strong coloured solution they are likely to die, either by exosmosis or more often by actual poisoning.

It will therefore be useful to have a deeply coloured liquid which is not poisonous, and which does not exercise any sensible osmotic action on microscopic beings placed in it. To satisfy these conditions it is sufficient to substitute for the coloured solutions water holding in suspension coloured insoluble powder. Indian ink, on account of its harmless nature and its deep colour, is very fit for this purpose. It consists, as is well known, of lampblack and a gummy substance, very slightly perfumed with musk or camphor. On powdering it into water a very black liquid is obtained, owing to the fine particles of carbon held in suspension; it does not cause the plasmolysis of the cells, and the organisms continue to live perfectly in it.

The process of using it is as follows:—A little indian ink, not too much perfumed, is rubbed up in a porcelain saucer. It is important to triturate it carefully. The liquid should show, under the Microscope, excessively small granules of equal size, having a lively Brownian movement; it ought to have, when in very thin layers, a dark grey, but not an opaque black tint. A drop of this liquid is placed on a slide, the organisms to be examined are placed upon a cover-glass, and this is applied to the drop. In this way black particles between the cover-glass and the objects are avoided. The objects appear remarkably illuminated on the grey-black ground, so that their details can be seen distinctly. The carbonaceous matter does not seem to affect the organisms; they bear it very well, and the author has been able thus to preserve *Spirogyra*, *Vaucheria*, Infusoria, &c., for several days alive.

For prolonged observations it is of course advisable to use a moist chamber, or to prevent evaporation by placing the preparation in an atmosphere saturated with aqueous vapour.

Permanent preparations can also be made. To do this, the indian ink, in water, is gradually replaced under the cover-glass by indian ink in glycerin. Care must be taken that the black liquid does not pass the edges of the cover, otherwise currents will be produced in consequence of the evaporation, and the black particles will no longer be uniformly distributed.

Indian ink will, it seems to the author, render great service in showing the gelatinous envelopes of the lower organisms, and the gelatinized layers of the membranes of the higher plants. The gelatinous envelopes of many filamentous algæ, of *Glœocapsa*, of the colonies of zoogloea, &c., are with difficulty distinguishable in water, but nothing, on the contrary, is so easy when the observation is made in water charged with indian ink. The method might probably also,

it is suggested, be applied advantageously in the study of the digestion of the Infusoria, of the movement of diatoms and ciliated organisms, &c.

Apparatus for Aerating Aquaria.*—Different forms of apparatus are used in laboratories for supplying air to plants and animals kept for observation in aquaria. These, P. Francotte thinks, are all rather complicated, and he has therefore constructed two very simple models, which he has successfully employed.

Make a loop at 30 cm. from one of the extremities of a glass tube of from 5 to 7 cm. diameter and 1 m. long. To do this heat the tube and bend it on itself, the tube thus being divided into two unequal portions.

At 7 or 8 cm. from the loop, and in the shorter part of the tube, heat a small point by the blow-pipe. The heated glass forms a little bead, and whilst this is very hot draw it out (by a piece of tubing) into a little capillary tube, and bend it if possible at a right angle at a distance of 1 cm. from its point of origin, at the same time breaking off the end. The tube, thus prepared, is put in communication with a vessel of some litres' capacity, placed at a height of from 1 m. to 1·50 m. This can be done by a piece of indiarubber tubing and a siphon, the short arm of which is immersed in the vessel. By sucking the lower end of the tube, the latter will be filled with water. The liquid column will play the part of a piston in a pump; the air will be drawn through the opening of the capillary tube, and a number of little columns of water will be produced containing between them bubbles of air.

To regulate the flow of water and insure the air being supplied in proportion to the liquid used, the indiarubber tube should be compressed by a clip, and the apparatus made to work as slowly as possible, so that the air-bubbles drawn in can be easily counted. The lower extremity of the tube is plunged in the aquarium, where the air causes a bubbling and movement in the water.

Dr. Fol recently suggested † saturating with carbonic acid the sea-water containing Medusæ, star-fishes, &c., in order to render them motionless. This can be best accomplished by a modification of the above apparatus. In place of drawing out a capillary tube, a tube of the same diameter as the principal tube is soldered at right angles to it and slightly bent. The branch tube is then by an indiarubber tube placed in communication with the apparatus containing the gas, ether, &c.

