JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

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MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Fasoldt's "Patent Microscope."—Mr. C. Fasoldt, the well-known ruler of fine lines, has devised the Microscope shown in fig. 1.

The peculiarities of the construction are (1) the combination of the coarse- and fine-adjustments in one mechanism, which is shown in fig. 2, "intended to prevent the breaking of objects and injury of objectives through the accidental moving of the tube"; (2) the vertical illuminator, in which by a pair of plates opening angularly by the rotation of a cam and a single diaphragm plate, pivoting together or separately in front of a fixed quadrangular aperture, the light can be variously regulated. The glass disc reflector is attached to a bar, which can be withdrawn for cleaning or replacing by turning the milled-head cap in front. It can also be inclined as well as moved out of the field of view by pulling the bar through the milled-head cap, when the disc lies in the piece of tubing on which the cap fits; (3) the changing nose-piece applied below the vertical illuminator, by which the objective can be attached or released by the action of a trigger-piece on a sliding tooth, the inner edge of which has the Society screw-thread, and presses the screw of the objective against two similar but fixed teeth opposite; and (4) the fixed stage-ring has a deep groove round the outer edge, in which the upper plate rotates by means of two short pins on the inner edge of an overlapping flange, two diametral slots in the fixed ring enabling the upper plate to be removed.

The combined coarse- and fine-adjustments are shown in fig. 2. At the back of the body-tube slide is fixed a short screw-socket, through which a long coarse-threaded screw passes, the rotation of the screw causing the socket, and with it the body-tube, to move up or down. Near the lower end of the screw is fixed a small pinion with spiral teeth, in which a similar but much larger pinion engages for the coarse-adjustment, raising or lowering the body-tube somewhat slowly, after the manner of worm-wheel and tangent-screw mechanism. The screw has a plain cylindrical fitting at each end, by which the small pinion is kept in close contact with the larger one.

Mr. Fasoldt claims for this system of coarse-adjustment the impossibility of any running down occurring by the accidental concussion of the body-tube, as the mechanism remains locked unless set in motion by the milled heads.

For the fine-adjustment a long bent lever is applied to the lower end of the coarse-adjustment screw, so as to raise it through a space of about 1/8 in. against the downward pressure of a short spiral spring encircling the upper end, the great difference in the size of the pinions permitting this range of motion without disengaging the teeth. The lever is acted upon at the back by a milled-head micrometer-screw.

Mr. Fasoldt writes that he uses the illuminator in the following way:—

"When the Microscope is in position and the object on it, first find

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

the object with any objective from 2–3/4 in., using either transmitted light or dark field with light through condenser, the latter

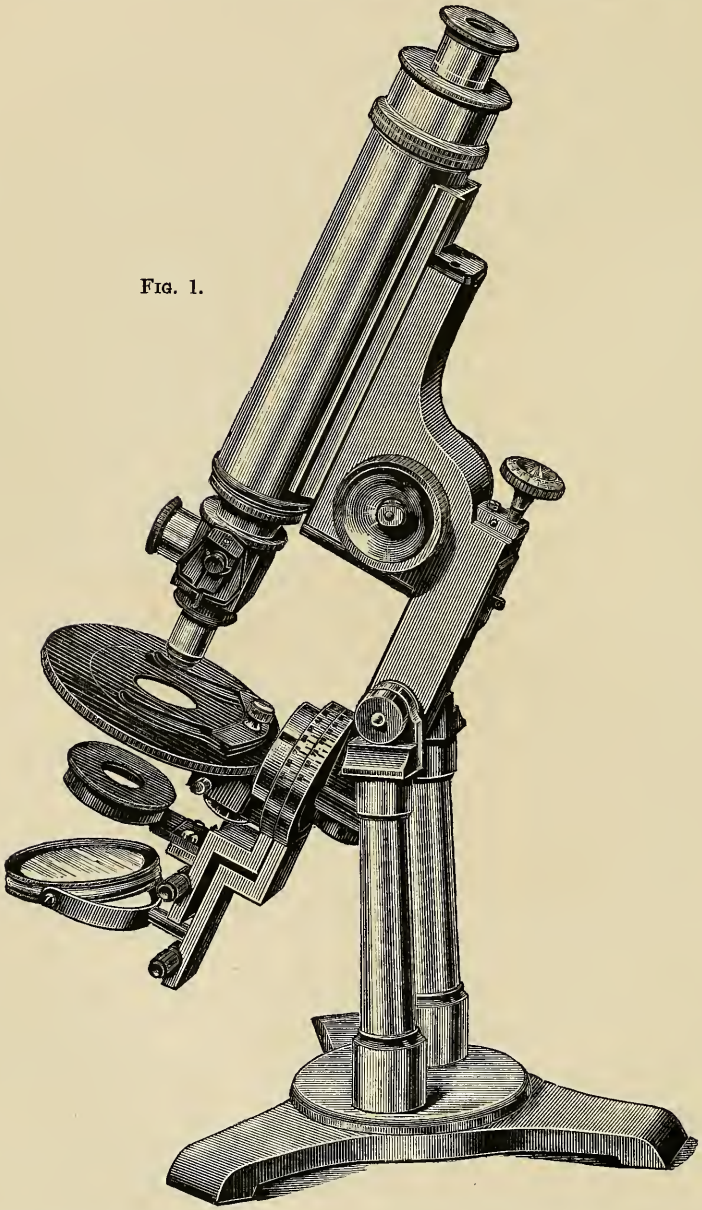
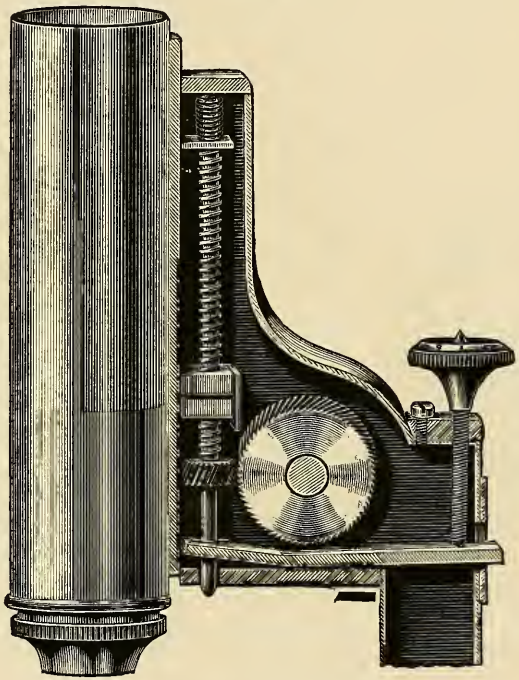


Fig. 1.

standing at an angle of about 45° from the stage, and throwing the light directly on the lines, when the latter will give a spectrum. After

having them in focus the objective can be changed for a higher homogeneous-immersion lens. Set the lamp about 20 in. distant from illuminator (at which distance I get the best resolution), using the sharp edge of the flame, and in horizontal line with opening of illuminator. I use an achromatic lens 2 in. focus as condenser (1 in. in diameter), and put it further away from illuminator opening than focal distance, the opening being open about the thickness of a penny and the light appears on shutters like a 'cat's-eye.' After having light in place and the pin in front of illuminator, to which the reflecting glass is attached, standing

Fig. 2.



in an angle of about 45°, you will see only a partially illuminated field, with dark spot in centre; when you have it so you are ready for work.

The illuminator can be used only on dry mounts. If you do not want to use the illuminator the reflector can be drawn out by the bar in which the pin is. Then it forms only a single patent nose-piece.

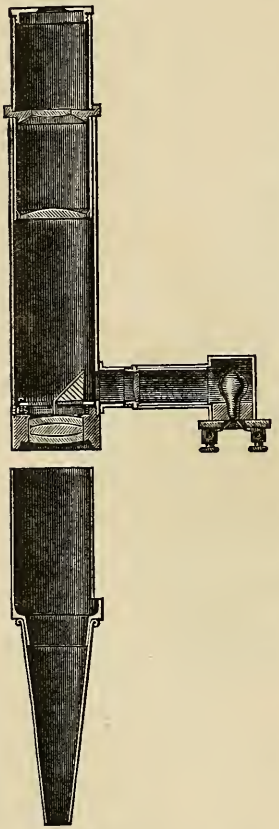
Before putting the light through the illuminator the object should first be brought in focus, using either oblique or central illumination, for lenses of short working distance. The reflector can be set at any angle by turning the milled cap through which the bar passes to which the reflector is fastened. The milled cap is held down by two pins in the cylinder and a groove in the cap into which the pins pass. There are two notches in the cap, which enter into the round groove directly opposite each other. When they are brought in perpendicular position

with the illuminator and to where the pins stand, the whole cap can be taken off for the purpose of putting glass in should one be broken.

For dry lenses I place the flame lower than the opening and use no condenser, but open the shutters to their fullest extent. You will obtain different results by using the light at longer and shorter distances. For examining blood-corpuscles, latter should be mounted on cover-glass, and you can get the best results by using less light."

Czapski's Ear- (Tympanum) Microscope.*—At the instigation of Prof. Kessel, the representative of aural surgery in the Jena University, Dr. S. Czapski undertook the construction of a Microscope which, provided with its own means of illumination, should by its handy form permit of observation of the ear under a magnification of about six to eight times. The following arrangement was given to the instrument (fig. 3) which repeated trials proved to be the most suitable.

Fig. 3.



An objective of about 10 mm. opening and 20 mm. focal length is connected by a tube 60 mm. long with an eye-piece magnifying ten times. The objective alone contributes nothing to the magnification; it simply throws the image in approximately unchanged magnitude in front of the eye-piece, so that the whole magnification is about that of the latter. Above the eye-piece is screwed a tube 25 mm. long, which carries a diaphragm for directing the line of sight, here so widely divergent, but this is not absolutely necessary. The length of the whole Microscope is about 100 mm.

Above the objective is a reflecting prism (silvered on the hypothenuse surface) which covers half the objective, and for the avoidance of all external reflections is completely inclosed with a tin cover. The position of the prism is adjustable, so as to direct the light exactly in the middle of the field of view. The light from a small electric incandescent lamp, after passing through a lens, is thrown upon the prism through an opening in the tube opposite the prism. Lamp and illuminating lens are contained in a side tube, the former being independently movable and easily replaceable. Instead of the glow-lamp a gas or petroleum lamp can be used, placed at the side. A socket in which the Microscope slides smoothly is attached by means of a bayonet catch to the ordinary ear-funnel; for the passage of the side tube the socket is slit along three-quarters of its length. The above mode of connection of funnel and tube was preferred to a solid join, partly in order

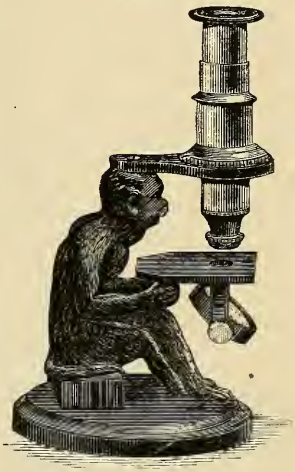
* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 325-7 (1 fig.).

to leave the funnel unchanged for its ordinary use with the reflector, and also to enable it to be easily cleaned.

To use the instrument the funnel, with or without the additional tube, is placed in the ear and its position arranged by means of an ordinary reflector for viewing the interior of the ear. The Microscope is then carefully pushed down into the socket until the image is sharply defined. By moving the instrument to and fro it is possible to obtain a view of every part of the external meatus which can be seen by the naked eye, and its use presents no difficulty even to the novice.

The field of view is not contracted by the prism over the objective, but the light is halved in intensity. The lens-openings are, however, made so large that the brightness of the image is quite sufficient. The illumination is of course most intense over the whole field of view when the lamp is as near as possible to the prism, but regard for the ear and cheek of the patient places a certain limit to the approach of a hot source of light. The lamp and illuminating lens must be so arranged that only the part of the object appearing in the field of view is illuminated, but this as uniformly as possible. The proper arrangement is easily obtained by trial.

Fig. 4.



Moreau's Monkey Microscope.—This Microscope (fig. 4), by M. Moreau of Paris, was exhibited at the December meeting of the Society. In its design Art as well as Science has been drawn on, for instead of an ordinary base and pillar a figure of a monkey is introduced which holds in its hands the stage and mirror, while the cross-arm carrying the body-tube and socket is screwed to the top of its head!

Crouch's Petrological Microscope.—Messrs. Henry Crouch, Limited, have constructed an instrument on the model of that of MM. Nachet, in which the stage and objective rotate together with the upper part of the body-tube, while the eye-piece remains stationary. It is not, therefore, necessary to centre afresh with every change of objective.

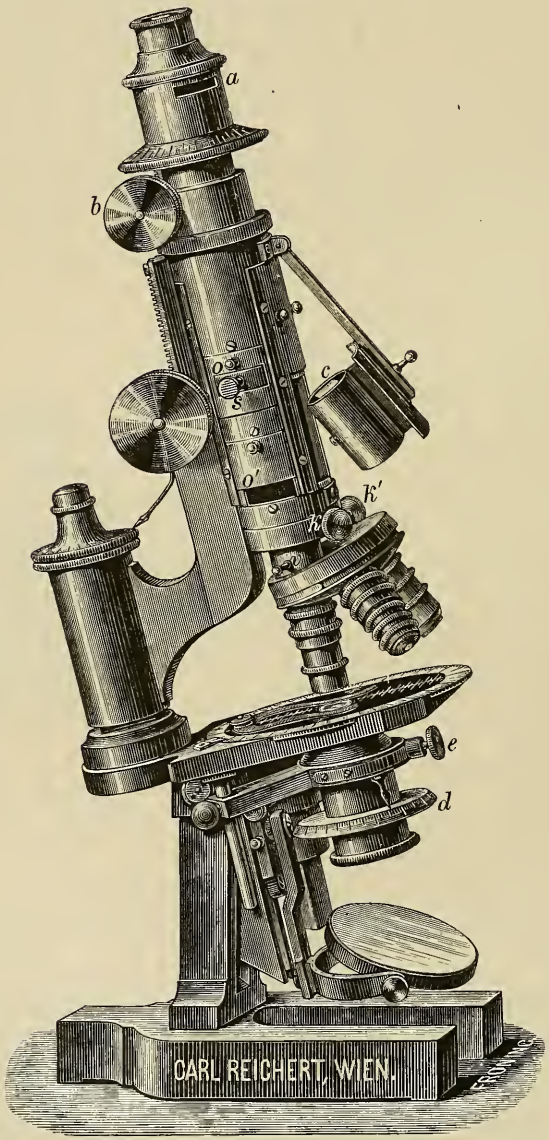
Among other points is the device for the convenient focusing of the substage condenser when convergent polarized light is employed. The lenses are placed in the tube of the polarizer and are then thrown in and out of the line of light at the same time as the polarizer, by merely moving the bar on which both are mounted. A milled ring above the polarizer focuses the condensers by a single rotating movement, similar to that by which the polarizer itself is rotated. Two analysers are provided, one in the eye-piece and the other in a draw-box above the objective.*

Reichert's Petrological Microscope.—Herr C. Reichert's Petrological Microscope (fig. 5), constructed for the Vienna Mineralogical Institute, has two specialities.

* Cf. Mawer's 'Primer of Micro-petrology,' 8vo, London, 1888, pp. 64–6 (1 fig.).

The first is the introduction into the body-tube of a second analyser *c*, which is supported on a hinged arm so that it can be rapidly inserted

Fig. 5.



and removed. This arrangement was adopted by M. Nachet for the Microscope which we described in 1881.*

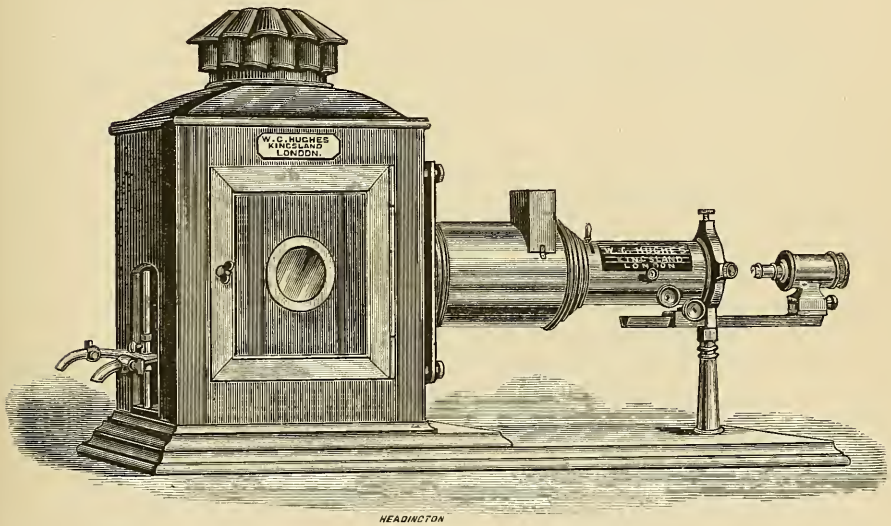
* See this Journal, 1881, p. 934.

The second is thus described (in English) by the designer :—" The tube has three ouvertures *o*, *o'*, and *a* ; *a* serves to place there a quartz wedge ; *o'* to place there a quartz plate, and *o* for the reception of a lens *s*, which magnifies the axial image sketched by the objective, and which conducts the rays of the objective, so that if we will pass from the observation in parallel light to that in convergent light, it is but necessary to place the corresponding objective and the lens *s* without changing the eye-piece, which can be exactly adjusted on the object by the aid of a rackwork of the draw-tube *b*."

The Microscope has the usual rotating stage, centering movements to the body-tube *k* and *k'*, diaphragm holder *e*, polarizer *d*, and eye-piece analyser.

Hughes' Patent Oxyhydrogen Microscope.—This instrument (fig. 6) has been designed and constructed by Mr. W. C. Hughes " with a view to enable scientists, teachers, and lanternists to display on the screen in a clear and well-defined manner the minutiæ of anatomical and geological sections, preparations of insects and vegetable tissues, and general microscopic objects either by ordinary or polarized light.

Fig. 6.



" After a careful and protracted series of experiments, an arrangement has been adopted by which the rays of light converging from a new form of triplet condensers are concentrated into a narrow parallel beam which will pass through the small apertures of the ordinary microscopic objectives, and so be transmitted to the screen, without that loss which is so disappointing in the ordinary lantern Microscope.

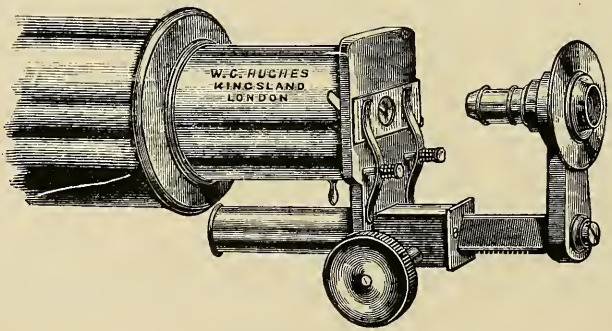
" To obtain this maximum of illumination Mr. Hughes has designed a special chamber jet, with which sufficient light can be obtained to magnify transparent subjects to 1900 diameters, which has hitherto been unattainable ; thus a flea, which is about 1/10 in. total length, will be

thrown on the screen 16 feet long, and every hair distinctly defined, and nearly as brilliantly as a picture shown by the Pamphengos lantern. The proboscis of the blow-fly can, with various powers, be projected from 8 to 16 feet long, and all the details of an insect's eye in section can be shown most perfectly; the circulation of the blood in the foot of a frog is easily displayed, and the wonders of pond life made manifest without the slightest difficulty or trouble. With the electric light no limit can be put on the magnifying power of the instrument, although, for all ordinary purposes, the lime light is all that is needed to obtain the results above mentioned. Every precaution has been taken to arrest the passage of heat to the objects by means of non-conductors, and the results obtained have met with the approval of all those who have seen its perfect performances.

"This Microscope can be fitted to any good optical lantern, but it is preferable to purchase the instrument in its entirety, as above illustrated. The lantern and Microscope are firmly attached to a solid base-board, rendering any interference with the adjustment unnecessary, an arrangement which will be found invaluable for perfect manipulation. Any ordinary microscopic objective may be used, but it is advisable to adopt those . . . which are specially corrected to insure the largest amount of light, and give a very flat and sharply defined image on the screen."

Hughes' Improved Microscopic Attachment—Cheap Form.—Mr. W. C. Hughes has devised this form of Microscope (fig. 7) for use with the ordinary magic lantern in place of the front lens, and claims that it will

Fig. 7.



show ordinary microscopical slides on the screen for class or demonstrating purposes far more brilliantly and better defined than the old form of cheap lantern microscopic attachment. It will show chemical, anatomical, and other objects on a disc 8 to 10 feet when limelight is used, and with the "Pamphengos" lantern very excellent results can be obtained. "With a 1/2-in. the spiral formation of a blow-fly's tongue can be shown, the sheep tick, 6 ft. long, exceedingly sharp and well defined, sections of wood, spiders, flies, scorpions, and each hair on a flea or other small insect is brought out with great distinctness. Pond life is easily demonstrated, *Volvox globator*, showing young inside, and *Hydra*, 6 ft. to 7 ft. long. It has a movable substage condenser which enables it to be used with different object-glasses, new form of spring on the stage, by

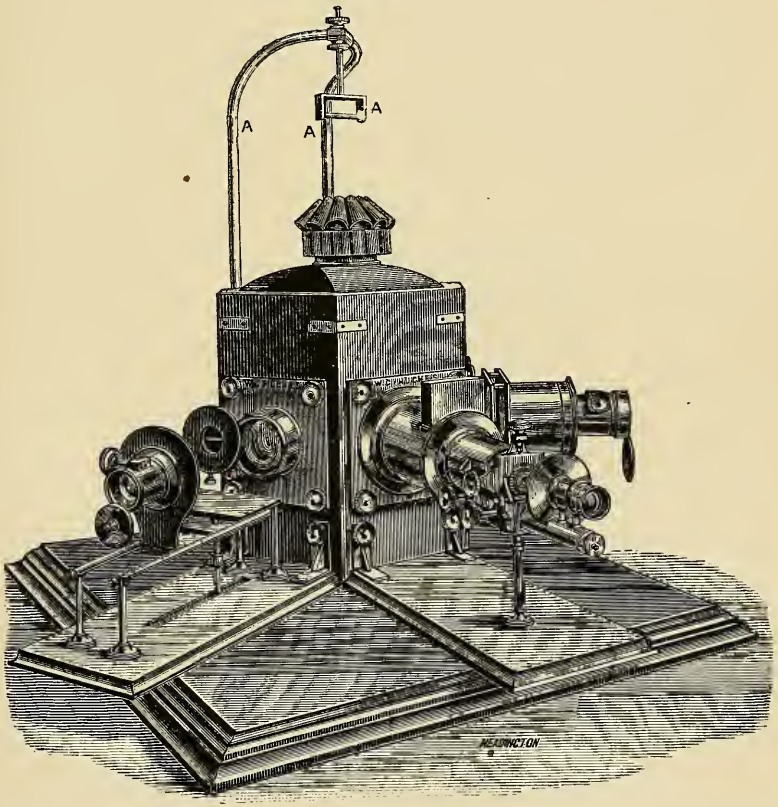
means of which the thinnest objects can be held as firmly as the glass zoophyte troughs. The bar with rack motion is constructed on the best principle by which wear and tear can be compensated for, by simple adjustment of the screws, thus insuring absolute absence of all shake.

"If desired, the image, by a special contrivance superior to the usual right angle reflecting prism, can be thrown direct on the paper for drawing. It has a new form of diaphragm arrangement, by which the aperture can be changed with great facility.

"The Microscope can be adapted, say to the centre lantern of a triple, while the other two can be utilized for showing ordinary photographs and photomicrographs to consecutively illustrate a given object under different phases without leaving the screen blank."

Hughes' Special Combination Scientist Optical Lantern.—Mr. W. C. Hughes has patented the new form of lantern shown in fig. 8, in

Fig 8.



which he "lays claim to having supplied a want long felt by the professional lecturer, both in the class-room and in the theatre, namely, that of rapidly throwing upon the screen (*a*) the general view of an object

(*b*) the microscopic portion of the same enlarged, and (*c*) in the matter of chemistry and physics, the experiment in actual operation."

The mahogany body is hexagonal, and each of the three front sides is provided with condensers and projecting arrangements. The back opens to give access to the radiant, which in this case is a Brockie-Pell arc-lamp; but, if necessary, a lime-light can be readily substituted. The lamp is fixed to the base-board, 3 ft. square, and the body can be rotated through 60° on either side of the central position, thus allowing any of the three nozzles to be directed towards the screen. The three sets of condensers are placed so that their axes intersect at a point about which the radiant is placed. The centre nozzle is fitted as a lantern Microscope, with the Microscope-attachment described in the preceding note, with alum cell and various sets of condensing lenses and objectives, and a space in front of the main condensers is provided for polarizing apparatus. The focusing arrangement consists of a skew rack and pinion and a fine screw adjustment; and the whole Microscope can be easily removed and a table-polariscope substituted. The right-hand nozzle is arranged for the projection of ordinary lantern-slides, and the left-hand one is provided with an adjustable slit for spectrum work. A small table sliding on rails serves to carry the prisms, and the same rails support projecting lenses.

Duc de Chaulnes' Microscope.—In the *Museo di Fisica*, Florence, we recently saw the Microscope shown in fig. 9, and by the courtesy

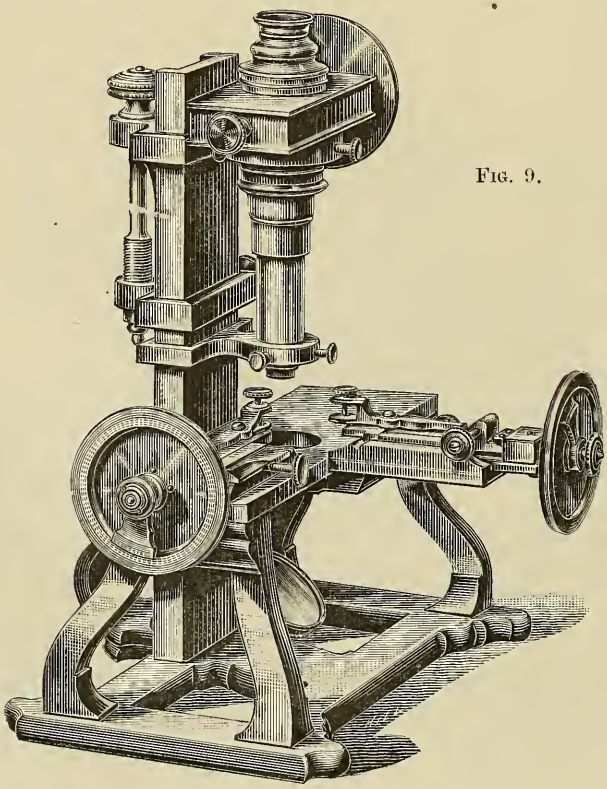


Fig. 9.

of the Curator, Prof. Meucci, we were enabled to secure a photograph of it. Nothing was known as to the origin of the instrument, but from its resemblance to the Microscope figured in plate i. of a folio work entitled 'Description d'un Microscope et de différents micromètres, &c.,' published in Paris, in 1768, by the Duc de Chaulnes, we are able to assign the design to him.

The principal aim in the construction seems to have been to facilitate the verification of micrometric measurements, especially of micrometer-divisions, for the production of which the Duc de Chaulnes devised an elaborate dividing engine in which he claimed to have embodied some original methods of obtaining accuracy in dividing scales.

The design of the Microscope proper, and of the eye-piece micrometer, seems to have been copied to a considerable extent from instruments made in England by John Cuff. The novelties were (1) in the application of a stage of an unusually substantial character, supported by four shaped legs on a framed base, the stage being arranged specially to carry screw-micrometers acting on the object in rectangular directions; (2) the body-tube is supported both at the nose-piece and near the eye-piece in centering sockets, by which the optic axis can be exactly collimated. In the original figure the body-tube is not mounted with these centering arrangements, and levelling screws are shown at each corner of the base, while a rack-work is applied for the coarse-adjustment. The Florence instrument is constructed more solidly than the one shown in the Duc de Chaulnes's figure, the extreme importance of solidity being probably discovered more and more during the progress of the construction.

Dippel, L.—**Aus dem optischen Institute von Carl Reichert in Wien.** (From the Optical Institute of Carl Reichert in Vienna.)
[I. The new large stand, No. Ia. II. The apochromatics and compensation eye-pieces.] *Zeitschr. f. Wiss. Mikr.*, v. (1888) pp. 145–50 (1 fig.).

(2) Eye-pieces and Objectives.

Monobromide of Naphthaline as an Immersion Medium.—Mr. H. Jackson, of the Chemical Laboratory, King's College, recommends this substance, not only as a solvent for balsam in mounting, but more particularly as a medium for immersion objectives. The refractive index is too high to use it alone, but diluted with castor-oil it gives excellent results. The relation of its dispersive power to the refractive index shows it to be both theoretically and practically superior to cedar-oil. The smell of it after remaining on the fingers for a little time is unpleasant.

Czapski, S.—**Compensationsocular 6 mit 1/1 Mikron-Theilung zum Gebrauch mit den apochromatischen Objektiven von Carl Zeiss in Jena.** (Compensation-ocular 6 with 1/1 micron graduation for use with Zeiss's apochromatic objectives.)
[Cf. this Journal, 1888, p. 797.] *Zeitschr. f. Wiss. Mikr.*, v. (1888) pp. 150–5.

(3) Illuminating and other Apparatus.

Thoma's Camera Lucida.*—Prof. Dr. R. Thoma considers that the ordinary form of camera lucida is unsatisfactory for low magnifications (1–6). Moreover no account is taken of the refractive condition of the

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 297–304 (4 figs.).

observer's eye, to suit which, changes have to be made in the distance of the paper which give rise to distortions.

His new camera (fig. 10) has two mirrors, one C silvered, and the other *a* of clear glass, and both set at 45°. The observer looks at the object through the unsilvered mirror, and at the same time by reflection from the two mirrors sees the drawing paper *z*. There are two convex lenses, one *b* in a vertical plane between the two mirrors, and the other *d* in a horizontal plane between the object and the unsilvered mirror. The camera and stage slide on a graduated vertical rod (fig. 11), the feet of which rest on the drawing paper, and the positions of the camera and stage are so arranged that the object and the paper are at the foci of the two lenses. Consequently an eye accommodated to infinity sees both

Fig. 10.

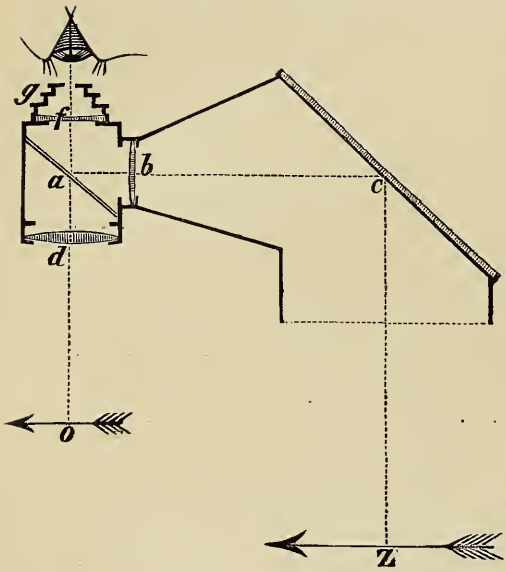
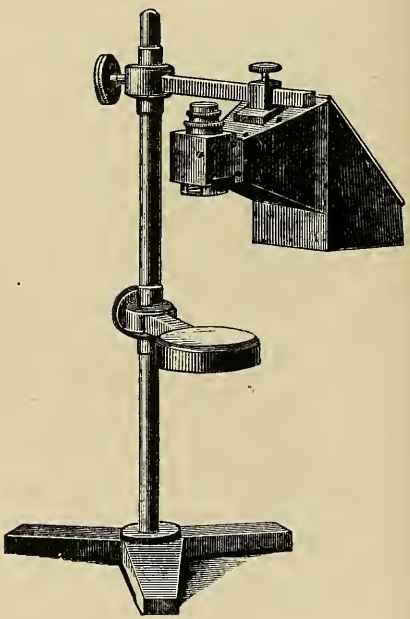


Fig. 11.



object and drawing clearly. To regulate the illumination of the two images, smoked glasses are used. A spectacle glass *f* can, if necessary, be placed in the eye-piece to correct to infinity the eye of the observer. To avoid parallactic displacement of the images a diopter *g* is fitted in the eye-piece above the spectacle glass. The author gives tables of the necessary lenses and distances of object and drawing plane for different magnifications. For diminutions, the positions of object and drawing plane are reversed.

Besides the capability of accommodation to the state of the observer's eye, the apparatus possesses the advantage that for weak magnifications a large field of view is obtained.

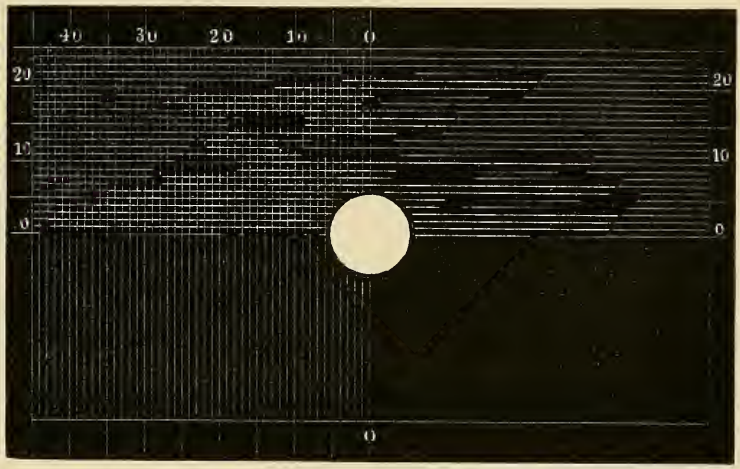
Finally the author points out how the use of weaker convex lenses may enable the observer to dispense with the concave glass used for

correcting to infinity a myopic eye. The stronger the myopia, the weaker may be the lenses used to produce a considerable magnification. Thus for a myopic eye of − 8 D, to produce a magnification of ten times, the object-lens need only be one of + 13·5 D, and the drawing lens one of − 9 D. To bring any eye then to this state of myopia, a suitable convex lens is placed in the eye-piece. By this means high magnification up to ten times can be obtained without distortion of the images.

Finder.*—Dr. J. Pantocsek describes the finder shown in fig. 12, which he considers to be more serviceable than Maltwood's finder, which he considers "time-wasting" and "minute."

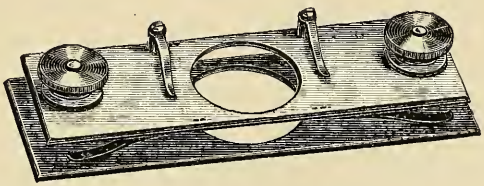
Four lines are drawn on the stage at right angles, intersecting in the optic axis; these are marked 0. Lines a millimetre apart are drawn parallel to those on the upper half and the left half of the finder, thus giving horizontal lines in the right upper quadrant, vertical

Fig. 12.



lines in the left lower quadrant, and squares in the left upper one. Each ten of the lines are marked as shown in the fig. When the object is in the field, note is taken of the two lines on which the left and upper sides of the slide rest, thus: 42/11.

Fig. 13.



Adjustable Safety-stage.—In this form of safety-stage the additional refinement has been introduced of two clamp screws at either end of the

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 39-42 (3 figs.).

plates, by which the upper plate can be brought nearer to or further from the lower plate. The result of this is to make the stage more or less sensitive. If, for instance, the plates are widely apart so that the pair of springs between them are relaxed, the upper plate yields to the slightest touch; when, however, the plates are brought closer together, so that the springs are compressed, the upper plate is much more rigid.

Engelmann's Microspectrometer.*—Prof. T. W. Engelmann points out that both the microscopic anatomist and physiologist are compelled to use peculiar methods of research, and that this is especially the case when it is necessary to examine properties and appearances quantitatively as well as qualitatively. A review of the ordinary methods of microscopical investigation shows that they are almost solely qualitative. As a contribution therefore to quantitative methods of microphysiological research, the author describes a microspectrometer for the analysis of the colour of microscopically small objects.

Originally devised for the quantitative determination of the absorption of different colours through living plant-cells, the apparatus is serviceable for quantitative microspectral analysis generally, and can be used with advantage for most microspectrometrical researches in place of the ordinary larger apparatus. The principle of the instrument is practically that of Vierordt's spectrophotometer. The spectrum of the object is compared with a standard spectrum, and quantitative measurements are obtained by altering the width of the slit until the brightness of corresponding parts of the two spectra is the same. The apparatus, which in use takes the place of the eye-piece in the body-tube, is represented in figs. 14, 15, and 16. The lower part contains the two slits and the arrangement for obtaining a comparison spectrum. The upper part is the spectroscope proper.

The under part consists of a rectangular box A, provided above and below with wide circular openings, into which are screwed the tubes *b* and *c*. The tube *b* fits in the place of the ordinary eye-piece, and is fastened by the screw *b'*, while into the tube *c* fits the eye-piece *oc* during the setting up of the object, replaced later by the cylindrical underpiece *a'* of the spectroscope. The latter rests with the ring *r* in the circular groove *s*, and is here fixed in a constant position with respect to the slits. The insertion and removal of the upper piece can thus take place without any shaking, so that there is much less danger of displacement of the images than in the micro-spectral ocular of Abbe and Zeiss, in which the two pieces are movable one within the other.

In the right of the box A is fixed the small tube *d*, through which, by means of a mirror S or lens, the light from a source at the side is directed upon the totally reflecting prism *pr*. By means of the handle *h* projecting from the box A at *h'*, this prism can be brought at will beneath or out of reach of the right slit which gives the standard spectrum.

The tube *d* carries at its end a frame *n* for the reception of diaphragms and ground or coloured glasses. In order in all cases to obtain a uniform, and, from the position of the observer's eye, as far as possible independent illumination of the standard slit, at the recommendation of Prof. Abbe a lens is fitted into the inner opening of the tube *d*; this throws a

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 289–96 (1 fig. and 1 pl.); and Arch. Néerland., xxiii. (1888) pp. 82–92 (1 fig. and 1 pl.).

virtual image of the outer opening of the tube on the spot where is the opening of the objective.

The most important part of the lower piece is the mechanism of the two slits, which are independent of each other and lie in the same horizontal plane. The symmetrical movement of the edges is effected, as in the author's microspectral objective and in the spectral apparatus of

FIG. 14.

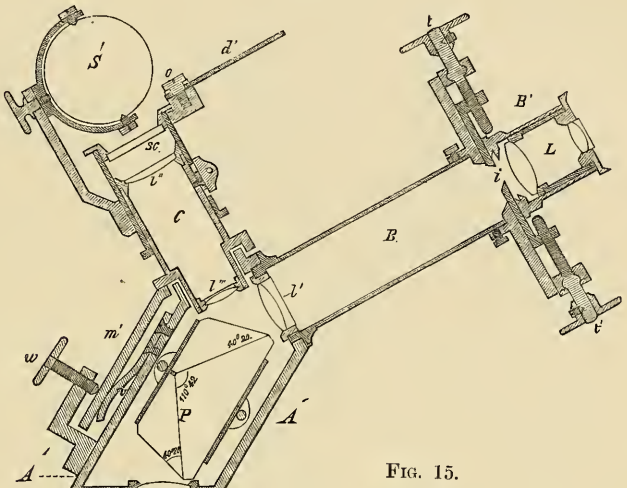
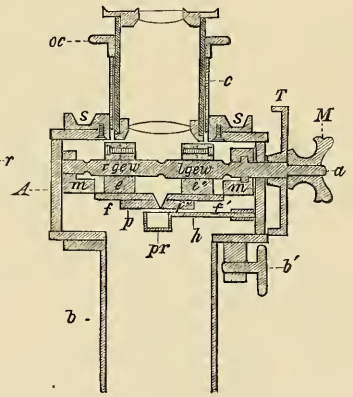


FIG. 15.

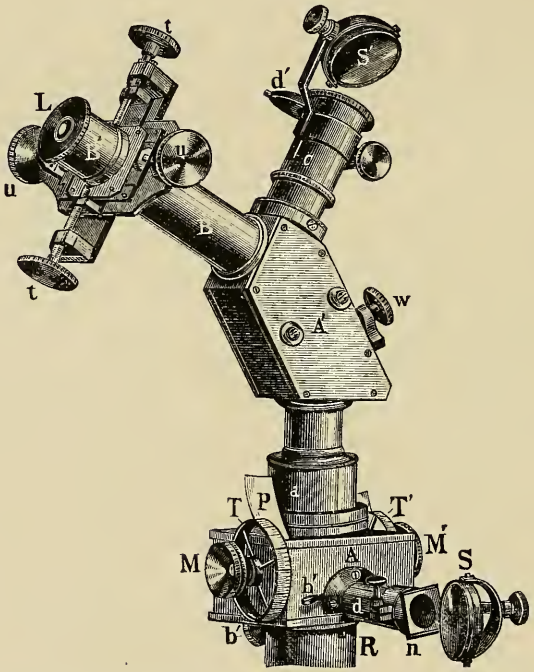


Donders, by a single screw which carries two oppositely wound threads. The mechanism of one of the two slits is shown in vertical section in fig. 15. The edges p and p' are screwed on the blocks e and e', which carry companion screws for the screw-threads on the common axis a. The screw on e is right-handed, that on e' left-handed. To avoid backlash e and e' are kept apart by a spring not visible in the figure. The axis a is firmly fixed on the strong metal frame m, so as not to be movable in the direction of its length. Consequently, by rotation of a, the

edges of the slit separate equally from the unchanged middle of the slit.

The movement of the screw is read off on a divided scale T fixed to the axis, of which 50 divisions, about 1·57 mm. apart, correspond to 100th of a millimetre. The scale readings were controlled by placing the slit apparatus on the stage of the Microscope and measuring the width of the slit with the eye-piece micrometer under a magnification of 500.

Fig. 16.



On loosening the screw M which fixes the scale to the axis, the former can be turned about a so as to bring the zero point into position.

The piece of white card p seen in fig. 16 is used for the better illumination of the scale.

The mechanism of the second slit, of which only the scale T′ and screw-head M′ are seen in the fig., is exactly similar. In order, in case of accidental displacement of the edges, to bring the middle of the one slit exactly in the line of prolongation of the other, and so insure accurate superposition of corresponding parts of the two spectra, the two edges are fastened by means of two adjusting screws on the plates f and f' carried by the blocks e and e'.

The upper piece, the details of which are shown in vertical section in fig. 14, consists of the box A′ containing the prism system P, which is composed of two prisms of crown glass (refractive index for the yellow rays 1·511, refractive angle 40° 20′) and one of flint (index 1·691, angle 110° 42′). Beneath the box A′ is screwed the collimator-tube a',

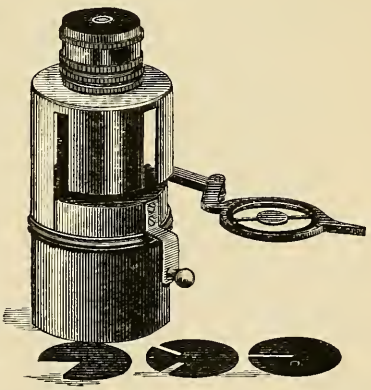
of which the lens *l* throws the rays coming from the slits parallel upon the prism system. The long axis of the box is at an angle of 30° with both collimator and telescope B. By the objective *l'* of the lattter a real spectrum of the two slits is thrown in the plane *i*, which is observed under a magnification of 20 times by the lens L contained in the tube B'. The apparent magnitude of the spectra thus exceeds by about 4 times that of the spectrum in the microspectral-ocular of Abbe-Zeiss, and by 8 times that of the Sorby-Browning ocular. Projected to a distance of 250 mm., the distance of the Fraunhofer lines *a* and *g* amounts to 185 mm. Except for observations on the extreme red and violet, the intensity when using gaslight is sufficient to allow of the use of the strongest immersion system. With a slit of less than 0·025 mm. the spectrum of the sun's light after passage through two ground glasses showed the D line doubled, with one line clearly broader and darker than the other.

Fitted into a third opening in the prism-box is a second collimator-tube C carrying at *sc* an Angström's scale of wave-lengths (bright lines on a dark ground) which is illuminated by means of a mirror S'. When not in use, a movable screen *d'* is pushed over the opening of C. The light rays from the scale rendered parallel by the lenses *l''* and *l'''* are reflected into the telescope from the end face of the prism system, and an image of the scale is formed by the lens *l'* in the plane *i*.

To obtain the proper position of this image with respect to the spectra, the tube C is movable to a limited extent in the box A', so that the direction of its axis to the end-face of P can be altered. For this purpose, C is fastened to the metallic arm *m'*, which is pressed by means of a spring *v* against the screw *w*. By turning the latter the correct position of C is easily obtained.

Finally, the tube B is provided with two pairs of diaphragms movable in the plane *i* at right angles to each other. One pair is used in order to limit the spectra to the particular group of wave-lengths under examination. The edges, which run parallel to the Fraunhofer lines, are adjusted by the screws *t* and *t'*. The other pair, movable by the screws *u* and *u'* (seen in fig. 16) serve to make the two spectra of the same breadth, for experience shows that, in order to compare two spectra, they should be of the same form and size.

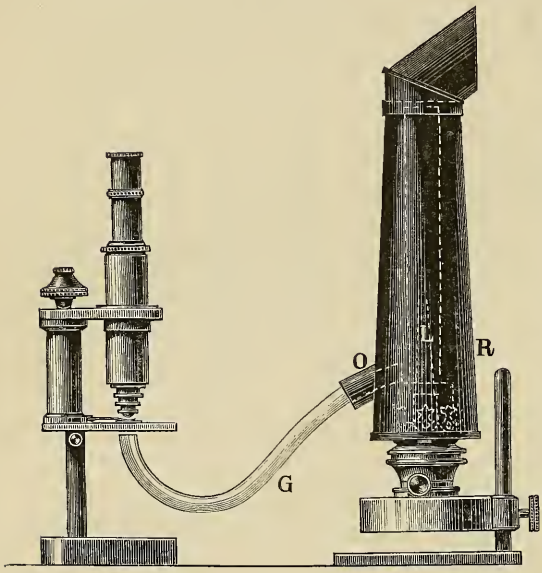
Fig. 17.



Powell and Lealand's Apochromatic Condenser.—Following upon the extension of the apertures of objectives due to what Prof. Abbe has termed "Stephenson's homogeneous-immersion system," Messrs. Powell and Lealand have brought out the Apochromatic Condenser of 1·4 N.A., shown in fig. 17. This extended aperture involves the employment of a combination of lenses of such large diameter, that it was not found practicable to utilize the usual revolving disc of diaphragms, stops, &c.; hence the application of a pivoting diaphragm-carrier that can be slid up in close contact with the posterior lens of the condenser, the pivoting

facilitating the changing of the diaphragms. The carrier is arranged to hold either a series of graduated apertures alone or in combination with a series of central stops, and a few diaphragms are supplied of special forms, such as single or double slots, and single or double circles cut more or less eccentrically, so that a great variety of different kinds of illumination can be obtained.

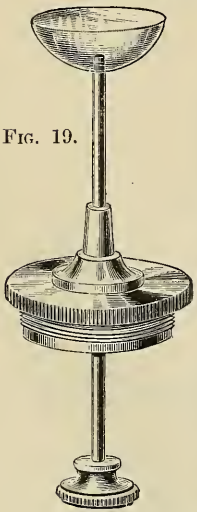
Fig. 18.



We understand that the sliding arrangement of the tube supporting the diaphragm-carrier, as shown in the figure, was suggested by Dr. Dallinger as being more convenient in use than the system first employed by Messrs. Powell and Lealand, in which the tube was wholly removed for every change in the diaphragms.

Koch and Max Wolz's Lamp.—Fig. 18 shows this lamp in position, when the solid glass rod is used to illuminate a transparent object. The principles of its construction were described at p. 1025 of the last volume of this Journal.

Fig. 19.



L is the source of light—a mineral oil lamp. Outside the glass chimney is a black one, on the inside of which is a reflector R. At O is an opening fitted with a short tube, in which is fixed the curved glass rod G. The end of this rod is squared off, and lies underneath the stage. The quality of the light may be modified by putting coloured glasses upon the smooth end of the rod.

Although the source of light shown in the illustration is derived from mineral oil, gaslight or other sources can be used.*

Adjustable Hemispherical Illuminator.—The Bausch & Lomb Optical Co. now fit this illuminator as shown in fig. 19. The glass hemisphere is attached to an adjustable rod which slides in an adapter screwing on a substage adapter. It is a very convenient accessory in instruments having separate mirror and substage bars, as any number

* Cf. Zeitschr. f. Wiss. Mikr., v. (1888) p. 478 (1 fig.); and this Journal, 1888, p. 1025.

of slides may be used, and any degree of obliquity obtained without disturbing the illuminator.

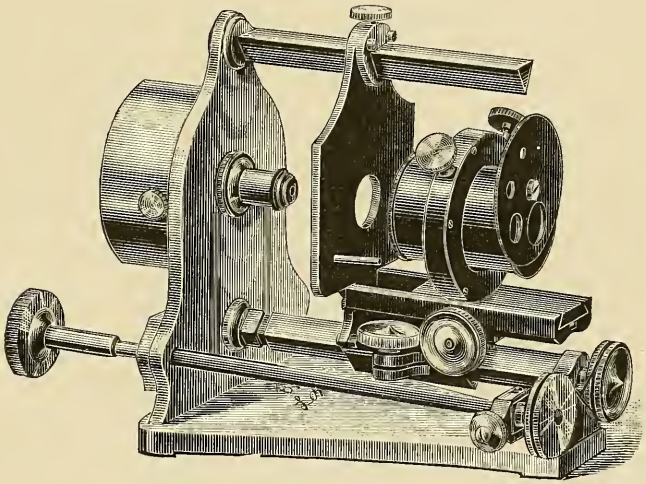
WHELPLEY, H. M.—[Illumination.] *The Microscope*, VIII. (1888) p. 351.

(4) Photomicrography.

Kibbler's Photomicrographic Camera.—This (fig. 20) was devised by Dr. A. Kibbler and carried out in detail by Mr. W. Bailey. It is thus described by the designer.

"The stand consists of a base and an upright, the latter being pierced for the object-glass. At the back of the upright is a shutter for making the exposure and a hood to connect this part of the apparatus with a camera. The connection can be made to any size camera by a simple tube made either of wood or metal and of a length to please the operator. From the lower part of the upright is a rod (firmly supported at the further end by the base) upon which travels the stage with its clamp and screw. The sliding movement of the stage upon the rod serves for a rough adjustment. The fine-adjustment is at the end of the rod and is controlled by a long arm working at the side and connected

FIG. 20.



by a cord. In order that the tension of the cord may be constantly maintained one end of the long arm is made to travel outwards by a tangent screw, the other end working in a ball-and-socket joint to compensate for this lateral movement. At the upper part of the upright is a V-shaped rod upon which the stage also runs. The upper rod tends materially to steady the movements of the stage and is also furnished with a screw which can be used for clamping the position of the stage, after the focusing is accomplished by the fine-adjustment, so that no movement can occur during the process of changing the sensitized plates or exposing. The lower rod which supports the stage and the upper

clamping rod are placed as far away from the optical centre as possible in order to prevent any disturbance of the focus from expansion when subjected to a strong heat-producing light.

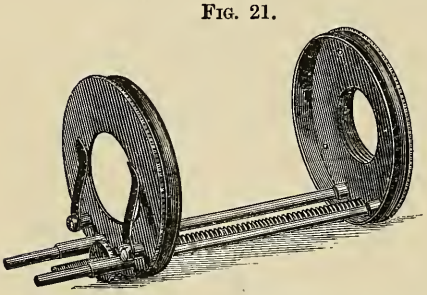
"The substage consists of a tube about 3 inches long with a short-focus condenser at the proximal end and the diaphragm plate at the distal end. It can be moved either backwards or forwards or can be accurately centered by screws which are shown in the woodcut. This particular form of substage possesses, Dr. Kibbler considers, manifold advantages. In the first place the diaphragm plate, being removed to some little distance from the stage and having the short-focus condenser in front of it, is thrown quite out of focus with the object-glass and consequently does not tend in any way to diminish the area of the field, but, on the contrary, produces a general and uniform diminution of light. But what is of still more importance the diaphragm-plate is found in this combination to have developed new functions and acts somewhat similarly to the "stop" used by photographers in the photographic lens. That is, it increases both the area of definition and the depth of focus. Without the condenser the diaphragm-plate, to produce a similar effect, would have to be removed to a distance that would become inconvenient in practice. The condenser obviates this by projecting the diaphragm-plate optically further away by making it still more out of focus and so lessens the distance at which it is necessary to be placed. The condenser also has the effect of converting what otherwise would be a straight pencil of light, into a cone before it reaches the object and transforms it into a more suitable form of illumination for showing the defining powers of an object-glass to the best advantage."

The instrument is made entirely of brass and possesses great stability.

Mawson and Swan's Photomicrographic Apparatus.— This apparatus (fig. 21) is of an extremely simple character and enables an ordinary camera to be used for photomicrography.

It consists of a light metal disc, which can be screwed on the camera front in place of the ordinary lens, the opening in the centre being furnished with the Society screw, so that ordinary microscopic objectives can be readily attached. Upon three horizontal rods projecting from this disc slides another similar disc, also with an opening in the centre, and having a pair of small spring clips for the slide which it is desired to photograph. The third rod is encircled, behind the stage, by a spiral spring, and focusing is effected by turning the screw-nut on the rod, which forces the stage towards the objective, the spring moving it back again when the screw is released.

FIG. 21.



Robinson's Photomicrographic Cameras. — Messrs. J. Robinson & Sons make two forms of cameras which are of an extremely simple character.

The "Student's Micro-Camera" is shown in fig. 22, and is intended for plates $2\frac{1}{8}$ in. $\times$ $1\frac{5}{8}$ in. It is made of mahogany, and is fitted to the Microscope by cutting a hole in front and lining it with velvet, the eye-

Fig. 22.

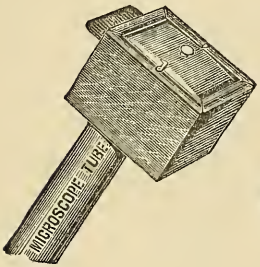
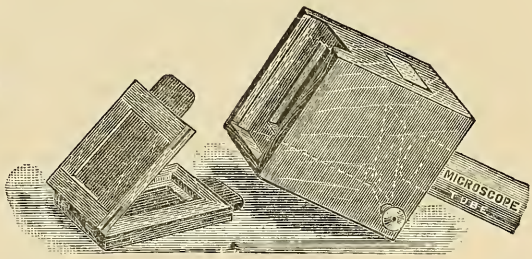


Fig. 23.



piece being removed. After focusing, the camera must be removed from the Microscope to the dark room, where the ground glass is replaced by the plate.

The "Superior Micro-Camera" (fig. 23) has a double dark slide which avoids the necessity of removing the camera from the Microscope during the operation, and the inside shutter (shown by dotted lines in the fig.) enables the exposure to be made more easily without any danger of shaking the apparatus.

Photomicrography with Magnesium Light.*—Dr. E. Roux recommends a magnesium oxyhydrogen light for photomicrography.

Common powered magnesia is mixed up with water to a stiff paste, then stuffed into glass tubes of 4–5 mm. internal diameter. From this it is squeezed out and then cut up into pieces 5 mm. long. These pieces are rolled into balls and stuck on the end of a piece of platinum wire. They are then exposed for three or four hours to a temperature of 100°. They are then first exposed to the hydrogen flame of an oxyhydrogen burner, and afterwards to that of the oxygen. After this treatment they are hard and unalterable in the air.

One of these small pieces of magnesia will last for fifteen hours straight off. The light is uncommonly effectual for photography, and offers the advantage that it illuminates regularly, is not diffusive, and remains fixed to the same point.

Marktanner's Instantaneous Photomicrographic Apparatus.—Dr. G. Marktanner points out that when single individuals out of a great number of moving objects (e. g. fresh blood-corpuscles) are to be photographed, the observer must be in a position, with apparatus ready for the exposure, to wait for the instant when the moving object appears in the field of view. Two conditions are to be noted: that the object during the observation must be only moderately illuminated; and, further, that the observation must be made through a second tube while the body-tube is connected in the usual way with the camera. The latter condition is fulfilled in the Nachet apparatus: it was the consideration of the former which led the author to construct the new

* Photogr. Wochenbl. Berlin, 1888, No. 5. Cf. Zeitschr. f. Wiss. Mikr., v. (1888) pp. 497–8.

arrangement, which can be fitted to any photomicrographic apparatus in which Microscope and camera are not rigidly connected.

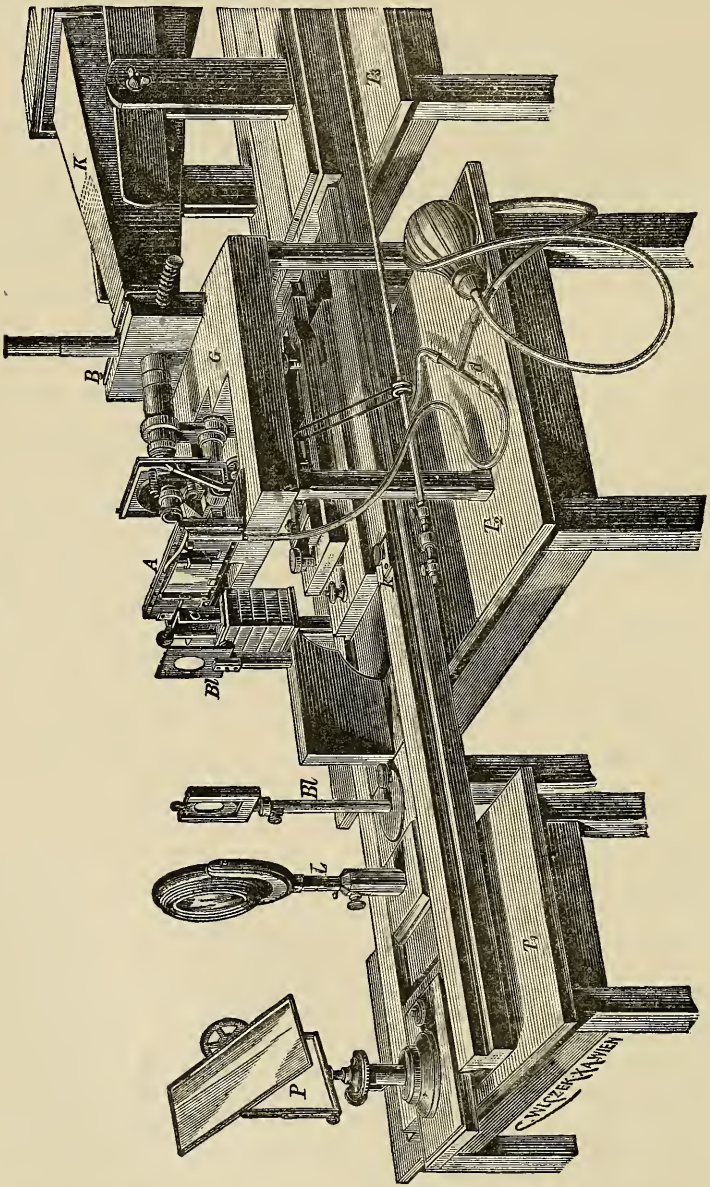


Fig. 24

The apparatus (fig. 24) consists of two instantaneous shutters A and B. The double function of A is to shut out the sunlight during the

observation, and during the taking of the picture to allow a momentary entrance of direct sunlight; while that of B is to throw, during the observation, the light from the object by means of a totally reflecting prism into a second tube through which the image can be observed; at the moment of exposure the prism moves to one side, and permits light from the object to enter the camera.

The shutter A, fig. 25, consists of a slide, 5½–6 cm. broad and about 15 cm. long, working between grooves in a wooden or metal frame, and movable by a spiral spring *s*, the tension of which is regulated by the screw *m*. At one side of the slide is a circular or square aperture, over which a smoked or opalescent glass can be placed. Beyond the aperture is an open space of variable breadth of 1–2 cm. Before the slide is released the aperture is in front of a corresponding circular opening of 4–5 cm. diameter in the frame. The release of the slide takes place pneumatically by the knob of the cylinder *c* raising the spring with the catch *r*. This slide is placed behind the diaphragm opening of the Microscope in such a way that the middle-point of the opening in the frame is on the optic axis. The shutter B, fig. 26, provided with brass tubes for connecting it with camera and Microscope, consists of a metal box containing a totally reflecting prism which, during the observation, directs the light from the object into the side tube *t*, and at the same time closes the opening behind leading to the camera. The prism is fixed to a movable slide which is under the tension of the spring *s*, with screw *m*; on releasing it pneumatically, the slide carrying the prism moves to one side and allows light to pass from the tube to the camera.

In order to allow of observation with the eye-piece for different positions of the camera, the author makes the two lenses composing the eye-piece movable, so that the distance between them can be varied within certain limits; the images thus obtained are not quite plane, and have coloured edges, but are otherwise sufficiently well defined.

The two shutters are released together by means of two tubes joined by a three-way piece to a caoutchouc ball. Care must be taken, however, that the shutter B works somewhat quicker or is released sooner than A, so that the light-path to the camera is open during the illumination of the object as the open space *f* in A passes in front of the opening in the frame. This is easily effected for equal tension of the two springs by using a three-way cock instead of merely a three-way piece, and placing the cock in a definite position.

To avoid shaking the whole apparatus, the two shutters are mounted, as seen in fig. 24, on a single separate stand. The shutter B is connected with the camera by Zeiss's method. Somewhat large moving objects (e. g. Daphnida) are placed in cells which just leave room for movement between the two sides.

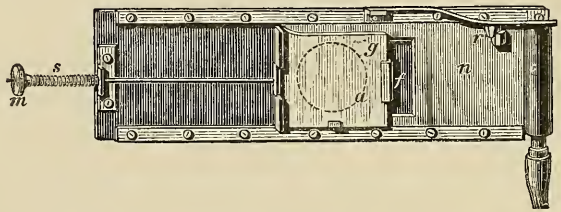
Sunlight rendered monochromatic by ammonio-copper oxide or Fehling's solution is the light employed for the adjustment. When the objects move too fast for successful adjustment, observation is made of an air-bubble in the cell.

To increase the illumination during the exposure, a condensing lens L of large opening (10 cm.) is inserted in such a position that the object is at its focus, or, if the field of view of the objective is greater than the surface thus illuminated, so that the object is in the converging part of the beam. If, however, the object surface to be illuminated is smaller (by use of a stronger objective), a condenser can

be used with the lens, which in this case should not be of too short focal length (at least 30 cm.).

The whole disposition of the instrument is seen from the figure (24), in which *d* is the three-way piece, P the plate mirror, L the condensing lens, B*l* the diaphragms, C the cell, K the front part of the camera, T_1 and T_3 tables on which rests the base-board carrying the camera and

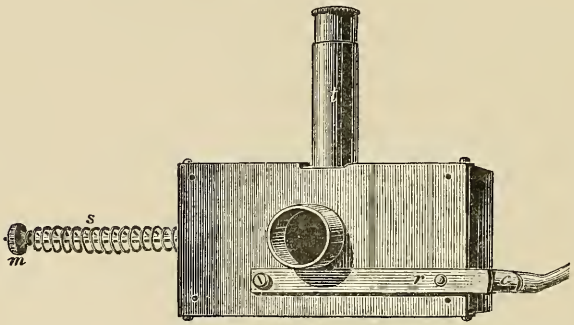
Fig. 25.



optical bank, T_2 the table on which stands the small table G carrying the shutters A and B, and *k* the screw for regulating the tension of the adjustment-cord, which, in this apparatus as in that of Prof. Stricker, works not on the micrometer-screw of the Microscope, but on a second micrometer-screw connected with the stage.

For the adjustment the condensing lens is removed, and the path of the beam of light reflected from the mirror is centered by means of the

Fig. 26.



two diaphragms of equal opening. In the figure is represented the moment when the adjustment is just finished and the lens inserted, but the diaphragm turned towards the mirror not yet replaced by one of wider opening. The latter is chosen of such a size that it cuts off only the zonal edge of the beam, and is situated at such a distance (at least 15 cm.) from the second diaphragm, that the light cone exactly passes through the latter. With a condensing lens of 10 cm. opening and focal length of 33 cm., diaphragm I. (with 70 mm. opening) is distant 62 mm., and diaphragm II. (with 28 mm. opening) 222 mm. from the lens.

As regards the time of exposure, for small crustacea with a magnifi-

cation of 100 and condensing lens as above of 10 cm. opening, 1/20 of a second is sufficient.

A construction similar to that used in Marey's photographic pistol may be employed to take several successive pictures of moving objects. The same result may, however, be more simply attained by using Janssen's principle, viz. that by quick working of the shutter sharply-defined pictures can be taken on a moving plate, which need not come to rest (as in Marey's apparatus) during each exposure. To this end the photographic plate is pneumatically put in motion (rotation, sliding or free fall) at the same time as the shutters, and the shutter A acts so as to give quick successive illuminations of the object. This is effected by means of a rotating slide, carrying on its periphery 10–12 sector-shaped openings: one opening, viz. that behind the object before the release of the slide is circular, and provided, as above described, with an opalescent glass.

Easy Method for "Photographing" Sections.*—Dr. A. Trambusti says that he has obtained very excellent results from photographing mounted sections in the following simple manner, which is directly derived from De Giaxa's method of reproducing by coarse photography cultivation-plates.†

A small piece of albumenized paper sensitized with silver nitrate is placed on a piece of wood covered with black. To this is clipped on, cover-glass downwards, the slide to be photographed, and this simple apparatus is then exposed to direct or diffuse sunlight until the paper outside the section has become sufficiently black. The paper is then removed to a water-bath in order to remove any excess of silver nitrate and after a little time placed in a bath of chloride of gold. It is next fixed with hyposulphite of soda in the usual way.

Instead of paper sensitized with silver nitrate the author has also tried paper prepared with ferrocyanide. The apparatus arranged as before is exposed until the olive colour is no longer perceived. It is then washed in water. This completes the process. The picture obtained by this method, which is certainly quicker than the other, is of a sky-blue colour.

A score or more of these reproductions may be made in less than an hour.

The author used preparations stained red, and expresses the opinion that the results therefrom are better than with other colours.

Chromo-copper Light-filter.‡—Prof. E. Zettnow says that the copper-chromium filter is very useful for bacteriological purposes, as bacilli stained red, blue, or violet come out quite black on the focusing glass, and therefore a preparation (cover-glass or section) stained with methylen-blue can be photographed with great brilliancy. If sunlight is used and a very concentrated fluid be desired, then the following mixture, diluted afterwards if required, is made:—160 grm. copper nitrate and 14 grm. chromic acid mixed with 250 ccm. of water. For general purposes the following solution in a layer 1–2 ccm. thick is more convenient:—175 grm. copper sulphate and 17 grm. bichromate of potash mixed with 1 litre of water.

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 335–6 (1 pl.).
† See this Journal, 1888, p. 827.
‡ Centralbl. f. Bakteriol. u. Parasitenk., iv. (1888) pp. 51–2.

Over other yellow or green fluids the copper-chromium filter possesses the advantage of only letting through a very small part of the spectrum; if concentrated, only yellow-green rays from λ 580–λ 560; if diluted, λ 590–λ 545; with great dilution orange rays appear; for these the erythrosin plate possesses very slight sensitiveness.

A filter roughly resembling the foregoing may be made by adding ammonia in excess to a mixture of copper salts and chromate of potash. This, however, only lets through such green rays as the erythrosin plate is but little sensitive to. The maximum and minimum of sensitiveness in the plate lie close together.

It was found that by using the copper-chromium filter combined with mineral-oil light and long exposure the sharpness left nothing to be desired with ordinary objectives up to a magnification of 400. After this difficulties arise which are only overcome by the use of apochromatics, a condenser, and the light-filter.

(5) Microscopical Optics and Manipulation.

Optical Effect of Focusing up or down too much in the Microscope.* —Mr. W. M. Maskell writes that, if when observing *Gonium*, the objective be lowered a very little, so as to throw the alga out of focus, and to see, as it were, beyond its surface, not only do the outlines become blurred and indistinct, but a somewhat curious change of colour is noticeable. The whole plant assumes a green ground colour, the spaces formerly visible between the cells being obliterated, and at the same time an elegant geometrical pattern is produced, with various tints. Four crimson specks appear at about the middles of the four inner cells, and with these as centres four delicate circles of bright yellow interlace each other, the radius of each circle being the distance between two crimson spots. The spots are also connected by narrow bands of lighter red colour. The outer ring of cells appears as composed of pyriform bodies, the points inwards and overlapping, producing thus the semblance of green spokes in the four circles. In each of these cells, on the circumference of the circles, is a crimson spot formed of concentric curves open towards the middle of the plant. By focusing downwards a little more or less the crimson spots or the golden circles may be made more or less conspicuous on the green ground.

If, again, the object-glass be screwed *up*, past the true focus, an entirely different effect is produced. Instead of the whole plant appearing solid, the spaces between the cells are amplified, and the whole colony seems larger and more scattered; and the cells, quite disconnected, are now not green, but yellowish-brown, with a broad darker band encircling each. These effects of colour are noticeable not only with a 1/4 in. objective, but also with the 1/8 in., and they may even be made out with the 1 in., though, of course, not well, as the plant then appears so small.

The author adds, "Of course, I presume that the effects here spoken of are easily explicable: the passage of the light through the semi-transparent green cells, the translucent envelopes, and the empty spaces, producing complementary colours. And in itself the thing is doubtless not of any importance. Yet indirectly it may possess some value, as in a certain kind of way a warning. From the measurements which I have

* Sci.-Gossip, 1888, pp. 248-9 (3 figs.).

been able to make I imagine (my fine-adjustment not being graduated there is no attempt at complete accuracy) that the distance through which the 1/4 in. objective passes from the true focus to the lower position is not more than the 1/150 in.; and from the true focus to the higher position about the same, or rather less. This is accomplished by a very slight turn indeed of the milled head of the fine-adjustment. In the case of *Gonium pectorale* it is usually pretty clear when one has the plant properly in focus, especially as the view of the flagella comes as a guide. But there are many objects as to which it may be supposed that so small a difference as 1/150 in. may not seem to throw them out of focus, whilst in reality they are so to an extent which might cause error. Query: might the striæ of diatoms come under such a category? It is a common thing to hear and read that the appearances of things under the Microscope are not always to be taken as strictly true; and doubtless the microscopists of old days owed some of the queer figures they drew to this cause. The changing colours and form of *Gonium pectorale* as above noticed may perhaps serve a useful purpose, if they warn some young microscopists to be very particular in the observations they make; possibly also some older hands might take a hint."

PENNY, R. G.—**Microscope Objectives—Angular Aperture.**
Engl. Mech., XLVIII. (1888) p. 316.

(6) Miscellaneous.

Death of Dr. Zeiss.—We deeply regret to have to record the death of Dr. Carl Zeiss, the eminent Jena optician, who in conjunction with Prof. Abbe has done so much to advance the practical construction of objectives. His name will for many generations be associated with the most important epoch of Microscopy; the epoch in which the famous diffraction theory of Prof. Abbe was promulgated which revolutionized microscopical optics, to be succeeded by the important suggestion of our late Treasurer, Mr. J. W. Stephenson, which resulted in the homogeneous-immersion objectives first made in 1878, and later followed by the still further advance shown by the construction of apochromatic objectives. In the practical construction of these and the homogeneous-immersion objectives the deceased played a leading part, and whilst it is impossible to exaggerate the services which Prof. Abbe has rendered to microscopy in these matters, he would, we are sure, be the first to admit the invaluable assistance he received from Dr. Zeiss.

The remarks of the President and others on Dr. Zeiss's death will be found at p. 162.

Death of Mr. Zentmayer.—The following is the report of the Committee of the New York Microscopical Society, which was appointed, *more Americano*, to draft resolutions relative to the death of Mr. Joseph Zentmayer:—

"Whereas this Society has received with sorrow the announcement of the death of Mr. Joseph Zentmayer, which occurred at Philadelphia, Pa., on March 28th, 1888, it is hereby

"Resolved:—

"1. That in the death of Mr. Joseph Zentmayer the labourers in the various branches of science employing optical instruments have lost the inspiriting presence and helpful co-operation of an eminently intelligent and successful author, inventor, and mechanician, whose knowledge of

optical principles has been attested by his brilliant publications ; whose attainments have been recognized by his election to membership in various organizations, and whose mechanical skill and conscientious carefulness are still shown in the large variety of instruments issued from his establishment.

"2. That a record of this action be forwarded to the family of Mr. Zentmayer as a token of our heartfelt sympathy with them in this bereavement."*

American Society of Microscopists.—Meeting of, in 1888.
Amer. Mon. Micr. Journ., IX. (1888) pp. 96–7, 133–4, 153–4, 187–95.
The Microscope, VIII. (1888) pp. 242–3, 275, 377–80.
Queen's Micr. Bulletin, V. (1888) p. 16.
St. Louis Med. and Surg. Journ., LV. (1888) pp. 163–4.

FABRE-DOMERGUE.—**Premiers principes du Microscope et de la Technique microscopique.** (First principles of the Microscope and of microscopical technique.)
viii. and 280 pp., 32 figs., 8vo, Paris, 1889.

Internationalen Ausstellung zu Brüssel, Die wissenschaftlichen Instrumente auf der. (The scientific instruments at the International Exhibition at Brussels.)
[Microscopy only sparingly represented.]
Zeitschr. f. Instrumentenk., VIII. (1888) pp. 394–8.

JAMES, F. L.—**W. J. Lewis, A.M., M.D., F.R.M.S., President American Society of Microscopists.**
[Biographical sketch.] *The Microscope*, IX. (1889) pp. 7–10 (portrait).

[MANTON, W. P., and others.—**Lantern Illustrations of Microscopical Subjects.**]
["We notice that physicians are beginning to avail themselves of the lantern to illustrate their papers on microscopical subjects. At the recent meeting of the American Medical Society, some excellent views of diseased tissues were shown, and we notice that Dr. A. G. Field, of Des Moines, recently entertained the Iowa State Medical Society by a stereopticon exhibition of the microbes mentioned in his paper before that body. This is an excellent method of impressing an audience with the idea that the author of an article knows what he is talking about. We expect to see the lantern commonly used for such purposes in the near future."]
The Microscope, VIII. (1888) p. 207.

Microscope and Adulteration. *Tit-Bits*, XIV. (1888) p. 305.

ROYSTON-PIGOTT, G. W.—**Microscopical Advances.** XLI., XLII., XLIII.
[Attenuated dots and lines. Size of fine threads or of organic particles. Delicate attenuations and anti-diffraction micrometer. Attenuations. Mr. Boys' infinitesimal glass gossamers. The use of a new micrometer gauge (consisting of parallel fibres of spun glass cemented on to a brass plate projecting freely in the field of the eye-piece).]
Engl. Mech., XLVIII. (1888) pp. 325, 389 (1 fig.), 431–2 (7 figs.).

Schott & Gen. in Jena, Neue optische Gläser des glastechnischen Laboratoriums von. (New optical glass from the glass laboratory of Schott & Co., of Jena.)
[Note as to further kinds of glass, principally for photography.]
Zeitschr. f. Instrumentenk., VIII. (1888) pp. 392–3.

STOKES, A. C.—**Microscopical Work for Amateurs.**
[Description of Leeuwenhoek's Microscopes and his work.]
Amer. Mon. Micr. Journ., IX. (1888) pp. 219–23 (5 figs. and 1 pl.).

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* Journ. New York Micr. Soc., iv. (1888) pp. 173–4. Queen's Micr. Bulletin, v. (1888) p. 24 (portrait).

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Collecting Diatoms.†—Mr. C. H. Kain, speaking of the bright-brown patches of diatoms frequently seen covering the surface of mud, recommends that they be collected in the following manner.

Half fill a bottle with water. Touch one of the brown patches lightly with the tip of the finger, and the diatoms will adhere; then place the finger over the mouth of the bottle and shake it. The diatoms are, of course, washed off and remain. By repeating this process again and again the water finally becomes quite brown. By the time the collector reaches home the diatoms will have settled to the bottom, and the water may be poured off and the diatoms cleaned. It is worth while to examine under the collecting lens every promising patch of brown mud, for very pure gatherings of quite different species may often be collected within a few feet of each other.

Culture of Unicellular Algæ.‡—Herr V. Jodin has made cultivations of various species of *Protococcus*, *Zygnema*, &c., in artificial media, consisting of solutions of the requisite minerals in distilled water. The most suitable solution is the same as that used by Raulin in his experiments on *Aspergillus niger*. The solution is placed in flasks which are exposed to the light and the carbonic anhydride is renewed in the air of the flasks by an automatic generator. This simply consists of a flask filled with a solution of ferric oxalate, connected with the culture-flask by a bent glass tube passing through the caoutchouc stopper of the latter. The ferric oxalate evolves carbonic anhydride on exposure to light. Under favourable circumstances the crop obtained in several weeks' exposure amounts to 10 grams of fresh algæ or 1 to 2 grams of dried product per litre. These cultivations are well adapted to throw light on the chemical processes taking place in the green cell, since the crops obtained are uniform and homogeneous, and are free from the disturbing influences arising from the differentiation of organs and the migration of proximate principles in the higher plants. The author concludes by stating that the proportion of nitrogen in *Protococcus* varies from 1·43 to 6·67 per cent. of the crop. The conditions of assimilation of this element are still under experiment.

Soyka, J.—**Ueber Milchreis, einen neuen festen Nährboden.** (On rice-milk, a new solid culture medium.)

Deutsch. Med. Wochenschr., 1888, p. 833.

(2) Preparing Objects.

Reaction of Elastic Fibres with Silver Nitrate.§—Prof. C. Martinotti describes a new method for demonstrating elastic fibres in the various tissues and organs.

Fresh tissue in pieces of 2 to 3 ccm. are placed in a 2 per cent. solution of arsenic acid for 24 hours, but if parts attached to bone are to be

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Bull. Torrey Bot. Club, 1888, pp. 128–31.

‡ Ann. Agronom., xiv. pp. 241–5. See Journ. Chem. Soc., 1888 (Abstr.), p. 1124.

§ Comm. alla R. Accad. di Med. di Torino, 1888, pp. 5–15. Cf. Zeitschr. f. Wiss. Mikr., v. (1888) pp. 521–2.

examined (periosteum, tendon, &c.) a 4 per cent. solution warmed to 50° C. is preferable. In this the bones are decalcified. The pieces are next placed for 5–15 minutes in Müller's fluid, and then in the following silver-glycerin solution:—2 grm. of silver nitrate are dissolved in 3 ccm. of distilled water; to this are added 15–20 ccm. pure glycerin. Herein they remain for 24–48 hours. On removal they are quickly washed in distilled water and then transferred to alcohol; therein the excess of silver nitrate is removed. The preparations may be kept in spirit for any length of time. Sections are made under alcohol. In order to prevent any harm from the action of light the sections are immersed for a short time in a 3/4 per cent. solution of salt, and from this at once transferred to absolute alcohol for dehydration. They are cleared up in creosote and mounted in balsam.

Solvent for the Gelatinous Envelope of Amphibian Eggs.*—Dr. C. O. Whitman has found hypochlorite of sodium an excellent solvent for the gelatinous envelope of the amphibian egg. He obtained a 10 per cent. solution, and diluted it with five or six times its volume of water. The eggs are first hardened by heating or by immersion in some preservative fluid, then placed in the Labarraque solution until the gelatinous envelopes are so far dissolved that the eggs may be easily shaken free. They are then washed and preserved in alcohol. This method works perfectly with the eggs of *Necturus*, and has given equally good results with the eggs of the frog. The time required for dissolving the envelope in the case of *Necturus* is about five minutes. Care should of course be taken not to leave the eggs exposed to the solvent longer than is necessary in order to destroy the envelope.

Method of Examining Fragaroides.†—M. C. Maurice gives the following account of the methods adopted in his study of this Ascidian. He found that, owing to the presence of transverse muscles in the gill, the creature contracted too suddenly when treated with picrosulphuric acid, and he used, therefore, the acetic acid method of MM. Van Beneden and Julin. Pure glacial acetic acid (crystallizable) must be used. The colonies were plunged into it entire, and remained there for from 2 to 5 minutes, according to their size. They were then placed in 70 per cent., 90 per cent., or even absolute alcohol at once. By this means the natural appearance was completely preserved. Specimens of which sections were to be made were placed in borax-carmine for from 15 to 18 hours, for it was necessary that the red coloration of the nuclei should be very intense. They were next cleared with hydrochloric acid and washed with 70 per cent. alcohol till the acid had all disappeared. They were then placed in an exceedingly weak solution of Lyons blue made with 70 per cent. alcohol. After remaining in this for from 15 to 20 hours, and being shaken two or three times, they were fixed in paraffin in the ordinary way.

Preparing Fresh-water Bryozoa.‡—Although it is not easy to preserve Bryozoa in the extended condition, Herr M. Vorworn claims to have obtained excellent results with *Cristatella* by means of a 10 per cent. solution of chloral hydrate. The colonies were placed direct in this solution, and though at first they became contracted, they

* Amer. Natural., xxii. (1888) p. 857. † Arch. de Biol., viii. (1888) pp. 220–3.
‡ Zeitschr. f. Wiss. Zool., xlvi. (1887) p. 99 (2 pls. and 9 figs.). Cf. this Journal, 1888, p. 27.

slowly relaxed again, and after a few minutes were so benumbed that they could be placed without harm for 10 minutes in a watery solution of sublimate. The author does not recommend that sublimate should be replaced by alcohol or osmic acid. Borax-carmine was used for staining the animals.

Preparing Tetrastemma melanocephala.*—Mr. A. Bolles Lee used *Tetrastemma melanocephala* for studying spermatogenesis in Nemertines. The best fixative for these preparations was found to be concentrated sublimate solution with the addition of 1 per cent. acetic acid. This reagent showed itself to be superior to osmic acid, chromic acid, and iron chloride, all which kill less quickly, and frequently excite such violent muscular contraction that the contents of the seminal vesicles are greatly altered.

The best staining solution for the sections was an alcoholic hydrochloric acid carmine (100 ccm. of 80 per cent. spirit are boiled with two drops of strong hydrochloric acid and excess of carmine). From this fluid the preparations are transferred to pure spirit, wherein they remain until no more colouring matter is extracted. A good nuclear and double stain is effected by adding a little picric acid to the spirit, the picture thus obtained being sharper than that produced by borax-carmine. As a preliminary to deposition in paraffin, the author recommends cedar oil in place of chloroform. Preparations are best teased out in a 4 per cent. chloral hydrate solution and stained afterwards with Delafield's hæmatoxylin and methyl-green.

Karyokinesis in Euglypha alveolata.†—Dr. Schewiakoff found that the best fixative was Flemming's chrom-osmium-acetic acid, but it must not be allowed to act long, and the animal must be thoroughly washed afterwards. Grenacher's alum-carmine and picrocarmine were the best stains, but picrocarmine must be used with care, as it easily overstains. The animals are then thoroughly washed, and having been passed through spirit of increasing strength and oil of cloves, mounted in balsam or dammar. The foregoing manipulations were carried out in a watch-glass, in which the selected animal was placed. The selection was made by means of a lens magnifying 30 times and a capillary tube.

The nucleus was isolated by Bütschli's method. The animal was fixed to a certain spot by pressure on the cover-glass; this pressure was kept up carefully until the siliceous envelope was broken. A few more taps and a to-and-fro movement of the cover-glass broke up the protoplasm and isolated the nucleus. This procedure was assisted by means of a stream of water added at one side in such quantity that it was at once absorbed by bibulous paper at the other.

Permanent Preparations of Fresh-water Algæ.‡—Dr. L. Klein recommends, for marking the position of any individual example, Schieffer-decker's apparatus.§ This is in appearance and size somewhat like an objective, and can be screwed on to the nose-piece. At its lower end it carries a diamond point, which by aid of a screw can be moved excentrically. When used, the object is first placed in the centre of the field. The nose-piece is then turned round and the tube lowered until the

* Recueil Zool. Suisse, iv. (1888) pp. 409–30 (1 pl.).

† Morphol. Jahrb., xiii. (1887) pp. 193–258 (2 pls. and 4 figs.). Cf. this Journal, 1888, p. 66.

‡ Zeitschr. f. Wiss. Mikr., v. (1888) pp. 456–64.

§ Described in this Journal, 1887, p. 468.

diamond point just touches the cover-glass. By moving the point out eccentrically, a circle may be scratched on the cover-glass with comparative ease. This device can be employed with advantage for algæ mounted in glycerin jelly, but is not to be adopted for wet mounts, because small objects are easily moved out of position.

If several specimens are to be mounted together, the author advises the use of a capillary tube bent at an angle of 120° about 2 cm. from the end of the tube. Then under a magnification of about 100 the desired specimens are sucked up by capillary action, and the process repeated until a sufficient quantity have been obtained.

For collecting Desmidiaceæ the author uses a syringe of the following construction:—A thick glass tube about 2 cm. wide and 30–40 cm. long is closed in front with a cork, through which passes a short fine tube of glass terminating in an opening of 1–2 mm. in diameter. It is advised to have several of these points, and that some should be bent at an angle of 90°, as this angularity is often convenient. The piston is plugged with tow and thread.

Owing to the influence of light on Desmidiaceæ and on Volvociniæ, these objects may be successfully separated if the vessels containing them be exposed to sunlight in such a way that they are protected from the direct rays. In a day or two it will be found that many forms will crawl out of the mud towards the light side, where they may be collected. A pure sample of *Volvox* may be frequently obtained by placing a small quantity of the material in a pipette, and then placing the pipette point end upwards against the window. In a few minutes the Volvociniæ will be found at the top, from whence an almost pure collection can be expelled.

For ringing round preparations mounted in glycerin-gelatin the author advises the employment of amber-lac dissolved in linseed oil. Put on in thin layers it is quite transparent, and allows the use of immersion lenses.

Heydenreich's cement, although it has excellent points, has the disadvantage of requiring to be stained, and the dyes used for this purpose gradually work into the preparation. For completing the fastening down, the author formerly used equal parts of colophonium and yellow wax. To this he now adds to every 10 parts 1–2 parts linseed oil and 1 part of Canada balsam. This is put on warm.

Mounting Fresh-water Algæ.*—Dr. L. Klein mounts fresh-water algæ in glycerin or glycerin-gelatin. The author uses the former for very small objects, and adopts for this purpose the technique proposed by Migula. A drop of 1 per cent. osmic acid is run under the cover-glass, and in ten to twenty minutes afterwards the glycerin. In order not to blacken the oil-drops, &c., the osmic acid is added in as small quantities as possible, and this is best done by blowing it under the cover-glass through a capillary tube. In all other cases the author uses glycerin-gelatin, which, with the proper precautions, is an excellent imbedding material. The object is first hardened by exposing it as a hanging-drop to the fumes of the acid for a few minutes. It is then placed in one or two drops of dilute glycerin, and the surplus having been drained off or the water evaporated, a drop of glycerin-gelatin previously heated in a test-tube is dropped on by means of a fine glass tube. By this device air-bubbles are avoided.

* Hedwigia, 1888, pp. 121-6.

Some objects may be fixed by heating them on the slide up to near boiling-point, instead of using osmic acid.

Preparation of Fungi.*—Dr. G. Istvánffi describes the various modes of preparing fungi for microscopical examination. Preservation in alcohol of 60 per cent. serves for smaller dry fungi, Gasteromycetes (except such as can be preserved dry), most Ascomycetes, the colourless Agaricini and Polyporeæ (but not the *Boleti*), and the Hydnei, Clavariei, Thelephorei, and Tremellini. For the softer Hymenomycetes, alcohol cannot be used. A solution of salt answers better for these; but, with many, only preserves them for a comparatively short time. Pure sodium chloride should be dissolved in freshly boiled water till saturated, then filtered and used at once. The fungus should be completely immersed in it. This answers for many Hymenomycetes and *Peziza*. Other preserving fluids are corrosive sublimate of 0·1 per cent., boracic acid of 2 per cent., and a mixture of acetic acid and glycerin. Fungi which are preserved dry should always be washed with a 0·5–1·0 per cent. solution of corrosive sublimate, to destroy bacteria, larvæ, &c.

A convenient mode of making sections is also described, which should be set, in the case of dark-spored species, by an alcoholic solution of mastic or Canada-balsam; in that of white-spored species with gelatin.

Experiments with Chitin Solvents.†—The first experiments of Mr. T. H. Morgan were made upon the eggs of the common cockroach, and the selection turned out to be a most fortunate one. A great many eggs are laid at one time, the whole number being surrounded by a stiff chitinous coat, forming the so-called raft. The solvents used were the hypochlorites of sodium and potassium, recommended by Dr. Looss in 1885.

The most successful experiments on the cockroach's eggs were as follows:—

(1) The rafts were placed, in a fresh condition, in a weak solution of eau de Labarraque (commercial fluid diluted with five or six times its volume of water), and left until the chitinous envelope became soft and transparent. The time varies; if slightly warmed the time is less for the warm solution, perhaps thirty minutes to one hour; but one must go more by the appearance of the chitin than by any definite time. If the embryos are far advanced, they may now be removed from the envelope one by one; if still young, they had better be hardened and cut all together. In both cases the eggs or embryos were next washed for a few minutes in water, and then transferred for an hour to picro-sulphuric acid, then as usual they are passed through the grades of alcohol, 70 per cent., 80 per cent., 95 per cent.

(2) To specimens which have been already hardened and preserved the solvent may also be applied; but in all cases where fresh material is easily obtainable, it should immediately have its chitin softened and then afterwards be preserved. Here the method is somewhat shorter, since the substance has been previously hardened. From alcohol—weak solution—they are put into the Labarraque and softened as above, then passed through water and the alcohols, &c.

* Bot. Centralbl., xxxv. (1888) pp. 343–5, 381–3, 394–5.

† Stud. Biol. Lab. Johns Hopkins Univ., iv. (1888) p. 217, and Dr. C. O. Whitman in Amer. Natural., xxii. (1888) pp. 857–8.

In most cases in which an animal egg or embryo is encased in chitin, the best results have been obtained by straining the sections after they have been cut and fixed to the slide. If the specimen is small, staining *in toto*—after having the chitin softened, or if before this has taken place, after having made an entrance through the chitin with the point of a needle—is equally good. The greatest difficulty, and practically the only one which is met with, is that the Labarraque solution not only attacks the chitin itself, but after a time the soft tissues of the animal—apparently the connective tissue. Where the chitin surrounds the object completely, as is the case with the cockroach's raft, the object can be removed from the solution as soon as the chitin is softened, and before the underlying parts have been attacked. In cases like this the solvent is at its best.

Very often, however, the soft tissues of the animal are exposed in places between the chitin covering. This is well illustrated by the joints of insects' legs, &c., and very frequently these exposed places are attacked before the chitin is completely softened, thus causing the joints, if much handled, to fall apart. By judiciously diluting the solution and taking the parts to be softened from it before the joints are attacked, its application will be found practicable even here.

The greatest difficulty of all is when the chitin is internal, completely surrounded by soft tissue. Better results are obtained here with very dilute solutions—diluted from eight to ten times, or even more. It must be admitted that in this last case the application of the solvent is more doubtful, and of not nearly so much service as in the first and second supposed cases.

Strong solutions, then, had better be used only when the chitin completely surrounds the soft animal parts, and dilute solutions must be used in all cases where these latter substances are exposed. The solution not only softens the chitin, but removes all pigment either in the chitin or in the tissue beneath, and this is at times advantageous.

Bonda's Hardening Method.*—Dr. C. Bonda describes a new hardening process especially adapted to the central nerve-system. It is briefly as follows:—

The material in mass (as for instance the brain of a large dog) is placed for from twenty-four to forty-eight hours in a 10 per cent. aqueous solution of pure nitric acid, whence it is removed without rinsing into a solution of potassium bichromate, made by dissolving one volume of a cold saturated solution of the salt in two volumes of water. The bichromate solution must be replaced in the course of a few hours with a solution consisting of equal volumes of the saturated solution and water. In this the material is left until sufficiently hardened. It is recommended that brain and spinal cord be kept at least eight days in the fluid, and that the temperature be maintained at about that of incubation, or say from 100° to 110° F. The author highly eulogizes the manner in which material thus hardened shows up after staining with hæmatoxylin.

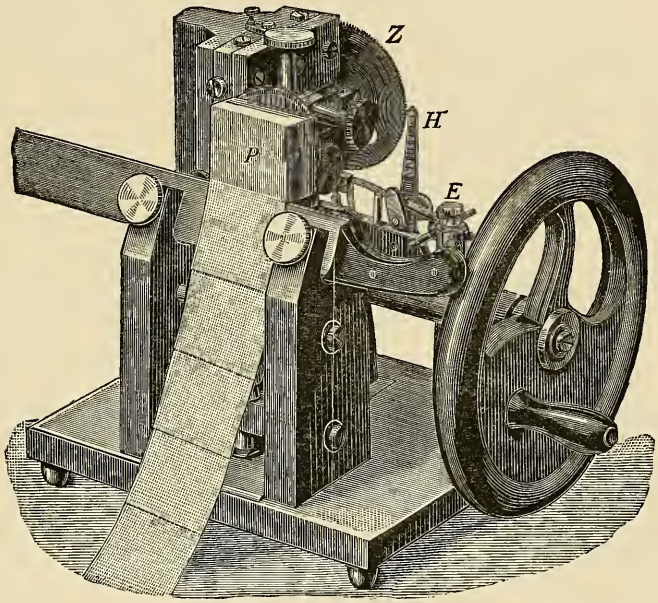
* St. Louis Med. and Surg. Journ., lv. (1888) p. 230, from Centralbl. Med. Wiss.

(3) Cutting, including Imbedding and Microtomes.

Minot's Automatic Microtome.*—The microtome of Dr. Minot is, in the opinion of Mr. J. S. Kingsley, the best of the automatic forms. Equipped with it and a Thoma or Schanze instrument for celloidin sections, any laboratory may be considered as well prepared for any ordinary section work.

In the Minot microtome, the general features of which can be seen from fig. 27, the knife is stationary, while the object is moved. Motion

Fig. 27.

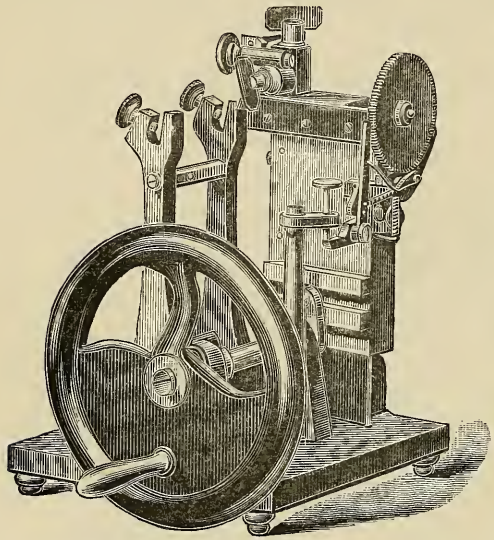


is communicated either by a crank or by a belt to the balance-wheel from a water-motor. Each revolution of the shaft raises and lowers the object-carrier, the section being cut on the downward stroke. The object-carrier is advanced towards the knife when at its extreme height, by means of a micrometer screw placed between the ways on which it runs. This screw has threads 0·5 mm. apart, and the large wheel Z which turns the screw bears 300 teeth upon its margin. This wheel is turned by means of a pall which strikes the upright lever H, seen in the fig., while a set-screw E allows the pall to engage from one to twelve teeth at a revolution. Thus the instrument has a capacity of cutting sections from 0·04 mm. to 0·0033 mm. as desired. The object P imbedded in paraffin is soldered with the same material to one of the section-holders, and this is then placed in its proper socket and clamped.

* The Microscope, viii. (1888) pp. 241–2 (1 fig.); and Zeitschr. f. Wiss. Mikr., v. (1888) p. 474 (1 fig.).

This part of the apparatus is provided with proper clamps and set-screws, so that motion is possible in the three dimensions of space, allowing perfect orientation of the specimen.

Fig. 28.



Mr. Kingsley has used this machine for about three months almost daily, and it has proved itself all that could be expected. It is well-made and simple, and it is an easy matter to cut with it ribbons three feet or more in length, without a break and without losing a single section.

A second view of the instrument is shown in fig. 28.

Plate Modelling Method or Plastic Reconstruction of the Object.*—Prof. G. Born once again attacks this subject in an article of twenty-three pages. At the end he apologizes for the length of his article, but bids his readers be of good courage, for the actual manipulation is not nearly so long as the description.

The method, which has been several times noticed in this Journal, essentially consists in making an enlarged model of the object, from which the sections are taken. The first principles are that no section should be lost, that they should be of the same thickness, and that they should be so marked that when laid together no difficulty should be experienced in applying them one to the other, or in cutting off or out the superfluous parts.

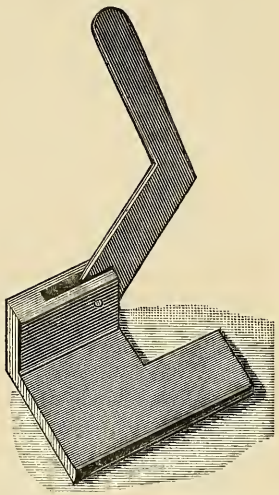
The object is as a rule imbedded in paraffin, and a block thereof made so that the sides are parallel and the angles right angles. Certain marks are intercalated on the block so that their correct position is easily noted. When the sections are cut, the next thing is to draw a magnified image of the object. This is done on sheets of wax, or rather a layer of wax on a sheet of paper. The magnified image is then cut out of the wax-paper, and all the sections having been laid together, an enlarged model of the original object is produced correct in all its details.

This of course sounds very simple, but the difficulty of manipulation is great but not insurmountable. After having imbedded the object very carefully in paraffin, it is laid in its rough state on the orthostat, an instrument shown in fig. 29, O, F. The adjacent part of the apparatus *a b* is then applied, and the outer space filled up with paraffin, so that a roughly rectangular block is produced. But in order to make the sides perfectly flat and level and at right angles, another instrument is required. This is shown in fig. 30, the uplifted arm being a knife and

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 433–55 (4 figs.).

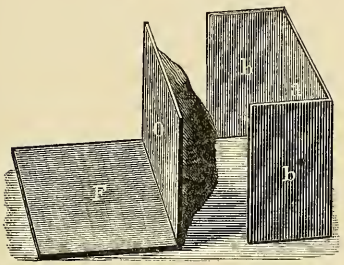
the cut-out oblong the space into which the paraffin block is fitted. When the sides have been accurately pared down they are marked by means of the apparatus shown in fig. 31, which makes a series of holes in one of the planed-down sides. The holes and sides are then stained with soot or any other suitable medium, after which the block is dipped again in paraffin.

Fig. 30.



For the purpose of plastic reconstruction the author advises that ribbon sections should not be cut, and in order to unroll sections he advocates the use of the apparatus shown in fig. 32. This is essentially an iron table pro-

Fig. 29.



vided with a flap coming off at a right angle. Beneath the flap is placed a spirit-lamp, and on the table the section. The position on the table given to the section must of course vary with the heat. It should be so placed that it gently unrolls itself.

With regard to the modelling process it is only necessary to state that the chief difficulty lies in making the wax-paper plates. For this

Fig. 31.

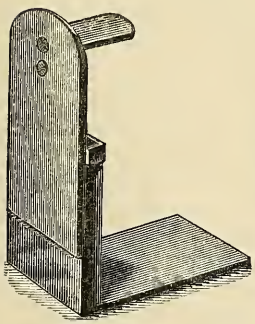
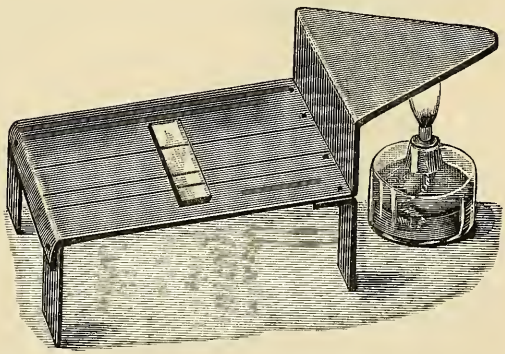


Fig. 32.



purpose are required a lithographer's stone, strips of metal which vary in thickness but not in length and breadth (50 cm. by 1·5 cm.), and an iron roller. The thicknesses given are 0·4, 0·6, 0·8, 0·9, 1, 1·2, 1·5,

1·8, and 2 mm. With such thicknesses if the sections be made 0·015, 0·02, 0·03, 0·04 in thickness, a suitable multiple will always be found. The principle of making the plates consists in rolling out a layer of wax on a sheet of paper, the thickness varying with the size of the model required. Upon the paper has already been drawn the magnified image of the object. Along the sides of the stone are laid two strips of metal; the surface is then brushed over with turpentine, the paper is placed on, and then the wax having been poured over the paper, the roller is used to make a flat and even layer.

When these wax-paper plates are finished, the superfluous parts are cut out, and then they are stuck together so as to produce the magnified model desired. In this last part of course a good deal of manipulative skill is required so that no parts are damaged and that the surface is quite regular.

Cutting Microscopical Objects for the purpose of Plastic Reconstruction.*—Dr. N. Kastschenko has devised two more modifications of his apparatus intended for being adjusted to the object-holder of microtomes, the first of which was described in this Journal, 1887, p. 511.

The original apparatus had for its object to pare down the sides of a paraffin block in such a way that some geometrical pattern might surround the object. This pattern or "definition line" was intended to facilitate the reproduction of the object in a magnified model (plastic reconstruction) from the sections made.

From the author's point of view of course it is important that the definition or boundary surfaces (which on section of the object are seen

Fig. 33.

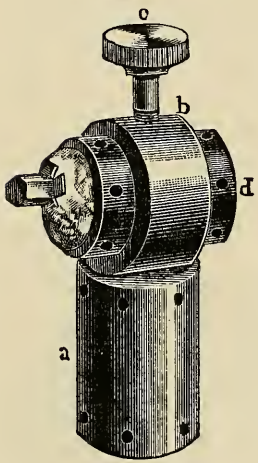
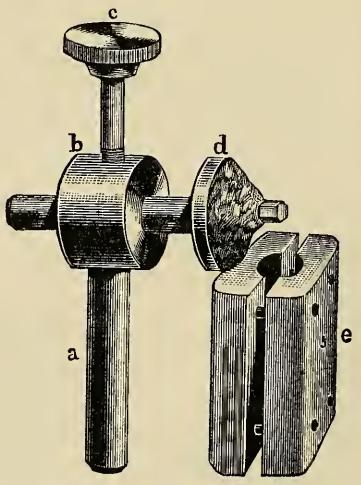


Fig. 34.



as definition or boundary lines) should be perfectly parallel, or at any rate have a fixed and determined position. The apparatus which he advocates is intended to effect this. The first or original model was intended for the Schanze microtome. The two models given above were constructed

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 173–81 (2 figs.).

for the Thoma-Jung, and for the Spengel-Becker microtomes. They are shown in figs. 33 and 34, their natural size.

In fig. 33 is shown the "cutter" or parer, as constructed for the Thoma-Jung object-holder. It may, however, be fitted to any microtome with a cylindrical object-holder. Its construction is extremely simple. It consists of a stout ring *b*, the internal diameter of which is exactly equal to that of the object-holder. The ring is immovably united to the piece *a*, which in its turn is exactly like the paraffin cylinder which fits into the object-holder. In the ring is seen the binding-screw *c*. The paraffin-holder *d*, which fits inside the ring, may be either solid or hollow.

The holes in *d* and *a* are for the purpose of turning round the apparatus. While the object is being pared down the part *a* is fixed firmly in the object-holder, and when the block has had its definition-surfaces thus prepared, it is removed from the cutter and fixed on the object-holder in such a way that it is cut in a direction perpendicular to the surfaces.

The second model, fig. 34, differs very little from the author's original apparatus. In this newer model the stem *a* is straight, instead of being bent at a right angle. This apparatus is intended to be used in any ordinary object-holder, and is of such dimensions that movement in any direction when it is fixed in the clamp is possible. This "parer" fits into the apparatus *e*, which consists of two blocks of wood loosely united by short metal wires. The wooden holder of course fits into the clamp while the block is being shaved down. When the boundary surfaces have been satisfactorily adjusted to the paraffin block, the latter is removed from the "cutter" or parer, and inserted into the wooden holder wherein it is sectioned.