Detection of Sewage Contamination by the use of the Microscope, and on the Purifying Action of minute Animals and Plants.‡—Dr. H. C. Sorby writes: "By studying with the Microscope the solid matters deposited from the waters of a river, the previous contamination with sewage can usually be detected without any considerable difficulty. If the amount be serious, the characteristic particles of

* Bull Soc. Belg. Micr., x. (1884) pp. 141–3.
† See this Journal, iii. (1883) p. 137.
‡ Journ. Soc. Arts, xxxii. (1884) pp. 929–30.

human excrement can easily be seen; and if it is small, and has been carried a long way by the current, it can usually be recognized by means of the hairs of oats derived mainly from the droppings of horses, which resist decomposition for a long time, and are not consumed as food by minute animals. I, however, do not propose to enter into detail in connection with this part of my subject, but specially desire to call attention to the connection between the number of minute animals and plants, and the character of the water in which they live, and also to their influence in removing organic impurities.

For some time past I have been carefully ascertaining the number per gallon, of different samples of river and sea water, of the various small animals which are large enough not to pass through a sieve, the meshes of which are about 1/200 part of an inch in diameter. The amount of water used varies from ten gallons downwards, according to the number present. By the arrangements used there is no important difficulty in carrying out the whole method in a satisfactory manner. I confine my remarks entirely to general mean results.

The chief animals met with in fresh water are various entomostraca, rotifera, and the worm-like larvæ of insects. I find that the number per gallon and percentage relationships of these mark, in a most clear manner, changed conditions in the water, the discharge of a certain amount of sewage being indicated by an increase in the total number per gallon, or by an alteration in the relative numbers of the different kinds, or by both. All my remarks apply to the warm part of the year, and not to winter.

It is known that entomostraca will eat dead animal matter, though probably not entirely dependent on it. I have myself proved that they may be kept alive for many months by feeding them on human excrement, though they soon died without it. If the amount of food in any water is small, not many of such animals can obtain sufficient; but if it be abundant, they may multiply rapidly, since it is asserted that in one season a single female *Cyclops* may give rise to no less than four thousand millions of young. In stagnant muddy ponds, where food abounds, I have found an average of 200 per gallon. In the case of fairly pure rivers the total number of free-swimming animals is not more than one per gallon. I, however, found that where what may be called sewage was discharged into such water the number per gallon rose to twenty-seven, and the percentage relationships between the different groups of entomostraca were greatly changed. In the Thames at Crossness, at low water, the number was about six per gallon, which fell to three or four at Erith, and was reduced to less than one at Greenhithe.

There is, however, a very decided limit to the increase of entomostraca when the water of a river is rendered very impure by the discharge of too much sewage, probably because oxygen is deficient, and free sulphide of hydrogen present. Such water is often characterized by the great number of worm-like larvæ of insects. Thus, in the Don, below Sheffield, in summer, I found the number per gallon, of entomostraca only about one-third of what it is in pure waters;

whilst, on the contrary, the number of worm-like larvæ were more than one per gallon.

Now if the minute free-swimming animals thus increase when a certain amount of sewage supplies them with ample food, it is quite obvious that they must have a most important influence in removing objectionable impurities. The number of excrements of entomostraca in the recent mud of such rivers as the Thames is most surprising. In one specimen from Hammersmith, I found that there were more than 20,000 per grain; and the average number at Erith in August, 1882, was above 7000, which is equivalent to about 200,000 per gallon of water at half-ebb, from the surface to the bottom. This enormous number must represent a very large amount of sewage material consumed as food; and though, as in the case of larger animals, a considerable part of their excrements no doubt consists of organic matter capable of putrefaction, yet there can be no less doubt that the amount entirely consumed in the life-processes of the animals is also great.

As named above, I kept *Cyclops* alive for many months by feeding them on human excrement. It is thus easy to understand why, when they abound in the Thames, the relative amount of human excrement is very considerably less than in the winter, when their number must be much smaller.

We thus appear to be led to the conclusion that when the amount of sewage discharged into a river is not too great, it furnishes food for a vast number of animals, which perform a most important part in removing it. On the contrary, if the discharge be too great, it may be injurious to them, and this process of purification may cease. Possibly this explains why in certain cases a river which is usually unobjectionable may occasionally become offensive. It also seems to make it clear that the discharge of rather too much sewage may produce relatively very great and objectionable results.