COLMAN, W. S.—**Section Cutting and Staining.** A practical guide to the preparation of normal and morbid histological specimens.
viii. and 107 pp., 6 figs. 8vo, London (Lewis & Co., 136, Gower Street, W.C.), 1888.

(4) Staining and Injecting.

New Stains for Microscopical Purposes.†—Prof. E. Zschokke gives the results of his examination of the following six pigments, which he has used for staining animal and vegetable tissues:—

(1) Benzopurpurin B. An amorphous brown powder, soluble in water, and giving a cinnabar red solution and corresponding stain. It acts very much like acid fuchsin and is much superior to eosin, being unacted on by alcohol, anilin oil, oil of cloves, &c. It makes a good contrast stain to hæmatoxylin, and can be used after Gram's method.

(2) Benzopurpurin 4 B. An orange-red dye, soluble in spirit. The sections should be transferred from spirit to the alcoholic solution of the dye. It stains connective tissue orange. It is little altered by acids or alkalies. It may be used sometimes as a double stain with logwood.

(3) Deltapurpurin. A brownish-red powder, easily soluble in water. Preparations are stained in two minutes a diffuse purple-red. The dye is very stable and not easily extracted. Like the preceding two, it may be used as a contrast stain to hæmatoxylin.

(4) Benzoazurin. A brown powder, easily soluble in water, the

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 465–70.

solution having a blue-violet colour. Strong solutions stain rapidly, and the nuclei are darker than the protoplasm. Alkaline solutions change the blue hue to red, and eventually decolorize the section. Acids, alcohol, and clarifying media do not at all affect the dye. It appears to be a good substitute for hæmatoxylin.

(5) Chrysophenin. A sulphur-yellow pigment, but little soluble in water, easily soluble in alcohol. Preparations stained in an alcoholic solution assume a diffuse yellow colour. It is unaffected by acids and alkalies.

(6) Rhodanin-red and rhodanin-violet. Both are basic dyes, soluble in water and spirit. The stains imparted by their solution are carmine-red and reddish-violet. The pigment is rapidly extracted both by spirit and water. They stain bacteria, but no mordant has been found to fix them.

Of the foregoing six pigments, it will be seen that two are very suitable for histological purposes, viz. benzopurpurin B and benzoazurin.

Carmine Staining of Nervous Tissue.*—Dr. H. S. Upson gives the three following methods for staining nervous tissue after Müller's fluid or alcohol.

(1) The following alum-carmine solution is first made. 1 gram carmine is boiled with 100 ccm. of a 5 per cent. alum solution (rubidium alum is the best). To 5 ccm. of this solution are added 10–20 drops of acetic acid and 1 to 3 drops of molybdo-phosphoric acid, and then filtered. The sections are placed in this mixture for 2 to 10 minutes. or longer, and then carefully washed, dehydrated, cleared up, and imbedded. The axis-cylinders, ganglion-cells, and connective tissues are stained, and the nuclei very clearly.

(2) 5 ccm. of the foregoing alum-carmine solution are saturated with zinc sulphate and filtered. Sections are placed in this solution for 1/2 to 12 hours, and then treated as above. This method gives very good results, especially with peripheral nerves and spinal cord.

(3) 0·06 grm. carminic acid are dissolved in a mixture of 4 ccm. water and 1 ccm. spirit. The sections remain in the mixture for 3 to 10 minutes, are then washed for a short time in water, and are then placed in one of the following mordants for a few minutes. They are then washed in water and treated as before. The action of the mordants produces the following staining:—Dilute acetic acid, a yellowish-red; saturated solution of lead acetate, blue; iron sulphate, black; manganese sulphate, red; nickel sulphate or barium chloride, violet. The longer the tissue has remained in Müller's fluid or spirit the more lasting the stain will be.

Staining Microbes black for Photomicrography.†—Dr. R. Neuhauss stains bacteria black in the following way. Campeachy wood extract is dissolved in boiling water and the solution filtered as hot as possible. After this has stood for at least eight days it is warmed up every time it is to be used. The cover-glass to be stained is boiled in the solution for ten minutes. It is next washed in hot water and afterwards immersed for a long time in a weak solution of neutral chromate of soda. This solution is made by adding, drop by drop, a 5 per cent. soda solution to a weak boiling solution of chromic, and until the liquid gives a neutral reaction.

* Neurol. Centralbl., vii. (1888) pp. 319–21. Cf. Zeitschr. f. Wiss. Mikr., v. (1888) pp. 525–6.

† Zeitschr. f. Wiss. Mikr., v. (1888) pp. 484–6.

In order to obtain a deep black the whole process must be repeated three or four times.

The advantages of this black stain are that the negatives of bacteria are extraordinarily sharp and well defined both with sun and artificial light. The details in the bacteria, spores, &c., appear with the greatest clearness. The flagella, too, unstainable with anilin dyes, are stained quite black.

Lastly the preparations do not lose colour.

Nucina as a Staining Agent.*—Prof. N. Léon calls attention to the value of the black substance of "nuts" (Nucina) as a staining agent. Though chemists are, as it seems, still ignorant of its chemical formula, solutions are easily obtained. Nucina has the property of actively differentiating the parts of which cells are composed; it blackens nuclei, bacteria, and the leucites of vegetable cells and easily differentiates the constituent parts of spermatozoa. The aqueous solution is obtained by putting nuts into alcohol; as soon as the spirit becomes green, owing to the solution of chlorophyll, the nuts are carefully washed with water so as to extract the alcohol. 25 nuts were then placed in a porcelain vessel with 500 grams of distilled water, which was boiled till half the water had evaporated. The liquid, after being filtered several times, was boiled afresh with 10 per cent. of alum; the solution has a blood-red colour with direct light. The alcoholic solution is made by boiling nuts in water, removing them, and allowing the water to deposit the black nucina; 100 grams of alcohol at 80° were added for every three grams of nucina. This solution has a black colour; after its use a few drops of hydrochloric acid should be applied to the section.

Baumgarten's Triple Staining Method.†—This method as given by M. A. Lewin consists in the following series of operations:—

(1) After having washed the sections in absolute alcohol, they are placed for 5 minutes in borax-picrocarmine; excess of stain is then removed with blotting-paper. (Borax-picrocarmine is prepared by adding powdered picric acid to a solution of Grenacher's borax-carmine until the fluid assumes a blood-red colour.)

(2) The sections are then plunged for 2 minutes into absolute alcohol to which crystals of picric acid have been added until the spirit resembles hock. This operation is to be performed twice.

(3) The sections are next immersed for 1 minute in Ehrlich's gentian-violet solution. This solution should be freshly made. Excess of stain should be removed with filter-paper. (The gentian-violet solution is prepared by adding 11 volumes of a saturated alcoholic solution of the pigment to 100 volumes of a 5 per cent. solution of anilin oil in water and then filtering.

(4) The sections are next immersed for one minute in a solution of iodine (iodine, 1; iodide of potassium, 2; water, 300); from this they are transferred to absolute alcohol, wherein they remain for 30 seconds.

(5) Excess of gentian-violet is then removed with hydrochloric acid and alcohol (HCl 3; C_2H_6O 97). In performing this step it is necessary to watch the decoloration carefully, as the reaction is very delicate.

* Zool. Anzeig., xi. (1888) pp. 624-5.

† Journ. de Micrograph., xii. (1888) pp. 415-6. Cf. Bull. Soc. Belg. Micr., 1887, No. 7.

(6) The preparations are next immersed for 5 minutes in absolute alcohol which has been rendered yellowish by means of a few crystals of picric acid.

(7) The preparations are then cleared up in oil of cloves and mounted in xylol balsam.

By this procedure a triple staining is obtained.

Staining Actinomyces.*—Dr. A. Baránski recommends picrocarmine for staining Actinomyces. A small quantity of the yellow granules or of the pus is spread out on a cover-glass, and having been dried in the air is drawn several times through the flame of a spirit-lamp. The cover-glass is then placed in the picrocarmine solution for 2 or 3 minutes, then washed in water or spirit and examined in water or glycerin. If for a permanent specimen the cover-glass is dried after having been washed and then mounted in balsam. Sections require to stay in the picrocarmine solution 2–3 minutes or longer. In other respects the manipulation is the same. The Actinomyces are stained in various shades of yellow, the surrounding tissue being dyed red.

Method for Distinguishing and Isolating Cholera Bacteria.†—Cholera bacilli, says Dr. O. Bujwid, form a scum on the surface of nutrient media, and this scum consists of a pure cultivation of cholera bacilli. This skin or scum when grown for 24 hours at 37° C. in an alkaline solution containing 1–2 per cent. peptone and 0·5 per cent. of salt resembles very much that formed by *Bacillus subtilis*. Now cholera bacilli give with certain mineral and organic acids, but specially with hydrochloric, a reaction which has been shown to be due to the formation of indol, and of a trace of nitrite. Impure cultivations and also bacteria resembling cholera bacilli also give this reaction, but it is much less intense, and only takes place after a longer time. For example, impure cultivations of cholera in a slightly alkaline 2 per cent. peptone solution, and kept for 24 hours at a temperature of 37° C., do not give any noticeable reaction, while pure cholera bacteria bred under similar conditions give a beautiful purple-red colour with hydrochloric acid. Hence it is possible to ascertain merely by the aid of hydrochloric acid if we are dealing with pure or impure cultivations of cholera spirilla.

It is of importance for the success of this reaction that the peptone should be very good and that the time and temperature limits should be carefully observed, because if cultivated at ordinary temperatures and for longer periods (3 or 4 days) the same result will be obtained with the acid from other bacilli, for example, Finkler's and Miller's. Hence the reaction is not only qualitative but quantitative.

Shellac Injection for the Vessels of the Eye.‡—Dr. Bellarminow has used shellac injection for the vessels of the eye with good results. Yellow shellac is used in a thick spirituous solution. About 1 part of shellac to 1½ parts alcohol are placed in a flask for 24 hours and frequently shaken. The mixture is then heated at 45°–50° for 2–5 hours, and then filtered through two or three thicknesses of gauze. The syrupy filtrate is then stained with cinnabar or Berlin blue, and used for injecting arteries or veins. It will not penetrate the capillaries, and if required for this purpose should not be thicker than cream.

* Deutsch. Med. Wochenschr., 1887, p. 1065.
† Centralbl. f. Bakteriol. u. Parasitenk., iv. (1888) pp. 494–6.
‡ Anat. Anzeig., iii. (1888) pp. 648–50.

The pigments are first rubbed up with spirit, and having been filtered through gauze, added in the desired proportion to the shellac solution. In 10–12 minutes the injected mass is hard. Syringe and canula must be immersed in spirit previously and carefully washed therewith after injection. After injection the eyes are placed for 24 hours in 0·2–0·3 per cent. chromic acid, and then having been cleaned up with a brush, are washed in running water for 24 hours. The thicker parts and those which retain the pigment are then macerated in eau de Javelle for a longer or shorter time. If allowed to work too long the macerating fluid destroys the walls of the vessels and renders the preparation useless. It is then washed again in running water for 12 to 24 hours, and afterwards, having been mopped up with blotting-paper, it is stretched between two slides and allowed to dry.

Permanent preparations may be mounted dry and ringed round with paraffin or some quick-drying varnish, or may be cleared up in turpentine and mounted in balsam.

Double injection gives very good results, the arteries with cinnabar from the carotid, the veins with Berlin blue from the venæ verticosæ.

Black Injection-mass.*—Prof. A. Letellier advocates the use of a mixture of vanadate of ammonia and tannin as an injection-mass. The advantages of this mixture are that it is black in itself, and does not depend for its colour on solid particles in suspension; that it has no tendency to diffuse outside the vessels into the tissues; that the mass will pass through the finest canula and not block the point; that the walls of the vessels, even when not entirely filled, are stained black; and that when pieces of the injected tissue are placed in spirit the colouring matter is not withdrawn, as vanadate of ammonia is insoluble in alcohol.

The preparation of this injection-mass is extremely simple. Vanadate of ammonia is soluble in warm, and tannin in hot water. The two solutions are kept apart until required for use, when they are mixed in proportion to the tint required.

For the tannin, pyrogallic acid or a solution of nut-galls, made by macerating the bruised galls in cold water, may be substituted.

Technique of the "Corrosion" of Celloidin Preparations.†—Dr. Bellarminow recommends that celloidin sections of the eye injected with Berlin blue should be treated with eau de Javelle in order to destroy the pigment which interferes with the examination. Thick sections are placed for ten to thirty minutes in a solution of sodium carb., calcar. chlor., 12·5 each, water, 100 parts. Thinner sections in a weaker solution. They are then washed in running water for twenty-four hours. Then dehydration, clearing up, and Canada balsam. The celloidin imbedding increases the resistance of the sections to the action of eau de Javelle, consequently this reagent is very suitable for the purpose.

* Bull. Soc. Linn. Normandie, i. (1888) pp. 171–4.
† Anat. Anzeig., iii. (1888) pp. 650–1.

(5) Mounting, including Slides, Preservative Fluids, &c.

Preparation of Type-plates and arranged Groups of Diatoms.*—Mr. K. M. Cunningham says that Mr. R. Getschmann prepares his slides of arranged diatoms after the following method:—

A table is placed before a well-lighted window, and on this are the requisite appliances for work, the chief requisite being a small dissecting Microscope, fitted with simple achromatic lenses, varying in their focal length as the case might require, but a lens of about 1/4 in. focus answering for actual work. Preparatory to beginning a selection of diatoms for the design to be arranged, a quantity of cleaned diatom material is evenly spread over an ordinary slide, this is carefully examined, and from it are selected all the perfect forms likely to be used in a design, and transferred to a cover-glass; all forms of the same shape being grouped together, or arranged in lines for convenience afterwards. If necessary, several cover-glasses can be thus filled with perfect forms, free from cracks or other blemishes, and placed aside, protected from dust, until required. The diatoms are picked out from the spread layer of material by the aid of hair bristles of varying degrees of fineness mounted in a slender wooden handle, and projecting therefrom about a half-inch; the bristle should be straight and, if possible, have a fine taper to a sharp point; this is used with a free and steady hand, and, to facilitate steadiness in picking out, the two arms are rested upon two cushioned blocks of wood, tapering from the level of the stage of the Microscope to their bases on the table. A further indispensable piece is a glass slide, having an area at its centre of about a quarter of an inch, or somewhat less, ruled into minute squares at the rate of about forty lines to the quarter-inch; on this slide, and properly centered, must be placed the cover-glass upon which it is desired to produce the group. The cover-glass is prepared by spreading at its centre a minute drop of liquid gelatin, by means of a little brass spatula, and allowing it to dry. A number of cover-glasses, after having been carefully chosen and thoroughly cleaned, might be prepared, and also set aside for use later. The clear and transparent gelatin should be filtered before use by passing it through suitable filter-paper, so as to prevent all chance dirt from marring the mount. When ready to begin a group, fix the cover-glass centrally over the area of squares by means of three little touches of wax, and then also adjust, close to the same cover-glass, one of the cover-glasses containing the diatoms previously selected for the grouping; or, if necessary, two or more, according to the complexity of the proposed design. With the selecting bristle in the right hand, and the eye adjusted to the lens, bring the glass containing the selected diatoms into the field of view, then carefully select as a centre a perfect disc, say, a *Coscinodiscus;* now shift the gelatined cover-glass into view and deposit the disc at its centre, and carefully adjust it so that its centre shall seem to cover the intersection of a group of the small squares; around the disc, as a centre, adjust a series of small circular forms, spacing them at equal distances from each other. Should it next be desired to introduce a series of slender forms they may be adjusted into position by lining them over the guide lines radiating from the centre of the disc, or through the diagonals of the squares; in this manner proceed until the design is completed.

* The Microscope, viii. (1888) pp. 237–41 (2 figs.).

When the grouping is finally inspected, it is permanently fixed to the gelatin layer by holding the slide on a level, under the mouth, and breathing on it very carefully a few times. This is perfectly reliable and more expeditious than breathing through rubber or glass tubes for the same purpose.

For the purpose of mounting, it is well to have a quantity of cells finished on slides and kept on hand. The slides are centered on the turntable, and shallow cells of black shellac are built up to suit the diameter of the cover-glass to be mounted thereon. This cell is filled with a drop of Canada balsam pressed out of a metal tube. The cover-glass containing the arranged diatoms is now freely immersed in filtered spirits of turpentine, and also flushed with it, so as to expel all air from the diatoms and to clean off all motes or particles that may have lodged upon it during or after preparation of the same. The cover-glass is then set upon its edge to drain off superfluous turpentine, and while it drains gently soften the shellac cell over a spirit-lamp, pick up the cover-glass and gently lay it centrally over the cell, and press firmly into contact with the cell; the slide is then set aside with the cell-side down, and supported on a level, to obviate as much as possible the floating out of place of any of the forms, which are sometimes displaced while drying.

The procedure described above is essentially that followed by the leading preparers, with more or less slight variations as to finish of cells and media used in mounting.

For the arrangement of type-plates of diatoms, the guide-lines and squares ruled on the cover-glass carrier serve to allow the forms to be adjusted in lines and properly spaced with the same ease as in symmetrical grouping. When such beautiful results are produced by simple and inexpensive means, it does not seem to be worth while to attempt this class of work with compound Microscopes, with mechanical fingers and ruled guides set in the eye-piece.

Xylol-dammar.*—M. Martinotti advocates the use of dammar dissolved in xylol as a mounting medium to be preferred to balsam in certain cases. He prepares his solution in the following way:—

Forty grm. of dammar and 40 grm. of xylol are mixed together in a stoppered bottle, and allowed to stand for three or four days at the ordinary temperature. The solution is then filtered. The filtrate, which will amount to about 70 grm., is then evaporated in a water-bath down to about 45 grm.

The object of this concentration is to obtain a solution of the resin in the smallest quantity of xylol possible, just enough in fact to merely dissolve the resin. This concentrated solution becomes yellow, but retains its limpidity. The next step is to dilute this solution with oil of turpentine, by which means the yellowish colour is made to almost disappear.

Kaiser's Gelatin for arranging microscopical preparations in series.†—Dr. A. Poli arranges objects on the slide with Kaiser's gelatin in the following manner:—With a fine brush, just as many daubs are made with the melted gelatin as there are preparations to be mounted, the preparations are then transferred on the brush to the places where the thin layers of gelatin are, slight pressure being used in order to make them stick. Should the preparations not lie in the desired

* Malpighia, ii. (1888) p. 270. † Ibid., pp. 107–9.

position, the slide may be heated a little, up to 45°, and when rearranged, allowed to cool. Glycerin is then added to the preparation, the cover-glass imposed, and the preparation fixed up in the usual way.

Limpid Copal Solution.*—A limpid and colourless solution of gum copal has long been a desideratum to microscopists, and Dr. F. L. James has spent many hours in trying to obtain one. The following process he found originally in a German journal, 'Der Techniker,' and having given it a fair trial, can say that if a high grade of bright copal is chosen, the product will be perfectly limpid and almost colourless. By sorting the copal, a solution as limpid as water may be obtained.

Dissolve 4 parts of camphor in 48 parts of sulphuric ether and add 16 parts of pulverized gum copal thereto. Cork the flask carefully, and stand aside with occasional agitations until the copal is partly dissolved and partly swollen to its fullest extent. Then add 16 parts of alcohol of 96° and 1 part rectified oil of turpentine, and agitate thoroughly. Let stand with occasional agitations for several days, and at the expiration of a week or so, the contents of the flask will be found to have separated into two layers, of which the lower is rather dark, thick, and possibly dirty, according to the quality of the copal, but above this a layer will be found rich in copal and as clear as crystal itself. The lower layer may be further treated with camphor and sulphuric ether, and afterwards with alcohol, and made to give a still further yield of the crystalline fluid. The only objection to this solution of copal is that it is somewhat brittle when dry. This may be obviated by adding a few drops of purified nut or poppy oil thereto.

Preserving-fluids for Fleshy and Succulent Plants.†—Herr R. Sadebeck recommends for this purpose a 4–5 per cent., i. e. a nearly saturated solution of barium-lead-nitrate, the object retaining its colour in it for one or two months, while the solution itself remains clear. Another good preserving-fluid for similar objects is a solution of corrosive sublimate of a 0·1 per cent. concentration, to which a few drops of hydrochloric acid have been added. Boracic acid does not prevent decay, even in a saturated solution. For Fungi which contain but little soluble matter, a 20 per cent. solution of alcohol may be recommended.

Determining the Thickness of Cover-glasses of Mounted Preparations.‡—Dr. S. Czapski gives the following method for ascertaining the thickness of cover-glasses where the preparation is already mounted. This is very desirable for high powers. The procedure presupposes the possession of some cover-glasses, the thickness of which is known, and that the head of the fine-adjustment screw is divided by radial lines.

The upper and under surface are focused with an objective of 0·6 to 0·9 aperture and central illumination, and the amount of turn given to the fine-adjustment screw noted for each cover-glass; of course it is unimportant whether the exact value of the screw turn is known or not. If the surfaces of the cover-glass do not present any obvious marks to focus on, an artificial one, such as dust or scratches, must be supplied. If the numbers thus obtained be compared with the known real thickness of the covers, a reduction factor is obtained from their quotients, which is available for determining measurements of a similar kind, that is to say for measurements of other cover-glasses with the same objective, ocular,

* St. Louis Med. and Surg. Journ., lv. (1888) p. 231.

† SB. Gesell. Bot. Hamburg, iii. (1887) p. 61. See Bot. Centralbl., xxxvi. (1888) p. 128.

‡ Zeitschr. f. Wiss. Mikr., v. (1888) pp. 482–4.

diaphragm, and tube-length. The focusing differences are always to be multiplied with this factor in order to obtain the true depth (thickness) of the layer.

As an example:—Objective DD Zeiss, diaphragm 8 mm. diameter, tube-length 155 mm., and four cover-glasses, the thicknesses of which, already ascertained, are 0·146, 0·168, 0·187, 0·22. The focusing differences marked by the head of the fine-adjustment screw were 35, 40, 45, 52 divisions. Then the reduction factors in 1/1000 μ are

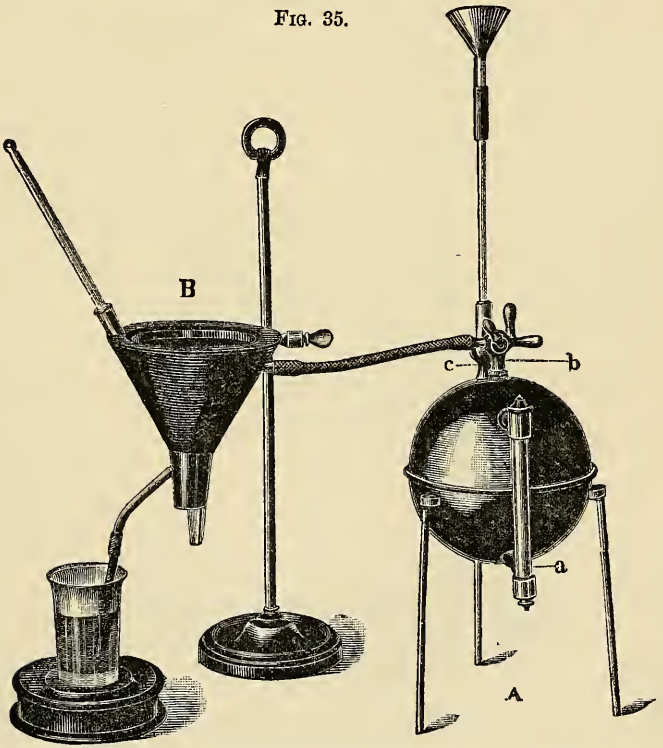
$$\frac{146}{35} = 4{\cdot}17, \quad \frac{168}{40} = 4{\cdot}20, \quad \frac{187}{45} = 4{\cdot}16, \quad \frac{220}{52} = 4{\cdot}23,$$

or on the average 4·19, say 4·2. If the thickness of these cover-glasses had not been known, but the focusing differences had been obtained and multiplied by 4·2, the results would have been 0·147, 0·168, 0·189, 0·218, instead of 0·146, 0·168, 0·187, 0·22. Differences of $+0{\cdot}001$, $0{\cdot}0$, $+0{\cdot}002$, $-0{\cdot}002$; a result more than sufficiently accurate for the purpose.

(6) Miscellaneous.

Garbini's small Steam-generator for Microscopical Technique.*—Dr. A. Garbini describes a small steam-producing apparatus which he

Fig. 35.



uses in microscopical technique, especially where paraffin and gelatin are required.

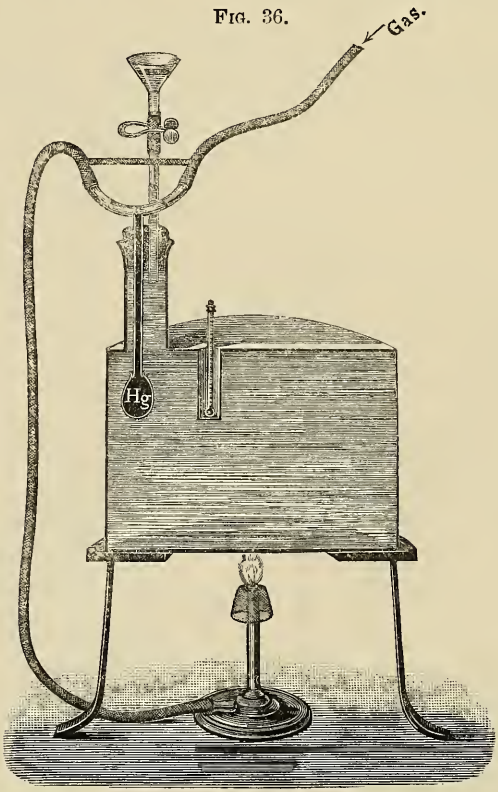
* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 168–71 (1 fig.).

The apparatus (fig. 35) consists of a spherical copper boiler A, supported on three legs, and having a water-gauge *a*, a steam exit pipe *b*, which is fitted with a stop-cock, opening two ways, and a pipe *c*, into which fits a funnel with a very long stem. This serves both for pouring water into the boiler, and also as a safety-valve. The funnel is connected with the boiler by means of a caoutchouc tube. The funnel B is fitted with three tubes, one through which the steam enters, and another through which it passes out. The diameter of the latter is less than half that of the former. The third tube is for a thermometer which is fixed by means of a cork bung.

It is necessary to plug the aperture between the rims of the copper and glass funnels with a piece of flannel in order to prevent the steam from escaping.

Paraffin Oven with simple arrangement for maintaining a constant temperature.*—Dr. E. Sehrwald describes a simple apparatus for heating paraffin, which is easily made and keeps a constant temperature.

Fig. 36.



It consists of a copper box (fig. 36), from the top of which ascends a tube for filling with water, and a second smaller one descends for the reception of a thermometer. When the box is filled with water the

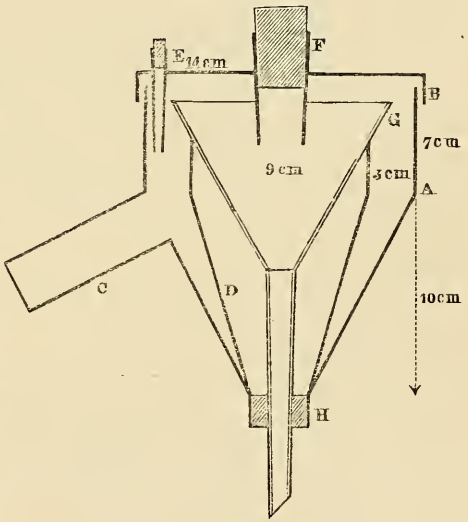
* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 331–4 (1 fig.).

larger tube is closed with a cork bung, through which pass two tubes. One of these is Y-shaped, and has at its lower extremity a small bag made of vegetable parchment. The arms of the Y are connected by means of a cross tube having a narrow lumen, and the ends of the arms are joined on to a caoutchouc tube through which the gas passes. The effect of this arrangement is that when the water gets hot, the mercury with which the leg and bag of the Y-shaped tube are filled, rises into the Y, and thus shuts off the gas. The stream of gas, however, is still kept up through the narrow connecting tube, and this prevents the light from going out altogether. The second glass tube has a funnel connected by means of a short piece of rubber tubing and forms the arrangement whereby the apparatus is regulated for a given temperature. For when the water begins to get warm it rises up the tube and so into the funnel, the mercury remaining stationary. Directly the desired temperature is reached, a strong clamp is put on the short piece of rubber tubing, and then the mercury begins to regulate the supply of gas for this temperature. If a higher temperature be desired, it is only necessary to remove the clamp and allow the water to ascend until the proper point is reached, and then re-clamp. If a lower one be necessary the clamp is undone, and the gas-jet removed until the temperature has fallen.

Stein's Steam Funnel.* —Dr. L. v. Stein has constructed a funnel for facilitating the filtration of gelatin and agar solutions.

The outer funnel A, fig. 37, is made of copper, and has the following dimensions: — Diameter, 14 cm.; height 10 cm.; sides A B, 6–7 cm. The tube for heating it C, is seen at one side. The internal filter D has sides 3 cm. high, its diameter is 9 cm., and its height 10 cm. It is covered with the lid B, into which are soldered the two tubes E and F, both being closed with corks. The filter is filled with water through E, and through F passes the solution to be filtered. In the middle is seen the section of the glass funnel G, the stem of which is fixed tight by the cork bung H.

FIG. 37.



When required for use, the copper funnel is filled with water as far as A, and a filter-paper placed within the glass funnel. As the steam developes it exerts some pressure on the fluid, since it can only escape through the stem of the glass funnel. In one hour 100 cm. of a thick

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 329–30 (1 fig.).

agar solution can be filtered; while gelatin runs through with the rapidity of water, and the apparatus has the further advantage of sterilizing the solution at the same time that it filters it.

Distinguishing Stains of Human Blood.—We observe that in a recent criminal trial an analyst deposed that human blood-corpuscles could be distinguished from those of some other animals. This opinion was based on the size of the corpuscles.

It has been established by irrefragable evidence, both here and in the United States, that this view is an entire mistake, and it is to be hoped that the person charged in the case referred to will not be convicted and hanged before the error is corrected.

Methods for ascertaining the Number of Atmospheric Germs.*—M. P. Miquel, who has done much for the analysis of germ-laden air, has given up the insoluble "filter" for a plug consisting of a soluble material. This device was suggested twenty-five years ago by Pasteur, and dried Glauber's salt or dried sea salt have been recommended for the purpose. Indeed, any soluble substance, when dry and sterilized, and which does not act antiseptically, is suitable for the purpose; and in solving the problem required, i. e. of ascertaining how many germs were imprisoned in the plugs, it would appear that oscillations of temperature between 0° and 30° made little difference to the plugs.

For the development of germs the necessary conditions are threefold, viz. a suitable medium, a temperature of about 30°, and sufficiently long period of observation (30–40 days). From numerous experiments it was found that peptonized meat broth was far superior to peptonized gelatin as a nutrient medium, only about one-half the germs really existing in the air being developed on gelatin plates.

The author concludes by maintaining that the gelatin-plate method is inapplicable to air analysis in all those cases where the air contains more fungi than bacteria germs.

Method for determining the true Shape of Microscopic Objects.†—Dr. E. Berger uses the following method for determining the shape of the posterior chamber of the eye:—

The objects are imbedded in celloidin on threads placed vertically and set at a distance of 1 mm. The sections are made serially and are marked numerically. The outlines of each section and of the transverse sections of the rows are then drawn with the camera in such a way that the last overlap. Then, if the thickness of the sections be known, the projections, to adopt the phraseology of architects, &c., of the object examined can be ascertained.

The enlargement is found by calculating the distances of the images of two sections, next each other in a row, by means of their true distance, 1 mm. For each enlargement it is easy to construct a scale so that the real size of the object can be read off.

Bessey, C. E.—Vacation Notes upon some Botanical Laboratories. [Strassburg, Leipzig, and Berlin.] *The Microscope*, IX. (1889) pp. 5–7.

Brown, F. W.—A Course in Animal Histology. V., VI., VII. *The Microscope*, VIII. (1888) pp. 336–7, 375–7, IX. (1889) pp. 12–14.

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* Ann. Instit. Pasteur, 1888, p. 346.

† Comptes Rendus Soc. Biol., v. (1888) pp. 215–6.

FORMAD, H. F.—**[Liquids for Re-moistening Blood.]**
The Microscope, VIII. (1888) pp. 339-40, from *Journ. of Comp. Med. and Surg.*

FREEBORN, G. C.—**Notes on Histological Technique.**
[Selective stain for connective tissue. Carminic acid. Macerating fluid for nerve-cells. Substitute for cork in imbedding. Application of methyl-green for demonstrating the chemical reaction and death of cells. Making sections of teeth and bone with the preservation of the delicate parts. Easy method of reproducing photographically histological sections.]
Amer. Mon. Micr. Journ., IX. (1888) pp. 231-2, X. (1889) pp. 9-10.

LATHAM, V. A.—**Notes on Practical Examination of Muscle-fibres.**
The Microscope, VIII. (1888) pp. 330-3.

[MANTON, W. P., and others.]—**Reagents in Microscopy.**
[Reagents should be "as mild and innocuous as can be obtained, and their effects carefully studied before we draw conclusions as to the structure of the objects examined.] *The Microscope*, VIII. (1888) pp. 246-8.

„ „ **Rudiments of Practical Embryology.**
[Celloidine method. Embryos as transparent objects. Labelling. Slide Cabinet.]
The Microscope, VIII. (1888) pp. 334-5, 374-5.

S., D.—**A Microscopist's Table.** *Engl. Mech.*, XLVIII. (1888) p. 333 (1 fig.).

WHELPLEY, H. M.—**Microscopy of the United States Pharmacopœia.**
The Microscope, VIII. (1888) pp. 317-8.

WOTHTSCHALL, E.—**Ueber die mikrochemischen Reactionen des Solanin.** (On the microchemical reactions of solanin.) II.
Zeitschr. f. Wiss. Mikr., V. (1888) pp. 182-95.

MICROSCOPY.

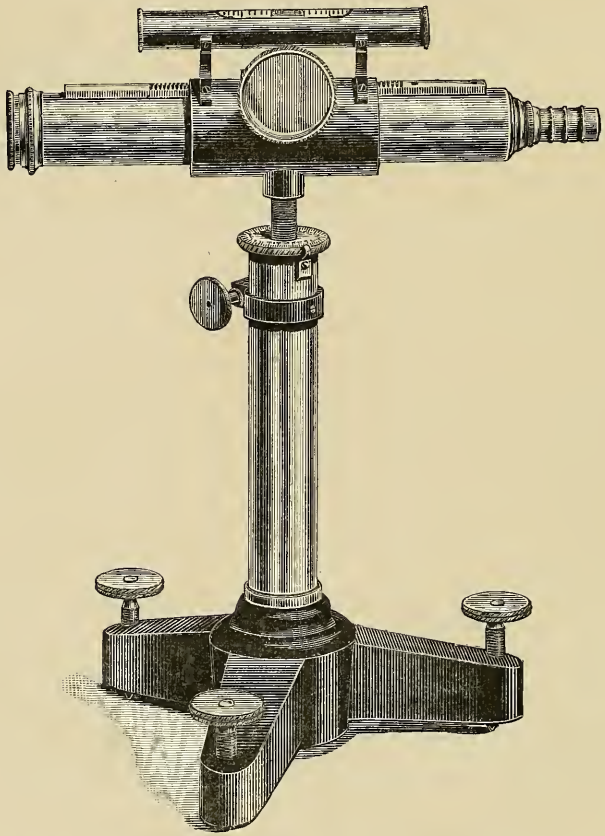
a. Instruments, Accessories, &c.*

(1) Stands.

Pfeffer's Botanical Microscope.†—This instrument (fig. 38) was designed by Dr. W. Pfeffer for measuring the growth of plants, more especially in cases where it would be inconvenient to make use of a lever which requires a thread to be tied to the plant.

The body-tube racks in a horizontal socket, over which is supported

Fig. 38.



a spirit level, the instrument being adjusted by the three screws in the feet of the tripod. The socket is attached to a fine micrometer screw, which works through a screw collar on the top of the pillar; by turning this collar, which is graduated and milled, the screw rises and falls, and with it the

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Pfeffer's 'Pflanzenphysiologie,' Band ii. (1881) pp. 84–5 (1 fig.).

socket and body-tube, forming a fine-adjustment. A coarse-adjustment is formed by the collar not being attached directly to the pillar, but to a tube sliding in it, which can be raised and lowered and clamped by a clamp screw. The eye-piece micrometer is somewhat peculiar, every alternate line of the principal set of 24 lines being numbered from 0 to 11, with longer lines at 1, 6, and 11. In the middle of their length the spaces between the principal lines are redivided into 5 subdivisions.

Ahrens' Giant Microscope.—The object of Mr. C. D. Ahrens in constructing this instrument was to have a Microscope with an exceptionally large field for use with his new form of polarizer.*

The body-tube is $4\frac{1}{8}$ in. in diameter at the top, and below the field-lens it cones down to the nose-piece; it has two attachments, one by screws to the top of the stem and tail-piece, and another at the nose-piece, where it is attached to a short bar screwed to the stem. The stage racks on the stem which ends in a cross-piece which carries a short tail-piece on which the mirror socket racks. The pillar rotates on the tripod.

The achromatic eye-lens is $1\frac{3}{4}$ in. in diameter, and the field-lens $3\frac{3}{4}$ in., the foci being respectively 3 in. and 6 in. A diaphragm is placed in the focus of the eye-lens.

Mr. Ahrens considers that the defects in flatness of field † and marginal colour referred to when the Microscope was exhibited were due to the objective used.

* See *infra*, p. 276.

† See this Journal, 1888, p. 1066.

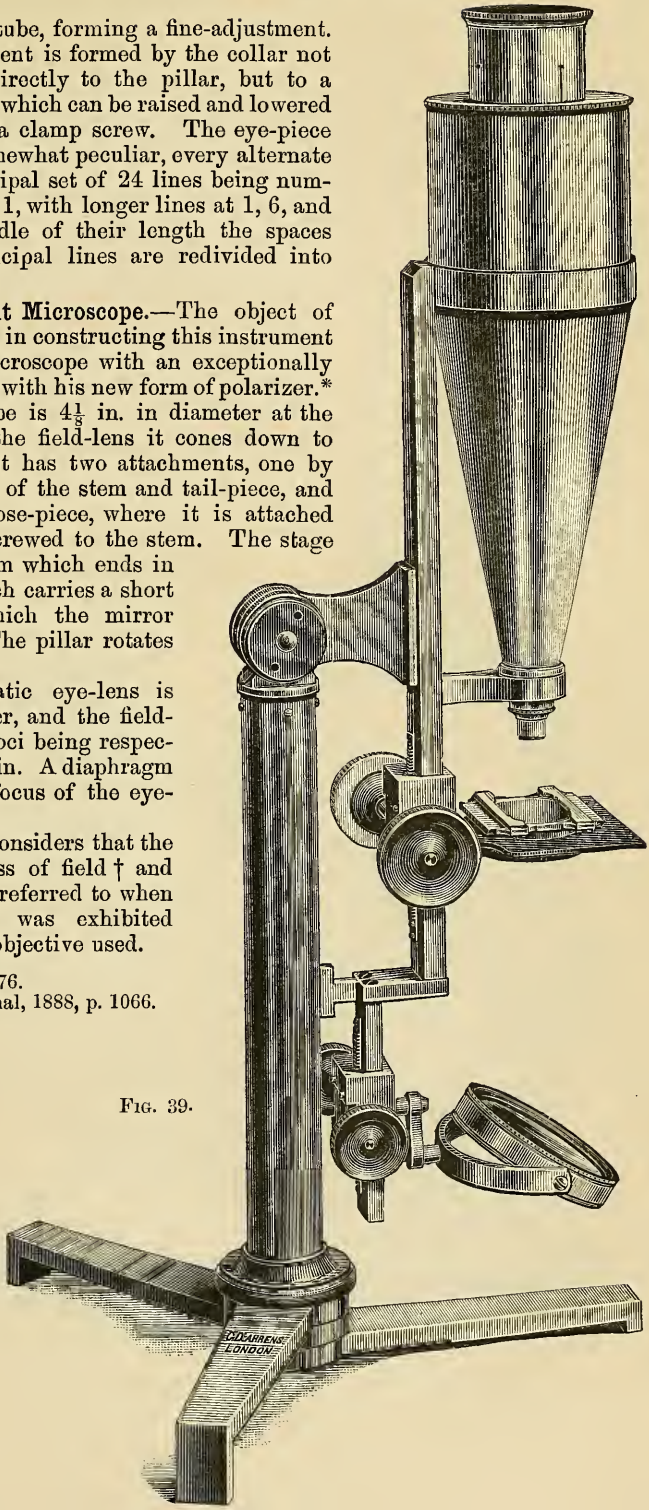


FIG. 39.

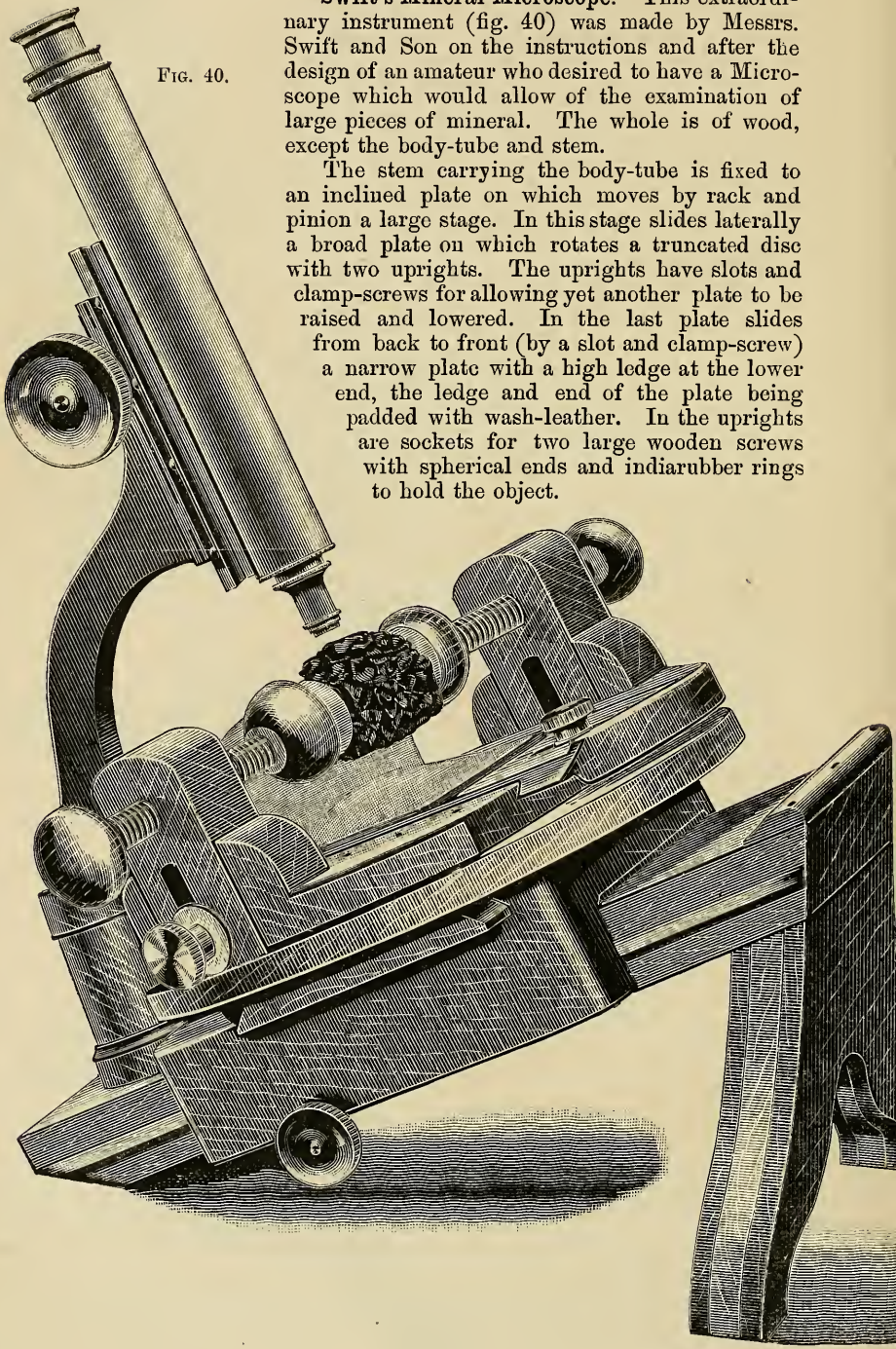


Fig. 40.

Swift's Mineral Microscope.—This extraordinary instrument (fig. 40) was made by Messrs. Swift and Son on the instructions and after the design of an amateur who desired to have a Microscope which would allow of the examination of large pieces of mineral. The whole is of wood, except the body-tube and stem.

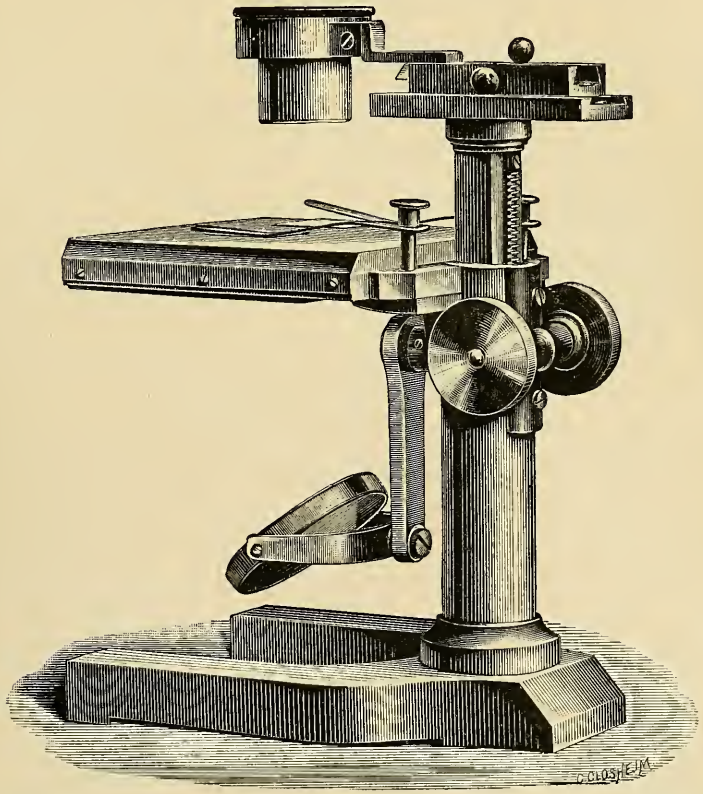
The stem carrying the body-tube is fixed to an inclined plate on which moves by rack and pinion a large stage. In this stage slides laterally a broad plate on which rotates a truncated disc with two uprights. The uprights have slots and clamp-screws for allowing yet another plate to be raised and lowered. In the last plate slides from back to front (by a slot and clamp-screw) a narrow plate with a high ledge at the lower end, the ledge and end of the plate being padded with wash-leather. In the uprights are sockets for two large wooden screws with spherical ends and indiarubber rings to hold the object.

Binocular Dissecting Microscope.*—Prof. F. C. Van Dyck describes a "binocular dissecting and mounting simple Microscope, made of a stereoscope by turning the lenses end for end, and tilting them so as to prevent the disagreeable convergence of optic axes, which an ordinary 'reading glass' necessitates. The arrangement is equivalent to a reading glass cut in two, so that its parts may be set at such angle and distance as prove effective. If you try it by holding a couple of stereoscopic lenses about five inches from a flower, you can prove the comfort of the thing, and try, by shutting one eye, how much good the binocular effect does. The aberrations are very marked, of course, but do not practically annoy."

"I have used mine," he says, "for a year or more, and find it very convenient. The affair is so cheap and so easily made by any one that I am inclined to publish a note on it if new, which it is, so far as I know."

Leitz's large Dissecting Microscope. — The speciality of this Microscope (fig. 41) consists in the arrangement for extending the lens-

Fig. 41.



holder. This is attached to a bar which slides by a small knob in a grooved plate, the latter again sliding in a second grooved plate rotating

* Queen's Micr. Bulletin, v. (1888) p. 25.

on the top of the stem. The second plate is moved by two knobs at the sides.

A blackened brass plate slides beneath the glass stage, so that it can be used for both transparent and opaque objects.

Two large wooden hand-rests, similar to those of Mayer's dissecting Microscope, fit on pins (not shown in the fig.) at the sides of the stage.

Henrici, J. F., and C. C. Mellor.—**An Old Microscope of the Culpeper Type.**
[Same model as figured on Plate IV. of 'Adams' Essays on the Microscope,' 1787.] *Proc. Amer. Soc. Micr.*, X. (1888) pp. 140–2 (1 fig.).

Piersol, G. A.—**Continental Microscopes.**
Queen's Micr. Bulletin, V. (1888) pp. 23–4.

(2) Eye-pieces and Objectives.

Beck, C.—**The Construction of Photographic Lenses.**
["The achromatic Microscope was worked out by Lister and others by practical methods, and even at the present time many things are done in practice which are not even known of by theoretical men. I believe I am correct in saying that there is no book which gives a correct representation of a high-power microscopic object-glass, and most of the figures which are to be seen in books are entirely misleading." Also remarks on Jena glass.]
Journ. Soc. of Arts, XXXVII. (1889) pp. 180–92 (6 figs.).

Detmers, H. J.—**American and European Microscopes.**
[Controversy as to Objectives.]
Proc. Amer. Soc. Micr., X. (1888) pp. 149–54; cf. also *The Microscope*, IX. (1889) pp. 14–15, and *St. Louis Med. and Surg. Journ.*, LV. (1888) p. 348; also Dr. J. Pelletan in *Journ. de Microgr.*, XIII. (1889) pp. 101–4.

Ewell, M. D.—**American Objectives and Dr. Zeiss's Apochromatic Objectives.**
[Opinion unfavourable to the latter.]
The Microscope, IX. (1889) pp. 30–1.

Heurck, H. van.—**Les Apochromatiques jugés en Amérique.** (The Apochromatics judged in America.) *Journ. de Microgr.*, XII. (1888) pp. 438–40.

James, F. L.—**The Old Nonsense still on its Rounds.**
[Comments on the "Wonderful Swedish Optical Glass" paragraphs. See this Journal, 1888, p. 499.]
St. Louis Med. and Surg. Journ., LV. (1888) pp. 350–1.

(3) Illuminating and other Apparatus.

Ahrens' Modification of Delezenne's Polarizer.*—Mr. C. D. Ahrens has devised a modification of Delezenne's polarizer, which consists of a total-reflection prism combined with glass plates and black glass mirror, arranged so that the polarized beam is parallel to the original one. The combination of plates and mirror is adopted so as to give enough light and still keep the polarization sufficiently good. One or two plates laid over the mirror are found to give the best results. The fact that a beam polarized by reflection is not coincident with the original beam renders it inconvenient if not impossible to rotate the polarizer, and to overcome this defect Dr. S. P. Thompson has arranged two quarter-wave plates, one of which may be rotated. The first plate circularly polarizes the plane-polarized beam, and the second (or rotating one) re-plane-polarizes it in any desired plane.

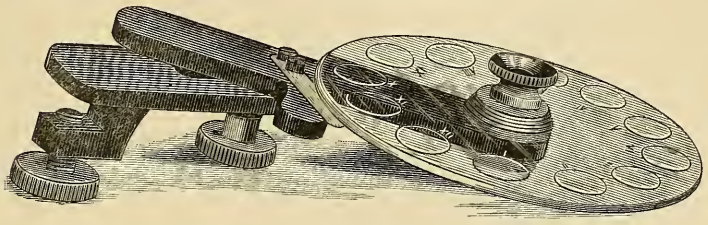
Falter's Rotating Object-holder.—This apparatus (fig. 42) of Messrs. G. Falter & Son of Munich is intended to provide a rotating object-holder which can be adapted to any Microscope.

The objects are arranged round the circumference of a glass disc

* Nature, xxxix. (1889) p. 358.

which rotates on an arm pivoting on a second arm which is clamped to the stage. The first arm can be clamped to the second in any position by the milled head screw shown in the woodcut. A piece of watch-spring beneath the disc serves as a brake to steady the motion. When

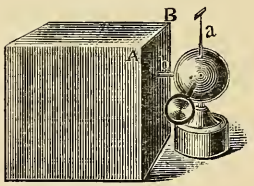
Fig. 42.



the arm is set excentrically, the apparatus enables the observer to search over a fresh gathering of diatoms, &c. Other discs can be substituted as desired.

Apparatus for measuring very minute Crystals.*—Herr G. Lattermann has devised the small apparatus shown in fig. 43, for the measurement on the goniometer of crystals 1/10 to 1/20 mm. in length, which on account of their smallness could not be adjusted on this instrument.

Fig. 43.



The apparatus consists of a small hollow cube of metal, and a jointed piece with axes *a* and *b*. The crystal to be measured is fastened on the point of a fine needle, with somewhat stiff Canada balsam. By turning the axis *a*, the edge between two faces of the zone to be measured (or rather its horizontal projection) is adjusted under the Microscope upon the thread of the eye-piece running from back to front, while at the same time the edge A B is directed on the stage also from back to front. The effect of this movement is to bring the zonal edge into a vertical plane parallel to a face of the cube. The cube is then turned over on its left side, and the zonal edge (now in a horizontal plane) is brought strictly parallel to A B, by turning about the other axis *b*. If the apparatus be now placed on the goniometer resting on a face at right angles to A B, and be centered, the crystal will be in a suitable position for measurement.

Electricity, Application of, to Microscopy.

[Discussion by Dr. W. J. Lewis, Dr. L. D. M'Intosh, and Dr. W. M. Seaman.] *Proc. Amer. Soc. Micr.*, X. (1888) pp. 178–9 (1 fig.).

Royston-Pigott, G. W.—**The Anti-diffraction Micrometer.**

["In using spider lines a certain amount of diffraction confuses the measurement. When a metallic obstacle is interposed, the impingent rays of light are *dispersed* in a fan-like form. It has occurred to me that a refracting cylinder, on the contrary, would refract or inflect these rays inwards, producing darkness. These principles are best illustrated by optical diagrams. The opaque jaws of the micrometer slides are edged with thin rods of glass,

* Tschermak's Mineral. u. Petrogr. Mittheil., ix. (1887) p. 49 (1 fig.). Cf. Zeitschr. f. Wiss. Mikr., iv. (1887) p. 542 (1 fig.).

fitting together accurately parallel. The image of the object to be measured is brought between them and the ivory wheel, divided into hundredths, each division representing with 1000 the one-millionth of an inch. Each revolution of this wheel is *audibly* marked by a spring catch; besides this, an adjusting screw serves to set the zero-jaw accurately, and teeth 50 to the inch display the number of whole turns."]

Engl. Mech., XLVIII. (1889) p. 389 (1 fig.).

(4) Photomicrography.

Zeiss's large Photomicrographic Apparatus.—Dr. Zeiss supplies for photomicrographic purposes the special stand shown in fig. 44, which is generally similar in form and size to the other large stands of the maker. There is, however, in addition, an unusually large stage, with mechanical movements, rotating by rack and pinion, and having a wide opening for use with a low-power objective giving a very large field of view. The Abbe illuminating apparatus is so arranged that it can be easily removed and replaced by special spectral, polarization, &c. apparatus. The body-tube is also of an unusually large diameter, partly for avoiding internal reflection, and partly to render possible the use of the low-power objective.

The Microscope is not attached to the same support as the camera, but both parts are on separate stands, which it is claimed is more convenient for working. The stand, screwed to a metal support which is provided with three levelling screws, is set up at one end of the platform A (figs. 45 and 46), which is adjustable for height. At the other end of the platform is an angle-plate C, which supports an electric lamp; while the space between the lamp and the Microscope M is occupied by an optical arrangement consisting of two stout metal rails carrying the illuminating apparatus for use with sunlight, two vertical screens E and F, movable by rack and pinion, which can be quickly turned on one side, and again brought back exactly to their old position; a plane mirror G, adjustable in height, with coarse- and fine-adjustment in the vertical as well as in the horizontal axis, in order to correct slight irregularities in the course of the heliostat; and a stand H for the reception of glasses for yellow and blue absorption liquids. For the use of the arc-lamp, as shown in fig. 46, there is a water-chamber T with plate-glass ends for the absorption of the heat-rays, and a lens L for projecting the image of the carbon points on the ground-glass plate. On the end of the metal support B is an arrangement *a*, by which the movement of a Hooke's joint *b* with rod *b'* can be transferred to the micrometer screw. This is effected by means of a toothed wheel which can be brought into gear with the toothed wheel of the micrometer screw. The tube carries a double socket *h* into which, by turning the camera, slides a corresponding socket-piece attached to the end of the camera, so that a very perfect light-proof connection between Microscope and camera is effected without disturbing the former. The socket-piece can be easily removed and replaced by a macroscopic objective for ordinary photographic work. The camera K is mounted on a separate light but solid cast-iron stand SS, provided with iron rails on which it can slide smoothly by means of rollers. The total length of the camera when fully extended is 1·5 m.

In order to fit the apparatus for taking fluid preparations, the camera is divided into two halves, of which the one nearest the Microscope can be turned up vertically, as in figs. 47 and 48, or inclined at any angle.

FIG. 44.

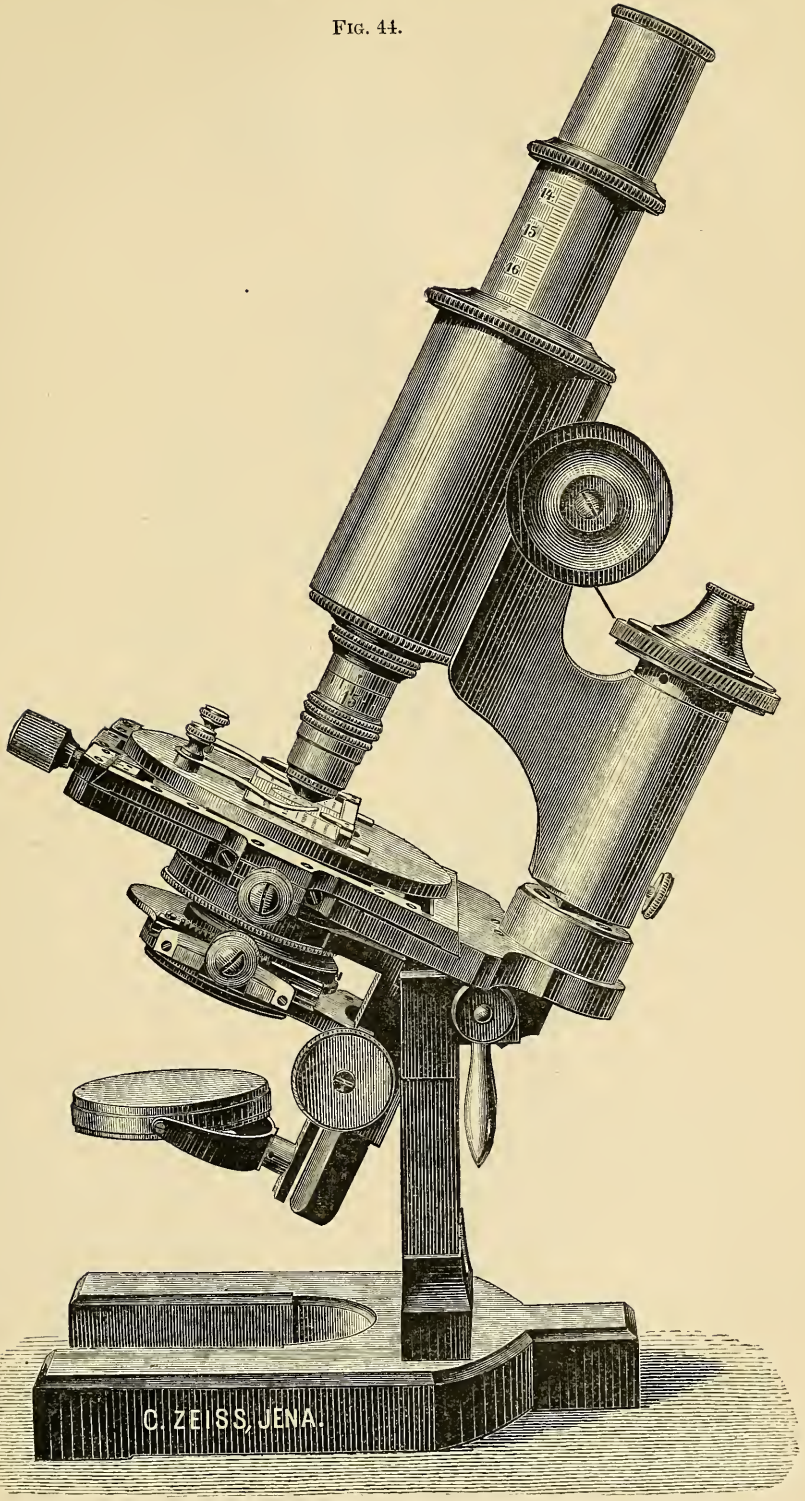


Fig. 45.

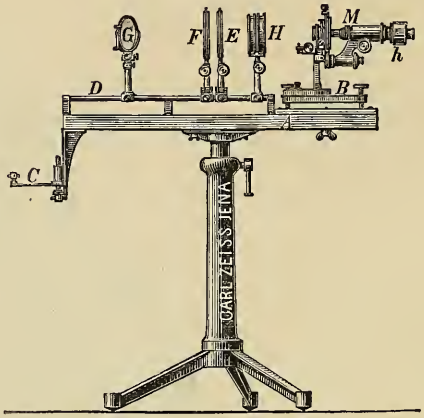
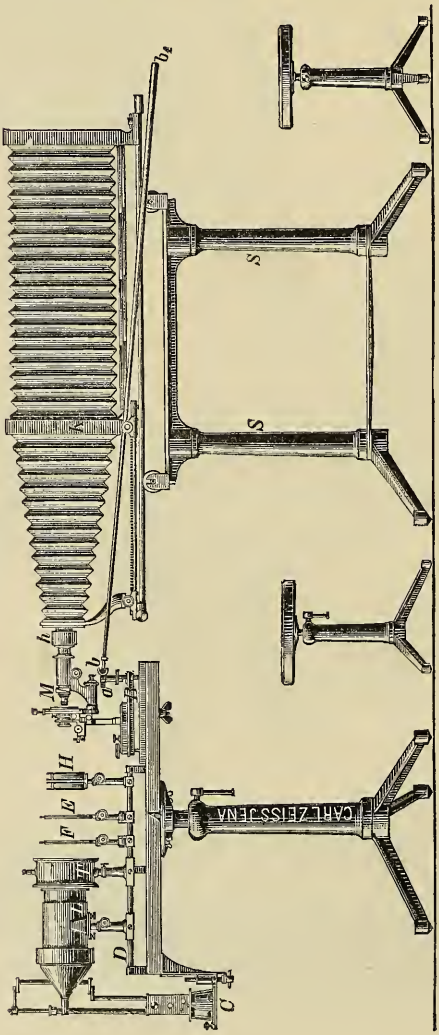
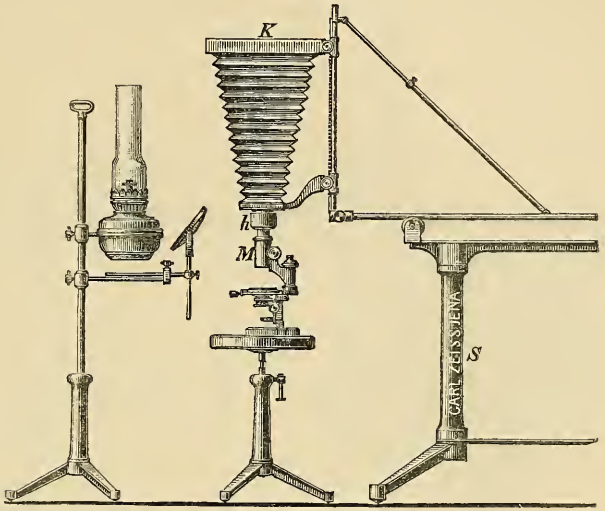


Fig. 46.



Movement of the plane of the image, and also of the Microscope end of the camera is effected by pinions acting on a strong rack. Both halves of the camera are arranged for plate-holders of 24 by 24 cm. which, however, by the addition of frames can be used for plates of any

Fig. 47.



smaller size. Two adjusting plates, one of ground glass, and the other transparent, and provided with a cross on the Microscope side, serve for the coarse- and fine-adjustment of the image. A third plate-holder can be added, which for the purpose of ascertaining the best time of exposure, permits a great number of proofs to be taken one after another on the same plate. To this end the holder is movable in a guide, and is made to pass in front of a slit which allows only a small strip of the image to fall on the sensitive plate. The bellows of the camera can be drawn a little away from the plate-holder, so as to permit the image to be viewed from the front, it being thrown on a piece of white paper as in Nachet's method.

With regard to the choice of a room to serve as a laboratory for photomicrographic work, and the setting up and adjustment of the apparatus, Dr. Zeiss's very elaborate catalogue of photomicrographic apparatus * should be consulted, in which valuable information is also given on the nature of different sources of light and the manner of their use for photomicrography, and on the special precautions required in the chemical part of photomicrography.

In photomicrographic work an objective of 75 mm. focal length has been constructed which serves to take large objects (2 to 4 cm.) under a magnification of ten to fifteen times. It possesses all the advantages of the other apochromatic objectives.

As illuminating apparatus, either an Abbe condenser of 1·20 to

* C. Zeiss, 'Special-Catalog über Apparate für Mikrophotographie,' 4to, Jena, 1888, iv. and 56 pp., 16 pls. and 9 figs.

1·40 mm. aperture, or a specially constructed *achromatic* condenser of 1·0 mm. aperture can be used. To obtain a successful photomicrograph it is necessary that the illumination should be limited to that part of the object which it is desired to photograph, because otherwise the light

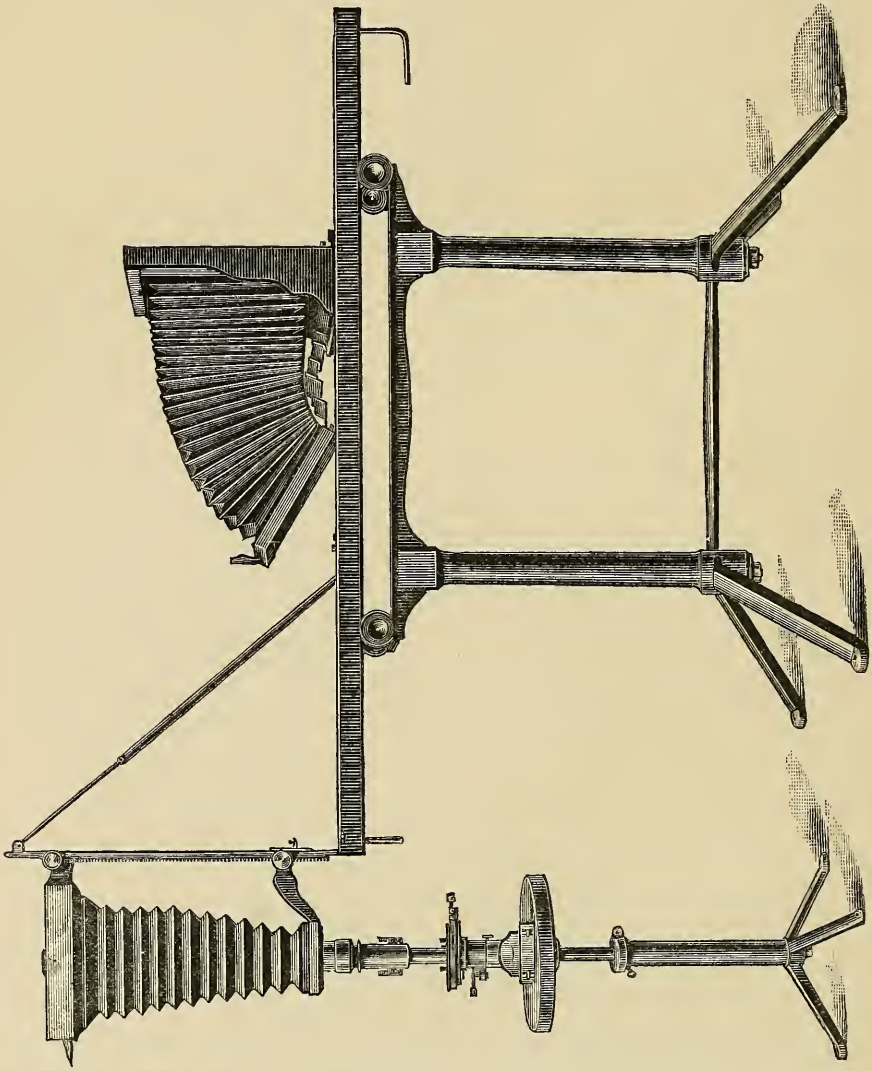
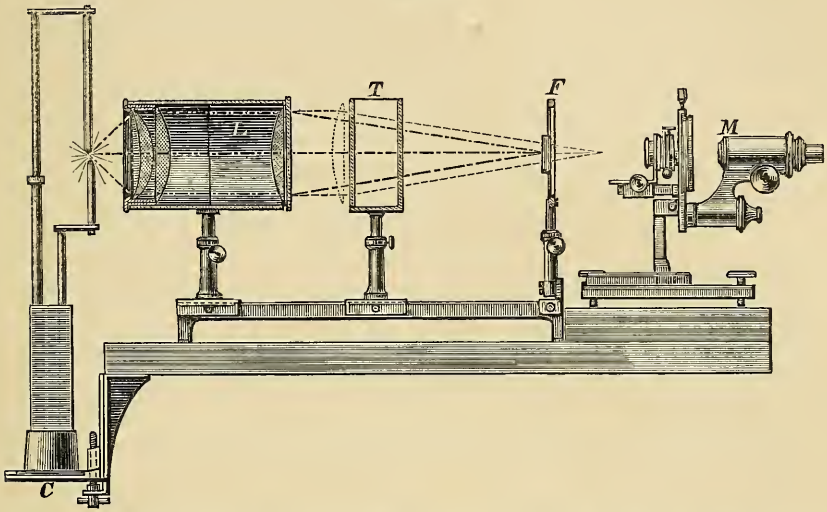


Fig. 48.

coming from the surrounding parts has the effect of fogging the picture. A sharp image of the source of light must therefore be projected upon the object, and to this end the condenser is provided with an arrangement for cross-centering and for fine-adjustment. The limitation of the illuminating cone is effected by an iris-diaphragm.

For the 75 mm. objective a specially small lens of great focal length is used as condenser, since it is here necessary to project an image of the source of light within the objective. The condenser for use with the electric arc light consists of two plano-convex and one concavo-convex lens L (fig. 49). The part of the system near the lamp is fixed

Fig. 49.



once for all at the proper distance for producing a parallel beam, and to diminish spherical aberration the concave face is turned to the lamp. The part turned to the Microscope, which brings the parallel rays again to a focus, is movable in a sliding socket which permits the displacement of the image on the optic axis within pretty wide limits.

Detmers, H. J.—**Photography with High-powers by Lamp-light.**
Proc. Amer. Soc. Micr., X. (1888) pp. 143–8 (1 fig.).

F. C. S.—**Beginner's Guide to Photography.**
[Includes 'Appaiatus for Photomicrography,' pp. 58–62.]
128 pp., 34 figs., 8vo, London, n.d.

Gray, W. M.—**Photomicrography.**
Queen's Micr. Bull., V. (1888) pp. 21–2, from 'Science of Photography.'

Neuhauss, R.—**Anleitung für Herstellung von Mikrophotogrammen.** (Guide to preparing Photomicrographs.) *Aerztl. Centr.-Anzeig.*, 1888, No. 38.

Perken, Son, and Rayment's Photomicrographic Apparatus.
Engl. Mech., XLVIII. (1889) pp. 369–70 (1 fig.).

Swift and Sons' (J.) Photomicrographic Apparatus.
[Lord Edward Churchill's. See this Journal, 1888, p. 1061.]
Scientific News, II. (1888) p. 379 (1 fig.).

(5) Microscopical Optics and Manipulation.

Microscopical Optics.—Recent occurrences would appear to show that we have allowed too long a period as the measure of a microscopical "generation." In ordinary life thirty years is considered to represent a generation, and as it is less than ten years since the more salient facts of

microscopical optics were brought prominently before microscopists, we were a little surprised to find that principles which it had cost so much time and trouble and money to record should be suddenly trampled upon in what, from our point of view, was a most unreasoning and unreasonable manner.

As it is possible that the explanation is to be found in the fact that, notwithstanding the shortness of the time, new minds have come upon the scene which were not in being at the time of the old discussions, we propose to consider in detail in this and following numbers of the Journal the various errors above referred to, so that at any rate for the next ten years, we may hope to be free from similar misapprehensions.

(1) We will first deal with the notion that the diffraction theory as promulgated by Professor Abbe is affected either in principle or application by the increase of the theoretical maximum of the apertures of objectives from 1·33 (water) to 1·5 (oil). The text on which we found this explanation is a statement quoted in this Journal for 1888, p. 1034, and the full text of which will be found in the place indicated in the footnote.*

The best answer that can, we think, be given to this notion is the following paragraph from a paper written by Professor Abbe *before* the introduction of homogeneous-immersion lenses, and it will be seen that at that time he assumed the existence of objectives of 1·5 and discussed the capabilities of much larger apertures, a point which we need hardly remind our readers, has not yet been reached.

Professor Abbe said:—"With regard to a still further extension of aperture beyond 1·5 (the refractive index of crown glass), 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, 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

* Eng. Mech., xlviii. (1888) p. 178.

least equals that aperture. If the Microscopes of the future should utilize the 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."*

It will be seen, therefore, that the diffraction theory, even before the introduction of homogeneous-immersion objectives, took account of apertures higher than 2, so that there is no foundation for the wildly ridiculous suggestion that it is possible to "trace in all Dr. Abbe's "subsequent papers the influence of two moods, and that at times he "could not resist the evidence, as the aperture of the objectives became "larger, that the image given by them was a truthful one." †

In addition to this it should be recalled that the first detailed exposition of the diffraction theory on its final basis was published by Professor Abbe in 1882. As homogeneous-immersion objectives were made by Professor Abbe and Dr. Zeiss in 1878, it is quite a misapprehension to write that "since then has come the oil-immersion objective and "the oil-immersion condenser, throwing a flood of light on the image "not possible under the old methods, and what I cannot understand is that "people should *now revive the old doubts.*"‡ Whatever were the old doubts they still remain in the same position—unchanged and unremoved by anything that has happened since they were first shown to exist.

(2) The second point with which we will deal is contained in a statement the text of which is as follows:—

> ". . . Even Dr. Abbe seems to be frightened at the logical outcome of his own theory, for further on he says, 'It is obvious that a perfect fusion in every case of the same diffraction images, and then an exact superposition of the resultant diffraction image upon the absorption image, is only possible when the objective is uniformly free from aberration over the whole area of its aperture.' This clearly means that given perfect correction of the objective there is perfect definition of the object, which to me seems to contradict the former part of the paper." §

The misunderstanding here arises from not comprehending the difference between the defining and the delineating power of an objective.

Take, for example, the case of an objective which has an aperture sufficient only to take in the first set of spectra of *Pleurosigma angulatum*. If the objective is perfectly corrected we shall have perfect definition *of the image to which those spectra give rise*. But the objective not having an aperture sufficiently large to take in the second set of spectra will necessarily give a less perfect image than another objective which takes in those spectra, and the first objective therefore, though perfectly corrected and giving perfect definition of what it *does* show, gives only an imperfect image.

In the next number of the Journal we shall deal with further misapprehensions of the same kind as those above referred to.

* This Journal, 1884, pp. 292–3

† Journ. Quek. Micr. Club, iii. (1888) p. 268. ‡ Ibid., p. 269. § Ibid., p. 268.

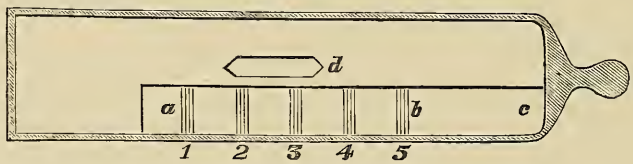
Mode of using the Quartz Wedge for estimating the Strength of the Double-Refraction of Minerals in thin slices of Rock.*—Major-General C. A. McMahon describes a rough and ready method for estimating the strength of the double-refraction of minerals in rock sections, which he has used with advantage for some years. It serves to replace the somewhat complicated methods, requiring special apparatus, of Babinet and Michael Lévy, when perfect exactness is not required.

When a quartz wedge is inserted in a slot in the eye-piece of a Microscope, arranged with crossed nicols, at an angle of 45° to the plane of polarization, a series of chromatic bands will be observed in the wedge, each band consisting of a spectrum of colours in an ascending order, the colours of the first order of Newton's scale being the nearest to the thin edge of the wedge. The width of these bands varies directly with the thickness of the quartz, and inversely with the slope of the wedge.

The stronger the double-refraction of a mineral, the higher will be the order of the tint exhibited by it when slices of different minerals of uniform thickness and at the same angle to an optic axis are examined. The usual method of using the wedge therefore consists in comparing the tint exhibited by the mineral with the corresponding tint in one of the chromatic bands in the wedge.

In working this method the author employs a special wedge (fig. 50), which only occupies half the depth of the slot, so that the observer is

Fig. 50.



able to directly compare the tint of a mineral, say at *d* (fig. 50), with the spectra seen in the wedge *a b c*.

The method now to be described differs from the above in depending on the phenomena produced in the wedge by the passage of light through the mineral to the quartz.

If, while the quartz wedge is inserted in the eye-piece as above, a second quartz wedge be placed on the stage with its axis at right angles to that of the wedge of the eye-piece, the velocity of the extraordinary ray is retarded in one of the two plates and accelerated in the other. A dark line will then appear due to the points where the velocity of the extraordinary ray on emergence from the upper quartz wedge becomes the same as that of the ordinary ray.

If the analysing quartz wedge be kept stationary and the other moved on the stage so that thicker and thicker portions of the quartz are successively brought within the range of vision, the dark line moves gradually from the thin towards the thicker end of the analysing wedge, so that spectra (in inverse order) of the 1st, 2nd, 3rd, and higher orders come in between it and the thin edge of the wedge. Thus the distance

* Geol. Mag., v. (1888) pp. 548-53 (1 fig.).

of the black line from the thin end of the wedge is proportional to the thickness of the quartz on the stage.

By substituting for the quartz wedge on the stage mineral sections of uniform thickness cut at the same angle to the optic axis, the distance of the black line from the thin end of the analysing wedge in each case gives a means of estimating the strength of the double-refraction.

As applied to the examination of minerals contained in rock sections, the method is complicated by the fact that they vary in thickness and also in the angle to an optic axis at which they are sliced. The fact that sections prepared by a skilful lapidary do not differ greatly in thickness, helps to obviate the first difficulty; and the second is partly overcome by choosing for examination the most brilliantly coloured crystals, which are presumedly those cut approximately parallel to an optic axis. At any rate, the method enables one to separate at a glance such strongly refracting minerals as rutite, dolomite, calcite, sphene, anatose, and zircon. So powerful is the double-refraction of rutite, calcite, and sphene that two wedges are sometimes necessary in order to bring the dark line within the range of vision.

So also the minerals of very feeble double-refraction are easily separated. In these cases sometimes the black line is *on the very edge* of the quartz wedge, or is just beyond the range of vision. In the latter case a 1/4 undulation plate is inserted above the object-glass, which has the effect of shifting the spectra up the wedge.

In ordinary rock sections quartz rarely exhibits more than one chromatic band between the dark line and the edge of the wedge; whilst such minerals as muscovite, olivine, and actinolite commonly present three and sometimes as many as five such bands. A feeble double-refracting mineral will never exhibit the phenomena presented by one of strong double-refraction, but the latter when cut approximately at right angles to an optic axis will resemble a mineral of feeble double-refraction cut approximately parallel to an optic axis. In this case, however, the mineral will exhibit characteristic appearances when examined in convergent light.

In cases where a mineral is so minute as to be less in diameter than the width of one of the chromatic bands exhibited by it, the number of bands which come in between the dark line and the thin edge of the wedge can still be counted if, confining his attention to one colour, the observer counts the number of times before extinction that the mineral assumes that colour as the wedge is moved across it.

As an illustration of the close approach to accuracy obtained by the use of the method the author mentions the case of sphene, which the determinations of refractive indices made by M. Lévy and Lacroix show to have a position, as regards intensity of double refraction, between zircon and calcite, a position assigned to it by the author on the evidence afforded by the rough and ready use of the quartz wedge.

"**Method of using with ease Objectives of shortest working distance in the clinical study of Bacteria.**" *—Dr. A. C. Mercer writes as follows:—

"The working distance of homogeneous-immersion objectives of short focus and great numerical aperture is little. In the clinical study of bacteria, sputa and other more or less fluid material are generally

* The Microscope, ix. (1889) p. 46

prepared on the under surface of cover-glasses, commonly, when not measured and assorted, so thick as to make examination with the above most suitable objectives impossible.

To avoid this difficulty I dry and stain the material on the slide, drop homogeneous-immersion fluid upon the preparation, and lower the objective into the drop. Homogeneous fluid replaces both the balsam and the cover-glass with optical propriety.

A twenty-fifth, which has been nearly useless over ordinary cover-glass preparations, is now used with gratifying freedom in manipulation over uncovered, but homogeneously immersed, slide preparations."

"**Back of the Objective and the Condenser.**"*—The following are extracts from an interesting article by Mr. E. M. Nelson on this subject. Observing that a condenser was described as a "fad of English microscopists," he thinks it will be worth while to try and account for this by no means uncommon idea. The task is not an easy one, for there are many fallacies underlying this impression.

"First, we have spherical aberration. Many objectives, both cheap and expensive, are turned out full of spherical aberration. If more than the immediate centre of these lenses is used, the object will be flooded or drowned in light.

There are two kinds of flooding with light: one is due to spherical aberration, as above, the other to the too powerful illumination of the object. This last, however, seldom obtains in the Microscope, but is always made an excuse for the other. Suppose we have a first-rate 1/2 of 60°. This lens will not be performing at its best unless it is illuminated by a solid axial cone of 60° from a condenser, the object being placed in the apex of the two cones.

Under these conditions, it is by no means necessary that the illumination of the object should be too brilliant for the eye. If it is, it may be modified by blue or neutral tinted glass. If the lens is free from spherical aberration, the image will be clearer and sharper than if the cone were to be reduced by means of a diaphragm. But if the lens is mediocre or inferior in its correction for spherical aberration, then the image will be fogged, though not necessarily too bright for the eye. This fog, however, will pass off, as the angle of the illuminating cone is reduced by the diaphragm.

Very many histologists, biologists, &c., prefer their Microscopes without condensers, because they are unable to illuminate their objects with cones large enough to develope, so to speak, the latent spherical aberration in their objectives; at the same time, they seem to be unaware of the fact that neither can they develope the resolving power of the lens.

Secondly, low-angled glasses for penetration: this fallacy is hung on a peg of physical truth—viz. that penetration is inversely proportional to aperture.

The continual parading of this truth, and the placing of it in undue prominence in several well-known microscopical works, has wrought an incalculable amount of mischief.

It has not only held back the progress of microscopy, but it has directed many earnest workers in the wrong way.

* Eng. Mechanic, xlviii. (1888) pp. 236-7 (4 figs.). See also pp. 260, 277, 278, 295, and 296.

I was myself caught with this plausible fallacy some years ago, and lost a good deal of ground before I discovered the error. This fallacy is an exceedingly difficult one to confute in an article such as this, because it does not consist solely of one error, but is, in reality, a whole cluster of errors.

To illustrate one of these errors, I take two quarters, one wide, the other low-angled, both of the same power, and both thoroughly well corrected. I, the demonstrator, allow the demonstratee to select any object out of my cabinet, or bring one of his own; this object is then successively examined by each lens, properly illuminated by a condenser, and by the same eye-piece; the unanimous testimony of the demonstratees being that the observations are much more satisfactory with the wide-angled lens.

I then ask the demonstratee to fix on some definite point in the object illustrating the superior penetrating power of the low-angled lens.

The object is re-examined, the objectives are changed a score of times; but the result of it all is, that they say, they thought there would have been more difference; but, practically, there does not appear to be any. I have devoted a great deal of time to this question, and have gone carefully over these experiments myself, and consequently know what must be the verdict of every impartial observer.

The explanation is as follows:—Let us suppose that a section of tissue is the object,* and the test is to trace the course of a vessel in it. Where no special difficulty arises the one lens is as good as the other,† but the moment the vessel gets involved in similarly coloured or other tissue, the increased resolving power of the wide-angled lens makes itself felt, and at once differentiates the structure, which the narrow-angled lens fails to do.

The difference of focal depth might form an element for consideration if the lens were rigidly fixed at a certain distance from the object; but there is such a thing as a fine-adjustment, and by means of it the observer is able to trace the course of the vessel by the wide-angled lens, and without effort or thought to direct the movement of the lens; therefore, the question of depth of focus assumes more of a theoretical objection than a practical one.

The question will be asked, What has all this to do with condensers? The answer is, that histologists invariably use narrow-angled lenses. A plane mirror when used with diffused daylight near an ordinary window gives a cone of illumination; the angle of this cone varies with the diameter of the mirror and its nearness to the object, say from 10° to 30°. In no instance of mirror illumination, either plane or concave, would I expect to find 30° exceeded, and such an angle as that would never be reached by the average histological Microscope.

Therefore we can see that a histologist would, perhaps, be able to fill his low-angled inch, and to inadequately fill his low-angled 1/4. The 1/4 he would not be able to fill enough to develope any spherical aberration it might have, unless, indeed, the lens was execrably bad.

* Histologists invariably choose this or some similar object. They fight shy of diatoms, because they know the superior defining power of the wider-angled lens would be more apparent. The diatom would exhibit the difference of focal depth better than any other histological object.

† Not strictly speaking, for a narrow-angled lens never gives such a good image as a wide one.

Suppose he now tries his lenses on a Microscope with a condenser. In regard to his low-angled inch, he can find no difference as it was filled before, but with his 1/4 the definition is worse, because he has brought out the spherical aberration of his lens; he therefore prefers the Microscope without a condenser, and calls them a 'fad of English microscopists.' Let him, however, view the same objects with similar lenses, well corrected and of decent angles, properly illuminated by a condenser, and his conversion will be complete.

Thirdly, the object. There is a golden rule for microscopists which has been so frequently stated that I would not repeat it were it not that it is so frequently disregarded. It is this: 'Use as low a power as possible.'

The favourite procedure with histologists is to use a high power uncritically where a low power used critically would be far better.

I would greatly prefer to use a 4/10 of 80° with a 1 in. eye-piece than a 1/6 of the same angle with a 2 in. eye-piece, both being used with a condenser. What shall we say when a 4/10 of 80° with the 1 in. eye-piece is used with a condenser, and the 1/6 of 80° and 2 in. eye-piece is used without?

I am firmly persuaded that we should hear far less of 'low-angled glasses for penetration' if powers suitable to the object were used.

There are published microscopical works with diagrams stated to have been drawn under the magnification of an oil-immersion 1/12, which, as far as the detail in them is concerned, might have been drawn with a 1/2 in.; and yet such a thing calls forth no remark in the microscopical world. . . .

Let me append just two statements out of the many I have heard from histologists themselves on this subject. 'We canuot see anything like this with an oil-immersion 1/12.' The object in this case was tubercle bacillus with a 1/2 in. A yonng graduate fresh from one of the first laboratories in the kingdom remarked, 'We have nothing like this at ——.' Some anatomical subjects under a power of 140 with a 4/10 of 80° called forth that statement. So much for the testimony of others. I will now give two instances from my own experience. A curved piece of pink-stained dirt about the size of a *Rotifer vulgaris* was shown to me for a comma bacillus. If a true comma bacillus had been placed under that Microscope it would have been quite invisible.

On another occasion I was shown *B. anthrax* under an oil-immersion 1/12; in this instance it was just possible to differentiate a something out of the general smudge which might be said to resemble the object when you knew what to look for. The exhibitor has public reputation for microscopical knowledge.

Fourthly, a histologist prefers his Microscope without a condenser, because the condenser would accentuate the deplorable condition of his fine-adjustment. A sharp critical image requires a precise focusing apparatus, but an uncritical image, i. e. an image without an edge * to it, can stand a jerky fine-adjustment.

Fifthly, daylight. Bad as a Microscope without a condenser is, it becomes far worse when illuminated by artificial light instead of daylight.

With lamplight a cone from the plane mirror becomes an impossibility, so one has to be contented with the best that can be got (sometimes

* An image in which the boundaries of the detail are all fluff.

diverging rays) from what is often an ill-arranged* concave mirror. The concave mirror is generally made too small, and of too shallow a curve.

I now come to the second part of my subject, viz. the condenser and the objective back.

1. It is advantageous to know the maximum aperture of your condenser. It can be easily measured by an Abbe's apertometer.

2. It is of more importance, however, to know the aperture of the largest cone free from spherical aberration which can be obtained from a condenser. This cannot be found out by the apertometer.

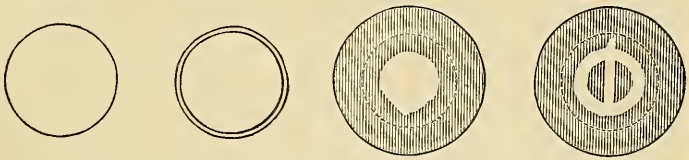
3. It is also of paramount importance to know the apertures of the cones which the various diaphragms will give. These, of course, could be measured by an apertometer; but with very many forms of diaphragms it could only be accomplished with difficulty.

I will now endeavour to give some useful hints with regard to these questions. I will take No. 3 first.

Fig. 51 exhibits the back of a dry lens of N.A. 0·5 = 60°, illuminated by a condenser of greater aperture free from spherical aberration, the condenser and flame image having been centered and focused.

Fig. 52 shows the same objective, with a smaller diaphragm placed at the back of the condenser. The edge of this diaphragm is seen just

Fig. 51. Fig. 52. Fig. 53. Fig. 54.



appearing at the margin of the objective. The aperture of the condenser, when used with this diaphragm, is therefore a shade less than N.A. 0·5—say 55°.

In a similar manner the apertures of the condenser with other diaphragms may be estimated with sufficient accuracy for all practical purposes.

Now with regard to No. 52, it is necessary to have a wide-angled objective; the condenser and flame are centered and focused as before, the eye-piece removed, and while the back of the objective is being examined the condenser is slowly racked up. It will be noticed that a point is reached when the disc of light is at its largest (fig. 53); on a further movement of the condenser two black spots appear, one on either side of the middle of the disc (fig. 54), and these increase as the condenser is further racked up. *The last point before the appearance of the black spots indicates the largest aperture of the condenser free from spherical aberration, and is the limit of the condenser for critical work.* Any further advance of the condenser gives merely annular illumination, which, of course, is to be avoided, except in the case of dark grounds with stops for low powers. The extreme margin of even the best condenser is only useful for giving an oblique beam with a slot."

* The concave mirror is usually fixed to the tail-piece, with or without a crank. This is thoroughly wrong in principle. A concave mirror should always be fixed to a tube sliding in the tail-piece to allow of it being focused. The crank-arm is quite of secondary importance.

Aperture Table.—The following Table of Apertures has for some years been printed on the wrapper of this Journal, but as part of the space which it occupies is now required for other purposes a condensed table will in future be used, the full table being reprinted here for future reference.

Numerical Aperture. ($n \sin u = a$)	Corresponding Angle ($2u$) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2.)	Penetrating Power. $\left(\frac{1}{a}\right)$
	Air ($n = 1{\cdot}00$).	*Water* ($n = 1{\cdot}33$).	*Homogeneous Immersion* ($n = 1{\cdot}52$).	White Light. ($\lambda = 0{\cdot}5269\ \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0{\cdot}4861\ \mu$, Line F.)	Photography. ($\lambda = 0{\cdot}4000\ \mu$, near Line *h*.)		
1·52	..	..	180° 0′	146,543	158,845	193,037	2·310	·658
1·51	..	..	166° 51′	145,579	157,800	191,767	2·280	·662
1·50	..	..	161° 23′	144,615	156,755	190,497	2·250	·667
1·49	..	..	157° 12′	143,651	155,710	189,227	2·220	·671
1·48	..	..	153° 39′	142,687	154,665	187,957	2·190	·676
1·47	..	..	150° 32′	141,723	153,620	186,687	2·161	·680
1·46	..	..	147° 42′	140,759	152,575	185,417	2·132	·685
1·45	..	..	145° 6′	139,795	151,530	184,147	2·103	·690
1·44	..	..	142° 39′	138,830	150,485	182,877	2·074	·694
1·43	..	..	140° 22′	137,866	149,440	181,607	2·045	·699
1·42	..	..	138° 12′	136,902	148,395	180,337	2·016	·704
1·41	..	..	136° 8′	135,938	147,350	179,067	1·988	·709
1·40	..	..	134° 10′	134,974	146,305	177,797	1·960	·714
1·39	..	..	132° 16′	134,010	145,260	176,527	1·932	·719
1·38	..	..	130° 26′	133,046	144,215	175,257	1·904	·725
1·37	..	..	128° 40′	132,082	143,170	173,987	1·877	·739
1·36	..	..	126° 58′	131,118	142,125	172,717	1·850	·735
1·35	..	..	125° 18′	130,154	141,080	171,447	1·823	·746
1·34	..	..	123° 40′	129,189	140,035	170,177	1·796	·741
1·33	..	180° 0′	122° 6′	128,225	138,989	168,907	1·769	·752
1·32	..	165° 56′	120° 33′	127,261	137,944	167,637	1·742	·758
1·31	..	160° 6′	119° 3′	126,297	136,899	166,367	1·716	·763
1·30	..	155° 38′	117° 35′	125,333	135,854	165,097	1·690	·769
1·29	..	151° 50′	116° 8′	124,369	134,809	163,827	1·664	·775
1·28	..	148° 42′	114° 44′	123,405	133,764	162,557	1·638	·781
1·27	..	145° 27′	113° 21′	122,441	132,719	161,287	1·613	·787
1·26	..	142° 39′	111° 59′	121,477	131,674	160,017	1·588	·794
1·25	..	140° 3′	110° 39′	120,513	130,629	158,747	1·563	·800
1·24	..	137° 36′	109° 20′	119,548	129,584	157,477	1·538	·806
1·23	..	135° 17′	108° 2′	118,584	128,539	156,207	1·513	·813
1·22	..	133° 4′	106° 45′	117,620	127,494	154,937	1·488	·820
1·21	..	130° 57′	105° 30′	116,656	126,449	153,668	1·464	·826
1·20	..	128° 55′	104° 15′	115,692	125,404	152,397	1·440	·833
1·19	..	126° 58′	103° 2′	114,728	124,359	151,128	1·416	·840
1·18	..	125° 3′	101° 50′	113,764	123,314	149,857	1·392	·847
1·17	..	123° 13′	100° 38′	112,799	122,269	148,588	1·369	·855
1·16	..	121° 26′	99° 29′	111,835	121,224	147,317	1·346	·862
1·15	..	119° 41′	98° 20′	110,872	120,179	146,048	1·323	·870
1·14	..	118° 0′	97° 11′	109,907	119,134	144,777	1·300	·877
1·13	..	116° 20′	96° 2′	108,943	118,089	143,508	1·277	·885
1·12	..	114° 44′	94° 55′	107,979	117,044	142,237	1·254	·893
1·11	..	113° 9′	93° 47′	107,015	115,999	140,968	1·232	·901
1·10	..	111° 36′	92° 43′	106,051	114,954	139,698	1·210	·909
1·09	..	110° 5′	91° 38′	105,087	113,909	138,428	1·188	·917
1·08	..	108° 36′	90° 34′	104,123	112,864	137,158	1·166	·926
1·07	..	107° 8′	89° 30′	103,159	111,819	135,888	1·145	·935
1·06	..	105° 42′	88° 27′	102,195	110,774	134,618	1·124	·943
1·05	..	104° 16′	87° 24′	101,231	109,729	133,348	1·103	·952
1·04	..	102° 53′	86° 21′	100,266	108,684	132,078	1·082	·962
1·03	..	101° 30′	85° 19′	99,302	107,639	130,808	1·061	·971
1·02	..	100° 10′	84° 18′	98,338	106,593	129,538	1·040	·980
1·01	..	98° 50′	83° 17′	97,374	105,548	128,268	1·020	·990
1·00	180° 0′	97° 31′	82° 17′	96,410	104,503	126,998	1·000	1·000
0·99	163° 48′	96° 12′	81° 17′	95,446	103,458	125,728	·980	1·010
0·98	157° 2′	94° 56′	80° 17′	94,482	102,413	124,458	·960	1·020
0·97	151° 52′	93° 40′	79° 18′	93,518	101,368	123,188	·941	1·031
0·96	147° 29′	92° 24′	78° 20′	92,554	100,323	121,918	·922	1·042
0·95	143° 36′	91° 10′	77° 22′	91,590	99,278	120,648	·903	1·053
0·94	140° 6′	89° 56′	76° 24′	90,625	98,233	119,378	·884	1·064
0·93	136° 52′	88° 44′	75° 27′	89,661	97,188	118,108	·865	1·075
0·92	133° 51′	87° 32′	74° 30′	88,697	96,143	116,838	·846	1 087
0·91	131° 0′	86° 20′	73° 33′	87,733	95,098	115,568	·828	1·099

Numerical Aperture. ($n \sin u = a$.)	Corresponding Angle ($2u$) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2.)	Penetrating Power. $\left(\frac{1}{a}\right)$
	Air ($n = 1{\cdot}00$).	*Water* ($n = 1{\cdot}33$).	*Homogeneous Immersion* ($n = 1{\cdot}52$).	White Light. ($\lambda = 0{\cdot}5269\,\mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0{\cdot}4861\,\mu$, Line F.)	Photography. ($\lambda = 0{\cdot}4000\,\mu$, near Line *h*.)		
0·90	128° 19′	85° 10′	72° 36′	86,769	94,053	114,298	·810	1·111
0·89	125° 45′	84° 0′	71° 40′	85,805	93,008	113,028	·792	1·124
0·88	123° 17′	82° 51′	70° 44′	84,841	91,963	111,758	·774	1·136
0·87	120° 55′	81° 42′	69° 49′	83,877	90,918	110,488	·757	1·149
0·86	118° 38′	80° 34′	68° 54′	82,913	89,873	109,218	·740	1·163
0·85	116° 25′	79° 37′	68° 0′	81,949	88,828	107,948	·723	1·176
0·84	114° 17′	78° 20′	67° 6′	80,984	87,783	106,678	·706	1·190
0·83	112° 12′	77° 14′	66° 12′	80,020	86,738	105,408	·689	1·205
0·82	110° 10′	76° 8′	65° 18′	79,056	85,693	104,138	·672	1·220
0·81	108° 10′	75° 3′	64° 24′	78,092	84,648	102,868	·656	1·235
0·80	106° 16′	73° 58′	63° 31′	77,128	83,603	101,598	·640	1·250
0·79	104° 22′	72° 53′	62° 38′	76,164	82,558	100,328	·624	1·266
0·78	102° 31′	71° 49′	61° 45′	75,200	81,513	99,058	·608	1·282
0·77	100° 42′	70° 45′	60° 52′	74,236	80,468	97,788	·593	1·299
0·76	98° 56′	69° 42′	60° 0′	73,272	79,423	96,518	·578	1·316
0·75	97° 11′	68° 40′	59° 8′	72,308	78,378	95,248	·563	1·333
0·74	95° 28′	67° 37′	58° 16′	71,343	77,333	93,979	·548	1·351
0·73	93° 46′	66° 34′	57° 24′	70,379	76,288	92,709	·533	1·370
0·72	92° 6′	65° 32′	56° 32′	69,415	75,242	91,439	·518	1·389
0·71	90° 28′	64° 32′	55° 41′	68,451	74,197	90,169	·504	1·408
0·70	88° 51′	63° 31′	54° 50′	67,487	73,152	88,899	·490	1·429
0·69	87° 16′	62° 30′	53° 59′	66,523	72,107	87,629	·476	1·449
0·68	85° 41′	61° 30′	53° 9′	65,559	71,062	86,359	·462	1·471
0·67	84° 8′	60° 30′	52° 18′	64,595	70,017	85,089	·449	1·493
0·66	82° 36′	59° 30′	51° 28′	63,631	68,972	83,819	·436	1·515
0·65	81° 6′	58° 30′	50° 38′	62,667	67,927	82,549	·423	1·538
0·64	79° 36′	57° 31′	49° 48′	61,702	66,882	81,279	·410	1·562
0·63	78° 6′	56° 32′	48° 58′	60,738	65,837	80,009	·397	1·587
0·62	76° 38′	55° 34′	48° 9′	59,774	64,792	78,739	·384	1·613
0·61	75° 10′	54° 36′	47° 19′	58,810	63,747	77,469	·372	1·639
0·60	73° 44′	53° 38′	46° 30′	57,846	62,702	76,199	·360	1·667
0·59	72° 18′	52° 40′	45° 40′	56,881	61,657	74,929	·348	1·695
0·58	70° 54′	51° 42′	44° 51′	55,918	60,612	73,659	·336	1·724
0·57	69° 30′	50° 45′	44° 2′	54,954	59,567	72,389	·325	1·754
0·56	68° 6′	49° 48′	43° 14′	53,990	58,522	71,119	·314	1·786
0·55	66° 44′	49° 51′	42° 25′	53,026	57,477	69,849	·303	1·818
0·54	65° 22′	47° 54′	41° 37′	52,061	56,432	68,579	·292	1·852
0·53	64° 0′	46° 58′	40° 48′	51,097	55,387	67,309	·281	1·887
0·52	62° 40′	46° 2′	40° 0′	50,133	54,342	66,039	·270	1·923
0·51	61° 20′	45° 6′	39° 12′	49,169	53,297	64,769	·260	1·961
0·50	60° 0′	44° 10′	38° 24′	48,205	52,252	63,499	·250	2·000
0·48	57° 22′	42° 18′	36° 49′	46,277	50,162	60,959	·230	2·083
0·46	54° 47′	40° 28′	35° 15′	44,349	48,072	58,419	·212	2·174
0·45	53° 30′	39° 33′	34° 27′	43,385	47,026	57,149	·203	2·222
0·44	52° 13′	38° 38′	33° 40′	42,420	45,981	55,879	·194	2·273
0·42	49° 40′	36° 49′	32° 5′	40,492	43,891	53,339	·176	2·381
0·40	47° 9′	35° 0′	30° 31′	38,564	41,801	50,799	·160	2·500
0·38	44° 40′	33° 12′	28° 57′	36,636	39,711	48,259	·144	2·632
0·36	42° 12′	31° 24′	27° 24′	34,708	37,621	45,719	·130	2·778
0·35	40° 58′	30° 30′	26° 38′	33,744	36,576	44,449	·123	2·857
0·34	39° 44′	29° 37′	25° 51′	32,779	35,531	43.179	·116	2·941
0·32	37° 20′	27° 51′	24° 18′	30,851	33,441	40,639	·102	3 125
0·30	34° 56′	26° 4′	22° 46′	28,923	31,351	38,099	·090	3·333
0·28	32° 32′	24° 18′	21° 14′	26,995	29,261	35,559	·078	3·571
0·26	30° 10′	22° 33′	19° 42′	25,067	27,171	33,019	·068	3·846
0·25	28° 58′	21° 40′	18° 56′	24,103	26,126	31,749	·063	4·000
0·24	27° 46′	20° 48′	18° 10′	23,138	25,081	30,479	·058	4·167
0·22	25° 26′	19° 2′	16° 38′	21,210	22,991	27,940	·048	4·545
0·20	23° 4′	17° 18′	15° 7′	19,282	20,901	25,400	·040	5·000
0·18	20° 44′	15° 34′	13° 36′	17,354	18,811	22,860	·032	5·555
0·16	18° 24′	13° 50′	12° 5′	15,426	16,721	20,320	·026	6·250
0·15	17° 14′	12° 58′	11° 19′	14,462	15,676	19,050	·023	6·667
0·14	16° 5′	12° 6′	10° 34′	13,498	14,630	17,780	·020	7·143
0·12	13° 47′	10° 22′	9° 4′	11,570	12,540	15,240	·014	8·333
0·10	11° 29′	8° 38′	7° 34′	9,641	10.450	12,700	·010	10·000
0·08	9° 11′	6° 54′	6° 3′	7,713	8,360	10,160	·006	12·500
0·06	6° 53′	5° 10′	4° 32′	5,785	6,270	7,620	·004	16·667
0·05	5° 44′	4° 18′	3° 46′	4,821	5,225	6,350	·003	20·000

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[Explanation of the reason why one sees in the bright circle of light of the Microscope his own eyelashes as an inverted or erect image, according to the kind of ocular used. The explanation lies in the fact that the lashes produce in the cone of light which proceeds from the mirror a shadow figure, the projection of which into the retina depends on the focus of the rays issuing from the ocular. If these be little convergent, or the eye be far enough from the ocular, the image would be thrown behind the retina; accordingly an erect image (perceived inverted) appears. In the reverse condition (strong convergence of the rays issuing from the ocular, or a near position of the eye) the image falls in front of the retina. The shadow figure originates in the prolongation of the rays diverging from the image, which is really inverted but perceived erect.]
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(6) Miscellaneous.