Though such comparatively large animals as entomostraca may remove much putrefiable matter from a river, we cannot suppose that, except incidentally, they remove such very minute objects as disease germs, but it would be a subject well worthy of investigation to ascertain whether the more minute infusoria can, and do consume such germs as a portion of their food. If so, we should be able to understand how living bodies, which could resist any purely chemical action likely to be met with in a river, could be destroyed by the digestive process of minute animals. Hitherto I have had no opportunity for examining this question critically, but have been able to learn certain facts which, at all events, show that it is well worthy of further examination. It is only during the last month that I have paid special attention to the number of the larger infusoria, and various other animals of similar type, met with per gallon in the waters of rivers and the sea, which can be seen and counted by means of a low magnifying power. At low water in the Medway above Chatham, in the first half of June, the average number per gallon has been about 7000, but sometimes as many as 16,000. Their average size was about 1/1000 in. Possibly the number of still more

minute forms may be equally great; but, even if we confine our attention to those observed, we cannot but conclude that their effect in removing organic matter must be very considerable; and judging from what occurs in the case of larger animals, those 1/1000 of an inch in diameter may well be supposed to consume as food, particles of the size of germs. Up to the present time, I have, however, collected so few facts bearing on this question, that it must be regarded merely as a suggestion for future inquiry.

So far, I have referred exclusively to the effect of animal life. Minute plants play an important part in another way. The number per gallon of suspended diatoms, desmids, and confervoid algæ is, in some cases, most astonishing, and they must often produce much more effect than the larger plants. As far as I have been able to ascertain, their number is to some extent related to the amount of material in the water suitable for their assimilation and growth. In the mud deposited from pure rivers their number is relatively small, but in the district of the Thames, where the sewage is discharged, I found that in summer their number per grain of mud at half-ebb tide was about 400,000, which is equivalent to above 5,000,000 per gallon of water. This is two or three times as many as higher up or lower down the river, and, out of all proportion, more than in the case of fairly pure rivers like the Medway. Their effect in oxygenating the water must be very important, since, when exposed to the light, they would decompose carbonic acid and give off oxygen, under circumstances most favourable for supplying the needs of animal life, and counteracting the putrefactive decomposition so soon set up by minute fungi when oxygen is absent.

Taking then, all the above facts into consideration, it appears to me that the removal of impurities from rivers is more a biological than a chemical question; and that in all discussions of the subject, it is most important to consider the action of minute animals and plants, which may be looked upon as being indirectly most powerful chemical reagents."

Examination of Handwriting.* — Dr. G. E. Fell records a curious case in which the Microscope was applied by himself and Prof. D. S. Kellicott to the detection of the manipulation of a written document.

At first sight the document looked as if it was all written with one kind of ink—a heavy black ink. Closer examination with a Microscope, however, showed that the original writing was in a pale yellow ink, and that this had afterwards been traced over with the black ink. Further examination showed that the last clause, "And Colby's bond is hereby cancelled," had been originally written with ink of a brownish tinge. The document was held by the judge, before whom the case came, to be spurious, the inference being that the words quoted above had been added after it was signed, and that then the whole was traced over in order to make the entire document appear to have been written at one time and with the same ink.

* Proc. Amer. Soc. Micr., 7th Ann. Meeting, 1884, pp. 47-58.

The Microscope in Palæontology.*—Dr. M. Poignand briefly sketches the use of the Microscope in palæontology generally, and notices a few well-known instances in more detail. These include bones, teeth, scales and carapaces, shells, corals, sponges, plants, &c. The paper is accompanied by a plate illustrating the structure of the teeth of *Megatherium* and the sloth.

Adams, J. M.—Easy Method of staining Bacteria.

["Dissolve anilin violet, blue, or brown in glycerin, with or without alcohol or carbolic acid. Prepare thin covers by dropping with pipette a drop of bacterial fluid on each, and allowing it to dry thoroughly. Cover the dry bacterial film with a drop of the staining, and let it remain an hour, or long enough to stain deeply. Put a drop of water on centre of slide, and invert the cover on it ready for mounting, letting it sway slightly to and fro to wash away a part of the surplus staining and glycerin, but not to remove the film. Press down the cover with a blotter, which will absorb the surplus, and ring quickly. The glycerin being washed away in part does not materially dim the bacteria or affect the anilin, and it is surprising how distinctly visible all kinds of bacilli, spirilla, and some of the bacteria and micrococci appear by this process.