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[Chap. XV. The Art of making Photo-micrographs. Chap. XVII. The Lantern Microscope and the Opaque Lantern.]
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[Contains an appendix on microphysical and microchemical methods in chemical analysis of crystals, pp. 533–55, figs.]
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[1. Application of mineralogical and chemical methods to microscopical study. By A. M. Lévy. 2. Physical and optical facts. By A. M. Lévy and A. Lacroix. (Microscopes and Comparator, pp. 54–9, 4 figs.).]
xi. and 334 pp., 218 figs. and 1 pl. 8vo, Paris, 1889.

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[The Bridge to the Monument, from Lowell's 'Biglow Papers.']
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[Das Mikroskop, §§ 709–13 (4 figs).—The Microscope figured is a French form !]
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ROSENBUSCH, H.—**Microscopical Physiology of the Rock-making Minerals: an aid to the microscopical study of Rocks.** Translated and abridged for use in schools and colleges by J. P. Iddings.
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W.—**Die wissenschaftlichen Instrumente und Apparate auf der diesjährigen Naturforscher-Versammlung zu Köln.** (The scientific instruments and apparatus at the Cologne Naturalists' Meeting of 1888.)
[Microscopes, microtomes, photomicrographic apparatus, &c.]
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[Contains Lantern Microscopes and microscopic attachments.]
370 pp., figs. and 1 pl., 8vo, London, 1888.

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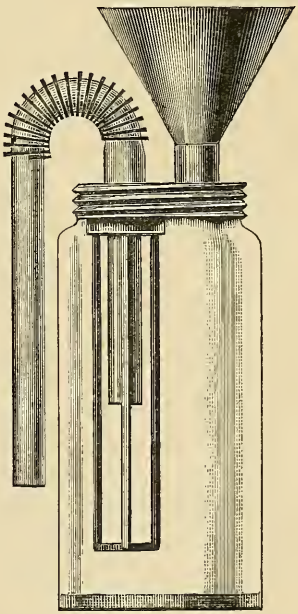
β. Technique.*

(1) Collecting Objects, including Culture Processes.

Improved Form of the "Wright" Collecting Bottle.†—The bottle I now use, says Dr. H. N. Lyon, is made of an ordinary metal-top fruit jar (fig. 55). In the cover are two holes. In one is soldered a funnel for the entrance of the water. In the other is a tube about half an inch in diameter. This tube reaches half-way to the bottom of the bottle on the inside, and extends far enough above the cover for a piece of rubber tubing to be firmly fastened to it. Surrounding the tube is a square frame reaching almost to the bottom of the bottle, made of four brass rods. This is covered for three-quarters of an inch at the upper end by a brass ferrule soldered to the rods and to the cover.

FIG. 55.



The strainer, which is of fine muslin, is made like a long narrow bag, and is drawn over the frame and secured by a thread passing round the ferrule. A rubber tube is attached to the outer end of the central brass tube, and a spiral spring is slipped over it to keep it from bending too short. This tube reaches about an inch below the bottom of the inner tube, and serves as a siphon to draw off the surplus water. It is self-acting, starting when the water in the funnel reaches the level of the highest

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Queen's Micr. Bull., v. (1888) p. 33 (1 fig.).

part of the bend in the siphon; it continues to act until the level of the water reaches the bottom of the inside tube. From four years' experience the author asserts that this strainer never becomes clogged.

Culture of Fungus of Favus (Achorion Schonleinii).*—Dr. A. J. Munnich obtained beautiful cultivations of the Favus fungus upon Löffler's alkaline-gelatin-agar, with 1 per cent. grape sugar, hydrocele-agar, and upon blood-serum. It grew most quickly and luxuriantly on meat-pepton-agar acidulated with lactic acid.

Pure cultivations were only obtained by taking the root of a hair, which had been cut off with every care from a scalp previously well cleaned, and dropping it into tubes of fluid gelatin or agar. Other methods such as plate cultivations and the like were always complicated with all sorts of fungi. Achorion grows best at 30°, and only slowly at 22°. The mycelium consists of filaments of different lengths and thicknesses, which end terminally in spheroidal or somewhat flattened expansions, or in bodies somewhat resembling the oogonia of Saprolegnia. There are also other bodies, perhaps sclerotia; these are large and small, flat or round, oval or reniform. Inoculation of the cultivations on animals were unsuccessful.

Ordinary Foodstuff as Media for propagating Pathogenic Micro-organisms.†—Prof. A. Celli has made some experiments to ascertain how far our ordinary foodstuffs offer suitable conditions for the growth and multiplication of pathogenic micro-organisms. The experiments were made from pure cultivations of the bacilli of anthrax, typhoid, Asiatic cholera, *Staphylococcus pyogenes aureus*, bacteria of fowl-cholera, glanders, streptococci of erysipelas, and Finkler-Prior's vibrio, partly on sterilized and partly on unsterilized media. These media were egg-albumen, meats fresh, boiled, salted, smoked, and roasted, ricotta (buttermilk curd), various cheeses, and some fruits, apples, pears, melons, and pumpkins. The conclusion drawn is that it is quite possible that our foods may become the vehicle for the spread of infectious diseases. Although most of the results might have been anticipated from *à priori* considerations, others are worth mentioning. Thus, fresh meat, when dried, loses its nutritive capacity. The cholera vibrio dies in twelve hours on boiled ham, and in six hours on saveloys, while the typhoid bacillus retains its viability for about a month, and anthrax for about two and a half months. On ricotta, typhoid germs were still viable after five days, while cholera vibrios were no longer so. On uncooked cheese, the viability of cholera germs was found to be impaired in twelve hours, while those of typhoid, anthrax, and of *Staphylococcus* retained their activity after seventeen days. On sterilized cheese, cholera germs did not seem to be able to obtain a foothold. On apples and pears, cultivations of typhoid bacilli and *Staphylococcus* did not thrive, and cholera bacilli were only recognizable microscopically; the latter seemed to lose in six to twenty hours their power of reproduction on transference to other media, although they retained their characteristic form, even if the fruit were dried. On pumpkins and melons, the bacteria of typhoid, anthrax, and cholera, and *Staphylococcus* kept pure up to six

* Archiv f. Hygiene, viii. (1888) p. 246.

† Bull. R. Accad. Med. Roma, 1888. Cf. Centralbl. f. Bacteriol. u. Parasitenk., v. (1889) pp. 159–61.

hours, that is to say, pure cultivations could be obtained by transference to gelatin. After about six hours the colonies were no longer pure.

Solid Media prepared from Milk.*—Dr. Van Puteren produces solid media for the cultivation of micro-organisms from milk in the following manner. The milk is evaporated with rennet which contains no pepsin, and it is then filtered in a vacuum. This procedure will produce a sufficiently transparent medium in 3/4 to 1 hour, and if gelatin or agar be added, in 1½ to 2 hours a crystal clear medium is obtained. The milk whey is prepared as follows. 1 litre of skim milk is poured into a tin saucepan holding 1½ litre ; to this is added 5–6 ccm. of rennet essence, and the mixture warmed over a Bunsen's burner to 40°–42°. When coagulation has set in (3–5 minutes) the mixture is filtered through gauze folded eight times. The filtrate, amounting to 860–880 ccm., is repoured into the saucepan, and 6 to 10 per cent. dry gelatin and the albumen of two eggs added. When dissolved the fluid is again filtered, and 2 per cent. of sodium albuminate is added. It is then neutralized with a weak solution of caustic potash, and afterwards filtered through a simple cotton-wool filter moistened with hot water in an exhausted space. 100 ccm. of distilled water are afterwards added to make up for the loss in boiling. The filtrate sets well, and is suitable for all bacteriological work. If a crystal clear solution be desired the filtration as before must be repeated, and afterwards through a paper filter on a Plantamour's hot funnel.

Another solid medium is made with agar. The same procedure is adopted, the only differences being that 1 per cent. of agar is added to the filtrate and 1 per cent. of sodium albuminate.

A list of some thirty micro-organisms examined on these media is given. The list includes Blastomycetes, Hyphomycetes, and Schizomycetes.

(2) Preparing Objects.

Demonstrating Transverse Striations in Axis-cylinders and Nerve-cells.†—M. J. Jakimovitch, who has been examining by the silver method the transverse striations on the axis-cylinders of the central and peripheral fibres, has found that similar striations exist in the large nerve-cells of the anterior cornua. The following method is recommended : —

Very small pieces of nerve or spinal cord from a recently killed and healthy animal are placed in silver solution in the dark. For the central nerves the solution should be 1/4 per cent., for the peripheral 1/2 per cent., and for the nerve-cells 1 per cent. The nerves are left 24 hours, the cells 48 hours in the solution. The preparations are then carefully washed in water and exposed in this to the light. When the preparation has become of a dark brown colour it is placed in a mixture of formic acid (1 part), amyl-alcohol (1 part), and water (100 parts). The object exposed to the light in this mixture for 2 or 3 days at first becomes brighter, a part of the reduced silver being dissolved ; hence the mixture must be renewed from time to time. When all the silver has dissolved a darker colour is permanently assumed. The nerve-cells are left in this mixture for 5 to 7 days.

* Wratsch (Russian), 1888, No. 15. Cf. Centralbl. f. Bacteriol. u. Parasitenk., v. (1889) p. 181.

† Journ. de l'Anat. et de la Physiol., xxiii. (1888) pp. 142–67 (1 pl.).

Preparations thus made are teased out in a drop of dilute glycerin, or they may be sectioned after hardening in spirit.

Macerating Fluid for Nerve-cells.*—Dr. G. C. Freeborn obtains nerve-cells from the spinal cord in the following manner:—Thin slices of spinal cord or cerebellum not over 1/16 in. thick are placed in fifty times their volume of a 5 per cent. aqueous solution of potassium chromate for 24 hours. At the end of this time the grey matter has become jelly-like and transparent, and then, having been cut away from the white, is placed in a long narrow tube. Mohr's burette with the lower end plugged with a cork answers the purpose perfectly. The burette is then filled up to within an inch of the top with fresh macerating fluid and a cork forced in until it comes within 1/2 in. of the surface of the fluid. The burette is then inverted, and this manipulation is repeated at intervals of half an hour until the bits of tissue are reduced to powder. The burette is then placed upright, and when the material has all settled the fluid is poured off. The material is then carefully washed with distilled water by repeated decantation, and finally poured into a conical glass burette. The water is then poured off and the material stained with picro- or ammonia-carmine. This, which takes from 12 to 15 hours, is followed by washing in distilled water and preservation in a mixture of 1 part spirit and 3 parts glycerin.

By this method cells from spinal cord and cerebellum may be obtained with their processes attached down to the fourth division.

Preparing small Intestine.†—For hardening the small intestine in order to examine the epithelium, Dr. R. Heidenhain recommends a saturated aqueous solution of picric acid, alcohol or chromic acid, then alcohol. Sections parallel or vertical to the surface show bridges of protoplasm uniting the adjacent cells. In order to render the rodlets clearly visible, pieces of intestine on the cells are placed for a day in a 5 per cent. solution of chromate of ammonia. In the fresh villi similar results can be obtained by placing pieces of the fresh mucosa in about 2 per cent. salt solution (1–3 per cent. according to the animal) for 15 to 20 minutes, then fixing in 0·1–0·2 per cent. osmic acid, and isolating the cells in order to examine the relation of the rodlets to the protoplasm. To show the nodular thickenings at the lower end of the rodlets, the mucosa is best hardened in alcohol and stained with hæmatoxylin and chromate of potash.

In order to differentiate by staining the separate elements in the villous stroma the following method is said to be very good. The pieces of intestine taken from a recently killed animal are placed for 24 hours in a half per cent. salt solution saturated with sublimate. They are then transferred every 24 hours to alcohol of 80, 90, 97, and 100 per cent. The pieces are then treated with xylol, imbedded in paraffin, and sections 0·005 to 0·01 mm. thick made; these are fixed warm on the slide with 50 per cent. alcohol. It is important that the temperature should not exceed 35° C. or the villous tissue will be much shrunken. Staining on the slide is done with the following solution: orange 100 ccm., acid fuchsin 20 ccm., methyl-green 50 ccm., all saturated solutions. This

* Amer. Mon. Micr. Journ., ix. (1888) pp. 231–2.

† Pflüger's Arch. f. d. Gesammt. Physiol., xliii., Supplement (1888) pp. 1–103 (4 pls.).

mixture is diluted with water in the proportion of 1 to 60–100, in order to stain the sublimate preparation. In order to stain many sections at once, glass troughs 15 cm. long, 2·5 cm. broad, and 5 cm. high were used, and half filled with the staining solution. Herein, the preparations remained for 6 to 24 hours. Excess of the dye was removed with 90 per cent. alcohol, and after dehydration in 98 per cent. spirit and clearing up in xylol, the preparations were mounted in xylol balsam.

It is remarked that in the leucocytes found in the intestinal mucosa black granules become visible after treatment with osmic acid, but as these stained red after the foregoing solution, and were insoluble in ether and xylol, they could not be fat.

Investigation of Nervous Elements of Adductor Muscles of Lamellibranchs.*—Sig. R. Galeazzi made use of the following method in his investigation of the nervous elements of the adductor muscles. The muscles were placed in a mixture of one-third formic acid, and two-thirds water, in order to soften the connective tissue which surrounds the muscular bundles. After ten minutes they were washed with distilled water, and then cut into small pieces in the direction of the longitudinal axis of the muscular fibres; then were put into a 1 per cent. solution of chloride of gold, where they were left till they had a yellowish-orange colour. They were then placed in distilled water, to which a third part of formic acid had been added, and were placed in the shade; after 24 to 36 hours they were coloured dark violet. They were next placed in a mixture of water, glycerin, and nitric acid, and, after 24 to 36 hours, could be easily isolated in glycerin. This method is much to be preferred to that of making sections.

Preparing Musca vomitoria.†—For fixing the chrysalides of flies, Dr. J. van Rees coagulated the albumen by means of warm fluids, water, alcohol of 30 to 100 per cent., and weak chromic acid. Imbedding was effected in paraffin with benzin; sometimes 3 to 5 days were found necessary for saturating with paraffin heated from 52° to 58° C. Ranvier's picrocarmine and Flemming's hæmatoxylin did good service singly or combined, also double staining with hæmatoxylin and eosin, and lithium-carmine.

The logwood staining is made more effective by washing in slightly acidulated 70 per cent. alcohol, and the acid afterwards neutralized in ammoniated alcohol.

For examining the cutaneous muscular system of the larva or chrysalis the author belauds eosin dissolved in oil of cloves.

Examination of Thysanura and Collembola.‡—Dr. J. T. Oudemans dissected with needles living specimens of these insects, under the dissecting Microscope, but he examined them in 15–20 per cent. alcohol, and not in water. The tracheal system was studied in specimens opened in dilute glycerin. Other examples were hardened and cut into sections with Jung's microtome. Hardening was effected by warmed dilute picro-sulphuric acid (1 part acid to 5 parts water), and then by 80, 90, and 100 per cent. alcohol; another method, which had some advantages, was the use of 1 part alcohol 80 per cent., and 1 part alcohol 80 per cent. saturated with sublimate, and later, alcohol as before. To

* Arch. Ital. Biol., x. (1888) p. 389.
† Zool. Jahrb. (Anat. Abth.), iii. (1888) p. 1.
‡ Bijdragen tot de Dierkunde, xvi. (1888) p. 152.

insure rapidity of hardening it is well to remove a part of the chitinous membrane, after the animal has been for a few minutes in the fluid. Sublimate and alcohol with a drop of nitric acid were used for hardening the free enteric canal; for the examination of the eyes use was made of Grenacher's depigmenting mixtures. The staining of sections, which were fixed to the slides by Meijer's albumen, gave better results than staining the whole animal or parts thereof; Weigert's picrocarmine, alum-carmine, and others were used, but hæmatoxylin gave the best results.

Method of investigating Cyclops.*—In his researches into the morphology of *Cyclops* Prof. M. M. Hartog sometimes found it necessary to examine living specimens; undue pressure was avoided by putting under the cover a frond or two of *Lemna;* this arrangement has the advantage that by a push at the edge of the cover the *Cyclops* can be rolled over. The Abbe condenser was found invaluable. For dissection, French spear-head needles were used; the hard parts are best seen in water after treatment of the fresh animal with ammonia. For preservation Giesbrecht's method was used; staining was effected with Mayer's saturated tincture of cochineal in 70 per cent. spirit, or Kleinenberg's hæmatoxylin. For imbedding xylol was used, and paraffin little by little added. Hæmatoxylin is to be preferred for staining, but cochineal runs it close, especially when osmic acid has distinctly browned the specimen, the resulting colours varying from brick-red to chocolate-brown or violet, much like gold chloride. The last-named reagent was not very successful, owing to the tendency of the soft structures to shrink from the cuticle; for rapid staining diluted glycerin and picrocarmine is a useful medium.

Examination of Nematodes.†—Herr N. A. Cobb states that he obtained the most instructive results by dissecting Nematodes under the dissecting Microscope with a needle and a small knife about 1 mm. broad. It is best to cut along the lateral areas. For the examination of the central nervous system of the larger species he took about half a centimetre of the front end of the body and divided it by a longitudinal section in such a way as to get two lateral or, in other cases, dorsal and ventral halves. After removing the œsophagus the pieces were stained and imbedded in Canada balsam. In the case of the smaller free-living species, which it was impossible to dissect, they were either examined alive or after treatment with 1 per cent. osmic acid; the nervous system was most distinct after two or three hours' treatment. A compressorium was sometimes necessary; in its place the use of the following process was often found to be attended with good results. The worm was placed in a drop on a slide; two fine hairs were laid on either side of the drop, and over it a large cover-glass. If the drop of water was not sufficient to fill the space between the slide and the glass the animal could be squeezed between the slide and the cover-glass, and its position altered as might be required by moving the latter.

The preparation of good sections of large Nematodes is not easy, as, after imbedding in paraffin, the object becomes very hard, and sections difficult to cut; in fact, it became evident that good sections could not be obtained in the ordinary way. At last Herr Cobb set his razor perpendicularly to the path of the microtome and cut as quickly as possible;

* Trans. Linn. Soc. Lond.—Zool., v. (1888) pp. 2–3.
† Jenaisch. Zeitschr. f. Naturwiss., xxiii. (1888) pp. 42–3.

by this method he obtained bands consisting of perfect series. The sections were, almost without exception, treated by Schällibaum's method. Double-staining with hæmatoxylin and eosin sometimes gave good results, as did also those reagents with osmic acid added. The last reagent may be recommended for the nervous system, borax-carmine for the generative organs, gold chloride and hæmatoxylin with eosin for the cuticle. The reagents performed their work best when the preparations were placed in the warm oven. For the careful examination of the cuticle, and in the study of the ova, the author made use of a 2 mm. apochromatic immersion lens by Zeiss, the use of which he strongly recommends.

Preparing the Brain of Somomya erythrocephala.*—In order to harden the brain of *Somomya erythrocephala* Dr. J. Cuccati uses Flemming's mixture for 24 hours, or Rabl's fluid. In order that these may penetrate the head quickly he cuts away part of the cuticle and of the front of the mouth, and thus exposes the air-spaces in the head. In order to keep the heads immersed they were placed in test-tubes plugged with perforated discs of elder-pith. After hardening they were washed for a quarter of an hour, and then transferred to spirit of 36 and 40 per cent. for half an hour. This was followed by a mixture of spirit and chloroform for 12 hours. They were then imbedded in paraffin, and the chloroform slowly evaporated. The sections were stuck on with Meyer's albumen, then transferred to alcohol and water, and next stained with the following solution:—acid fuchsin, 3 grm.; distilled water, 100 ccm.; chloral hydrate, 1 grm. In half an hour they were stained, and then washed for 10 minutes in water, and having been dehydrated in alcohol were passed through oil of cloves and mounted in Canada balsam.

Preparing Megastoma entericum.†—Dr. B. Grassi and W. Schewiakoff, on examining *Megastoma entericum*, found that these endoparasitic Flagellata became detached from the epithelial cells of the small intestine (rats and mice), swam about, and died. They avoided this by scraping off the villi and teasing them out in an artificial serum composed of albumen 20 ccm., water 200 ccm., salt 1 gr. The animals were then killed in the vapour of osmic acid slightly warmed, and treated with a 10 per cent. soda solution, in order to examine the cilia, flagella, and undulating membranes. Staining of the nuclei was difficult, the best results being from Brass's acid carmine and hæmatoxylin. Previous treatment with Flemming's chrom-osmium-acetic acid was found to be advantageous.

Preparation of Muscineæ.‡—M. Amann prepares the peristome and leaves in the following manner. The two halves of the moistened capsule divided longitudinally are placed in a drop of a mixture of equal parts pure glycerin and strong carbolic acid. A cover-glass is imposed, and the slide heated with a spirit-lamp until the fluid boils and all the air-bubbles have disappeared.

Preparations thus mounted in carbolated glycerin may be preserved for years if kept in a dust-tight box, and the liquid which evaporates in the course of the first few days replaced.

* Zeitschr. f. Wiss. Zool., xlvi. (1888) pp. 240– (2 pls.). See this Journal, 1888, p. 944.

† Zeitschr. f. Wiss. Zool., xlvi. (1888) pp. 143–54 (1 pl.). Cf. this Journal, 1888, p. 599.

‡ Journ. de Micrographie, xii. (1888) pp. 527–9. Rev. Bryol., xv. (1888) pp. 81–3.

If a more stable mounting is desired, proceed as before, and then cover the specimen with a drop of carbolated gum, after which the cover-glass is put on. This medium is preferable to glycerin jelly, as it is manipulated cold. The gum is made as follows. Best white gum-arabic 5 grm., distilled water 5 grm. After the gum has dissolved add 10 drops of carbolated glycerin and warm gently until the fluid clears.

The author states that with a little practice very good sections can be made by merely placing the object moistened with water on the thumbnail of the left hand and chopping at it with a razor.

The sections are put in a drop of carbolated glycerin on a slide between two cover-glasses, and covered with a third cover-glass, so that the latter is supported by the two former. This renders their manipulation easy.

For bringing out the details of the structure of the peristome, and to distinguish certain cell-walls, the author uses a dilute solution of perchloride of iron (officinal solution of perchloride 1 part, distilled water 9 parts).

Clearing recent Diatomaceous Material.*—The preparatory clearing, says Mr. F. W. Weir, must of course vary with the nature of the material. A poor gathering, requiring a quart or two of material to commence with, and consisting chiefly of coarse sand, should be placed in a large pail of water, and stirred with a very rapid rotary motion, allowed to settle a moment, poured off and saved. This process should be repeated until the portion saved is sufficiently concentrated to be suitable for further treatment. If the collection is comparatively rich, and consists of the usual marsh deposit, it should be at once subjected to acid treatment, with, however, a thorough washing with salt. In order not to lose any diatoms it is often necessary to use the filter. For acid treatment the author prefers sulphuric acid and bichromate of potash. Place the wet material in a porcelain vessel; add about half as much powdered bichromate of potash as there is material; while stirring pour in sulphuric acid slowly, but with increasing rapidity. Allow the acid to cool, and pour into a gallon jar of filtered water. When thoroughly settled draw off the liquid with a siphon, repeating the process until the acid is entirely removed. If the acid clearing have been complete, there will now remain undesirable matter of three kinds, coarse sand, fine sand, and fine amorphous matter, which must be removed in three ways: coarse sand by centrifugal force, fine sand by friction, and amorphous sand by gravity.

Place a proportionate quantity of the material in a small tumbler; between the thumb and finger take a glass rod about 10 inches long, suspend with lower end in the glass, and by giving the hand a rotary motion in a small circle, cause the lower end of the rod to travel round the periphery of the bottom of the glass with the utmost possible speed. This keeps up the coarse sand in the centre, and the remainder may be drawn off before settling with a siphon applied to the edge of the bottom of the glass. Repeat the process until nothing but sand remains. Take the settlings and go through a similar process until sand no longer collects in the centre of the glass.

Now place the material in a wide-mouthed vial of suitable size. Fill the vial two-thirds full of filtered water and shake vigorously. Allow

* The Microscope, ix. (1889) pp. 1–4.

to settle for ten minutes, then draw off the water with the siphon and repeat the process until perfectly clear.

Next attack the fine sand. Take a shallow glass dish with very slightly concave bottom (a photographer's "bender" is most suitable), and place in it a quantity of the material not sufficiently great to heap up much. Separation is effected by rocking and tipping and shaking gently from side to side. As the diatoms are separated from the sand, draw them off with a pipette, add more water, and continue until none are left; repeat the process until all the sand is removed. Next allow to settle until all forms desired in a given settling are precipitated, draw off the water into a larger vessel, fill up the vial, shake and settle the same length of time as before, and continue until everything which will not settle in that time is washed out. The material will then be finished. Then take the residue, shake and settle longer, to deposit the next smaller forms desired. Proceed thus until all the forms are separated. If it be not desired to separate the different forms, but only to remove any fine particles which may remain, simply shake the vial vigorously, allow the material to settle until the Microscope shows that all the diatoms have sunk, siphon off the water and renew it, adding a few drops of ammonia, and repeat until all is clear, always replacing the filtered with distilled water in the last three or four shakings. As a mounting medium the author considers that styrax properly prepared is superior to any other and that no cement is better than hard oil finish. This, with the addition of finest dry lampblack, makes a cement that is not excelled.

Chitin Solvents.*—Mr. T. H. Morgan uses the Labaraque and Javelle solutions (potassium and sodium hypochlorites) for dissolving the chitinous parts of insects, so that they may be sectioned and rendered penetrable to staining fluids. The material, say the eggs of the common cockroach surrounded by the chitinous raft, is placed in the Labaraque solution, diluted five or six times, and slightly warmed for thirty minutes to an hour. The embryos are, after being well washed, then transferred to picrosulphuric acid, then to alcohols up to 95 per cent., then imbedded in paraffin cemented on the slide, and stained on the slide.

Corrosive sublimate and chromic acid were also used, but with less satisfactory results. Embryos transferred directly from Javelle solution to alcohol were nearly as good as those put through picrosulphuric acid.

BENDA, C. — **Makroskopische und mikroskopische Präparate für eine neue Härtungsmethode.** (Macroscopical and microscopical preparations for a new hardening process.)

Anat. Anzeig., III. (1888) p. 706.
(*Verh. Anat. Gesellsch. Würzburg.*)

GREPPIN, L.—**Mittheilungen über einige der neueren Untersuchungsmethoden des Centralen Nervensystems.** (Notes on some of the recent methods of investigating the central nervous system.)

Corrbl. Schweizer Aerzte, XVIII. (1888) No. 16.

MOSSO, A.—**Esame critico dei metodi adoperati per studiare i corpuscoli del sangue.** (Critical investigation of the methods used in the study of the blood-corpuscles.)

Atti R. Accad. Lincei—Rend., IV. (1888) pp. 427-33.

„ „ **Kritische Untersuchung der beim Studium der Blutkörperchen befolgten Methoden.** (Critical investigation of the methods used in the study of the blood-corpuscles.)

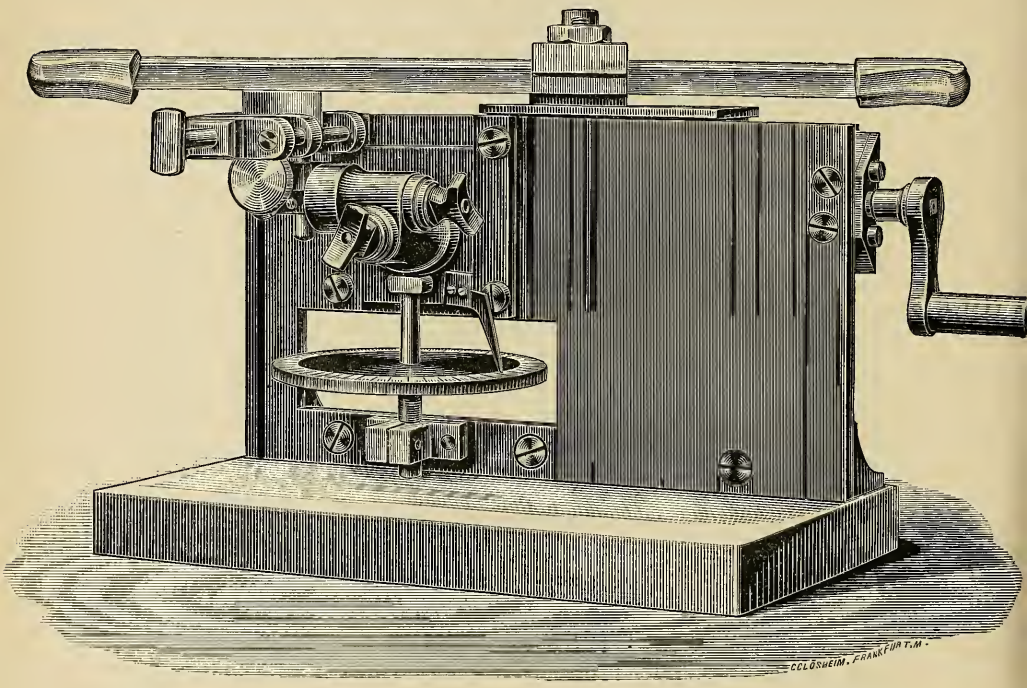
Virchow's Archiv, CXIII. (1888) p. 410.

* Amer. Mon. Micr. Journ., ix. (1888) p. 234.

(3) Cutting, including Imbedding and Microtomes.

Leitz's "Support" Microtome.—The speciality of this microtome (fig. 56) which is on the Schanze model, consists in the motion given to

Fig. 56.



the knife, which is not actuated by hand, but by the handle seen on the right, by which the knife is made to pass over the section.

Taylor's Combination Microtome.*—Dr. T. Taylor's microtome is adapted to three methods of section cuttings. The instrument is of metal screwed to a block of polished mahogany. There is a revolving table with graduated margin in the centre of which is fitted a freezing box having two projecting tubes, one to admit freezing water, the other as an outlet for it. The water is supplied from the reservoir and carried off by means of rubber tubing attached to these metal tubes, the terminal end of the outlet tube being furnished with a small glass tube, by which means a too rapid outflow of water is prevented. The tubes of the freezing box are so arranged as to prevent their revolving with the revolutions of the table.

When ether is used a little brass plug in front of the freezing box is removed and the rubber tubing detached.

In preparing to make sections, remove the freezing box altogether, and in its place substitute a cork, which projects suitably and presents the object from which sections are to be taken, imbedded in wax or paraffin,

* The Microscope, ix. (1889) pp. 4–5 (1 fig.).

at the proper angle to the blade of the knife, regulated by means of the finely cut screw-thread of the table.

The knife is curved, about five inches in length, and about one inch in breadth, ground flat on the under side, and held in position by a binding screw after the fashion of several microtomes now in use. A straight knife may be used if desired.

Substitute for Corks in Imbedding.*—Dr. G. C. Freeborn suggests as a substitute for corks, cylinders of white pine, one inch high, and varying in diameter from half to one and a half inches. These "deck plugs" offer the same advantages as corks for celloidin imbedding, but do not, like corks, get soft in spirit.

HUBRECHT.—**Demonstration des De Groot'schen Mikrotomes.** (Demonstration of the De Groot microtome.)

Anat. Anzeig., III. (1888) p. 722.
(*Verh. Anat. Gesell. Würzburg.*)

"**Microtomes** *ad infinitum* have been invented within the past few years for the purpose of more effectually slicing into infinitesimal and well-nigh invisible sections the 'harmless, necessary cat,' and other animals. This may be called the microtome era of microscopy—microtomes rival camera-lucidas in multitude."

Queen's Micr. Bulletin, V. (1888) p 32.

SCHIEFFERDECKER, P.—**Mittheilungen von den Ausstellungen wissenschaftlicher Apparate auf der Anatomen-Versammlung zu Würzburg und der 61. Versammlung deutscher Naturforscher und Aerzte in Köln im Jahre 1888.** (Notes on the Exhibitions of Scientific Apparatus at the Anatomists' Meeting at Würzburg, and the 61st Meeting of German Naturalists and Physicians at Cologne in 1888.)

[Contains especially notes on the various microtomes at the exhibitions.]

Zeitschr. f. Wiss. Mikr., V. (1888) pp. 471–81 (2 figs.).

(4) Staining and Injecting.

Carminic Acid Stain.†—Dr. G. C. Freeborn recommends Dimmock's solution for histological work. This is a 3/4 per cent. solution of carminic acid in 85 per cent. alcohol. The sections are stained in two to five minutes. If a pure nuclear stain be required, wash in 1 per cent. hydrochloric acid. The solution stains ganglion-cells very well if used in the following manner: sections of central nervous system are overstained in Dimmock's solution, and then washed in a 10 per cent. aqueous or alcoholic solution of the officinal solution of the chloride of iron. Herein the colour of the sections changes from red to black, and as soon as the hue alters to yellow, the section is washed thoroughly in water, dehydrated, cleared in origanum oil, and mounted in balsam.

By this process the nerve-cells and their processes are stained black, the intercellular substance being yellowish.

Staining Connective Tissue with Nigrosin (Indulin, Anilin Blue-black).‡—Dr. G. C. Freeborn recommends nigrosin for staining connective tissue. The solution used is made by mixing 5 ccm. of a 1 per cent. aqueous solution of nigrosin with 45 ccm. of an aqueous solution of picric acid. This makes a dark olive-green fluid. Sections are placed in this solution for three to five minutes, and then washed in water until their colour changes from a yellowish-green to a deep blue. The sections are then dehydrated, cleared in oil of cloves, and mounted in balsam.

After dehydration the sections may be double stained for five or six

* Amer. Mon. Micr. Journ., ix. (1888) p. 232.
† Ibid., p. 231.
‡ Ibid., p. 231.

minutes in a mixture of 1 ccm. of a saturated alcoholic solution of eosin and 49 ccm. of 97 per cent. spirit.

Sections by the first method show the connective-tissue fibres stained bright blue, nuclei blackish, all other elements greenish-yellow. In the second method the yellow colour is replaced by red.

Clearing and Staining of Vegetable Preparations.*—In his researches on the development of Vascular Cryptogams,† Dr. D. H. Campbell strongly recommends the practice of imbedding, and cutting with the microtome for similar investigations. In examining the structure of the megaspores of *Pilularia*, the spores were imbedded in paraffin, and then cut with a Cambridge rocking microtome. Schönland's methods, with some simplifications, were used in most cases, but in others the spores were gradually brought into clove-oil, and then into xylol instead of turpentine. This method requires little time, and often gives excellent results, but it is not always to be relied on, though in the early stages it answered very well, and the penetration of the paraffin was facilitated. When chromic acid mixtures were used, the specimens were brought gradually into absolute alcohol, which was then replaced by clove-oil, and finally by a saturated cold solution of paraffin in turpentine, before being placed in the melted paraffin. As a staining agent hæmatoxylin was used to some extent, but the best results were had with safranin and gentian-violet, the latter especially giving particularly beautiful colouring, the nuclei being much better differentiated than with the other colours.

Staining of Vegetable Tissues.‡—M. C. Sauvageau recommends the following process. If a section is treated with concentrated sulphuric acid, the cellulose-walls disappear almost instantly, while the intercellular cuticular coatings (the protoplasmic layer of Russow) remain unaffected, united to one another by the median lamellæ which separate two contiguous cells; but the rounded walls of the cells and of the intercellular canals have become rectilinear. After the action of the sulphuric acid, the delicate network which remains may be stained and preserved in the following way. If some grains of fuchsin are added to the sulphuric acid, the liquid becomes orange-yellow, or even dark brown if the quantity of fuchsin is sufficiently large. A drop of this liquid placed in much water gives it a rose-colour, like that given by a drop of fuchsin to alcohol. The very thin sections are laid in a drop of dark brown sulphuric fuchsin, and covered by a cover-glass. Some drops of water are placed by the side of the cover-glass, and a piece of blotting-paper—which should be made from flax, and not from cellulose, in consequence of the less action upon it of concentrated sulphuric acid—placed on the other side in order to remove the sulphuric acid and replace it by the water, and as this is gradually effected the orange-yellow colour turns gradually to red as if coloured directly by the fuchsin. The section is then composed entirely of the cuticular coatings of the aeriferous canals united by the median lamellæ. If the sections are treated with sulphuric acid and eosin, the cell-walls swell, and the cuticular coating is very clearly distinguished from the cellulose by its greater refringency. The parietal cytoplasm is coloured rose, and the punctations in the cell-walls are readily seen; there are usually one or

* Ann. of Bot., ii. (1888) p. 243.

† See *ante*, p. 254.

‡ Morot's Journ. de Bot., ii. (1888) p. 400.

two very narrow ones in the wall which separates two contiguous cortical cells, but the author has not seen them on the walls which separate cells from aeriferous canals. The observation is rendered easier by immersion for some moments in hæmatoxylin dissolved in alcohol; the protoplasm preserves the rose-colour given to it by the eosin; the cellulose swells and becomes light violet, and the cuticular coatings, the corners, and the median lamellæ are coloured dark violet.

Red Stain for Vegetable Sections.*—Dr. F. L. James says that a beautiful red stain for vegetable sections may be extracted from the parings of wine-sap and other red apples, by absolute alcohol. The paring of a single medium-sized apple gives about 1 drachm of a very deep ruby-coloured solution. The author has experimented but little with the stain, but can say that it is apparently stable.

Staining Bacilli of Rhinoscleroma.†—Dr. G. Melle advises the following new method for staining the bacillus of Rhinoscleroma. The sections are stained for 10–15 minutes in gentian-violet (2 parts gentian violet, 15 alcohol, 100 water), they are then immersed for 2–3 minutes in the iodine solution, and decolorized in absolute alcohol. Decoloration is completed by placing the sections for 1–2 minutes in a 30–40 per cent. nitric acid, and afterwards again in alcohol. The sections are next stained for 4 or 5 minutes in an aqueous solution of safranin. The bacilli are stained violet, and the ground tissue of the cells, &c., red.

By this method of staining the capsule environing the bacilli is not seen, and these are found in collections of 10–40 within the cells.

Injecting and Preparing the Circulatory System of Fishes.‡—For examining the circulatory system, says Dr. P. Mayer, injections are requisite. As the removal of coagula from the vessels of fishes is impossible, it is necessary to take special precautions. For killing the animals the author recommends fresh water, or a strong solution of potassium chloride in fresh water. Before the occurrence of rigor the animal must be cut through close behind the anus, and injected with distilled water or 10 per cent. alcohol. If the vessels be empty of blood the tissues may be allowed to relax, and then injected with soluble Berlin blue of the following composition:—1. Liq. ferri perchlor., 10 ccm.; aq., 500 ccm. 2. Ferrocyanide of potash, 23 g.; aq., 500 ccm.

No. 1 solution is poured into No. 2, and left for 12 hours, the yellow fluid is poured off, and the filtrate washed until it trickles through a deep blue. About 1 litre of injection fluid is thus obtained, and this will keep for about six months. As this gives a precipitate with salts and with blood, the vessel must be well washed out. A slight addition of acetic acid to the injection water is useful as in the presence of alkalies Berlin blue loses colour.

If a greater pressure than usual be required this may be obtained by inserting a 10 litre glass vessel provided with a manometer, in which the air can be compressed by means of a spray bellows. The caudal vessels were injected through the aorta by means of a conical glass cannula, and the superficial vessels from the venæ laterales cutaneæ. The injection completed, the vessel is plugged with a glass cone, and

* The Microscope, ix. (1889) p. 24; from 'National Druggist.'

† Resoconto d. Accad. Med.-Chi. di Napoli, 28 Aug., 1887. Monatschr. f. Prakt. Dermatol., 1888, p. 82.

‡ MT. Zool. Stat. Neapel, viii. (1888) p. 307.

the animal transferred to weak and afterwards to strong spirit. If the skin be softened for about 15 minutes in strong acetic acid, or brushed over with hydrochloric acid, it is easily scraped off, and from young specimens of *Scyllium canicula* can thus be obtained workable preparations of the superficial veins. If the lateral muscles be cut away and the rest mounted in balsam, the deeper vessels are obtained.

Of young animals decalcified with 90 per cent. spirit and nitric acid, sections 1/2 mm. thick are easily made. These are stuck on by Föttinger's method and then stained with weak acid carmine. If picric acid be added to the alcohol for washing and dehydration a picro-carmine stain is obtained. The relations of the valves must be examined in uninjected specimens.

Simple Apparatus for Injecting Fluids for Bacteriological Purposes.*—Dr. R. J. Petri's injector consists of three parts, a needle-cannula, a pipette, and a spray-bellows, the tube of which is fitted with a stopcock. The fluid to be injected is sucked up into the pipette, the needle is then fitted on the point, and the tube of the spray-bellows adjusted at the other end. The stopcock is turned off up till now. Then the web-covered ball is distended and the cock turned on. This is found to give sufficient force to inject 5 ccm. of fluid. In case of bellows not being at hand the fluid may be blown in.

Brücke.—**Ueber das Verhalten des Congo-rothes gegen einige Säuren und Salze.** (On the behaviour of congo-red with some acids and salts.)
SB. K. Akad. Wiss., XCVII. (1888) p. 5.

Dor, L.—**Méthode de Coloration rapide des Bacilles de la tuberculose et de la lèpre.** (Method of rapidly staining the bacilli of tuberculosis and leprosy.)
Lyon Méd., 1888, No. 18.
Centralbl. Klin. Med., 1888, p. 573.

Ferria, L.—See Griesbach, H.

Griesbach, H.—**Demonstration mikroskopischer Tinctionspräparate.** (Demonstration of microscopical stained preparations.)
Anat. Anzeig., III. (1888) p. 745.
(*Verh. Anat. Gesellsch. Würzburg.*)

„ „ **Kurze Bemerkung zu Dott. L. Ferria's Mittheilung: 'La colorazione delle fibre elastiche coll' acido cromico e colla safranina.'** (Short note on Dr. L. Ferria's article, 'The staining of elastic fibres with chromic acid and safranin.')
And reply by Dr. L. Ferria.
Zeitschr. f. Wiss. Mikr., V. (1888) pp. 486–90 and 490–1.

Klaatsch.—**Doppelfärbung von Ossifications-schnitten.** (Double staining of ossification sections.)
Anat. Anzeig., III. (1888) p. 722.
(*Verhandl. Anat. Gesellsch. Würzburg.*)

(5) Mounting, including Slides, Preservative Fluids, &c.

Fixing Objects to Cover-glasses.†—Dr. Von Sehlen fixes samples of fluids or any non-viscous matter to cover-glasses by means of albumen. The albumen mixture is made by mixing the white of an egg with an equal quantity of cold saturated boracic acid solution (about 4 per cent. of the acid). If after being kept a precipitate is thrown down, the solution is cleared by filtration.

The solution is merely dropped on a cover-glass, and then some of the material to be examined is intimately mixed with it. An even layer

* Centralbl. f. Bakteriol. u. Parasitenk., iv. (1888) pp. 785–7 (3 figs.).
† Ibid., pp. 685–7.

is then made in the usual manner, and the cover-glass dried in the air and fixed in the flame.

Glycerin Mounts.*—G. H. C. says that for this purpose it is best to use a cell made of hard rubber, unless the object be very thin, in which case cement cells may answer, but they should be at least two or three weeks old, otherwise the cement in drying may shrink, so that the cell becomes too small to contain all the glycerin, part of which may thus be forced out and rupture the mount. Clean the cover, and having centered the slide on the turntable run a ring of fresh cement tolerably thick around the top of the cell, and as quickly as possible put in the glycerin, about a drop more than enough to fill the cell up level. Run a needle around inside the cell to draw the glycerin quite up to the cement all round but not on to it, otherwise you may have trouble with bubbles. Put in the object and arrange it as quickly as possible. Take the cover between the thumb and the forefinger, wipe the cement, brush so that there is no excess of cement on it, and draw a ring of about 1/16 in. wide round the cover. Take it in the tweezers at the place where the cement is widest, not letting the points extend any further into the ring of cement than is unavoidable, breathe on the cover, invert it over the cell, and press down all round with a needle-handle. Rinse off the excess of glycerin with clear water and dry with blotting-paper. You may ring round afterwards or not as you please, but if you have been quick enough not to give the cement time to dry they will be tight and permanent.

Beck, J. D.—**A beautiful and durable Cement for ringing Balsam Mounts.**

["To a thick solution of gum arabic add a little glycerin to prevent cracking. Ring balsam mounts with this first, then finish with the cement coloured with magenta, or fuchsin, or the 'Diamond' black dye dissolved in water. Ornament with gold paint, &c., and finish with Winsor and Newton's mastic picture varnish. Try cement on a blank slide; if brittle when hard, add a little more glycerin, so that it will harden in twenty-four hours without brittleness."]

The Microscope, IX. (1889) p. 18.

Benedikt und Ehrlich.—**Zur Kenntniss des Schellacks.** (On shellac.)

SB. K. Akad. Wiss. Wien, XCVII. (1888) p. 127.

Cement ("inside") for Balsam Mounts.

[(1) Clear shellac cement, or colourless marine glue. (2) Seiler's gelatin cement.]

Queen's Micr. Bulletin, V. (1888) p. 45.

Dry Mounts. *Ibid.*, p. 25.

(6) Miscellaneous.

Practical Utility of the Microscope to Textile Workers.†—A question arising as to whether a large lot of yarn delivered at a mill equalled in quality the sample lot on which the order was based, tests were made as follows:—In lot No. 1, fifty fibres averaged under the Microscope 1/1265 in. in diameter. In lot 2, fifty fibres averaged 1/1260 in. in diameter. Of lot 1, thirty-six fibres, and of lot 2, thirty-five fibres, ranged in diameter between and including 1/1500 and 1/1200 in., showing a most remarkably close approach in quality of a large delivery to the sample order.

Sixteen loose outside fibres from a two-ply No. 40 worsted yarn,

* Queen's Micr. Bulletin, v. (1888) p. 42.

† T. c., p. 19.

averaged 1/833 in. in diameter, while ten ditto from a two-ply No. 28 worsted yarn averaged 1/833 in. Both yarns were from one spinner and both (as was afterwards discovered) made of three-eighths blood wool, which fact explains the exact correspondence in diameter as above.

The superintendent of one of the largest mills in New England uses the camera lucida for microscopic measurement of fibres, by a method effecting great saving of time and eyesight. His mill sorts wool into eight different sorts, and he states a good sorter has no difficulty in determining one quality from another, wherein the difference as between two sorts is measured by less than 1/1000 in. in average diameter of fibres, which fact he has determined with the Microscope. A large establishment giving him a sample of foreign cloth to duplicate, he ascertained by the camera lucida method the quality of wool in both warp and weft threads, and knowing from previous records the measurements of his own mill's sortings of wool, was thus enabled to pick out from stock on hand what would give, when worked up, a practical duplicate of the foreign fabric.

The condition as to health or disease in wool fibres, the freedom from or appearance of previous manipulation (as in shoddy yarns), the lumpiness apt to prevail in yarns constituted largely of noils (fine waste stock), the adulteration of yarns by the smuggling of cheaper materials into wool, silk, &c. (the Microscope led to detection of fifteen per cent. cotton in a so-thought worsted yarn), the source of foreign matters found on the face of cloth, as discovered when dyed, whether cotton off the spinning machinery or flax from the twine of the wool-sacks, or grasses from the sheep pastures, all these are matters largely determinable through the use of the Microscope, which it is considered will be more and more generally employed in textile industries, as competition becomes intense and general culture advances.

The writer concludes:—"As to the use of the Microscope on made-up goods this is microscopy in the gross, and is, I fancy, mainly confined to thread-counting. Consult some maker of fine cassimeres. A woman with a fifty-cent thread-counter can, I take it, distinguish much better as to the quality of two pieces of muslin or linen, by simply counting the threads to the quarter-inch, than she could by feel or naked eye."

Value of the Microscopic Analysis of Rocks.*—M. A. Renard in a lecture at the Royal Institution said:—"Our knowledge of eruptive rocks came to be enriched in an unexpected manner by the application of the Microscope to lithology. We need not here recall the almost marvellous results obtained by this method of investigation, inaugurated by Mr. H. C. Sorby, but we may say, in a word, that the microscopic analysis of rocks has changed the face of petrography. Let us confine our attention to some of the conceptions relating to modern volcanic rocks, as revealed by these new methods, methods which in delicacy, in certainty, and in elegance, are unsurpassed in any other branch of natural science. Not only have they enabled us to verify and control hypotheses, but they have led to the remarkable discoveries to which I am about to refer.

The eye, assisted even by the most powerful lenses, could recognize in lavas only those minerals which appeared in rather large crystals;

* Nature, xxxix. (1889) pp. 271–7.

chemical analysis generally gave merely the composition of the total rock, and its mineralogical composition was only suspected. The intimate texture of the rock remained impenetrable; it was impossible to determine with certainty the order in which the constituents of the molten mass had solidified; neither could we trace the various states through which the crystals had passed—their germs, primordial forms, and skeletons—or the aspect of the rock at different stages of its development.

Let us now apply the Microscope to the examination of a thin slice of lava, rendered transparent by polishing. The lavas, as we have said, may be compared to vitreous masses; but whilst in our artificial glasses we seek to obtain a pellucid and homogeneous product, the liquefied matter of volcanoes, when it flows forth, already contains certain differentiated products. The glass which contains these bodies may be regarded as the residue of the crystallization, whence the numerous crystalline individuals have extracted their constituent elements. In the black, brilliant, volcanic glasses, apparently opaque and destitute of crystallization, the Microscope discovers a world of mineral forms. It shows us their various states of growth, and the arrest of their development, consequent on the more or less rapid consolidation of the mass. It is especially in those rocks which, like obsidian, have preserved almost wholly their vitreous character, and are homogeneous to the naked eye, that we find the rudimentary crystals of curious form, representing the first step in the passage of the amorphous matter to the crystalline condition. Owing to the rapidity with which the vitreous paste consolidated, the crystals were unable to grow, and their development was sharply arrested. Hence the origin of these embryonic crystals which abound in natural glasses, and which we designate as *crystallites*. Analogous crystallites are produced in blast furnace slags, which have close relations to the matter of lavas. Their common origin is betrayed by certain family likenesses which the Microscope reveals. The slags, examined in thin sections, exhibit rudimentary crystalline forms, similar to the crystallites of volcanic glasses.

But usually the crystals have not remained in this embryonic state. If the lava has not been too rapidly cooled, the molecular movements are retained, even in a semi-liquid mass, and the paste developes crystals of minute dimensions, called *microlites*. These microscopic crystals are formed in the heart of the vitreous magma during its slow consolidation. Notwithstanding their infinite minuteness, these small polyhedra exhibit with marvellous exactitude all their specific characteristics, such as we are familar with in much larger crystals, and which we should not expect to find in lavas. They often form by their interlacement a beautiful network in the microlitic structure.

The dimensions of these microlites, invariably microscopic, and their arrangement, prove that they may be referred to a period of disturbance; that they were formed, indeed, at a time when the lava, though still in motion, was solidifying. They separated from the magma during the very act of outflow or eruption.

Besides these microscopic crystals and these groups of crystallites, which belong to the last stage of consolidation, the lava contains also a supply of larger crystals, more fully developed, and in many cases recognizable by the naked eye. These have been formed under calmer conditions, analogous to those presented by a tranquil fluid in which

crystallization is proceeding slowly. They were formed in the molten magma when it was still inclosed in the subterranean reservoirs. This slow growth is clearly proved by the formation of the crystals in concentric zones, and by their size. These large crystals, existing ready formed in the lava at thé time of its eruption, are surrounded by microlites or by a vitreous mass. It was after their slow development in the magma, during an intra-telluric period, that the mass in which they floated was upraised. The period of calm was succeeded by one of agitation, and the lava in its violent ejection carried forth the crystals, breaking them, corroding them, and partially fusing them. The Microscope offers distinct evidence of these phenomena. We see the large crystals dislocated and their fragments dispersed, their edges rounded and eroded, and their substance invaded and penetrated by the paste.

While the physical and chemical agencies brought into play by the movement of the lava thus attack the ancient crystals to the verge of demolition, the microlites are in course of formation. This vitreous matter, in which the large crystals float, solidifies as a mass of microscopic individuals. The latter are therefore related to a second phase of crystallization: they are developed in a moving viscous magma, and their further growth is arrested by the rapid cooling which induces solidification *en masse*.

The fluidal arrangement of the microlites distinctly shows, too, that the crystalline action was contemporaneous with the movement of the lava-flow. Indeed, we see in microscopic preparations that the microlites are accumulated around the large sections of crystals, forming wavy trains and presenting the arrangement which micrographers designate as *fluidal structure*. It is marked by the orientation of these infinitely small acicular crystals. When these streams of microlites meet the large imbedded crystals, they sweep round them, crowding into the spaces between the large sections, accommodating their flow to these outlines, and preserving for us the last movement of the mass at the very moment of solidification.

The Microscope, therefore, proves that crystallization in lavas belongs to two periods: the first, anterior to the eruption, during which the large crystals already found are suspended in a mass that we may regard as entirely vitreous; and the second period, when the microlites and embryonic crystalline forms are separated, dating from the ejection or outflow, and contemporaneous with the solidification of the rock.

From these microscopic observations on the crystals of the second period, we may conclude that they are formed purely and simply by igneous action, without requiring the hypothetical temperatures and pressures formerly considered necessary, and without that absolute repose regarded as needful for the regular crystallization of minerals. We see, indeed, that the microlites are formed after the outflow, at the normal barometric pressure and at a temperature far from being as high as generally supposed, and we witness the births of the crystals during the very flow of the lava stream. When the cooling is extremely rapid, the microlites have no time to form, and the lava can produce only crystallites.

But the Microscope enables us to determine the chronology of the crystals in lava in a still more detailed manner. We have already distinguished two great periods in their history; let us now indicate in

a general way how we may establish, to some extent, the date at which each species of the two groups is separated from the magma. Data leading to the determination of their relative age are afforded by their inclusions.

A crystal developed in a vitreous mass frequently incloses particles of the medium in which it grows. In this way certain sections under the Microscope appear penetrated with vitreous grains, imprisoned in the interior of the crystals and frequently arranged along the zones of successive growth. These inclusions prove that the crystals in question were formed in a vitreous mass, liquefied by heat. In other cases the inclusions are mineral species in the form of microlites; and it is clear that they must have been anterior in date to the mineral in which they are inclosed. Finally, in other cases, a species will mould itself around sharply defined crystals, conforming to other outlines, and filling up all the spaces between the minerals, thus showing that the crystals are of earlier origin than the surrounding mineral.

From these facts, which speak for themselves, we have been able to draw up chronological lists indicating the relative date of crystallization of each species of the two great periods. I will not stop to cite these lists, but we shall soon see how the law which governs the successive formation of the crystals, and their relative age, is evolved from synthetic experiments.

I have traced in broad outline the history of a lava, but have sketched only a few of the details which modern researches on lithological phenomena have developed with such startling reality; nevertheless, what we have seen is sufficient to show in a striking manner the power of analysis when supported by reasoning. I think I am not wrong in saying that from this point of view the study of a lava presents one of the finest examples of the application of the inductive method to the natural sciences. We hardly know whether to admire most the analytical processes, or the subtilty of observation, or the logical method by which the observed phenomena have been brought into connection.

Microscopic analysis, powerful as a method of investigation, has enabled us to trace, with close exactitude, the progress of crystallization in a rock where the unaided eye could discover only an indistinct and uniform mass; to penetrate into this marvellous tissue of volcanic products, where millions of polyhedra occur within the volume of a cubic centimetre; to determine, with mathematical precision, the nature of each of these infinitively small bodies; to track them to their birth, and follow them throughout their development, tracing all the modifications to which they have been subjected under the influence of physical and chemical agents."

"The great improvements in the construction of apparatus, and the application of the Microscope to lithology, have at length enabled us to successfully attempt the reproduction of all the modern volcanic rocks."

Microscopical Examination of Urine for Bacteria.*—Dr. von Sehlen recommends the addition of boracic acid to urine, as it does not precipitate the albumen, and acts as an antiseptic, thus preserving the urine and its sediment for future examination. The solution is made by dissolving 8 per cent. borax in hot water, then adding 12 per cent.

* Centralbl. f. Bakteriol. u. Parasitenk., iv. (1888) pp. 687-9, 722-4.

boracic acid, and afterwards 4 per cent. more borax. On cooling, the excess of the salt crystallizes out. In practice, 20 to 30 per cent. of this solution is added to the urine, so that the latter contains from 2 to 4 per cent. of boracic acid.

Action of Bleaching Agents on Glass.*—Prof. H. M. Whelpley calls attention to the fact that the ordinary bleaching agents employed in microscopy will corrode the glass of the solid watch-glasses sold for microscopic purposes. The action of those agents turns the glass opaque, and renders them unfit for use on the stage of the Microscope, where they are often employed, in low powers, in the examination of transparent bodies.

Micro-organisms of the Bible.†—C. W. S. points out that the lips are most sensitive to the reception of disease germs, and from the motly throng of dirty and diseased persons who appear in court and kiss the Bible, what infectious germs may not be obtained through this medium of distribution? It would be interesting for microscopists to examine such greasy and worn backs of court bibles as they can have access to, and to report the kinds and amounts of bacteria found thereon.

Certainly it is a wise precaution to keep court Bibles off the lips. Swearing with uplifted hand is not only safer, but more dignified.

In a Massachusetts school, where scarlet fever and measles had prevailed, some text-books fell into disuse, were put away for a time, and, when wanted, got out and redistributed, several months having elapsed. In but a few days after the reissue of the books the children began to be ill with measles. There can be little doubt that scarlet fever is transmitted in the same way.

Brown, F. W.—**A Course in Animal Histology. VIII.**
[Bone.] *The Microscope*, IX. (1889) pp. 47–51.

Freeborn, G. C.—**Notices of New Methods. VII.**
Amer. Mon. Micr. Journ., X. (1889) pp. 30–3.

Holway, E. W. D.—**[Use for the Microscope during the winter months.]**
["Some time spent in collecting through the other seasons would have provided beautiful objects in abundance."]
The Microscope, IX. (1889) p. 24, from 'Swiss Cross.'

Prize offered to Medical Microscopists.
[Dr. L. D. Mason, Vice-President of the American Association for the Study and Cure of Inebriety, offers a prize of one hundred dollars for the best original essay on "The Pathological Lesions of Chronic Alcoholism capable of Microscopic Demonstration." The essay is to be accompanied by carefully prepared microscopic slides, which are to demonstrate clearly and satisfactorily the pathological conditions which the essay considers. Conclusions resulting from experiments on animals will be admissible. Accurate drawings or photomicrographs of the slides are desired.]
St. Louis Med. and Surg. Journ., LVI. (1888) pp. 26–7.

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* The Microscope, ix. (1889) p. 25, from 'Meyer Bros.' Druggist.'
† Amer. Mon. Micr. Journ., x. (1889) p. 41.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Dick and Swift's Patent Petrological Microscope.†—Mr. A. Dick describes this Microscope (fig. 57) as follows:—

"Many years ago I requested Mr. Swift to make for me a first-rate Binocular Petrological Microscope. The centering of the stage by screws was, I suppose, as good as it could be made. I found it unsatisfactory when using high powers on small crystals. A centering nosepiece answered no better. Only by the simultaneous rotation of the polarizer and analyser by hand, little by little, could I keep the interference figures of small crystals in the field of view, or feel certain that the figures had not left it during rotation owing to the eccentricity of the centering. By small crystals I mean crystals under 1/1000 in. in diameter, and of such thickness as one finds them at the edges of petrological sections. Results obtained thereby were only slowly got, and always with some uncertainty. I tried the Nachet Microscope, but found it a cumbrous instrument. Latterly, I connected the polarizer and eye-piece analyser by a jointed rod, and got thereby excellent results, whilst I could still retain binocular vision for all but certain observations.

I suggested to Mr. Swift that he should manufacture a more perfect Student's Microscope than any now obtainable; one which would suit alike the mineralogical, petrological, botanical, or medical student. Having agreed upon the design of the instrument, I left to Mr. Swift the carrying out of the details, which he did in an ingenious manner and with excellent workmanship. When the Microscope was finished I went over it carefully, and handed it to several friends interested in such matters for suggestions, all of which have been carried out. You see the result in a small Microscope where there is little lumber and much capability of good work. Its interest to the Mineralogical Society lies in its adaptation to the study of the optical properties of minerals generally, and particularly to that of the thin plates of minerals seen in ordinary sections of rocks prepared for microscopical examination. For this purpose the analyser and polarizer are connected together by toothed wheels. They can thus be turned together in any position relatively to one another—crossed, parallel, or inclined—each nicol being so fitted that it can be set in any position. The wheels can be clamped in any position. The tube of the Microscope is of the ordinary construction. Within the lower part of it is a sliding tube which carries a sliding plate. In the plate are three circular openings, of which the central one is always open. In one of the other openings is fitted a Klein's plate; in the other a lens. The lens can be easily removed and another of different focus put in its place, according to the purpose for which it is to be used.

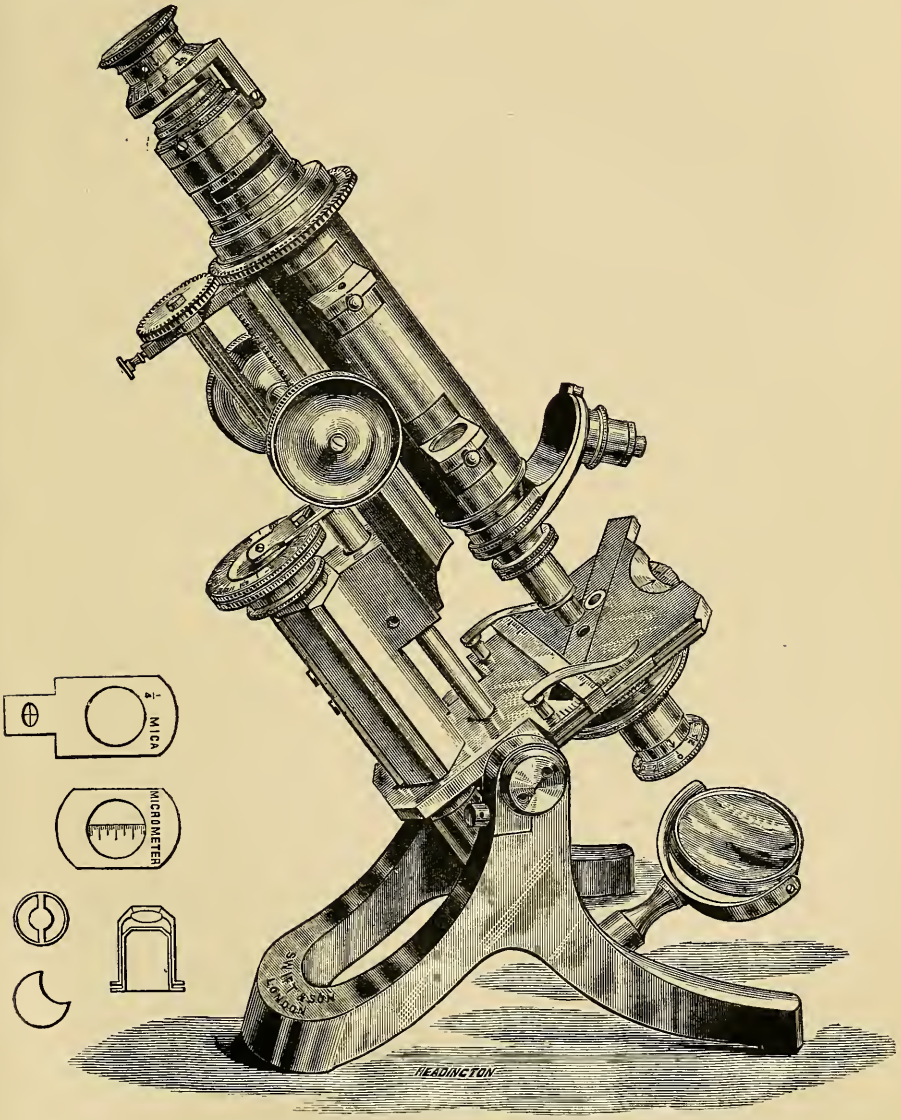
The lens of shorter focus brings interference figures into the eye-piece, where the *dispersion* may be studied, and also where the apparent angle in air of a biaxial crystal may be approximately measured, if the

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Mineralogical Magazine, viii. (1889) pp. 160–3.

section is large enough to fill, or nearly fill, the field. For this and other purposes, a micrometer can be pushed into the eye-piece. In the instrument now described, with a B eye-piece, 50° of the scale between

Fig. 57.



the optic axes are equal to an apparent angle in air of 69½° for muscovite. Exact measurements must, of course, be made by means of a stage goniometer.

The lens of longer focus is intended for use without the eye-piece, to enable the observer to see the interference figures (generally only the axial shadows being visible) by looking down the tube, when a 1/10 or 1/12 in. objective is used on very small crystals, in convergent light, between crossed nicols.

There is a weaker lens for the same purpose fitting into the top of the tube, which can be used with a 1/4 or 1/6 in. objective by those who, like myself, cannot see the figures without some aid.

The eye-piece, when in use, turns with the polarizing apparatus. It contains the usual cross wires, and has an adjustment to enable an observer to focus the wires or the micrometer alluded to above. A quarter-undulation plate of mica or a wedge of mica or quartz can be pushed through the eye-piece at 45° to the direction of the cross wires.

When the eye-piece is not in use its place can be taken by a fitting which carries the analyser and the weakest lens alluded to above. The condenser of the instrument consists of a lens screwed upon the top of the polarizer, which slides up and down. The lens is suitable for all objectives up to the 1/2 in. For higher powers and interference figures a small hemispherical lens is fitted into the stage and can be pushed into the axis of the instrument when required. The upper surface grazes the lower side of the glass slip carrying the object. The focusing is done by raising or lowering the polarizer carrying the aforesaid lens. This arrangement is found to work admirably.

The rotation of the eye-piece and polarizing apparatus is measured on a circle graduated to degrees, but by using a pocket-lens a good reading to half a degree can be obtained, and a fair reading to a quarter of a degree, nearer than which extinctions or angles cannot be measured, even under the most favourable circumstances.

When the indicator is at zero on the graduated circle the cross wires are upright and horizontal as the observer looks into the instrument. If the polarizer is in its catch any suitable crystal with straight extinction will be at the maximum darkness when parallel to either cross wire. If Klein's plate be now pushed into the tube of the Microscope, and the analyser turned in its fitting till the crystal and the field are of one uniform warm blue tint, it will be found that the nicols are accurately parallel. The nicols can then be turned parallel to one another by the toothed wheels. This is almost the only use I have found for the Klein's plate. I wished to put it aside altogether from a student's instrument, but Mr. Swift informed me that a Microscope, to be used even occasionally for petrological investigations, cannot be sold without such a fitting, buyers requiring it though they do not appear to make any use of it. It must be regarded as part of the little lumber which it seems this instrument must possess.

If the mineral with straight extinction is not lying parallel to either cross wire, it will be found that when the wheels are turned the crystal will be extinguished when either of the wires becomes parallel with it. If the mineral has an oblique extinction a reading of the circle must be made when one or other wire is parallel to one of the edges or lines of the crystal, and another reading after continuing the rotation till the maximum extinction is attained. The rotation is then continued through 45°, and a mica- or quartz-wedge pushed through the slot in the eye-piece to ascertain the direction of the major or minor axis of elasticity and its inclination to the edge or line if desired.

It is with the use of convergent light for interference figures that the accuracy and simplicity of this instrument become apparent. No centering being required, it is evident that an interference figure once seen will remain in the centre of the field during the entire rotation. If it passes out of view it is on account of the nature of the figure. Even in the case of the smallest crystals, no doubt is ever left in the mind of the observer whether the figure may not have disappeared owing to imperfect centering.

I have placed on the table two typical sections. The one contains large and well-defined crystals of augite, olivine, and felspar, from the Lion Haunch, near Edinburgh. It will be seen that by pushing any crystal towards the centre of the field till the angle to be measured touches the intersection of the cross wire, a reading of the angle is obtained. Pushing the crystal into the centre of the field, and examining it by convergent light under a high power, it is easy to ascertain the direction of the line joining its optic axes if they can be seen in the section. This is noted, and one of the cross wires brought parallel to it. A reading of the circle is then made, and the rotation continued through 45°. The high power is then replaced by a lower power, and the strongly converging upper lens of the condenser is pushed out so that the mineral may be examined in less strongly convergent light for the purpose of ascertaining in what direction compensation is obtained when the mica or quartz wedge is thrust through the eye-piece parallel or at right angles to the optic axial plane, inclined 45° to the planes of the crossed nicols. By thus studying the emergence of a bisectrix it is seen whether it is positive or negative. The other section consists of a Scotch hornblende-schist. The greater part of the section consists of water-clear granules of quartz and felspar, containing amongst the mosaic a number of well-defined crystals of rutile, and an immense number of less well-defined crystals of some mineral showing very dark borders, due to the fact that its refractive index is much higher or much lower than that of the mosaic. All the grains, except the hornblende and some parts of the mosaic, are under the 1/1000 of an inch, piled upon one another, for the section is a rather thick one except at the edges. In this section are two small grains, one of which shows the emergence of one optic axis of a felspar, whilst the other shows the cross of quartz cut nearly perpendicular to its principal axis. Close to it lies one of the still smaller grains of the more or less highly refractive crystal. It lies flat, gives straight extinction, and shows the nearly perpendicular emergence of an optic axis. I think the mineral is epidote, but draw attention to it merely to show the ease with which interference figures can be studied. To a petrologist accustomed to a rotating stage and fixed cross wires, a familiar section looks strange when first looked at on a fixed stage with movable cross wires, but after a few hours' work with the instrument, the feeling of strangeness passes, and that of the solid advantage of a perfect centering alone remains.

There is one fact which I should allude to in connection with the small interference figures seen on looking down the tube of the Microscope. It is, that the spot of light at the back of the objective in which the figures are seen rotates slightly when the wheels are turned. This is due to its being seen by the extraordinary ray. It may be regarded as a blemish, but is of no practical importance.

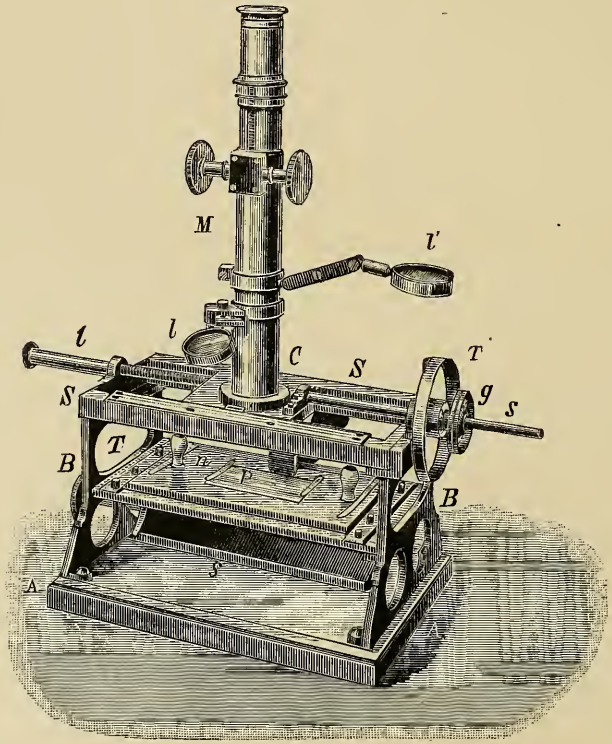
Beneath the stage is a universal fitting, whereby any substage

arrangement may be applied for special studies. In this paper I have confined my description to those concerned in the application of the Microscope to mineralogy and petrology."

Konkoly's Microscope for observing the Lines in Photographed Spectra.*—Fig. 58 represents the apparatus devised by Dr. N. v. Konkoly on the type of Hilger's instrument for the same purpose.†

A A is a nickeled cast-iron base on which are mounted the two perforated supports B B; these are united by the two frames T and S, of which the former serves as object-stage, while the latter carries the Microscope M. The frame S carries the slide C between swallow-tail

Fig. 58.



guides, and upon C the Microscope is fixed by three tension- and three pressure-screws. *s* is the steel screw which moves the Microscope, and the nut which propels it is the nave of the drum T', which is turned by the milled head *g*. The screw terminates in a sphere which is inclosed in a socket upon the slide C; the screw is prevented from turning in the socket by a pin, which does not, however, fit into a hole as is usually the case, but into a slightly elongated slit, so that the screw, with a

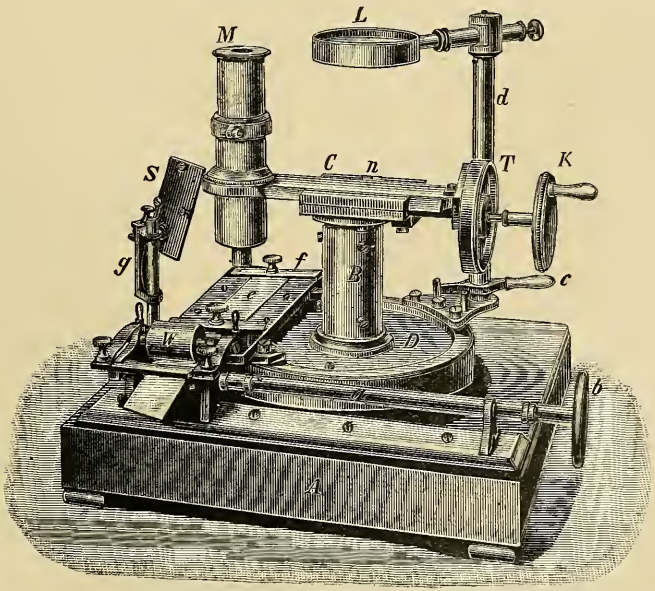
* Central-Ztg. f. Opt. u. Mech., viii. (1887) pp. 241–2 (1 fig.).
† See this Journal, 1887, p. 461.

little play, is able to follow the inequalities of the coarser parts of the apparatus (e. g. the guides S). Backlash is prevented by a spiral spring which is partly inclosed in the box *t*; this spring is made of greater length than usual, so that within the limits of its action there shall be no appreciable variation in the resistance; the author considers that the large resistance exerted at the beginning of its action by the spring as usually made causes great wear and tear of the micrometer-screw and its bearings, while at the end the resistance is so weak that the drum tends to leave its abutment. In this instrument the drum is a fixture upon the frame S. The drum is divided into 100 parts; the divisions are read by the lens *l'*, and whole turns are registered upon a millimeter scale, which is read by the lens *l*.

The stage T carries a frame which is moved between swallow-tail guides by a fourfold screw of steep pitch (not shown in the figure) in a direction perpendicular to that of the slide C. Upon this frame the negative is placed, and is held by two clips. *p* is a special stage designed to carry the smaller sized negatives of siderospectrographs. By means of the sliding stage different spectra, which have been photographed upon the same plate, can be brought under the Microscope in succession; the negatives are illuminated from below by an adjustable mirror.

Konkoly's Microscope for Reading the Knorre-Fuess Declinograph.*—Dr. N. v. Konkoly describes this as follows:—Screwed to a

Fig. 59.



mahogany base A is a massive brass disc D, on which is the column B; the latter consists of a tube 3 mm. in thickness, in which a rod is free to

* Central-Ztg. f. Opt. u. Mech., viii. (1887) pp. 217–8 (1 fig.).

turn, and is clamped after adjustment by means of six screws. On this rod is the guide of the sliding piece C, which carries on its left-hand side the Microscope M, having cross-wires in its eye-piece. The slider C and Microscope M are moved by a micrometer screw with drum T, which is divided into 100 parts. The drum is turned by a milled head, into which the ivory handle K is fitted for rapid movement. At *n* is a scale on C, which serves to read the whole turns of the drum. Under the Microscope is the carrier for the strip of paper. With Knorre's system the declination differences are recorded upon a paper ribbon, similar to that of the Morse telegraph, by means of a needle which moves with the micrometer, the zero point being marked by a fixed needle. The carrier consists of a brass plate having a groove which is of exactly the same breadth as the ribbon, and about 1·5 mm. deep, this depth corresponding to the thickness of the glass plate *e* which rests in the groove. This plate carries two brass plates, one of which is visible at *f*, and each of these has at one end a hole which fits over a pin in the carrier. The glass plate presses the ribbon to the bottom of the groove, so that the distance between it and the Microscope is always the same; the brass plates carry two knobs by which the glass plate is lifted. The ribbon passes between two rollers, the upper of which W is pressed by two springs against the lower, which is turned by the spindle *a* and milled head *b*. S is a mirror attached to a universal joint at the head of the column *g*, which serves to illuminate the ribbon. L is the reading lens held by the rod *d*, which can be turned in its socket on D by means of the handle *c*, and provided with two stops which bring it into position either over the scale *n* or the drum T.

Leitz's No. 1 Stand.—This is essentially a reproduction of the Zeiss form. Herr Leitz, however, was one of the first of the Continental makers to supply a rack movement and centering screws to the Abbe condenser.

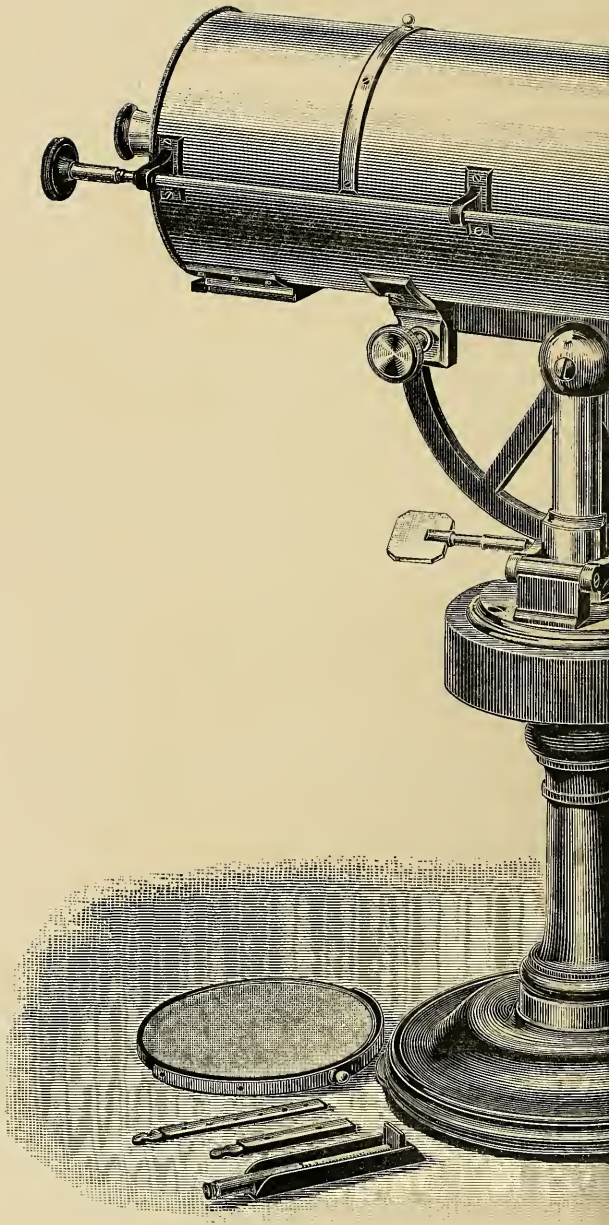
Adams's large Projection and Compound Microscope.—Plate IX. shows a Microscope of unusual design, bearing the inscription "Adams, inventor, London," which appears to have been intended to be used (1) as an ordinary compound Microscope, and (2) as a projection Microscope.

The body-tube is about 7 in. diameter and 24 in. in length, and is supported on an arc-piece toothed on the edge, in which engages an endless-screw for inclining the instrument more or less in the vertical plane. The base and pillar are of wood.

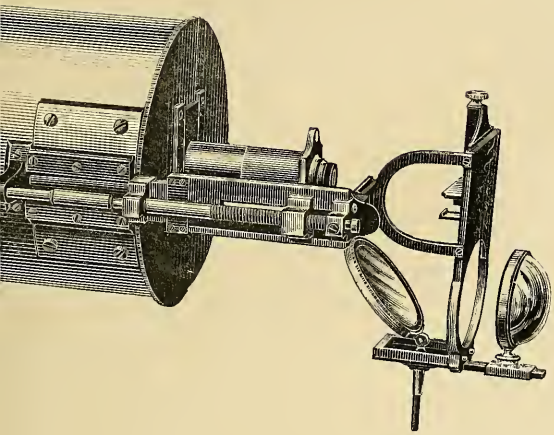
The focal adjustment is effected by an external screw and rod acting on the stage-support, after the manner of the usual focusing movement applied to reflecting telescopes of the Gregorian or Cassegrainian form.

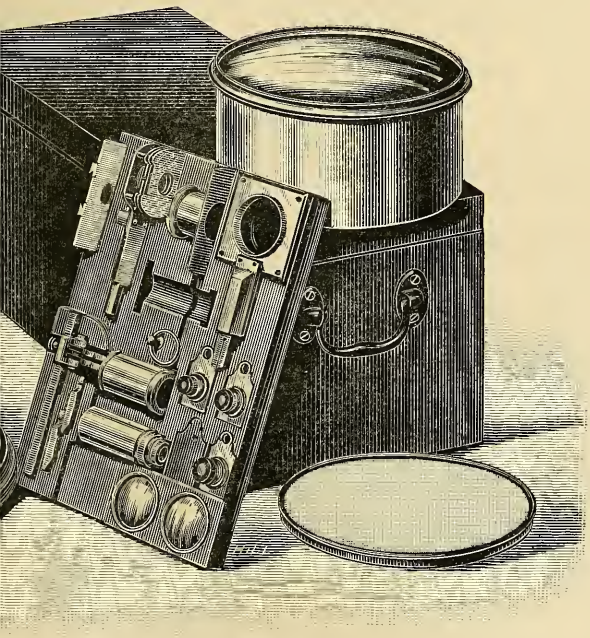
For viewing images on a screen the eye-piece was removed and a disc of ground-glass was inserted in a slot in the body-tube, and when more of the object was required to be seen in one view it is presumed that the ground-glass was removed from the slot and the large double-lens, shown on the box, was applied at the eye-piece end and the image projected through it upon a disc of ground-glass fitting on the end of the cylindrical mount of the double-lens.

The stage figured upon the instrument was for viewing opaque objects; the condenser in front collected the light upon the mirror, which was inclined suitably to reflect the rays upon the object.



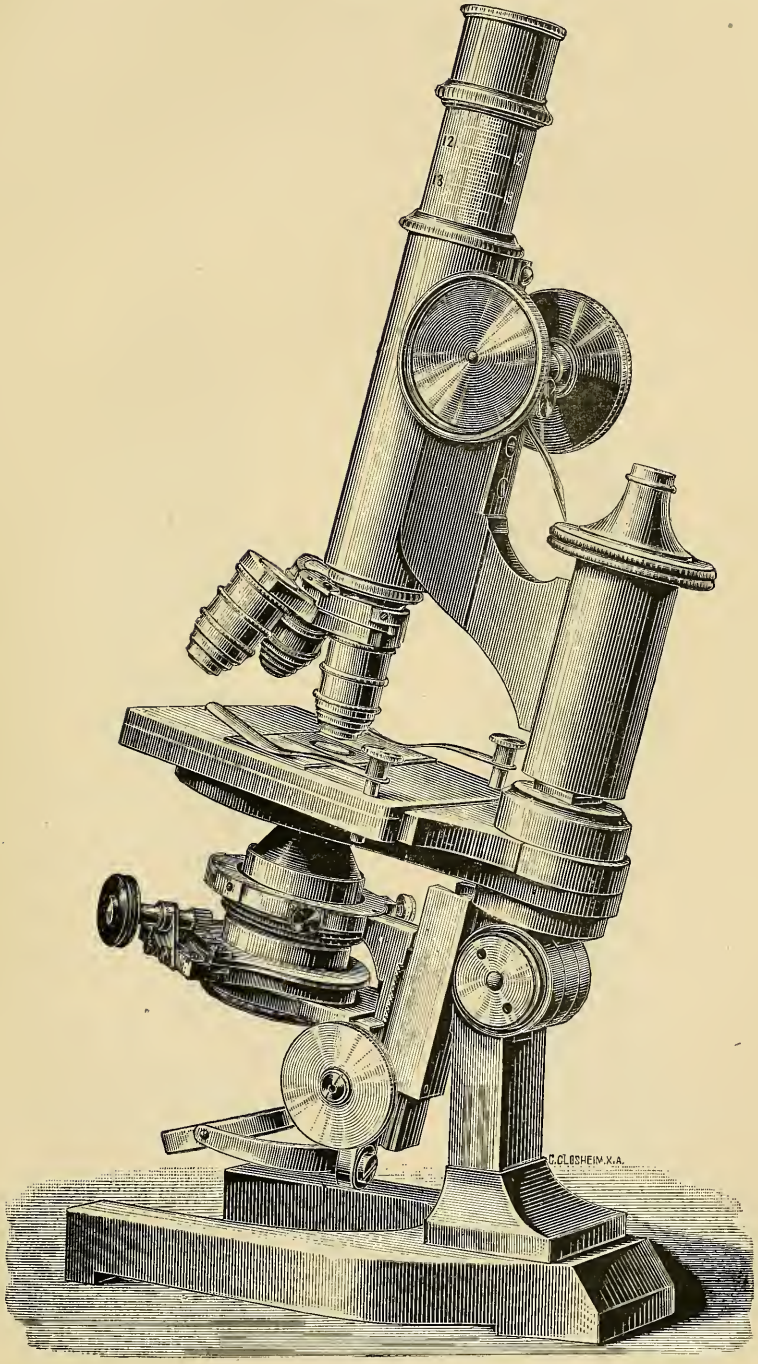
Adams's Large Projec





ompound Microscope.

Fig. 60.



Leitz's No. 1 Stand.

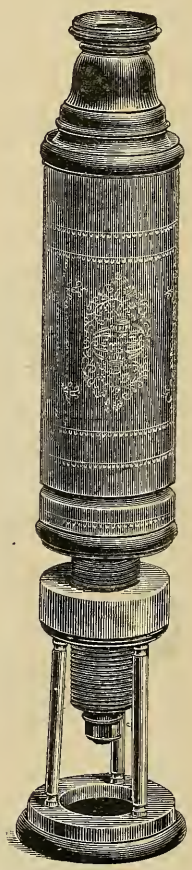
Two additional stages were employed for large or small transparent objects, various condensers being applied beneath. Fifteen simple-lens object-glasses formed the optical battery.

Charles I. Microscope.—At the recent Stuart Exhibition a Microscope exhibited was thus described in the catalogue :—" 389. *Microscope*, covered with gilt leather, which belonged to Charles I. Lent by Hon. A. Holland Hibbert."

By the courtesy of the owner we secured a photograph of the Microscope, whence our fig. 61 is engraved. The owner informs us that the

Fig. 61.

Fig. 62.



instrument descended to him "from an ancestor, Francis Rogers, for some time Keeper of the Wardrobe to Charles I."

As Charles I. died in 1647, the Microscope should represent a type of extremely early construction. In our opinion, however, though we have no difficulty in considering the instrument to date from the latter

part of the seventeenth century, the type of construction is too modern for the pedigree assigned to it by the owner.

The construction of the eye-piece is peculiar: the field-lens is fixed on the top of the body-tube, and the eye-lens is in the outer tube sliding over the body-tube, so that the distance between the eye-lens and the field-lens can be varied.

We may remark that the first application of a field-lens to the eye-piece of a Microscope that we have hitherto found recorded is in

Fig. 63.

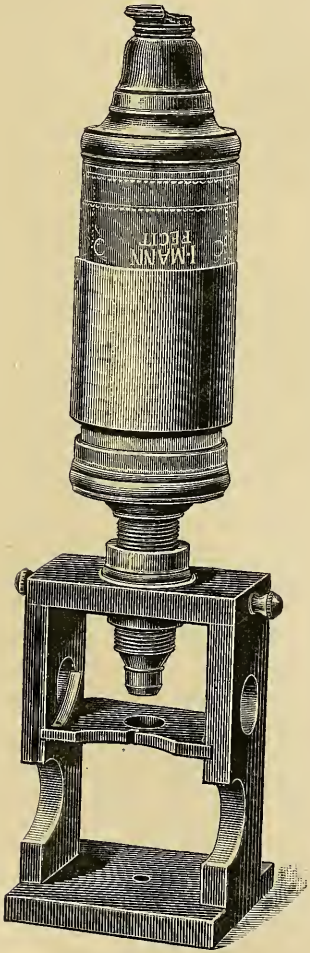


Fig 64.

Monconys' 'Voyages' (Lyon, 1665, 4to), where the editor (M. de Monconys' son) mentions that the first Microscope of this kind was devised by M. de Monconys about ten years previously, and was made at Augsburg.

Hooke appears to have first suggested the use of a very large field-lens, as described in his 'Micrographia' in 1665.

The system of eye-piece shown in the so-called Charles I. Microscope was (we believe) devised by Homberg, the well-known member of the *Académie des Sciences*, and the instrument was first figured in an Italian work (which we have repeatedly cited in this Journal) entitled 'Nvovi inventioni di tvbi ottici,' a communication to the *Accademia Fisico-matematica*, of Rome, in 1686, by Ciampini, the then editor of the *Giornale de' Letterati*. [We note in passing that Ciampini's authorship of the work in question is alluded to by Langenmantel in the *Miscell. curiosa*, 2nd Decade, 7th year, 1689, p. 444, and also in Bonanni's 'Micrographia curiosa' (Rome, 1691, 4to), p. 15.]

From the similarity to the figure of Homberg's Microscope, an instrument in the collection of M. A. Nachet has been identified, in which the peculiar construction of eye-piece above noted obtains. The identification of a number of other Microscopes of similar construction follows as a matter of reasonable probability, and we have thought the present a favourable occasion to notice a few of them (from Mr. Crisp's Collection).

Fig. 62 shows a "Homberg" Microscope acquired in Groningen, Holland, which differs from the "Charles I." instrument (1) in being covered with gilt parchment instead of leather, (2) in having a "set-nut" or clamping screw-ring to correct the tendency of the body-tube to shake in the thin screw-socket in which the focusing screw acts.

Fig. 63 shows a similar Microscope, formerly belonging to George III., but with a (probably) modern base-support, in which a mirror was fixed.

Fig. 64 shows a "Homberg" Microscope, formerly belonging to Pope Benedict XIV., having a small disc object-stage with a slight range of motion in the opening of the base, with a clamp-screw beneath. This instrument shows that the viewing of opaque objects was principally intended.

"Duc de Chaulnes'" Microscope.—We gave on p. 118 a figure of one of these instruments, which we examined in the *Museo di Fisica*, Florence, the specialty of which was evidently the verification of micrometric measurements.

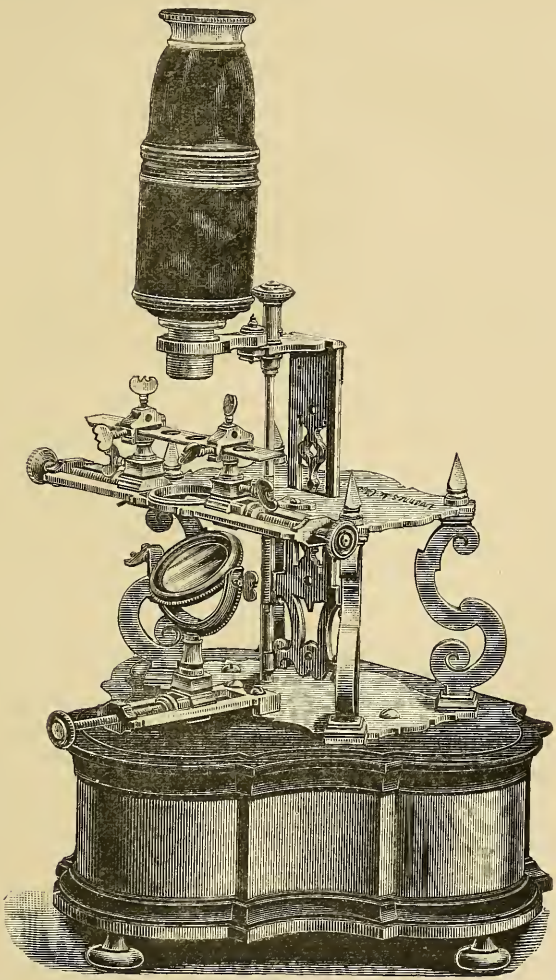
We here give a figure of a Microscope (fig. 65) we obtained in Naples, which is remarkable (1) for its ornate character, and (2) for its general resemblance to the Duc de Chaulnes' Microscope, though the aim of the construction probably differed considerably.

It bears the inscription, "D. Joannes de Guevave F. 1752," at which date even the best Microscopes were seldom provided with any form of mechanical stage. This instrument, however, has object-carriers, consisting of two short pillars travelling laterally, actuated by screws in grooves right and left of the stage; the upper ends of the pillars are pierced to allow the slide to be adjusted and clamped. The body-tube pivots laterally, so that, in combination with the stage movements, every portion of the object can be viewed successively. The mirror is also mounted on a short pillar moving forward or backward in a groove actuated by a screw in front.

In the general construction, stability seems to have been a very secondary consideration, whilst the ornamentation was elaborated with special attention. The body-tube is of tortoise-shell and ivory, and the shaped box base is of inlaid wood.

The peculiarity of the stage having four scroll supports, as in the Duc de Chaulnes' instrument, suggests the influence of one design upon

Fig. 65.



the other, and we have therefore ventured to classify the Microscope under this heading.

Müller, K.—**Die Verwendbarkeit des His'schen Embryographen.** (The utility of the His Embryograph.) *Naturwiss. Wochenschr.*, II. (1888) No. 22.

(3) Illuminating and other Apparatus.

Rogers' Eye-piece Micrometer.*—Dr. R. H. Ward describes a form of eye-piece micrometer devised by Prof. W. E. Rogers.

* 'Remarks at the Microscopical Section of the Troy Scientific Association,' 1889, February 4th.

"The whole scale (fig. 66) is divided to 1/100ths in., leaving the field nearly unobstructed and free from the confusion effect of crowded lines; and these wide divisions may be used (taking advantage of the middle lines in the subdivided spaces as a means of reading halves)

FIG. 66.

with low powers where close work is not required. But every fifth space is subdivided into ten, or 1/1000ths in., and by using these divisions for decimals, or these for units and the broad spaces for tens, one may gain the precision of the finer scale with almost the facility of the coarser. With a 1/10 in. objective the coarse spaces may be made, with a moderate use of the draw-tube, to cover 1/10000 in., and to read, with the assistance of one of the fine bands for tenths, 1/100000 in. A slight change of tube-length will give with equal facility a reading by 1/4ths of a micron (μ), or even 1/5 μ for easier relations to decimal notation.

Thus an average human blood-disc may reach from the line marked 2 in the cut to about the 9th line in the fine band *a*, giving two tens and nine units (29) by direct reading in 1/100000 in. Likewise a disc of dog's blood may reach from line 2 to the 7th line of *a*, of beef's blood from 2 to the 3rd line of *a*; or of sheep's blood from 1 to the 9th of *a*; reading respectively 27, 23, and 19 one-hundred-thousandth of an inch. Thus it would be easy to distinguish between all these except the first two, and possible in that case, if we were certain as to the true averages, and sure, which is more than doubtful, that the averages themselves may not vary enough to obliterate the narrow margin between them.

Any one who can subdivide the smallest spaces to tenths, with the eye, can of course read in millionths of an inch, or in fortieths μ; but few persons are likely to go, at any advantage, beyond the record of the finest lines. These appear wide enough apart to estimate in fourths

or fifths. But this becomes difficult if not futile on account of diffraction, imperfect definition, inequality in the illumination of the scale and of the object, parallax from tremor in both apparatus and observer, and error in making optical contact between the margin of the object and the line from which measurement is to begin; elements which bring a large personal equation into the case, as they vary greatly according to the capacity of individual workers and the quality of their outfit.

The above is intended to show what can be done by a skilful person with good but commonplace apparatus. The ruling may cost perhaps a couple of dollars, and a high-power ocular to carry it, about twice as much. The objective required for the work is not of unusual power or quality; and any small, plain Microscope of fair quality and good fine-adjustment, can be employed, a lengthening tube being improvised if there be no draw-tube. A screw-movement to adjust the lines in the ocular to the image of the object, or else a mechanical stage for adjusting the object to them, will be of great assistance; but as the latter, of efficient character and applicable to the most unpretending stands, can now be made for 18 dollars, it is not a very unreasonable luxury."

Glass versus Metal Micrometers.*—Prof. M. D. Ewell writes:—"I think most persons who use stage micrometers in the ordinary way, prefer to have them covered, on account of there being less danger of injury and their always being ready for use. When my experience was less than it is now, I remember attempting to clean a really excellent micrometer by Prof. Rogers, 1 cm. long, ruled the whole length to 0·001 mm. I found out that it was uncovered *after* I had scoured the lines vigorously. It was *then clean*, but that was its only remaining recommendation.

Prof. Rogers has experimented much to avoid the sweating that so often obscures the lines when the cover-glass is secured in place by any kind of cement. The most successful method, I think, has been to rule the scale on a cover-glass and mount it with the lines downward, upon a thick ring perforated, so as to allow a free circulation of air. This, again, has its peculiar disadvantages, as I have learned *after* the point of my objective (a 1/25 Spencer) had gone through the cover. The lesson was more impressive after I had paid Mr. Spencer's bill for re-centering the front lens. Micrometers so mounted are very fragile, unless the cover-glass is too thick for ordinary use. In a later communication I shall describe a device of my own to prevent the sweating above alluded to.

Another disadvantage of micrometers ruled on glass is the fact that there is always more or less uncertainty as to their staying qualities for some time after they have been ruled. This, so far as I have observed, is peculiar to all lines ruled on glass; for I have observed them not only in scales ruled by myself, but on those by Prof. Rogers and Mr. Fasoldt. I do not say that this is universal, but it happens often enough to make the possessor sad. The makers are not be blamed for this; for it seems due to an infirmity of the material. The only remedy is to let scales on glass season for an indefinite time, like thermometers, before issuing them.

My own judgment is that the very best scales are ruled upon metal.

* The Microscope, ix. (1889) pp. 43–5.

These can be depended upon. I have never seen one deteriorate by simple lapse of time. But these have their disadvantages. They cannot be used with transmitted light, as can scales ruled on glass. Still this difficulty is not insurmountable. I use up to 400 diameters the opaque illuminating objectives made by Bausch and Lomb, which give excellent results. With higher powers, up to 1/18, I have used with satisfaction Prof. Smith's vertical illuminator, with a bull's-eye condenser to concentrate the light. With a very high power, a 1/18 Zeiss', draw-tube drawn out full length, amplifier and high eye-piecing, I have never yet, on my standard centimeter on speculum metal by Prof. Rogers, been able to see anything but clear sharp edges to the lines, saving now and then a little pit in the metal. Of course, I understand that no *practical* use can be made of so high a power. I refer to its use simply to show the character of the lines. Any one who has used a glass micrometer with *very* high powers will agree with me in saying that in this respect they are vastly inferior to those on speculum metal.

In order not to change the tube-length, when measuring miscellaneous objects, such as blood-corpuscles, &c., I had Mr. Bulloch make for me an adapter or nose-piece of the same length as my Smith's illuminator, also made by him, which I screw on to the front of the tube, in place of the illuminator, when I desire to measure transparent objects. This sort of combination is, in my judgment, the very best that can be used. Metal micrometers have the disadvantage, however, of costing more than scales on glass; for such a scale should be ruled on a carefully prepared surface, which of course adds to the expense.

Now as to covering micrometers, in consideration of the disadvantages incident to covered scales, I would recommend the use of a scale uncovered. If desired for use with a homogeneous-immersion objective, it can be used with a large temporary cover, which can be held down with a mere dot of mucilage or water, not enough to reach the lines. It should not be rubbed, but may be kept sufficiently clean with a camel's hair pencil. I say *sufficiently* clean, of malice prepense; I now think that no one but an amateur with very little experience, will be annoyed by a little dust on a standard when used with a dry objective. If it becomes too thick, it can be removed with a camel's hair pencil. If used with an immersion objective, of course the top of the temporary cover should be clean. I find a little dust a real convenience, as facilitating the finding and focusing of the lines. A really fastidious person should use "Centimeter A" for a time. Its surface, the last time I saw it, was in places seamed and furrowed, like the track of a glacier. But enough of it is perfect for any sort of use, and its lines cannot well be excelled. Its correction for total length is very small, and its second mm. has practically no error.

Of course a micrometer in its ultimate subdivisions, such as are usually used in determining the value to be assigned to one division of the eye-piece micrometer, should have an error so small as to be practically insensible, or its error should be well determined. I have never yet seen, nor do I ever expect to see, a scale in *every* part absolutely free from error. I undertake to say that such a scale cannot be made by any living man, but the absolute and relative errors of a scale can be determined within very narrow limits, and a scale can be made, the errors of whose ultimate subdivisions are practically insensible. Such a micrometer is practically perfect. In a future communication, should the

subject be thought of sufficient importance and interest, I will describe the process by which any good observer, who is the owner of a filar micrometer, and who knows the correction for total length of his micrometer, and last but not least, who has sufficient patience, can determine the errors of any subdivisions small enough to be brought within the field of his Microscope."

Micrometer Measurements.*—Dr. M. D. Ewell, referring to his advocacy of the use of metal micrometers *uncovered*, recommends that if such a temporary cover should be used, it should always be used under precisely the same conditions, and the observer should be quite sure that both faces of such cover are parallel, otherwise the influence of refraction, the cover acting as a prism at some part of its surface, might introduce errors of unknown magnitude. For this reason, on further reflection, he thinks it better to have a permanent cover on micrometers intended for use with high power objectives, and to have the corrections of such micrometer determined with such cover *in situ*.

This leads him to notice a table of measurements published by Mr. C. Fasoldt.† intended to invalidate the result of the investigation of Centimetre Scale "A" of the American Society of Microscopists, and its so-called copies, by the different observers who have investigated them. As to this Dr. Ewell says:—"Mr. Fasoldt does not in his published paper give sufficient data to enable one intelligently to criticize or judge of the accuracy of his work; but there is one element of uncertainty about it that seems quite patent, viz. that it does not appear that the glass disc upon which the lines were ruled had either surface plane, or that the two surfaces of the disc were parallel. If nothing else appeared, to my mind the fact that the space was measured with different sorts of illumination, and with the lines first downward and then upward, thus introducing *unknown errors* due to the causes above specified, would deprive the results of any value they might otherwise possess. There is no means of intercomparison and of eliminating these unknown errors.

I cannot ascertain, however, from the paper, with what standard the 4/10 in. was compared, or exactly how it was compared. If, as I suppose, it was compared with the screw of a screw stage-micrometer, which was assumed to be a constant, I must beg to dissent from any conclusion thus obtained. I find it necessary, in ruling standards of any considerable length, to assume a value for the screw, rule a trial scale, and by actual comparison with some *authentic* standard deduce therefrom a series of corrections before ruling the final scale. If great accuracy is desired, it may be necessary to repeat this several times before ruling the final scale; and this is the case notwithstanding the errors of the screw have previously been carefully investigated. I would never trust any screw or train of wheels as a final *standard* of reference for more than about one-half the field of the Microscope, much less for so long a space as 4/10 in."