One pleasant advantage is the freedom from sediment, as is apt to occur with other methods of staining, and the ease with which the depth of colouring may be regulated, as well as the reliable work for time being."]

The Microscope, IV. (1884) pp. 224–5.

Analysis, the Microscope in. [*Post.*]

Sci. Monthly, II. (1884) p. 187, from *New York Independent Record.*

Aylward's (H. P.) Telescope Walking-stick to use with his Pond-life Apparatus.

Journ. of Microscopy, III. (1884).

Barrett, J. W.—New method of cutting sections for microscopical examination. [*Post.*]

Journ. Anat. and Physiol., XIX. (1884).

Caldwell's Automatic Microtome. [*Post.*]

Quart. Journ. Micr. Sci., XXIV. (1884) pp. 648–54 (1 pl.).

Chapman's (A. B.) Microscopic Slide Centerer. [*Supra*, p. 986.]

Sci.-Gossip, 1884, p. 260.

Dimmock's (G.) Method of cataloguing and arranging slides. [*Post.*]

Sci. Record, II. (1884) pp. 185–6.

Doherty, A. J.—On Injecting.

[Methods. Formulæ. The Syringe. Killing the animal. Injecting a whole animal. Hardening injected tissues. Injecting separate parts.]

Micr. News, IV. (1884) pp. 268–75.

Elsner, F.—Mikroskopischer Atlas (Microscopical Atlas). Part II., 8 pp. and 2 pls. of 29 photo-micrographs; Part III., 9 pp. and 2 pls. of 33 photo-micrographs; Part IV., 8 pp. and 2 pls. of 30 photo-micrographs.

[Contains Cocoa, Cinnamon, Cloves, All-spice, Capsicum, Nutmeg, Mace, Pepper, Saffron, Cardamom, and Adulterants.]

4to, Halle a. S., 1884.

English's (H.) Typical Series of Vegetable Fibres.

[Mounted in a mixture of glycerin and water, which is thought to be the best medium for the purpose.]

Amer. Mon. Micr. Journ., V. (1884) p. 200.

Fell, G. E.—Examination of Agreement, Exhibit "B." The People v. Colby. [*Supra*, p. 991.] *Proc. 7th Ann. Meeting Amer. Soc. Micr.*, 1884, pp. 47–58.

The Microscope, IV. (1884) pp. 207–8.

Freud, S.—Eine neue Methode zum Studium des Faserverlaufs im Centralnervensystem. (A new method of studying the central nerve-system.) [*Post.*]

Arch. f. Anat. u. Physiol., 1884 (*Anat. Abtheil.*) pp. 453–60.

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* Journ. of Microscopy, iii. (1884) pp. 163–70 (1 pl.).

GARBINI, A.—Manuale per la Tecnica moderna del Microscopio nelle Osservazioni zoologiche, istologiche ed anatomiche. (Manual of the modern technic of the Microscope in zoological, histological and anatomical observations.)
16mo, Verona, 1884.

GRAVIS, A.—Microscopical Technique at Naples in 1883.
[Translated and adapted by J. S. Kingsley from the French in Bull. Soc. Belg. Micr., *ante*, p. 483.]
Sci. Record, II. (1884) pp. 198–203, 227–31.

GRIFFIN, A. W.—On the collection and preparation of the Diatomaceæ. II. Preparation. *Journ. of Microscopy*, III. (1884) pp. 229–36.

HOFMEISTER, V.—See Bibliography *a*.

JAMES, F. L.—Method of preparing picro-carmine and indigo-carmine. [*Supra*, p. 982.]
Amer. Mon. Micr. Journ., V. (1884) pp. 178–9, 199, from *National Druggist*.

JIJIMA, J.—Entwickelungsgeschichte der Süsswasser-Dendrocœlen. (Development of Fresh-water Dendrocœla.)
[Contains methods of preparing Planarians and their Eggs. Abstr. in Amer. Natural., xviii. (1884) pp. 1068–9, *ante*, p. 746, and *supra*, p. 978.]
Zeitschr. f. Wiss. Zool., XL. (1884) pp. 359–464 (4 pls.).

KAIN, C. H.—Mounting Media. [*Supra*, p. 985.]
Micr. Bulletin, I. (1884) pp. 36–7.
Journ. of Microscopy, III. (1884) p. 259.