Klaatsch's Radial Micrometer.‡—The radial micrometer of Dr. H. Klaatsch consists of an eye-piece micrometer-disc, not only subdivided along the usual straight line, but traversed by two diameter lines cutting each other at right angles, and both of which are subdivided. In two

* The Microscope, ix. (1889) pp. 74-6.

† See this Journal, 1888, p. 814.

‡ Anat. Anzeig., ii. (1887) pp. 632-4.

out of the four radii thus produced the divisions are interrupted for a distance of 10 division lines from the centre. The image is thereby rendered clearer in the centre. Besides these divided radii there are four undivided ones, each of which bisects a quadrant. One octant also is subdivided by radii into 10°, 15°, and 20°. To this division of the micrometer-plate corresponds a lithographic chart, which is used in the preparation of the drawing to be made. While the apparatus enables an object to be measured in various directions, by the aid of the paper

Fig. 67.

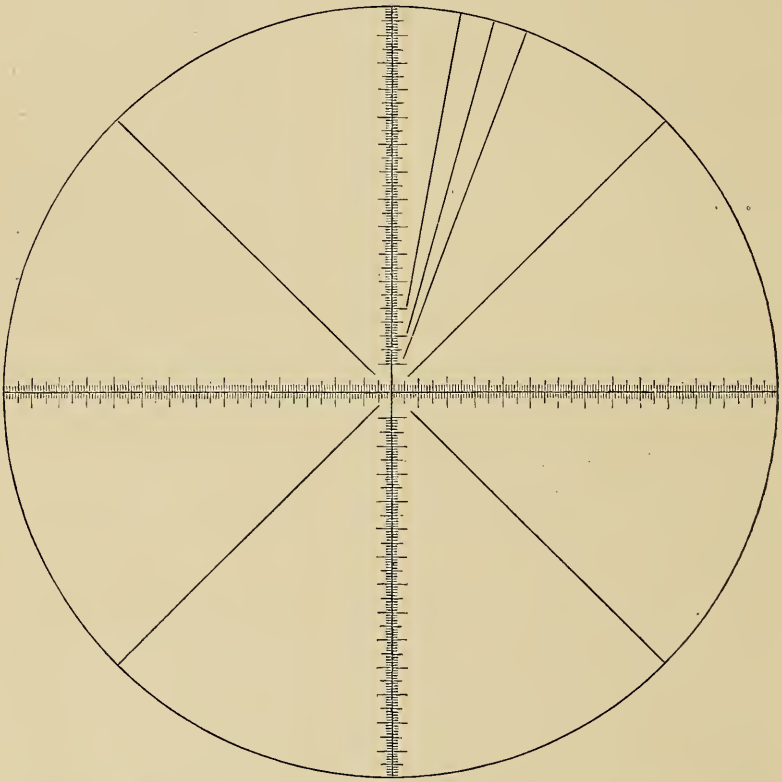


chart it allows the sketch of an accurate drawing to be made. When once from the first position five points (at the centre and on the four radii) are accurately determined, the ocular is turned, so that the undivided radii pass through the points of the preparation through which the divided radii previously passed. Thus four more points are obtained, and if these should not suffice for the sketch the radii of the octant can be made use of to obtain fresh points. In a similar way angles can be measured.

Krysinski's Eye-piece Micrometer and its uses in Microscopical Crystallography.* —The method proposed by Wertheim in 1862 for

* Zeitschr. f. Krystallogr., xiv. (1888) p. 17.

measuring the dihedral angle of microscopical crystals depends on the principle that the angle of inclination of two planes can be easily calculated when the positions have been determined of six points in space, of which three (not collinear) lie in one of these planes. For the measurement of the rectangular co-ordinates of these points, Wertheim used (1) an eye-piece with cross wires; (2) a fine division on the head of the micrometer screw of the Microscope; and (3) an object-stage movable by screws in two directions at right angles.

Dr. S. Krysinski considers that the practical application of this method can lead to no accurate measurements. In the first place the x and y co ordinates cannot be exactly determined, since they are measured by turning the screws on the movable stage, by which no precision can be obtained. The addition of stage micrometer screws would render the instrument too costly and complicated. To avoid this difficulty he proposes to use the screws only for producing the movement, and to effect the measurements by means of the eye-piece. For this purpose the eye-piece micrometer of Hartnack has been modified in the following way.

On the eye-piece fitting, about 12 mm. from the lower end, is a metal drum, 55 mm. in diameter and 10 mm. in height, which consists of two cylinders rotating in one another, of which the under is rigidly connected with the lower end of the eye-piece, while the upper, connected with the upper part of the eye-piece, is movable on the under part. In this under part are fixed the cross wires, and in the upper, just above the cross wires, the micrometer scale. This scale, movable to and fro in a guide by means of a projecting screw, consists of a right-angled triangle, of which one of the sides containing the right angle is exactly ten times as long as the other, and is divided into 100 equal divisions, with each division mark perpendicular to it, and equal in length to the shorter side. It follows from this construction that the segment of the division line cut off between the hypothenuse and the long side is equal to a tenth part of the corresponding segment of the long side. By means of two indices on both parts of the drum and catch-spring, care is taken that the long side of the scale can be brought at once into a position parallel or at right angles to one of the cross wires. Lastly, on the periphery of the drum is a corresponding vernier.

If the size of the microscopical object to be measured does not exceed the value of ten divisions, the measurement is effected by first bringing the long side of the scale into exact coincidence with an edge of the object, and then by means of the screw parallel to the long side pushing the scale along until its hypothenuse cuts the object in the diametrically opposite point. The division mark of the scale passing through this point of contact then gives directly the length of the object. This kind of measurement, which the author distinguishes as "Einkeilung," is executed on any given point of the field of view. When, however, the diameter of the object exceeds the length of ten divisions the long side must be brought into coincidence with it, and the length read off directly. On account of the unreliability of the table supplied by opticians, the author strongly insists that a table of values of the scale divisions should be independently made out for each objective.

The author then describes in what way with this instrument the x and y co-ordinates of a point in space can be easily and simply determined, and then the z co-ordinate by means of the micrometer-screw

of the Microscope. The directly found value of the z co-ordinates is the true one, only when object and objective are in the same medium; in any other case the directly found value must be multiplied by the ratio of the refractive indices of the media. The co-ordinates of the six points and the angle required are connected in the most general case by the following equations:—

$$a = y_2 z_3 - y_3 z_2 + y_3 z_1 - y_1 z_3 + y_1 z_2 - y_2 z_1;$$
$$b = x_3 z_2 - x_2 z_3 + x_1 z_3 - x_3 z_1 + x_2 z_1 - x_1 z_2;$$
$$c = x_2 y_3 - x_3 y_2 + x_3 y_1 - x_1 y_3 + x_1 y_2 - x_2 y_1;$$
$$a_1 = y_5 z_6 - y_6 z_5 + y_6 z_4 - y_4 z_6 + y_4 z_5 - y_5 z_4;$$
$$b_1 = x_6 z_5 - x_5 z_6 + x_4 z_6 - x_6 z_4 + x_5 z_4 - x_4 z_5;$$
$$c_1 = x_5 y_6 - x_6 y_5 + x_6 y_4 - x_4 y_6 + x_4 y_5 - x_5 y_4;$$

and

$$\cos \lambda = \frac{a a_1 + b b_1 + c c_1}{\sqrt{a^2+b^2+c^2}\ \sqrt{a_1^2+b_1^2+c_1^2}}.$$

In conclusion it is pointed out that the instrument described above is very convenient for measuring plane angles. This is simply effected by successively bringing the long side of the scale into coincidence with the two arms of the angle: the difference of the vernier readings in the two cases gives the value of the angle required correct to three minutes.

ENGELMANN, T. W.—**Over electrische verlichting by het Mikroskoop, met demonstraties.** (On electric illumination with the Microscope, with demonstrations.) *Handelingen v. h. I. Nederl. Natuur- en Geneeskund. Congres te Amsterdam.* Op. 30, IX. en 1. X. 1887, p. 129, Haarlem, 1888.

"Loiterer in a Microscopist's Laboratory."—Notes on the Substage Condenser, with special reference to that of Prof. Abbe. *Amer. Mon. Micr. Journ.*, X. (1889) pp. 55–60 (1 fig.).

"Struggling Microscopist."—The most useful Condenser for modern objectives. *Engl. Mech.*, XLIX. (1889) p. 196 (1 fig.).

(4) Photomicrography.

Moeller's Photomicrographic Apparatus.* — Dr. H. Moeller's camera (fig. 68) is similar to the one suggested by Harting, without bellows, and with which the eye-piece is used. It differs from it, however, in being fixed directly to the Microscope without any stand of its own. As the stand and fine-adjustment have thus to support the weight of the camera, the latter must be made as light as possible. To this end it consists of a four-sided wooden frame, of the shape shown in the fig., covered with light-proof dark cloth. At the lower end is a socket which slides over the eye-piece, and carries in its upper part a diaphragm disc which rests closely on the upper surface of the eye-piece, forming thus the point of support for the camera and a light-proof connection. For the sake of lightness the plate-holder is made of pasteboard with two easily moving shutters. The height of the camera is 21 cm., and its weight about 445 grm., which is so slight as to have no injurious effect on the micrometer screw.

On the subject of making use of the Microscope stand as a support for the camera, the author mentions that this was the case with the older apparatus of Gerlach, in which the weight was so great that a special

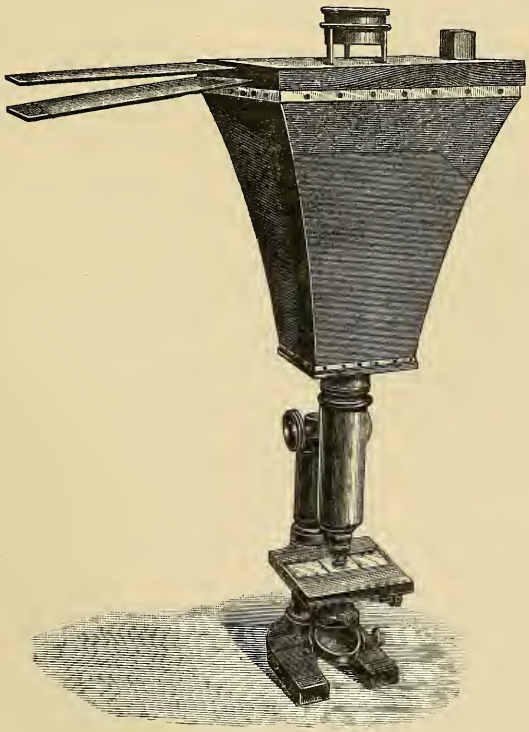
* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 155–65 (1 fig.).

catch had to be added in order to prevent the sinking of the tube. For this reason a separate stand was soon employed, which had, however, the effect of introducing objectionable complications, viz. a difficulty in adjusting the light-proof connection between Microscope and camera, and in avoiding shakings which affected unequally the two parts of the apparatus. The author considers that to the latter cause is to be ascribed a very large proportion of the failures in photomicrography, and from this his apparatus is free.

As the source of illumination, the author employs almost exclusively the Welsbach incandescent gaslight. The lamp is placed as near as possible (20–25 cm. in front of the mirror), and always without the interposition of lenses, so that the object is illuminated by transmitted light. The objection made by Neuhauss to the use of transmitted light, that shadows and coloured margins were produced, was not borne out by the author's observations.

Another source of error, however, viz. the difference between the visual and chemical foci, must in all circumstances be taken into account. This difference varies considerably for lenses of different construction:

Fig 68.



in immersion lenses it is so small as to be negligible, but the lower dry objectives show it without exception and require corresponding correction by the use of monochromatic-blue light.

The focal adjustment of the image in the camera is made on a glass

plate placed in the frame of the plate-holder after drawing out the two shutters and putting a 50 grm. weight on the opposite side to prevent the camera from tilting over. The figure represents the apparatus during the adjustment.

A simple method for determining the correct time of exposure was communicated to the author by Dr. Knoevenagel, of Linden, near Hanover; it consists in partially drawing out the under shutter after certain intervals of time, whereby the object to be photographed is brought upon the same plate under three or four different times of exposure. As an explanatory example the author takes the case of a very dark green preparation, using a dry objective which for a clear colourless preparation required an exposure of an hour's duration; the under shutter, before the beginning of the illumination, is drawn out a third, again a third after the expiration of an hour, and quite drawn out after a further half-hour, after which the exposure is continued for another half-hour; thus, on the plate there will be parts of the picture under one, one and a half, and two hours' exposure.

The power of accommodation of the human eye is a trouble to the maker and observer of photomicrographs. The eye sees, in fact, several planes, of which the plate only fixes one; thence arises the practice of the microscopist of rapid up-and-down focusing, by which an impression of relief is given to the object. In the appearance of a photograph there is thus something lacking which gives rise to a feeling of discontent until one has learnt to look at it in the right way. It is a matter of general experience that the drawing of a microscopic object often leads to a correct observation of it; for, whether consciously or unconsciously, it is possible to draw together in one plane images seen in different planes. If it is desired to demonstrate any one detail of a certain small part of a preparation, it is therefore desirable to make a drawing as well as a photograph.

Bézu, Hausser, and Co.'s Photomicrographic Apparatus.*—MM. Bézu, Hausser et Cie. have just brought out a photomicrographic apparatus (fig. 69), of which the following is a description:—

It is constructed on the vertical system, and is composed of three parts. The first is a strong stand, made of oak plank, 55 cm. long and 45 cm. broad, supported on four cast-iron feet about 20 cm. high. In the middle of this oak stage is placed the Microscope upon a copper stand with four legs, and this is moved up and down by means of a screw placed between the legs. The Microscope is firmly fixed to the copper stand by jamming the horse-shoe between grooves and holding it in position by a screw behind.

To the oak stand is fixed the table carrying the camera. This table is made of oak planking 35 cm. long and 25 cm. broad, and its legs of cast iron are 45 cm. high. At its centre is a circular aperture for a copper tube lined with black velvet. In the latter the Microscope tube works.

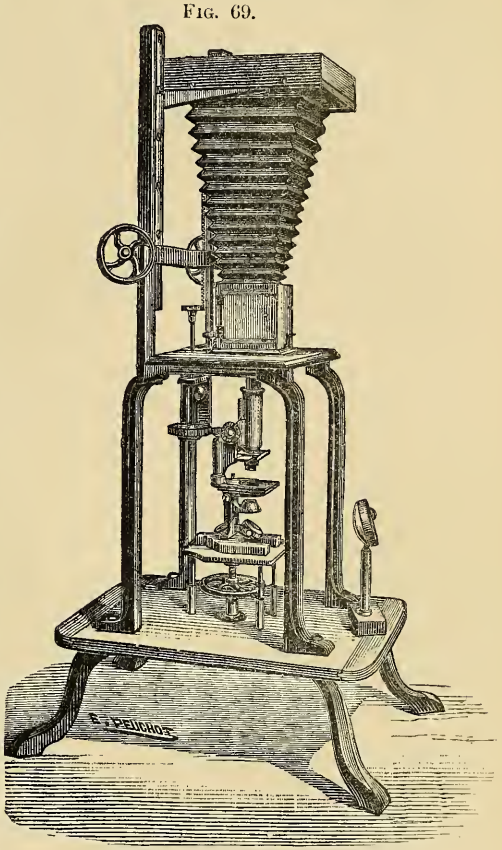
The camera is composed of three parts: a cubical box, the sides of which are 12 cm., a bellows, and a frame for the opaque glass screen. The latter is kept in position by two iron supports, which are really continuations of the hind-legs of the table, and moved up and down by a rackwork arrangement. When the bellows is fully extended the diameter of the image is 18 cm.

* Journ. de Micrographie, xiii. (1889) pp. 189–91 (1 fig.).

In order to examine and focus this image there is at the lower part of the camera a small shutter, behind which is a hole filled in with opaque glass. At the bottom of the camera-box is a mirror, which by means of a lever can be inclined at an angle of 45°, and the image thereby thrown on the small plate of opaque glass. It is then focused in the usual manner.

If considerable amplification of the image and high magnification be necessary, the focusing must be done directly on the large opaque screen. For this purpose a special arrangement is necessary, in order to be able to work the fine-adjustment. The milled head of the fine-adjustment is replaced by a toothed one. The stand which supports the camera is perforated by a cleft, into which fits a metal piece capable of vertical and horizontal movement. Connected with this piece is a rod, which, passing through the table, ends in a wheel, the teeth of which gear with those of the head on the fine-adjustment. The upper end of this rod also carries a head, and by turning this fine focusing is effected.

Fig. 69.



Schmidt and Haensch's Apparatus for Photographing the Tarnish Colours of Iron Surfaces.*—The researches of Martens show that correct pictures of the micro-structure of iron can be obtained by allowing a perfectly level weakly etched iron surface to tarnish at a high temperature, and observing it under the Microscope. Wedding found that the details of the micro-structure are brought out in a much higher degree if the iron surface is inclined obliquely to the axis of the Microscope. The same should apply to the taking of a photomicrograph of the surface. The camera which Schmidt and Haensch employ to this end is a bellows camera, which can be drawn out to a length of 1 m. The Microscope belonging to it has a low magnification, giving a field of view of about 16 sq. mm. The stage can be fixed obliquely to the optic axis of the Microscope by a mechanical contrivance. In this oblique position it is clear that only one line across the field of view will be sharply defined, and in order, then, to keep the stage and object

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 225-6.

at right angles to the axis of the Microscope, and, notwithstanding, to be able to observe and photograph the object in oblique reflected light, Messrs. Schmidt and Haensch insert between the object and the objective a glass plate inclined at an angle of 45° to the axis of the Microscope. A very intense light from the side is then directed to the face of this plate turned towards the object; part of the light passes through the plate, but part is reflected on the object, and by this arrangement of the illumination the iron surface appears in its characteristic tarnish colours, and is observed through the plates.

BASTELBERGER.—**Uses of Photomicrography.**

The Microscope, IX. (1889) pp. 92–3.

MADDOX, R. L.—**Sur l'Application de quelques Méthodes photomicrographiques.** (On the application of some photomicrographic methods.)

Ann. de Micrographie, I. (1889) pp. 145–52.

SHENSTONE, J. C.—**How to take Photomicrographs.**

Pharmaceutical Journ., 1889, April 6 (1 fig.).

(5) Microscopical Optics and Manipulation.

BESSEY, C. E.—**The need of making Measurements in microscopical work.**

["It is greatly to be desired that all workers with the Microscope should make more general use of the micrometer than is now the custom, particularly in botany."]

POLI, A.—**Le Microscope et sa théorie.** (The Microscope and its theory.)

Amer. Naturalist, XXIII. (1889) pp. 52–3.

Revue de Botanique, VII. (1888) pp. 20–5.

ROYSTON-PIGOTT, G. W.—**Microscopical Advances.** XLV., XLVI.

[Apochromatic results. Apochromatic focal planes.]

Engl. Mech., XLIX. (1889) pp. 123–4 (6 figs.), 209–10 (4 figs.).

" " " **Microscopical Imagery. Solar Splendours.**

Journ. of Microscopy, II. (1889) pp. 14–5 (1 pl.), 106–10 (1 pl. and 1 fig.).

" " " **A New Apochromatic Test.**

["The new test just discovered is the butterfly *Colias Cæsonia* (foreign). Those scales distinguished by fine ribs widely separated are remarkable for closely-packed molecules, lying in curvilinear rouleaux, generally about 1/120,000 in., and with the best glasses throw up brilliant focal discs."]

Engl. Mech., XLIX. (1889) p. 156.

Aperture Table.—In the table printed at p. 292 two of the figures in the last column (Penetrating Power) have been transposed. 1·35 N.A. = ·741 and 1·34 N.A. = ·746 and not *vice versâ* as printed. 1·37 N.A. = ·729 and not ·739. The water angle corresponding to 0·55 N.A. should be 48° 51′ and not 49° 51′.

(6) Miscellaneous.

Letter of Darwin to Owen.*—Mr. C. F. Cox, President of the New York Microscopical Society, recently laid before the Society the following letter of Charles Darwin to Sir Richard Owen, the date being supplied from the post-mark which it bears :—

"Down, Farnborough, Kent,
Sunday [March 26, 1848].

MY DEAR OWEN,

I do not know whether your MS. instructions are sent in; but even if they are not sent in, I dare say what I am going to write will be absolutely superfluous, but I have derived such infinitely great advantage from my new simple Microscope, in comparison with the one which I

* Journ. New York Micr. Soc., v. (1889) pp. 79–81.

used on board the 'Beagle,' and which was recommended to me by R. Brown, that I cannot forego the mere *chance* of advantage of urging this on you. The leading point of difference consists simply in having the stage for saucers very large and fixed—mine will hold a saucer three inches in inside diameter. I have never seen such a Microscope as mine, though Chevalier's (from whose plan many points of mine are taken), of Paris, approaches it pretty closely. I fully appreciate the utter absurdity of my giving you advice about means of dissecting; but I have appreciated myself the enormous disadvantage of having worked with a bad instrument, though thought a few years since the best. Please to observe that, without you call especial attention to this point, those ignorant of natural history will be sure to get one of the fiddling instruments sold in shops. If you thought fit, I would point out the differences which, from my experience, make a useful Microscope for the kind of dissection, of the invertebrates, which a person would be likely to attempt on board a vessel. But pray again believe that I feel the absurdity of this letter, and I write merely from the chance of yourself possessing great skill and having worked with good instruments, may not possibly be fully aware what an astonishing difference the kind of Microscope makes for those who have not been trained in skill for dissection under water. . . .

Ever, my dear Owen,
Yours sincerely,
C. Darwin.

P.S.—If I do *not* hear, I shall understand that my letter is superfluous. Smith and Beck were so pleased with the simple Microscope they made for me, that they have made another as a model. If you are consulted by any young naturalists, do recommend them to look at this; I really feel quite a personal gratitude to this form of Microscope and quite a hatred to my old one."

[Addressed] "Professor Owen, Royal College of Surgeons, Lincoln-Inn-Fields, London."

Bostock, E.—**The Presidential Address [to the Postal Microscopical Society].**
Journ. of Microscopy, II. (1889) pp. 1–8.

Detmers, H. J.—**American and European Microscopes.**
["Referring to the reports of his address which appeared last September, Dr. Detmers says, in contradiction, that he did not take Microscopes, objectives, or accessories to Europe; that he did not make a test of skill with the Germans; that he did not photograph objects in competition with them; and, in short, that no such fighting of objectives as was described occurred."]
Amer. Mon. Micr. Journ., X. (1889) pp. 53–5.

Hitchcock, R.—**The making of Apochromatics.**
[Account of a visit to Jena.]
Amer. Mon. Micr. Journ., X. (1889) pp. 49–53 (1 pl. and 3 figs.).

International Competition in Microscopy.
Amer. Mon. Micr. Journ., X. (1889) pp. 70–1.

[Manton, W. P., and others.]—**Microscopical Outfit for Physicians' use.**
The Microscope, IX. (1889) pp. 83–4.

Zeiss, C. F.—[Obituary Notice and Portrait.]
Central.-Ztg. f. Optik u. Mech., X. (1889) pp. 85–7 (portrait).

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Collecting Salt-water Sponges.†—The collector, says Mr. W. B. Hardy, should be on the ground an hour before the tide begins to rise and choose some sheltered nook among the rocks if the coast be a rocky one, or about the piles of a pier if it be an open one. There will be found attached to the under surface of inclined stones, and in the clefts of the rocks, on sea-weed, and in any sheltered spots where there is good surface for attachment, and where the sun does not strike too strongly, tenacious masses of sponge, yellow, green, brown, or orange-colour, and with large orifices on the surface. The most common is of a sponge-yellow colour, shading into green on exposed parts. This is the *Halichondria panicea*, or "bread-crumb" sponge of Ellis. Another common form, of a salmon colour, is *Hymeniacidon sanguinea*. Pieces of the sponge should be removed as carefully as possible and taken home in a considerable quantity of fresh water.

Nutritive Media for the Cultivation of Bacteria.‡—M. L. Benoist gives the following methods for preparing media for the cultivation of micro-organisms:—

(1) Meat broth:—In 4 litres of water are boiled 1 or 2 kg. of lean beef. It is kept boiling 5 hours, and during this time continually skimmed. When cold on the next day the fat is carefully removed and the liquid then filtered. It is then brought up to its original volume and neutralized with a 1:10 solution of caustic soda (3 cm. of this solution always suffice to neutralize the acids in 1 kg. of beef). When neutralized the fluid is boiled again for ten minutes and afterwards filtered. To every 1000 cm. of the filtrate 10 g. of sodium chloride are added.

(2) The foregoing may be satisfactorily replaced by the following artificial bouillon:—Water, 1000; pepton Chapoteau, 20; gelatin, 2; wood ashes, 0·15; chloride of sodium, 5. With the exception of the gelatin, the foregoing ingredients are boiled for a few minutes, and when the pepton is dissolved the mixture is filtered, and to it are added 20 cm. of a 10 per cent. gelatin previously clarified. The fluid thus obtained is always perfectly limpid and its composition invariable.

(3) Nutritive gelatin:—Water, 1000; gelatin Coignet No. 1, 100; pepton Chapoteau, 20; chloride of sodium, 5.

The vessels selected for dissolving the gelatin in should be lined with tin or silver, and not with porcelain. The pepton and salt having been dissolved in the boiling water, the vessel is withdrawn from the fire and the gelatin then added in pieces and kept stirred up until it is completely dissolved. The mixture is then neutralized by means of a 1:10 solution of caustic soda (1 ccm. of the alkaline solution suffices for 100 g. of gelatin). Two whites of fresh eggs, dissolved separately in 100 ccm. of water, are then added when the temperature of the fluid is about 60° C.; the mixture is then vigorously shaken

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c. (6) Miscellaneous.

† Sci.-Gossip, 1889, p. 11.

‡ Ann. de Micrographie, i. (1888) pp. 75–8.

and replaced on the fire. It is then gradually heated up to boiling, when it is again removed, having been kept the while constantly stirred with a glass rod. The albumen is separated from the gelatin by filtering while warm through fine cotton cloth and plugging the stem of the filter with cotton wool. Filtration is effected in a few minutes, and the liquid thus obtained is perfectly transparent.

(4) Nutritive agar:—The clarification of agar may be effected in the same way, but requires, for its dissolution, to be kept boiling for quite a long time. When quite dissolved it is necessary to add some tartaric acid in solution in order to render it acid. When clarified by means of white of egg, it is neutralized with the soda solution. When coagulated the solution becomes opalescent; but the author states that he hopes shortly to be able to produce agar media as clear as those of gelatin.

Method of Preparing Nutritive Gelatin.*—Mr. N. A. Moore first sterilizes the tubes to be used by heating them for one hour in a hot air sterilizer or oven at 150° C. Then take, say, 250 grams (about half a pound) of beef from which all fat has been removed. Chop or grind this to a fine pulpy mass. Transfer it to a beaker, and add 500 ccm. distilled water, i. e. 2 ccm. to each gram. Thoroughly stir up and place in ice-box till next day. The meat infusion should then be thoroughly stirred, and the liquid portion separated by filtering and squeezing through a linen cloth. The red liquid thus obtained must be brought up to 500 ccm. by adding distilled water. To this is now added 1 per cent. of pepton, 1/2 per cent. sodium chloride, and 10 per cent. of the best gelatin (5 grams pepton, 2·5 salt, and 50 gelatin). The beaker containing the mixture is now placed in a water-bath, and heated to 45° C., and allowed to stand until the gelatin is completely dissolved.

The next step is to add, drop by drop, a nearly saturated solution of sodium carbonate to the beef-infusion-pepton-gelatin mass until the reaction is slightly alkaline. (If it be made too alkaline this condition may be neutralized by acetic acid.) It is next clarified by adding the whites of two eggs, and the mixture is then boiled for half an hour in a water-bath. It is next allowed to cool and set, and then reboiled and filtered in a hot-air filter at 60° C. into the sterilized tubes (7–8 cm. in each). If not perfectly clear it must be refiltered. After they have been filled, the tubes are sterilized in a steamer at 100° C., or three successive days for 10 minutes, or they may be boiled for 5 minutes in a water-bath. If the gelatin is boiled too much it will not set on cooling.

Presence of Nitric Acid in Nutrient Gelatin.†—Dr. R. J. Petri has found that gelatin constantly gives the nitric acid reaction which was first obtained by means of the diphenylamin sulphuric acid reaction, and also by means of the brucin reaction and sulphate of iron with sulphuric acid. As the gelatins used did not give Griess's reaction for nitrous acid, it followed that this compound was a product of bacterial growth.

The next step was to test the various ingredients of the nutrient gelatins. In meat infusion neither nitrates nor nitrites were present. Peptons examined in the same were almost always found to be free, although in a few preparations, traces of nitrate were discovered.

* Amer. Mon. Micr. Journ., x. (1889) pp. 41–2.

† Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) pp. 457–60.

The various crude gelatins examined always showed the presence of nitrates.

The method employed was to soak commercial gelatin in distilled water and test the filtrate. This invariably showed the presence of chalk, sulphuric acid, phosphoric acid, and chlorine in addition to the nitric acid.

A second addition of distilled water to the gelatin, showed that the watery extract was now free from nitrates.

Hence it would appear to be advisable to treat gelatin for making nutrient media with distilled water, in order to obtain a pure substance.

Preserving Plate and Tube Cultivations.*—Dr. Schill states that plate and tube cultivations, &c., can be preserved indefinitely by covering them with a mixture of equal parts of alcohol and glycerin, to which one-hundredth to one-thousandth of corrosive sublimate has been added. After 24 hours or so, the fluid is poured off. Considerable care must be exercised in pouring the preservative fluid over the surface. Non-liquefying colonies are not at all damaged by this procedure, but liquefying colonies must be protected by fixing them down by means of a cover-glass, otherwise they run out and leave their excavations only.

Two Modifications of Esmarch's Roll Cultivation.†—(*a*) When test-tubes are used for roll cultivations, the cotton-wood plugs become moistened during sterlization, &c.; this inconvenience is quite avoided, according to Dr. Schill, if the common medicine bottle holding 100, 150, 200 ccm. be used, the narrow neck of which prevents the moisture from running up into the plug.

(*b*) Very often in roll cultivations the gelatin layer is very irregular. A regular and even layer of gelatin may be obtained by simply doing away with the rolling altogether, and adopting the following device. After the gelatin has been poured in, and the germs disseminated by shaking, a smaller (sterilized) tube is jammed inside it. This causes the gelatin to form a perfectly even layer, and when cool the inner tube is easily withdrawn by just pouring a little hot water in to loosen it. Of course, for non-aerobic organisms, there is no necessity to withdraw it at all. In the latter case, if it be desired to get at a colony, a piece of the outer tube must be removed with a diamond.

Flask Cultivations.‡—Instead of plate cultivations, Dr. Schill has used for several years small cast pocket-flasks (canteens) of colourless glass, which are about 6 cm. broad, 10 cm. high, and the sides about 1½ cm. apart. The neck, which has a lumen of 7–9 mm., is about 3 cm. long, and is situate about the middle of one of the small sides. One third full of gelatin, and laid on a broad side, these bottles afford a gelatin plate 50–60 cm. square.

Wafers for Cultivation Purposes.§—Wafers (Oblaten) are especially recommended by Dr. Schill as solid media for cultivating chromogenous Bacteria. The wafers are moistened with a nutrient solution, and sterilized in a Petri's capsule.

Development of Pathogenic Microbes on Media previously exhausted by other micro-organisms.‖—Dr. Soyka and Dr. Bandler have

* Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) p. 337.
† T. c., pp. 337–9 (1 fig.).
‡ T. c., p. 339.
§ T. c., p. 340.
‖ Fortschritte d. Med., 1888, pp. 769–73.

made experiments with the object of ascertaining if in nutrient gelatin which has been exhausted by the growth of some other Schizomycete, other kinds of fission fungi, afterwards introduced, would develope. Their results are as follows:—

(1) *Sp. choleræ asiaticæ* developed after *M. tetragonus Pneumoniæ*, swine erysipelas, pigeon diphtheria.

(2) *Sp. Finkleri* after Emmerich's short rods, erysipelas, rabbit septicæmia, *M. tetragonus pneumoniæ*, swine erysipelas, pigeon diphtheria, typhus abd.

(3) *Bacillus anthracis* after erysipelas, rabbit septicæmia, *M. tetragonus pneumoniæ*, swine erysipelas, pigeon diphtheria, and typhus abd.

(4) *Staphylococcus pyogenes citreus* after Emmerich's short rods, erysipelas, rabbit septicæmia, *M. tetragonus pneumoniæ*, pigeon diphtheria, and typhus abd.

(5) *Bacillus pyocyaneus* after Emmerich's short rods, erysipelas, rabbit septicæmia. *M. tetragonus pneumoniæ*, pigeon diphtheria, and typhus abd.

(6) *Bacillus prodigiosus* after Emmerich's short rods, rabbit septicæmia, *M. tetragonus*, *Staphylococcus flavus*, *B. cyanogenes*.

(7) *B. cyanogenes* after *B. typhi abd.*

Prevention of Cultivations from Drying.*—Dr. H. Plaut has found that sterilized oil preserves cultivations from drying excellently well. A flask of olive oil well plugged with cotton-wool is boiled, and when cold, is poured over the cultivation so that it forms thereon a layer about a finger's breadth deep. This procedure may also be adopted for cultivations which liquefy the medium, and does not prevent them from being inoculated on others.

(2) Preparing Objects.

Investigation of Cell-structure.†—Herr G. P. Platner in his investigations on cell-division found that the best method of preserving the subsidiary nuclei and their products is the use of osmic acid. The degree of concentration of Flemming's acid mixture is quite sufficient if allowed to act long enough. But as half an hour is not sufficient, and as a longer period essentially affects the power of making sections, some new method had to be adopted. Pieces of hermaphrodite glands cut up as small as possible must be put fresh into the stronger of Flemming's mixtures, and remain in it for an hour; the solution must then be diluted with three or four times its volume of water, and left to stand for twenty-four hours. After careful washing, alcohol of increasing degrees of strength may be added. The best staining material is hæmatoxylin prepared by Apathy's method. The hæmatoxylin solution consists of 1 part of crystals of hæmatoxylin, 70 parts of absolute alcohol and 30 of distilled water; the solution must be kept in dark vessels. The objects are stained *in toto* for twenty-four hours. Then they are removed to 1 per cent. alcoholic solution of bichromate of potash for a day; if lighter staining be required, the objects must remain longer. The objects were then placed in 70 per cent. alcohol, and kept in it, in dark vessels, for several days. Dehydration by absolute alcohol and use of cedar-wood-oil are all that are now necessary.

The specimens should next be imbedded in overheated paraffin for

* Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) p. 324.

† Arch. f. Mikr. Anat., xxxiii. (1889) pp. 126–7.

about twenty minutes, when bands of section 0·005 mm. thick can be easily cut. The advantages of this method are a good hardening and coloration first, and a consequent preservation of all parts of the series of sections.

Examining the Central Termination of Optic Nerve in Vertebrata.*—For tracing the course of nerve-fibres the following has been employed with great success by Prof. J. Bellonci :—

(1) The brain or a part containing the nervus opticus is placed in osmic acid (1/2 to 1 per cent.) for fourteen to twenty hours.

(2) Freehand sections are then made in 70 per cent. spirit. The sections are washed in distilled water for a few minutes, and then placed in 80 per cent. spirit for three or four hours.

(3) The sections are again placed in distilled water, and then transferred to the slide and the cover-glass put on.

(4) A few drops of ammonia are then allowed to mix with the water under the cover-glass. This reagent makes the brain as transparent as glass, except the nerve-fibres, which remain black, and which are brought out with such distinctness that their course is easily followed.

The sections are of course thick, but this is an advantage in tracing the winding course of the nerve-fibres. Sections cut in celloidin with the microtome can be treated in the same manner, but the action of the ammonia is then much slower, requiring several days.

Preserving Nervous Systems.†—Mr. A. Sanders has been examining the nervous system of *Ceratodus Forsteri* in the wild parts of Queensland. He adopted a method of treatment to which the nervous system was subjected before molecular death could take place. The head, immediately after it was cut off, was placed in Müller's solution to which alcohol in the proportion of one-third had been added; the solution was changed next day, and two or three times in the course of the succeeding three weeks. The skull containing the brain was then placed in a 2 per cent. solution of potassium bichromate, which was changed once a fortnight, until the brain was sufficiently hard to be cut into sections. This occurs at various periods, taking a shorter time in the higher Vertebrates than in the lower; in the case of *Ceratodus* the period was longer than a year. Mr. Sanders has always found this method to succeed well, and thinks it is of great advantage when there is no opportunity of cutting sections till some time after the capture of the animals, and he "can recommend it as an all-round method for travellers."

Investigation of Ova of Sepia.‡—M. L. Vialleton fixed the ova of *Sepia* with osmic acid and Kleinenberg's picrosulphuric mixture. After two days they were placed in 70 per cent. alcohol, which was renewed till all colour was removed, and they were then stained with carmine, and cut into sections. To isolate the protoplasmic layer the ova were placed in a mixture of equal parts of Kleinenberg's fluid and a 2·5 per cent. solution of bichromate of potash. This immediately hardens the chorion and allows of its being easily separated from the yolk; the eggs should not remain in for more than one or two minutes. They are then placed in a watch-glass containing Kleinenberg's fluid in such a way that the protoplasmic layer looks upwards. At the end of an hour and

* Zeitschr. f. Wiss. Zool., xlvii. (1888) p. 4.
† Ann. and Mag. Nat. Hist., iii. (1889) p. 158.
‡ Ann. Sci. Nat., vi. (1888) pp. 168-71.

a half this layer may be removed with a spatula from the subjacent yolk, and should then be spread out in a flat glass containing a very small quantity of picrosulphuric acid. This last should next be replaced by alcohol of from 70° to 90°. Boracic carmine and alcohol are good for staining advanced embryos; Kleinenberg's hæmatoxylin gives excellent results in the study of karyokinesis. Saffranin was used also as a control staining fluid.

Examining Ants for Intestinal Parasitic Infusoria.*—Mr. J. W. Simmons cuts off the abdomen of the insect, places it in a drop of distilled water, and teases. Cochran's crimson ink is recommended for staining the organisms, but any carmine ink would probably answer the purpose. Rosein is also useful. Osmic acid is employed for killing and fixing the Infusoria.

Mounting Fungi.†—The Rev. J. E. Vize writes that as to the medium in which the microscopic forms are to be mounted, he had worked at the Microscope for thirty-five years, and cannot tell yet, nor does he think the man is born who can tell, which is the best mounting medium. What suits one fungus does not necessarily suit another. Canada balsam contracts the spores and is apt to contort them. Glycerin pure and simple simply refuses in course of time to remain in the cell of the slide, and works its way out. Glycerin jelly is nearly as bad, and, in common with gelatin medium, contracts and expands with the temperature of the weather, and therefore is unreliable. Thwaite's fluid, like water, may be very successful for a time, but will be sure to change the colour of the tissue eventually. Camphor water and the other media which have been used in the vain attempt of beautifully balancing themselves, so as to check either the growth or decay of the plant, all fail. If any one asks him what media he should now use, and recommend others to use, his answer would be—for any fungi that would bear them (and they are not numerous), employ Canada balsam. First take the greatest possible care to keep the spores in their natural place by giving them as small a quantity, not of pure spirits of wine, which scatters them, but benzol, which has a different effect. Let the benzol evaporate, then mount. When Canada balsam will not suit, as is generally the case, he uses gelatin, warming all the materials used. Water is, to the best of his knowledge, indispensable when you want to see such portions of a fungus as the zoospores. Much advantage may be gained by putting on the label of the slide not only the name of the object, but the medium in which the same is mounted. He has slides in his cabinet of great scarcity, which it would be next to impossible to replace. Some of them have lost the whole of the medium in which they are placed through evaporation, and are almost valueless. Others have not gone so badly, but there are large bubbles of air in them, which are the forerunners of total evaporation. Had the original mounter of the same named the fluid in which they are placed on the slide, there would have been little difficulty in bringing them back to their primitive condition.

Fixing of the Spores of Hymenomycetes.‡—Dr. C. O. Harz finds that coloured spores of Hymenomycetous Fungi can be very well fixed

* The Microscope, ix. (1889) p. 88.

† Provincial Med. Journ., 1888, November. Cf. The Microscope, ix. (1889) pp. 91–2.

‡ SB. Bot. Ver. München, December 10, 1888. See Bot. Centralbl., xxxvii. (1889) p. 77.

on white paper by moistening the reverse side of the paper by a solution of Canada balsam in absolute alcohol. In the cases of colourless spores the difficulty is to find a coloured paper the pigment of which is not soluble in alcohol; and Dr. Harz used instead a slightly warmed solution of 1 vol. Canada balsam in 4 vols. turpentine oil, placed with a fine camel's hair brush on the reverse side of the paper. In the course of from two to four days the preparation can then be laid aside between paper, but is not completely dry for several weeks.

CARTER, F. B.—**Desmids: their Life-history and their Classification. II.** [Contains directions for "Collecting" and "Preserving and Mounting."] *Amer. Mon. Micr. Journ.*, X. (1889) pp. 73–9.

JAMES, F. L.—**The Philosophy of Mounting Objects.** *Amer. Mon. Micr. Journ.*, X. (1889) pp. 61–3. from 'Elementary Microscopical Technology.'

WALLER, T. H.—**Micro-chemical Methods for the Examination of Minerals.** *Midl. Naturalist.*, XII. (1889) pp. 59–65.

(3) Cutting, including Imbedding and Microtomes.

Imbedding in Paraffin.*—Dr. G. A. Piersol says that although the turpentine-paraffin so commonly employed in histological work yields excellent results, the advantages of chloroform-paraffin have led to its exclusive adoption in the laboratory of the University of Pennsylvania. It is very desirable to secure homogeneity of the paraffin after imbedding, and for this purpose the method of Kölliker is employed. In this the cell containing the object and melted paraffin is surrounded with cold water, the upper surface, which is alone left exposed, being cooled by blowing until a film is formed, when the whole is submerged.

The best paraffin is that commercially known as winter worked gum stock, and comes in cakes about 4 cm. thick; that having a bluish tint and emitting a metallic ring when struck is the best.

Substitute for Corks in Imbedding.†—Dr. G. C. Freeborn recommends "deck-plugs," which are cylinders of white pine, to be obtained of manufacturers of barrel bungs, and vary in diameter from 1/2 in. to 1½ in. Not only are they not made soft and yielding by soaking in dilute alcohol, but they may be written upon with lead pencil, thus enabling the microscopist to keep several specimens in the same bottle of alcohol.

JAMES, F. L.—**Sharpening the Section Knife.** *St. Louis Med. and Surg. Journ.*, LVI. (1889) pp. 156–7 (2 figs.).

(4) Staining and Injecting.

Logwood Staining Solution.‡—Prof. H. Gibbes recommends a logwood stain which is made as follows:—Take of logwood chips, 1 lb.; distilled water, 50 oz. Heat slowly to boiling in a porcelain-lined saucepan. Boil for 10 minutes, stirring the while with a glass rod, and add very slowly 1/2 to 1 oz. of potash alum. Only sufficient alum is to be added to turn the colour almost black. Set aside for 24 hours, then filter and add 4 oz. of rectified spirit. This solution is ready for use at once.

* University Medical Magazine, December 1888. The Microscope, ix. (1889) p. 89.

† The Microscope, ix. (1889) p. 93, from 'Pharmaceutical Era.'

‡ The Microscope, ix. (1889) p. 109.

Soluble Prussian Blue.*—M. C. E. Guignet gives the two following methods for making soluble prussian blue for injection purposes.

(1) Ordinary soluble prussian blue. To a boiling solution of 110 grams of ferridcyanide of potash, are gradually added 70 grams of crystallized iron sulphate. After boiling two hours it is filtered, and the filtrate washed with fresh water until the washings are strongly blue. The blue is then dried at 100° C.

Thus made the blue is of an extremely rich colour, and will take up a large quantity of gelatin without precipitating it.

(2) Pure prussian blue soluble in water. A saturated solution of oxalic acid is mixed to a pasty consistence with an excess of pure prussian blue. The liquid is filtered and allowed to stand for two months until all the blue is precipitated. It is then filtered and washed with weak spirit in order to remove any oxalic acid. When dried the blue dissolves easily in water.

A similar result may be at once obtained by precipitating the oxalic solution with 95 per cent. alcohol, or with a concentrated solution of sodium sulphate, and then washing the precipitate with weak spirit.

The author adds that molybdic acid will dissolve ordinary prussian blue in large quantities. A mixture of the blue and the acid are heated together, and after filtering, a deep blue liquid is obtained, which does not alter in boiling, or precipitate on the addition of gelatin, and when cold sets to a transparent mass of a dark blue colour. The molybdic solution is precipitated by sulphuric, nitric acids, &c. The molybdate and tungstate of ammonia also dissolve prussian blue.

Vital Reaction of Methyl-blue.†—Dr. Max Joseph has tested Ehrlich's method on Heteropods, and found that the clear intra vitam stain could not be satisfactorily fixed. He remarks that the commercial methyl-blue is unfit for use, and that only the chemically pure article will give the results obtained by Ehrlich. Instead of a saturated solution, the author recommends the strength originally employed by Ehrlich, 1/4 gram dye in 100 grams of physiological salt solution.

The best stain was reached about six hours after injection in the body-cavity.

Process of Staining Sections simplified by mixing the staining fluids with turpentine.‡—According to Dr. Kükenthal's experiments, a large number of colouring substances admit of being mixed with turpentine, and serial sections may be stained in a short time by such a combination. Methyl-green, methyl-blue, gentian-violet, safranin, Bismarck-brown, eosin, fuchsin, tropæolin, and malachite-green may be used in this way.

The dry colouring substance is dissolved in *absolute* alcohol, and the solution dropped into turpentine until the mixture has any intensity of colour desired.

Meyer's§ carmine solution.—Absolute alcohol, 100 ccm.; pulverized carmine, 3 gr.; hydrochloric acid (neutralized with ammonia), 25 drops.

* Journ. de Micrographie, xiii. (1889) pp. 94-5.

† Anat. Anzeig., 1888, p. 420. ‡ Amer. Naturalist, 1888, p. 1140.

§ The carmine is boiled in the alcohol and then the acid added. The solution is then filtered, hot, and enough ammonia added to neutralize. After filtering again the solution is mixed with turpentine and absolute alcohol.

Can be united with a mixture of turpentine and absolute alcohol (in equal parts?), and in this form used for staining sections.

The method of using these stains is very simple. The sections are fastened to the slide by Schällibaum's collodion, then left in the oven of the water-bath until the clove oil has been completely driven off. The paraffin is next removed by washing in turpentine, and then the slide is immersed in the staining mixture. As soon as the desired depth of stain has been received, the sections may be washed in pure turpentine and mounted in balsam.

If the stain is too deep, or a sharp nuclear stain is desired, it is only necessary to leave the slide a short time in a mixture of turpentine and pure (free from any trace of acid) absolute alcohol, and the colour will be reduced.

The colouring mixture may become cloudy, as the result of the evaporation of the alcohol; in such an event, the addition of a drop or two of alcohol generally suffices to clear the mixture.

This method enables one to use easily several stains in succession. Objects may also be coloured, *in toto*, with the advantage that the process of staining can be followed and easily controlled.

Double, Triple, and Quadruple Staining.*—Dr. H. Griesbach demonstrated at the meeting of the Anatomical Society held at Würzburg the following methods of staining. The dyes used were anilins in concentrated aqueous solutions either in combination, or as single successive stains. The stained specimens were cleared in anise oil, and mounted in balsam.

Double Stains.—Metanil yellow [phenylamidobenzolmetasulphonate of soda], and azo blue [tetraazoditolylbetanaphtholdisulphonate of soda]. Preparation: ala nasi of a child, alcohol hardening.

The sections are stained in a mixture of equal parts of the two staining fluids for 10 minutes, or for 10 minutes in the yellow fluid, and then for four minutes in the blue.

The epidermis, hair-shaft, inner root-sheath, striated and smooth muscle stain yellow; the rete Malpighii, the outer root-sheath, sebaceous and sweat glands stain brownish-yellow; connective tissue, elastic fibres, and membrane of fat-cell stain violet-blue; hyaline cartilage and nuclei do not stain.

Metanil-yellow and methyl-green.—Preparation: ala nasi of a child, alcohol hardening.

The sections are stained in a mixture of 5 ccm. of the yellow staining fluid, and 3 ccm. of the green. A crystalline precipitate forms which does not interfere with the staining. The sections are allowed to remain in this fluid for eight minutes or longer [1/4 of an hour], or they are stained for eight minutes in the yellow fluid, and then for one minute in the green.

Epidermis, hair-shaft, inner root-sheath, striated and smooth muscle stain yellow; the rete Malpighii, outer root-sheath, hair follicle, sweat and sebaceous glands, and nuclei stain green; hyaline cartilage and cells stain green.

Metanil-yellow and crystal violet [Hydrochloride of hexamethyl-pararosaniline].—Preparation: ala nasi of child, alcohol hardening.

Mix 7 ccm. of the yellow fluid with 2 ccm. of the violet. An amorphous

* Amer. Mon. Micr. Journ., x. (1889) pp. 30-3.

precipitate results which does not interfere with the staining. The sections are stained in this mixture for 6 minutes, or they are stained for 10 minutes in the yellow fluid, and then for 30 seconds in the violet.

Epidermis, hair-shaft, inner root-sheath, connective tissue, and elastic fibres, the membrane of fat-cells, and striated muscle stain yellow; the rete Malpighii, the outer root-sheath, all glands, smooth muscle, and cartilage with its cell-nuclei stain violet.

Metanil-yellow and safranin.—Preparation: human lip, alcohol hardening.

Mix 6 ccm. of the yellow fluid with 1 ccm. of safranin. An amorphous precipitate forms. This mixture gives either with a long or short stain more sharp pictures than the successive single staining.

Connective tissue stains yellow; epidermis, the rete Malpighii and the analogous layer in the mucous tissue, muscle, and labial glands stain light red, the nuclei standing out sharply.

Metanil-yellow and crystal Ponceau [alphaazonaphthallindisulfo-betanaphthol of soda].—Preparation: spinal cord of calf, alcohol hardening.

For the single as well as the combined stain, 24 hours are required.

The grey matter stains yellow, the white reddish. Under strong magnification, the neuroglia and connective tissue are found to be stained yellow; the axis cylinders dark bluish-red; the myelin light yellowish-red; one sort of ganglion-cells dark purple, another bluish-red; nuclei do not stand out sharp.

Metanil-yellow and Congo-red [tetraazodiphenyldinaphthylamindisulphonate of soda].—Preparation: spinal cord of calf, alcohol hardening.

The sections are stained in a mixture of the staining fluids for eight minutes, or they are stained for ten minutes in the yellow stain and then for five minutes in the red.

Ganglion-cells [without clear nuclei staining] and axis-cylinders stain dark violet-red; the medullary sheath light citron-yellow; neuroglia and all connective tissue light violet-red; epithelium of the central canal brownish-red.

Carminate of soda and metanil-yellow.—The central nervous system is hardened in Müller's fluid, then stained *in toto* with the carmine fluid. Sections are then stained for ten minutes in the yellow stain.

All nervous elements are stained red; all connective tissue elements yellow.

Crystal Ponceau and crystal violet.—Preparation: transverse section of the carotid of the calf, alcohol hardening.

The sections are stained for five minutes in the red Ponceau fluid, and then for one minute in the violet.

Nuclei of the endothelium and smooth muscle stain violet; all the other tissues red.

Congo-red and anisol-red [bisulfoxylnatronbetaoxynaphthalinazo-orthometoxylbenzol].—Preparation: spinal cord of the calf, alcohol hardening.

The sections are stained for five minutes in the combined stains, or for five minutes in the Congo-red solution and then for five minutes in the anisol-red.

Axis-cylinders and cell-bodies stain purple; all other tissues stain light red. Nuclei do not stain.

Metanil-yellow and ethylin-blue.—Preparation: ala nasi of a child, alcohol hardening.

When the two staining solutions are combined a black precipitate is formed, which redissolves in an excess of the metanil-yellow solution. This solution stains yellowish-green, the cartilage only being stained blue. If the sections are first stained for five minutes in a mixture of 5 ccm. of the yellow and 4 ccm. of the blue stain, or if the sections are stained for ten minutes in the yellow and then for two minutes in the blue, the pictures will be sharp.