KINGSLEY, J. S.—Microscopical Methods. IV. Imbedding.
Sci. Record, II. (1884) pp. 172–6 (1 fig.).
" " Rapid Imbedding. [*Post.*] *Sci. Record*, II. (1884) p. 269.
" " Glycerine Mounts. [*Post.*] " " pp. 269–70.

LENDENFELD, R. v.—On the Preservation of tender Marine Animals.
[Summary of the methods usually employed.]
Proc. Linn. Soc. N. S. Wales, IX. (1884) pp. 256–8.

LEWIS, W. J.—Hair, microscopically examined and medico-legally considered. [*Post.*] *Amer. Mon. Micr. Journ.*, V. (1884) pp. 162–6.
The Microscope, IV. (1884) pp. 197–201.
Also under the title of "The Microscope in Forensic Medicine."
Sci. Monthly, II. (1884) pp. 227–8.

LIBBEY, W., jun.—Celloidine as an Embedding Mass.
[Similar directions to those given *ante*, p. 822.]
Amer. Mon. Micr. Journ., V. (1884) p. 183.

M'MURRICH, J. P.—Killing Infusoria. [*Ante*, p. 813.]
Amer. Natural., XVIII. (1884) p. 832.

OSBORNE, H. F.—Upon a Microscopical method of studying the Amphibian Brain. [*Supra*, p. 978.] *Amer. Mon. Micr. Journ.*, V. (1884) p. 188.
Science, IV. (1884) p. 343.

PEYER, A.—Die Microscopie am Krankenbette. (Microscopy at the sick-bed.)
[Contains coloured plates of the appearance, under the Microscope, of urine (63), sputum (14), and fæces (2) in disease.]
8vo, Basel, 1884, xii. and 19 pp. and 79 pls. with explanations.

PIPER, R. U.—Identification of Blood-corpuscles.
[Table of the measurement of blood-corpuscles from 13 young dogs selected out of like tables of measurement of more than 400 dogs.]
The Microscope, IV. (1884) pp. 219–22.

PLAUT, H.—Färbungs-Methoden zum Nachweiss der fäulniss-erregenden und pathogenen Mikroorganismen. (Staining methods for demonstrating the putrefactive and pathogenic micro-organisms.) [*Post.*]
fol. Leipzig, 1884.

Pond Life, Collecting. [*Post.*] *Amer. Mon. Micr. Journ.*, V. (1884) p. 200.

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Amer. Mon. Micr. Journ., V. (1884) p. 171.
The Microscope, IV. [1884) p. 205.

Ryder, J. A.—On the preservation of embryonic materials and small organisms, together with hints upon embedding and mounting sections serially.
Ann. Rep. U. S. Fish Commission for 1882.
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„ „ On some points in Microtomy. [*Supra*, p. 978.]
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[Difficulties of interpretation. (Teasdale's test slides.)]
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„ „ [Mouth Organs of Diptera.] „ „ pp. 312–3 (5 figs.).
„ „ ["Daddy-Longlegs."] „ „ pp. 396–8 (4 figs.).

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Amer. Mon. Micr. Journ., V. (1884) pp. 185–7.

„ „ Method of demonstrating the presence of the Tubercle Bacillus in Sputum.
[Summary of Koch's account of his original method, as modified by Ehrlich and Weigert, from MT. K. Gesundheitsamt, II., Berlin, 1884.]
Amer. Mon. Micr. Journ., V. (1884) pp. 196–9.
from *Medical Annals.*

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[Practical demonstration of the advantages of his method—described in Rep. Amer. Assoc. Adv. Sci. for 1881—over others.]
Amer. Mon. Micr. Journ., V. (1884) pp. 183–5.

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[Contains directions for collecting and mounting diatoms.]
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[Contains a method of isolating the jaws of *Branchiobdella.* [*Post.*]
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[Part I. General rules for making and examining microscopical preparations. Part II. Cells. Part III. Tissues. Part IV. Reproductive organs of Phanerogams. Part V. Cryptogams.]
8vo, Zaltbommel, 1884, x. and 97 pp.

West, T.—*Bugula avicularia.*
[May be mounted with the polypus fully expanded by *dropping* gin carefully and slowly into a small vessel containing the specimen in sea water, observing to do so when they are *fully expanded.* This intoxicates them; they die in their extruded condition, and can be removed and mounted.]
Journ. of Microscopy, III. (1884) pp. 248–9.

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[Discussion on his paper published, I. (1881) p. 859.]
Journ. Quek. Micr. Club, II. (1884) pp. 86–90.