The epidermis, hair-shaft, outer root-sheath, connective tissue, elastic fibres, smooth and striated muscle stain yellow; all glands, membrane of fat-cells, cartilage, and nuclei stain blue.

Triple stains.—Metanil-yellow, methyl-green, and safranin.—Preparation: ali nasi of a child, alcohol hardening.

The sections are stained for eight minutes in the yellow solution, then for thirty seconds in the safranin solution, then for twenty seconds in the methyl-green solution, and finally passed through the metanil-yellow solution.

The different elements are differentiated as in the double stain with metanil-yellow and methyl-green, except the colour is of a darker shade, and all muscular elements are stained red.

Metanil-yellow, crystal Ponceau, and crystal violet.—Preparation: ala nasi of a child, alcohol hardening.

The sections are stained for 2–16 minutes in a mixture of 5 ccm. of the yellow solution, 5 ccm. of the Ponceau solution, and 3 ccm. of the violet solution, or they are stained for eight minutes in the yellow solution, then for six minutes in the Ponceau solution, and finally for fifteen seconds in the violet solution.

Cartilage and nuclei of cartilage-cells, the superficial layer of the epidermis stain bluish-violet; connective tissue, elastic fibres, and glands stain light red; the deep layer of the epidermis, the rete Malpighii, hair-shaft, the root-sheaths, membrane of fat-cells and muscle stain yellow.

Metanil-yellow, azo-blue, and methyl-green.—Preparation: ala nasi of a child, alcohol hardening.

The sections are stained for ten minutes in the yellow solution, then for six minutes in the blue solution, and then for two minutes in the green solution, finally, the sections are passed through the yellow solution.

The epidermis, hair-shaft, inner root-sheath, smooth and striated muscle stain yellow; membrane of cells, the rete Malpighii, membrana propria of glands, elastic fibres, and connective tissue stain violet; nuclei of gland cells and nuclei of the cells of the Malpighian layer, outer root-sheath, smooth muscle, and connective tissue stain green.

Crystal Ponceau, methyl-green, and crystal violet.—Preparation: ala nasi of a child, alcohol hardening.

The sections are stained for eight minutes in a mixture of 10 ccm. of the Ponceau solution, 4 ccm. of the green, and 2 ccm. of the violet, or they are stained for eight minutes in Ponceau solution, then for three minutes in the methyl-green solution, and then for five seconds in the violet solution.

The epidermis, hair-shaft, and outer root-sheath stain violet; smooth and striated muscle, elastic fibres, and connective tissue stain rose-red:

the stratum mucosum stain green ; the inner root-sheath, all glands and membrane of fat-cells, cartilage, and nuclei of its cells stain green.

Quadruple stains. — Metanil-yellow, safranin, methyl-green, and crystal violet.—Preparation : ala nasi of a child, alcohol hardening.

The sections are stained for twenty minutes in the yellow solution, then for one minute in the safranin solution, then again for five seconds in the yellow solution, then for two minutes in the methyl-green solution, then again for five seconds in the safranin, then again for five seconds in the yellow solution, and finally for ten seconds in the violet solution.

The epidermis, hair-shaft, inner root-sheath, and all nuclei stain yellow; the rete Malpighii, outer root-sheath, sweat glands, sebaceous glands, the nuclei of cells, and smooth muscle stain green; nuclei of connective tissue, elastic fibres, lobes of the sebaceous glands, with the nuclei of their cells, membrane of fat-cells stain red ; cartilage and the nuclei of its cells stain violet.

Staining Muscle with Saffron.*—In his researches on the regeneration of striated muscle, Leven first injected Flemming's solution into the muscle, and then having cut out a piece, this was, after further subdivision, placed for some days in the Flemming's solution, and finally hardened in absolute alcohol. Sections were stained in 4–8 hours with a solution of saffron made as follows: saffron, 1 part; absolute alcohol, 100 parts; distilled water, 200 parts. The sections were then washed in distilled water and left in acidulated alcohol (0·5 per cent. HCl) until they recovered their former yellow colour. They were then treated with absolute alcohol, oil of cloves, and finally mounted in dammar. If successfully done, the karyokinetic figures appear dark red, while the muscle nuclei are pale with dark-red nucleoli. Leucocytes take on the colouring matter more easily and keep it longer than the rest of the tissues, with the exception of the mitotic figures.

Iodine Reactions of Cellulose.†—M. L. Mangin describes a number of reagents into whose composition iodine enters which give staining reactions with cellulose.

The two well-known reactions, the one with iodine and sulphuric acid, and the other with iodine and chloride of zinc, are to a certain extent inconvenient of application. If iodized sulphuric acid be employed in too concentrated a state, the tissues are altered ; while if it be employed too weak there will be no action. With solution of chloride of zinc the concentration is variable, so that it is difficult to obtain identical results; and, furthermore, this reagent produces a coloration only after a certain period of time, and several hours are sometimes necessary for the staining to show itself.

The author then gives a list of salts and acids which, together with iodine, produce a staining reaction with cellulose, viz. :—Chloride of aluminium, chloride of calcium, chloride of manganese, chloride of magnesium, hydrated bichloride of tin, nitrate of zinc, nitrate of lime, phosphoric acid. These different reagents have not the same sensitiveness. In the case, for instance, of iodized chloride of aluminium, the staining appears more rapidly than is the case with chloride of zinc, and is preserved for several days. The chlorides of manganese and magnesium, and the nitrates of lime and zinc, only produce a feeble colora-

* Medical Chronicle, November, 1888. The Microscope, ix. (1889) p. 88.

† Bull. Soc. Bot. France, xxxv. (1888) pp. 421–6.

tion, but the author specially recommends phosphoric acid and chloride of calcium as being likely to replace advantageously iodized chloride of zinc and iodized sulphuric acid.

The author then describes the preparation of several of these new reagents. In order to make iodized phosphoric acid, the pure crystallized phosphoric acid must be taken, and to this must be added, in order to effect solution, a fourth or a third of its bulk of water, and then some crystals of iodide of potassium or iodine must be added until the liquid acquires the tint of rum or curaçoa. It is advisable to prepare this reagent in different states of concentration. It will be found to colour cellulose in a few minutes a deep blue colour. Occasionally, when the cellulose coloration is found to be partly masked by other matters present, it may be advisable to warm the sections to be studied with a weak solution of hydrochloric acid (1 per cent.) or potash (4 per cent.). After this the staining will be found to appear instantly.

Staining the Bacillus of Glanders.*—Dr. H. Kühne, who considers the staining of *B. mallei* to be especially difficult, advises the following procedure. Before immersing in the stain the sections are to be thoroughly freed from spirit. This done, they are placed for 3-4 minutes in carbol-methylen-blue (water, 100; carbolic acid, 5; alcohol, 10; methylen-blue, 1·5 gr.) and then decolorized in water acidulated with hydrochloric acid, after which the acid is extracted with distilled water. After a transitory immersion in alcohol they are transferred to anilin oil to which 6–8 drops of oil of turpentine have been added. Then to pure turpentine, xylol, and lastly balsam.

New Rapid Process for Staining Bacillus Tuberculi.—MM. Pittion and Roux have presented to the Société de Médecine de Lyon † a process for differential staining of bacillus tuberculi, in which the easily decomposable anilin water, or its substitute, carbolized water, is supplanted by aqua ammoniæ. There are in the process three fluids, viz.:—

Solution A. Ten parts of fuchsin dissolved in 100 parts of absolute alcohol.

Solution B. Three parts of liquid ammonia dissolved in 100 parts of distilled water.

Solution C. Alcohol, 50 parts; water, 30 parts; nitric acid, 20 parts; anilin-green, to saturation. In preparing this solution dissolve the green in the alcohol, add the water, and lastly the acid.

To use. To 10 parts of solution B add 1 part of solution A, and heat until vapour begins to show itself, then immerse the cover-glass, prepared as in the ordinary method of staining. One minute suffices to thoroughly stain the bacilli. Wash with plenty of water, and after rinsing with distilled water let fall on the film side of the cover-glass 2 or 3 drops of the green solution (C), and let it remain not longer than 40 seconds. Wash off with abundant water, dry, and mount in xylol balsam. The bacilli will, on examination, be found to be stained a fine rose red upon a pale or delicate green ground.

Most excellent preparations may be obtained by replacing the fuchsin with gentian-violet and the anilin-green with a weak solution of chrysoidin.

An experiment made with the above stain by Dr. F. L. James ‡ seems

* Fortschritte der Med., 1888, p. 860.

† St. Louis Med. and Surg. Journ., lvi. (1889) p 155. ‡ T. c., p. 156.

to prove its claims to superiority over all other stains yet tried. Not only is the process more rapid than any hitherto used (except that of Glorieux, and it equals even this remarkably rapid method), but a greater number of bacilli are developed. Further than this, the bacilli appear to be swollen by the process, and show up larger and more clearly.

(5) Mounting, including Slides, Preservative Fluids, &c.

Preparing and Mounting Diatoms.*—In his account of the diatoms of the Bay of Villafranca, M. Peragallo recommends the following plan for separating and preparing them for examination, in the case of those species which are dredged up from the bottom mixed with sand and mud.

The material is first passed through a coarse sieve with meshes about 1 mm. in diameter, the residue (which has passed through the sieve) placed in a dish, and hydrochloric acid added drop by drop to dissolve the calcareous matter; when effervescence has ceased, the deposit is placed in a large vessel and allowed to settle repeatedly after washing with water until every trace of acid has disappeared. It is then boiled in water alkalized by potassium or sodium carbonate, and shaken; the diatoms fall to the bottom, while the mud remains in suspension, and by repeated decanting the diatoms are obtained with but small admixture of any foreign matter except sand, especially if finally treated with sulphuric acid. The diatoms are lastly separated from the sand by a tedious process of moistening with alcohol and passing down an inclined glass tube, when the diatoms pass down and the sand remains behind. The whole process occupies more than a month, but is stated to produce very good results.

For mounting, the diatoms are always placed on the cover-glass. The fixing material recommended is gum adraganth, as prepared by M. Brun of Geneva, the refractive index of which is very near to that of glass, and as a saturating fluid a solution of styrax or liquidambar in benzin or in a mixture of benzin and absolute alcohol. The diatoms are placed in the position they are intended to occupy on the cover-glass by means of a mounted hair or small pincers with a wooden handle. The pincers are then lightly dipped into the solution of gum adraganth, and, after moistening the cover by the breath, the diatoms are lightly touched with the pincers. When the moisture has entirely evaporated, a drop of the saturating fluid is placed on the cover-glass, and when the air-bubbles have entirely disappeared, and before the fluid has completely evaporated, a drop of styrax is added. The preparation is then warmed, and placed by pincers on the slide, and the excess of styrax removed by linen soaked in alcohol.

Mounting Diatoms.†—M. Bialle de Langibaudière mounts diatoms in the following manner. Upon a clean cover-glass, previously placed upon a bronze or iron table, are dropped from a pipette several drops of distilled water. Then from the bottle in which the diatoms are preserved in spirit, is removed a small quantity of the fluid, with the same pipette. Of this fluid one drop is let fall into the distilled water on the cover-glass. Owing to the alcoholic fluid falling into water, the diatoms are scattered all over the cover-glass. The metal table is then gently heated, so that the water evaporates very slowly and without ebullition. The rest of the manipulation is performed in the usual manner.

* Bull. Soc. Hist. Nat. Toulouse, xxii. (1888) pp. 16–35. Cf. *ante*, p. 427.

† Journ. de Micrographie, xiii. (1889) p. 59.

Cement Varnishes and Cells.*—Mr. S. G. Shank finds that every medium of an aqueous or glycerin nature sooner or later softens all ordinary cell cements. Mounts of Algæ, &c., in copper solution, glycerin, in solution of chloral hydrate, in cells of solution of sealing wax and such similar cements, when about three years old, all show the cement creeping in towards the centre of the mount. All cells to be used for fluid (other than alcoholic) and glycerin solutions should be carefully covered with shellac. This may whiten where the fluid touches it, but it resists well. Cement down the cover with shellac also, and back it with a more tenacious varnish.

Lovett's cement, which is white lead 2, red lead 2, litharge 3, ground together with thin gold size to a working consistence, hardens more quickly than gold size, and seems to be entirely permanent. Mounts four years old prepared with this cement are still perfect, resisting glycerin and weak alcoholic solutions. This cement is troublesome to prepare and cannot be well kept, like shellac varnish.

Cells are, as a rule, made too deep or too wide. The expansion and contraction of considerable bodies of fluid soon loosen any but very carefully made cells. Fluid mounts which show signs of failure should, as a rule, be immediately remounted. The presence of air seems to facilitate decomposition. Frequently the bubble is a gaseous result of internal decomposition, which progresses in spite of liberal coats of varnish subsequently applied.

Glass slips, with concave centre, should be prepared for many objects. They cost about the same as loose glass cells, and are deep enough for a head of Tænia Solium, &c., and the addition of a ring of thick shellac, well dried, forms a cell deep enough for a wide range of objects. All fluid mounts ought to be revarnished every year whether they show signs of failure or not.

King's amber or Brown's rubber are transparent varnishes, and neither will impair the beauty of any fancy finish. White and black finishing varnishes may be made by adding to shellac varnish, tube oil-colour, ivory black, or zinc white. The resulting finish does not crack, but is not as brilliant as zinc cement or asphaltum.

The surface of a slide to which a cell is to be cemented, should be well cleaned with a mixture of equal parts of alcohol and chloroform. The best cement fails to adhere on a dirty glass surface.

Copal Cement.†—Mr. W. Z. Davies makes a transparent and colourless cement, which is useful as a finishing varnish and for cell-building, in the following manner :—

Take best clear copal gum, coarsely pulverized, mix with a sufficient quantity of benzol to cover it, and let stand for 24 hours. Take of chloroform twice as much as of the benzol, and in it as much gum camphor to saturate the chloroform, and then add a small quantity of pale linseed, nut, or poppy oil. The quantity of oil will vary according as a quick or slow drying cement is desired. If no oil, or a very small quantity is added, the cement will dry very quickly. Next add the mixture to the copal and benzol, shaking at intervals for several days, until as large a quantity as possible of the gum has been dissolved. Pour off, filter, and evaporate to any desired consistency.

This cement adheres well to glass, especially if the glass is warm

* The Microscope, ix. (1889) pp. 126-7. † T. c., pp. 78-9.

when the first coat is applied. Cells built up entirely of it are as colourless as the glass itself.

Finishing Slides.*—The only factors, says Miss M. A. Booth, to be taken into account for filling up the distance from slide to cover-glass without spreading, are a proper cement and the proper consistency of that cement. Let us assume that the cell is of block tin, and firmly attached to the slide by shellac cement or by gold size or marine glue, and so thoroughly dried that the cell cannot be moved on the glass by the vigorous use of a file. Where strength is not required, no cement is so convenient as asphalte or Brunswick black for rounding out the wall, and if applied at one operation there is nothing treacherous about it. But never put a fresh coat over a partially dried one.

Where it is desired to reinforce the cement which attaches the cell to the slip, the cement should be used pretty thick, and it is well to keep two bottles of each kind of cement, one a fresh and therefore thin one, and another from which the solvent has partially evaporated. With most cements it is best that they should be applied in successive coats, allowing time for each to dry before the next is applied. With cement of a proper thickness and a penknife to turn up the cement towards the cell, while the turntable is revolving, filling up the distance from slide to cover-glass is quite easy.

LYON, H. N.—**Cements, Varnishes, and Cells.**
The Microscope, IX. (1889) pp. 69–74.

ZABRISKIE, J. L.—**A Nest of Watch-glass Covers.**
Journ. New York Micr. Soc., V. (1889) pp. 76–8 (3 figs.).

(6) Miscellaneous.

Counting the Colonies in an Esmarch Plate.†—Where it is desirable to make an accurate enumeration of the number of colonies developed on an Esmarch plate, and where these are not very numerous, Dr. Tavel adopts the following method. The tube to be counted is pushed slowly and with a screw-like motion into an Esmarch enumerator, and at the same time a glass rod is fixed to its clamp, so that a spiral line is traced upon the glass, the turns of which are about 1 cm. distant from one another. The counting is done by following with a lens the course of the spiral from its beginning to its end. In this way the risk of counting a colony twice over is prevented.

BENECKE, F.—**Die Bedeutung der mikroskopischen Untersuchung von Kraftfuttermitteln für die landwirthschaftliche Praxis.** (The importance of the microscopical investigation of strengthening-fodder for practical agriculture.)
15 pp., 8vo, Dresden, 1888.

BIDWELL, W. D.—**A Land Title settled by the Microscope.**
[Examination of some lead-pencil memoranda alleged to be of different dates.]
Amer. Mon. Micr. Journ., X. (1889) p. 60.

BROWN, F. W.—**A Course in Animal Histology. IX.**
[Muscle.] *The Microscope*, IX. (1889) pp. 81–2.

FREEBORN, G. C.—**Notices of New Methods. VIII., IX.**
Amer. Mon. Micr. Journ., X. (1889) pp. 66, 79–80.

TATE, A. N.—**The Application of the Microscope to Technological Purposes.**
20*th Ann. Rep. Liverpool Micr. Soc.*, 1889, pp. 6–9.

WHELPLEY, H. M.—**Microscopical Laboratory Notes.**
Amer. Mon. Micr. Journ., X. (1889) pp. 65–6.

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* Micr. Bulletin, vi. (1889) p. 8.
† Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) p. 552.

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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MICROSCOPY.

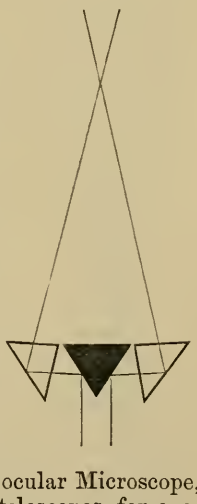
a. Instruments, Accessories, &c.*

(1) Stands.

Binocular Microscopes (Ahrens, Goltzsch, and Holmes).—It is no doubt somewhat rash to attempt to assert that we have reached a final point with regard to any branch of microscopy, but at the same time we are inclined to think that when this notice has been published, all the forms of Binocular Microscope will have been described that it can be at all worth any one's while to invent—at any rate, for any purpose of practical use. The only forms which have hitherto stood the test of use, are those of Nachet, Wenham, and Stephenson.

Ahrens's Polarizing Binocular Microscope.—Hitherto there has been some difficulty, Mr. C. D. Ahrens considers, in using binocular Microscopes with polarizing apparatus, mainly on account of the practical difficulties attending the use of analysing prisms with the double tube for the two eyes. "My invention has for its object the construction of binocular Microscopes in which the difficulty of analysing the light is obviated by employing actual polarizing surfaces to divide the rays as they emerge from the object-glass. This I prefer to accomplish in the following manner:—Over the object-glass is set a prism of black glass having a horizontal side upwards as close to the object-glass as is convenient, and having its two faces symmetrically inclined to the axis of the object-glass at angles of about 57°, which is approximately the angle of complete polarization. The bundle of rays is thus reflected at the proper angle, and divided at the same time into two parts. These parts or rays, passing obliquely right and left, are then reflected up the two tubes to the two eye-pieces, either by two total reflection prisms or by polished metal surfaces. Light polarized by a suitable polarizer before traversing the object, will be analysed by the said prism or prisms placed above the object-glass." The prisms are shown in fig. 74.

Fig. 74.



Goltzsch's second Binocular Microscope.† — We have already described ‡ Herr H. Goltzsch's first binocular Microscope, one of the features of which was the use of small telescopes for eye-pieces. He subsequently announced an improvement, by which the inconvenient vertical stage is dispensed with.

Close above the objective a rectangular prism is placed, the anterior acute angle of which is in the axis while the hypothenuse surface is inclined at an angle of $3\frac{1}{2}°$, so that half the pencil from the objective is diverted, to the extent of 7° from the axis, by total reflection. Behind the

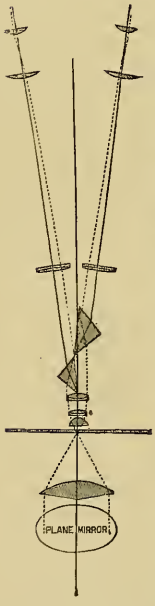
* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Carl's Rep. f. Exper.-Physik, xviii. (1882) pp. 27–32 (1 fig.).

‡ See this Journal, 1882, p. 95.

first prism is a second one, rather larger, but of similar form, the anterior acute angle of which projects slightly over the axis. This prism also diverts the other half of the rays to 7° from the axis. The pencils diverge upwards at an angle of 14° and at about 8 inches above the apex of the angle they are separated from each other by approximately the medium distance of the eyes apart. The telescopes which replace the eye-pieces have achromatic object-glasses and the usual double eye-lenses, and by means of rackwork can be moved so far on their axes as may be requisite for a decrease in the width of the eyes. The prisms are inclosed in a box, which, like the tube of an ordinary Microscope, can be raised or lowered by rackwork or a micrometer-screw. The size of the lower prism must be regulated according to the largest objective-lenses employed; the other may be somewhat (or even considerably) larger; this is advantageous in that a longer path of the rays in the glass moves the apex of the diverging axes lower down, and thus aids in limiting the height of the whole instrument. An aperture on the upper side of the box, central with the principal axis, allows of the insertion of a tube with a small opening, or an ordinary eye-piece, by means of which an exact adjustment of the prisms is made, it being necessary that a point of the object seen through the eye-piece in the centre of the field of view after the prisms are removed should also be in the centre of the telescopic field when the prisms are used.

Fig. 75.



The question of illumination is an important point. The plane-mirror is never sufficient alone for any kind of binocular Microscope. The concave can be employed if it is movable freely in the axis without lateral movement. Still better is a plane-mirror in conjunction with a movable convex lens, which can be removed from the stage to double its focal distance. This mode of illumination is, however, very disadvantageous for the production of sharp images; the light is often far too dazzling, and small diaphragms are consequently necessary. With the Stereo-Microscope these should never have the apertures round, but in the form of slits, placed at right angles to the edges of the prisms; seven or eight of these (from the narrowest to about 2 mm.) may be arranged radially upon an ordinary wheel of diaphragms. The plano-convex illuminating lens shown in fig. 75, used with a plane mirror, is, however, a much more suitable arrangement. Upon the plane surface of this lens two prisms are so placed that their thicker sides unite in the central line, this being parallel with the edges of the prisms. Such a lens forms two separate images of the illuminator; the two sets of rays intersect at a point a little above the lens, where the object is to be placed. Both fields of view are in this way equally illuminated with diffused light without showing an image of the illuminator itself. The lens has a radius of curvature of 32 mm. and a diameter of 40 mm., and the angle of the prisms is $8\frac{1}{2}°$; for the movement of the lens in the axis a space equal to twice the radius of curvature is sufficient. It can also be made in a quadrangular oblong form instead of round; in this case a central piece half as wide as long is sufficient; the light has then freer access to the mirror.

The author adds some remarks as to the special objectives necessary for a Microscope with telescopic eye-pieces. It must not be expected, he says, that proper images can be obtained with objectives which are suitable for ordinary Microscopes; for not only does the bisecting of the rays influence the quality of the images, but the course of the rays is quite different. We must have, therefore, objectives specially corrected for parallel pencils. The lenses of an ordinary objective are placed closer together, as though to suit very thick cover-glass. The object is of course at the focus of the objective instead of being outside it, as in the ordinary compound Microscope, or within it, as in the simple. The results already obtained justify, it is said, the hope that the moderate magnifying powers hitherto reached (scarcely above 200) can be considerably increased. With a power of 120 the striæ on the scales of *Hipparchia Janira* were well seen, with an eye-piece power equal only to the weakest now used; with stronger eye-pieces the power could easily be doubled.

Fig. 76.

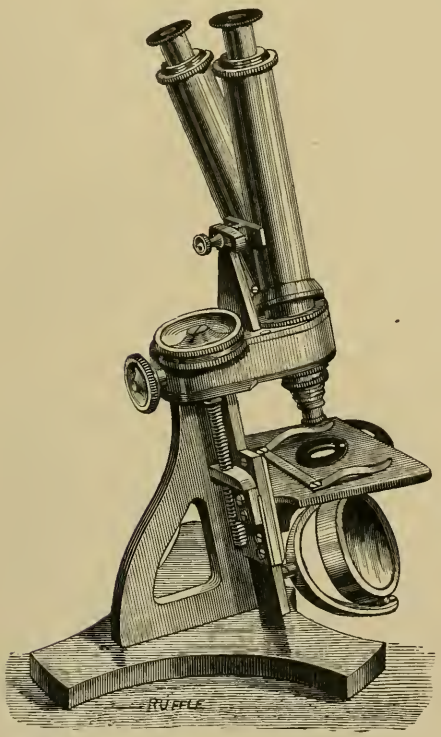


Fig. 77.

Holmes's Isophotal Binocular Microscope.—This is shown in fig. 76. The optical principle of the instrument was described at p. 870 of Vol. III. (1880). A peculiarity of the mechanical arrangement is that the tubes are made to rock from side to side on a socket. The object

of this is to enable one of the tubes to be brought in a line with the optic axis, when the Microscope is to be used as a monocular. The tubes are clamped in any given position (whether for monocular or binocular use) by a screw working in the short vertical piece shown behind them. The screw at the top of the standard acts on the stage and forms the only adjustment for focus. The isophotal prism slides inside the crossbar and is pushed forward over the objective, or withdrawn again when not required to be used, by the screw at the back of the bar.

There is a second body-tube also of peculiar construction (fig. 77) which has three tubes. The two outer ones are for use with the binocular prisms, while the central one serves for monocular observation.

Blix's Microscopes for measuring the radii of the curved surfaces of the eye.* — Dr. M. Blix uses two compound Microscopes for measuring the radii of the curved surfaces of the eye. Hitherto the surfaces have been considered as mirrors, in which, the smaller the image of any object, the smaller are the radii. The principle which Dr. Blix makes use of is the following:—

The image of a point in the axis of a spherical mirror, lies in the axis at a distance from the reflecting surface, which is determined by the distance of the luminous point from the mirror, and by the radius of the latter. If a compound Microscope, which transmits a ray of light from a point in the centre of the plane of the eye-piece to the objective, be placed in the direction of the normal to the reflecting surface and then adjusted so that the point of intersection of the normal with the reflecting surface—the principal point—is focused, then the image of the illuminating point will be at the same place as the point itself. If the centre of curvature of the reflecting surface is then focused the image will again coincide, but this will not take place in any intermediate position. If the displacement of the Microscope along its axis in the two cases is measured it will enable the radius of curvature of the mirror to be determined by calculation.

This result, however, is not so easily obtained in practice, as the field of view is too strongly illuminated by the light reflected from the surfaces of the objective-lenses. Two Microscopes are therefore employed by Dr. Blix, one to transmit the light and the other to observe its image. The axes of these two Microscopes intersect each other, so that the angle between them is bisected by the normal to the reflecting surface; they can be moved towards the reflector in such a manner that the point of intersection of their axes coincides with that of the normal and the reflector. The object (e. g. a diaphragm with a punctured cross brightly illuminated) in the field of the first tube, is by the shifting of the tube so adjusted that the image projected by the Microscope falls on the reflecting surface. By moving the second tube along its axis, the image of the cross is brought into its field also. If the Microscopes are now moved *together* in the direction of their axes, the image of the cross will disappear from the field of the second Microscope but will reappear as soon as the tubes are focused on the plane of the centre of the reflecting surface. By measuring the extent of movement of the tubes, the radius of curvature can be obtained.

* Zeitschr. f. Instrumentenk., i. (1881) pp. 381-90 (6 figs.). Cf. also Centr.-Ztg. f. Optik u. Mechanik, iii. (1882) pp. 33-4.

Figs. 78 and 79 will serve to illustrate the two positions of the Microscopes T and T_1, when adjusted first to the surface of the reflector A B (H being the "principal point") and afterwards to its centre C, o and o_1 being the objectives; d the eye-piece of the Microscope, and d_1 the diaphragm in the other, and a a_1 the points in the plane of the centre of curvature to which the Microscopes are directed in the second position.

The complete instrument with the two Microscopes is shown in fig. 80. It is fixed on a cast-iron table T which also supports F, Q, R for holding the head of the patient in the required position. Each Microscope has a tube for the objective o, and an inner eye-piece-tube

Fig. 78.

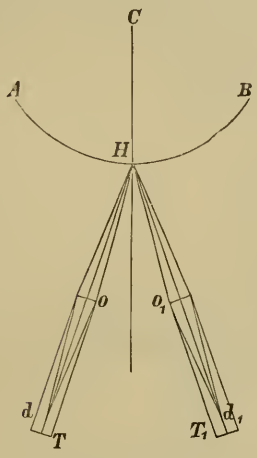
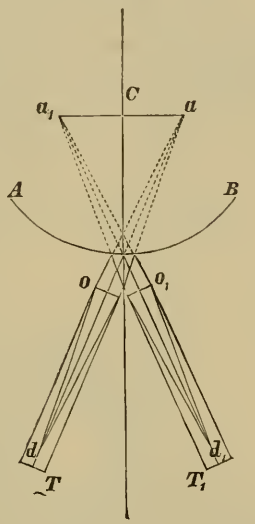


Fig. 79.

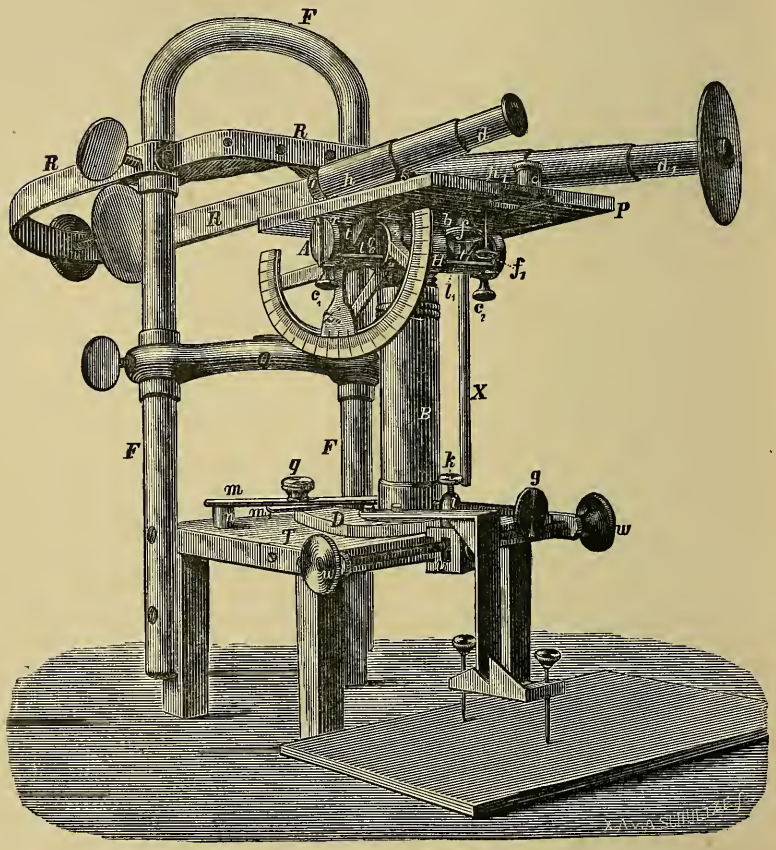


d and d'. In the right tube the eye-piece is replaced by a small round plane mirror from the centre of which the silvering is removed in the form of a cross. The left tube has a Huyghenian eye-piece, with cross-threads. Both objectives are of equal power with a focal length of 40 mm. The Microscopes are placed in two short tubes h h_1 attached to supports s s_1 which rest on the plate P. In the latter are guides, which regulate the movements of the tubes, so that they can only move in the direction of their axes. For displacing the tubes an eccentric movement is employed consisting of a cylindrical steel axis A, with a radius of 12 mm., protected by a brass sheath H attached to the stand, so that it lies horizontal and immediately under the plate P, at right angles with the vertical plane bisecting the angle between the tubes. At the sides, semi-cylindrical portions l l_1 are removed, in order to give room for the lowering of the triangular pieces t t_1 connected with the tubes. From the apices of these pieces is cut a slit at right angles to their base in which slides (pressed with a spring) a cylindrical steel rod r, 4 mm. thick, which lies within the periphery of A, parallel to it and at a distance of 10 mm. This distance can be regulated by four screws c_1 c_2 c_3 c_4. If the axis is revolved on its centre by the handle X, the rod will

describe a curve, and sliding in the two slits, will move the triangular pieces and with them the tubes forward in a horizontal plane.

An index z (with a vernier) on the axis A serves to measure the angle made by the revolution of the axis, on a scale graduated from the

Fig. 80.

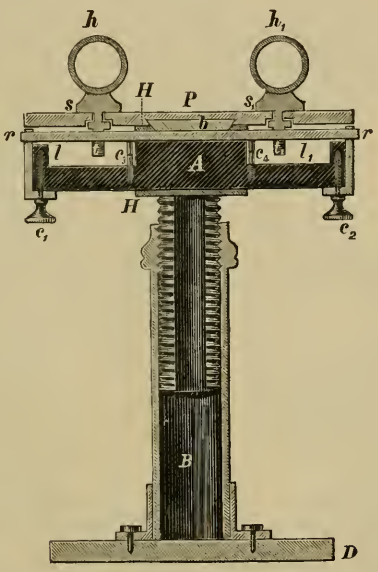


central point of the arc to 90° in either direction, whence the length of the radius can be calculated by appropriate formulæ given by the author.

If however what is required is to determine the distance between the principal points of *two* reflecting surfaces on the same axis—for instance, to measure the thickness of the cornea—an arrangement is necessary by which the point of convergence can be moved from the principal point in the one surface to that in the other, the common axis of the two surfaces bisecting the angle between the tubes. The latter must therefore be capable of being moved *parallel with this axis without changing their relative position.* For this the same eccentric mechanism is used as described above. The plate P is not fixed immovably to H, but a thin

plate *b* soldered to the latter, is inserted between them and on this the plate P moves (see fig. 81); screws *f* and f_1 fix P to *b*, and by means of two other screws the tubes and P can be firmly united. H is attached to the column B which can be lengthened, thus raising the plane of the tubes. The plate D is connected with the table T in a special manner (movable by the hand or by screws) which needs no particular description here—the mechanism is shown at *g*, *i*, *k*, *m*, m_1, *n*, *q*, *v*, and *w*.

Fig. 81.



In a later form Dr. Blix has simplified the instrument, principally by the omission of the cylindrical axis A and the parts in connection with it.

Andrew Ross's Screw and Pinion Coarse- and Fine-Adjustment.—Amongst an accumulation of pieces of experimental mechanism devised in connection with the Microscope at various times during the past sixty years, we recently found one of the earliest fine-adjustments designed by the late Andrew Ross, which is shown in figs. 82 and 83, and which comprises a coarse- and fine-adjustment in one piece of mechanism.

In place of an ordinary rack for the coarse-adjustment there is a long screw the thread of which serves as a rack. The screw is sunk in a groove cut vertically in the back of the stem F supporting the cross-arm and body-tube, leaving about one-third of its transverse section to be acted upon by the pinion D (and milled head E) for the coarse-adjustment. The upper end of the screw passes through the cross-arm B, and a milled head A is applied on the top by which it can be turned, the screw-thread then engaging the teeth of the pinion after the manner of a tangent-screw, so that the screw, together with the stem and body-tube, travels slowly up or down, forming a fine-adjustment.

We found the mechanism as left by Andrew Ross, and it has since been applied to a stand by Mr. Anderson, who informs us that he assisted in the original construction about fifty years ago.

Fig. 82.

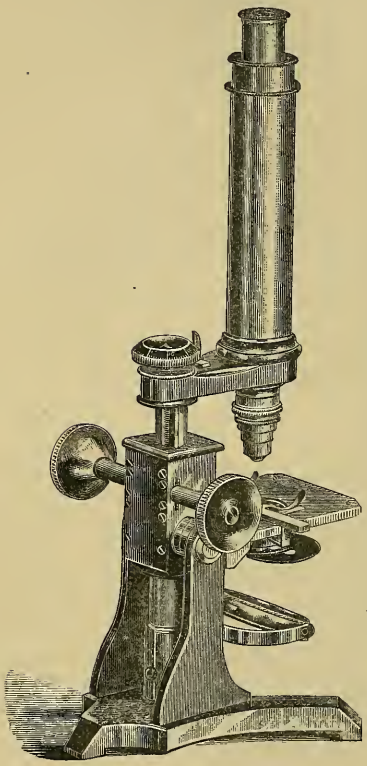
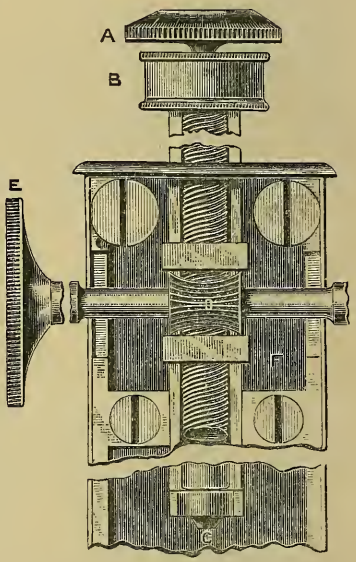


Fig. 83.



M'Intosh's Microscope-Attachment.*—Dr. L. D. M'Intosh devised this apparatus for use with solar or artificial light for projecting or photographing microscopic objects with oblique illumination, or projecting opaque objects, and before describing it he explains the construction of his solar Microscope and stereopticon combination (fig. 84). The optical parts can be used with either solar or artificial light, with only slight changes. To use sunlight, there is a plane mirror M, 12 by 14 in., which turns on a vertical horizontal axis by means of spur-wheel gears connected with rods R, R. The gears are supported by a bracket, which is securely clamped to a perpendicular board F. On the front of this board is an opening to receive the condensing lens, which is mounted in a brass tube C, with draw-tube. The draw-tube E has a screw-thread to receive either the microscopic attachment K, for projecting microscopic objects, or a stereopticon lens for projecting photographic transparencies. By means of the thumb-wheels V, W, the

* Proc. Amer. Soc. Micr., x. (1888) pp. 155–8 (4 figs.).

mirror can be adjusted at any angle desired for illuminating a transparency or microscopic object.

To use the solar Microscope or stereopticon, place it in a window exposed to direct sunlight, and adjust the mirror so that the light enters

Fig. 84.

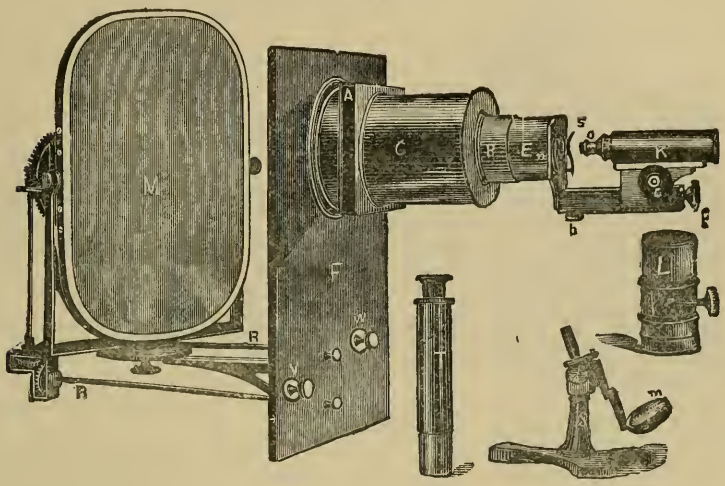
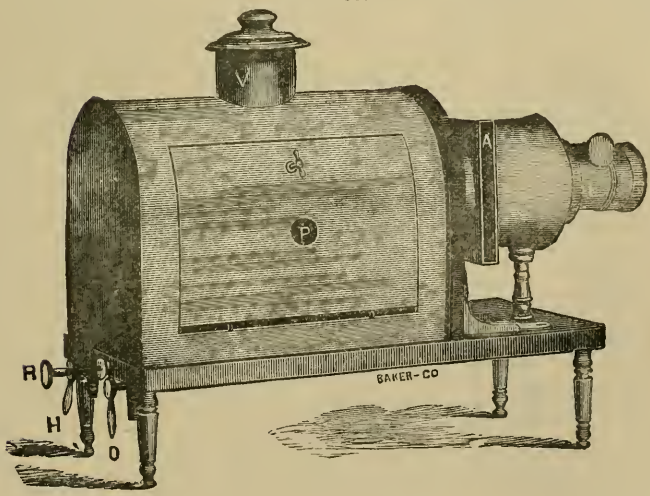


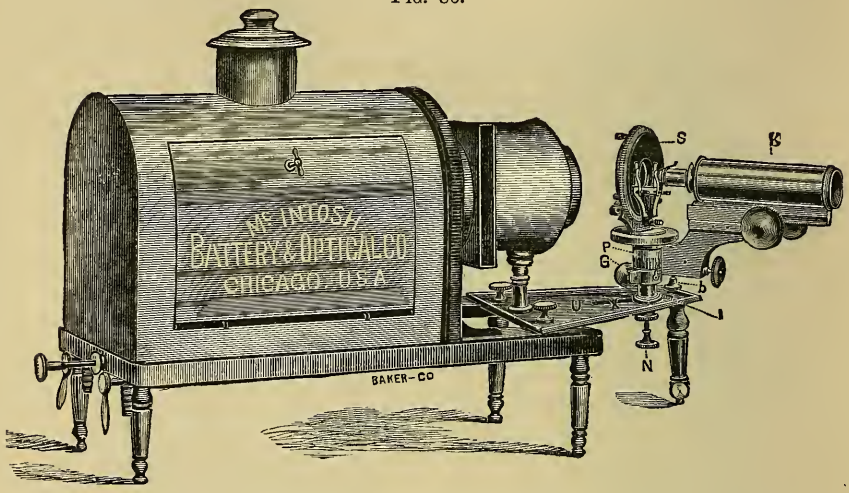
Fig. 85.



the condensing lens parallel with its axis; adjust Microscope or stereopticon lens; place the object on the stage, or, if a transparency, in front of the condenser, and a well-defined image is seen on the screen. To use the optical parts of the instrument just described with artificial

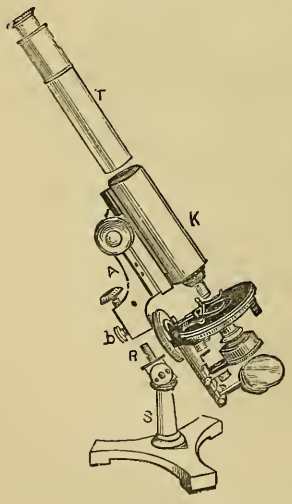
light, viz. oxy-hydrogen or electric, remove the brass tube C, containing the condensing lens and draw-tube, from the mirror attachment and connect to the combination stereopticon (fig. 85), using either the stereopticon lens or Microscope as desired. The light is centered and adjusted

Fig. 86.



by means of thumb-screws on the oxy-hydrogen jet. The adjustment is the same as with solar light. The only change (two condensing lenses are used with artificial light), one of these lenses is removed and only one used, and a small secondary condenser placed under the stage of the Microscope. With this combination just described we can only project, with transmitted light, transparent objects.

Fig. 87.

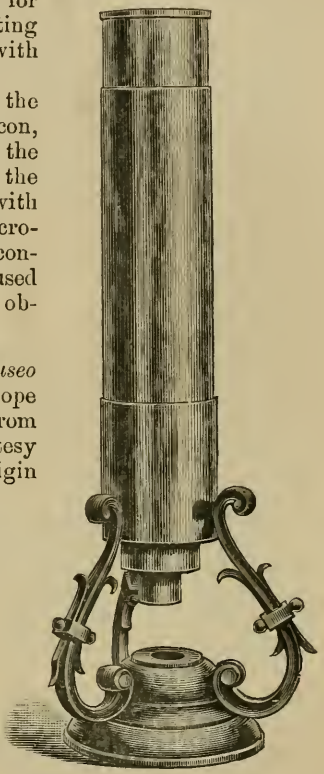


The attachment, fig. 86, is for photographing and projecting objects with oblique illumination, or projecting opaque microscopic objects. It is constructed as follows:—To the base of the combination stereopticon is clamped a triangular piece of brass U, by means of thumb-screws, with a slot X near its apex, to hold a movable hollow pillar I. This pillar is slotted on one side, and has a screw and clamp G to hold a perpendicular pinion P, which in turn receives the stage and working part of the stand (fig. 87). This is securely clamped by means of the screw G, fig. 86. Extending through from the lower end of the pillar I is a screw *h* for raising or lowering the stage of the Microscope and body-tube. The body-tube K of the Microscope is in a horizontal position, and the stage S vertical. These are directly in front of the condensing lens. By

means of the pinion P in the pillar I, the Microscope can be rotated horizontally to the right or left. The centre of an object on the stage corresponds with the centre of motion. By means of this rotation any angle, either of solar or artificial light, can be obtained for photographing and projecting, also projecting opaque microscopic objects, or projecting with transmitted light.

To use the attachment with solar light, the plate U can be removed from the stereopticon, and attached by means of a bracket to the front of the mirror-board (fig. 84, F) of the solar instrument, adjusted the same as with artificial light. For photographing microscopic objects a camera-box must be connected with the tube K, the same as is used with transmitted light to illuminate the object.

FIG. 88.



Old Italian Microscope.—In the *Museo Copernicano*, Rome, we noted the Microscope shown in fig. 88, which is reproduced from a photograph that we obtained by the courtesy of the Curator, Dr. A. Wolynski. The origin is unknown, but it may, we think, be inferred with some probability to be a very early form of Microscope from the fact that it was evidently devised for viewing opaque objects only. Our conjecture is that, from the peculiar design of the nose-piece, it may have been a very early modification of a "Divini" Microscope. The body-tube slides through the tube-socket, which is supported by ornamented tripod scrolls on a raised base; the whole is of brass. The eye-piece lenses are held in their cells by a thin plate of brass notched out, the teeth being merely folded on the edges of the lenses.

AMATEUR.—**Notes on the Microscope-stand and some of its accessories.**
[The foot or base—The supporting pillars—The arm—The body.]
The Microscope, IX. (1889) pp. 264–75.

BEHRENS, W., A. KOSSELL, and P. SCHIEFFERDECKER.—**Die Gewebe des menschlichen Körpers und ihre mikroskopische Untersuchung. Band I. Das Mikroskop und die Methoden der mikroskopischen Untersuchung.** (The tissues of the human body and their microscopical examination. Vol. I. The Microscope and the methods of microscopical research.)
viii. and 315 pp., 193 figs. 8vo, Braunschweig, 1889.

MATTHEWS, C. G., and F. E. LOTT.—**The Microscope in the Brewery and Malthouse.**
xxi. and 198 pp., 30 figs., and 22 pls. 8vo, London and Derby, 1889.

Microscope, The New Acme No. 5 with rack and pinion.
Queen's Micr. Bulletin, VI. (1889) p. 25 (1 pl.).

Watson & Sons' Edinburgh Student's Microscope.
Engl. Mech., XLIX. (1889) p. 471 (3 figs.).

WOOLMAN, G. S.—**Selecting a Microscope.**
Amer. Mon. Micr. Journ., X. (1889) p. 182.

(3) Illuminating and other Apparatus.

Taylor's Oleomargariscope.*—During the prosecution for violation of the Butter Laws of the District of Columbia, it was found necessary in jury trials to have a simpler form of microscopic and polariscopic combination than the cumbrous stand, with polariscope, in general use, since each of the parties interested —judge, jurymen, and attorneys— desired to see for themselves the crystalline forms seen in the fatty compounds known as oleomargarine. To this end Dr. J. Taylor contrived the oleomargariscope, illustrated by the accompanying figs. 89 and 90.

Fig. 89.

Fig. 90.

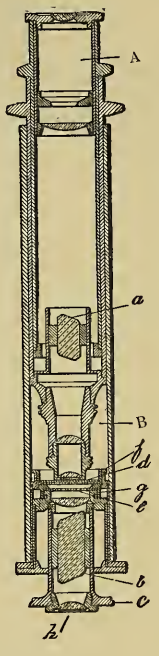


Fig. 89 represents its general appearance when not in use. Fig. 90 represents a sectional drawing showing its internal structure.

A, an ordinary eye-piece.

B, a 1/2 in. objective of the usual constructiou.

a, Nicol's prism or analyser.

b, polarizer firmly secured in tube *c*, which tube may be rotated as desired, thereby changing the prismatic colours.

d, two discs of thin plate glass, between which a small portion of butter or oleomargarine is placed, the discs held in position by ring *f*.

e, a disc of selenite held in position by ring *g*.

h, a lens for the double purpose of illuminating the polarizer and protecting it from dust.

A lens is also placed over and above the polarizer *b*, which concentrates the light on the object between the discs *d*.

It will be seen from the drawing that the objective is readily focused by means of the draw-tube.

When the object is held up to a strong light, if the butter is pure and free from adulteration, an even green or red colour only will be observed, depending upon the character of the selenite used. If "oleo" or lard is used instead of pure butter, a fine display of prismatic colours will be observed.

Recent Improvements in Electric Lighting applied to Micrography and Photomicrography.†—Dr. H. van Heurck describes the Radiguet battery and electric lamp of Prof. Engelmann, a combination very serviceable for the microscopist, since it affords a bright light whose intensity is under perfect control, and the cost of maintenance is very trifling.

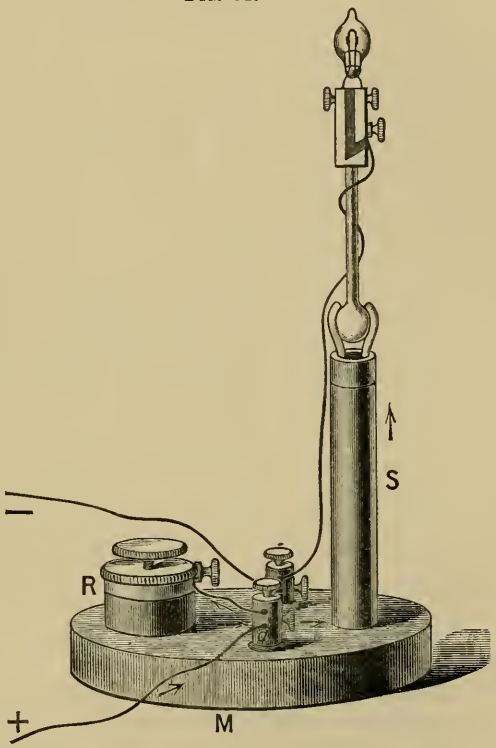
Each element of the Radiguet battery comprises a stoneware jar, a carbon cylinder, a porous pot, and an amalgamating support with its

* Proc. Amer. Soc. Micr., x. (1888) pp. 159-60 (2 figs.).
† Bull. Soc. Belg. Micr., xv. (1889) pp. 24-31 (4 figs.).

reservoir. The construction of the latter, in which alone the battery differs from that of Poggendorf, depends on the fact observed by Radiguet that when mercury containing traces of zinc is in contact with copper, the current tends to transport the mercury over the whole surface of the copper. It consists of a copper tube, coated with zinc, carrying a sort of basket which holds the zinc in the form of small balls. Beneath the basket is a porcelain dish which contains the amalgam, and is connected by a copper rod to the two metal pieces forming the base of the basket.

To start the battery an acid solution of sodium bichromate is poured into the outer jar and pure water into the porous pot. The liquid in the latter requires changing every week, and that in the outer jar every month. This is easily effected, without dismounting the battery, by the use of the Radiguet siphon. The larger arm of the siphon is connected by tubing with a caoutchouc ball, and incloses the narrower tube which forms the other branch. The lower extremity of the larger arm is narrowed, so that when the ball is gently pressed, the increase of pressure in the tube forces the liquid into the narrow branch and the siphon functions. By a strong quick pressure, on the contrary, the liquid is driven completely out of the tube, and the action is stopped at will.

Fig. 91.



The EMF of the battery is about two volts, and the best arrangement for maintaining a steady light for a considerable time is to unite for quantity two series of three elements.

The apparatus designed by Prof. Engelmann (fig. 91) consists of a copper base M carrying the rheostat R and lamp. The path of the current is seen from the figure, connection between rheostat and lamp being made by a rod of copper. The lamp can be adjusted in height by means of the two copper tubes S sliding one within the other, and can be brought into any position by means of the ball-joint. The rheostat consist of a cylinder of copper insulated from the base by ebonite or serpentine, and containing a pile of thin discs formed by a mixture of graphite and gelatin. By means of the screw the discs can be more or less compressed together, and thus the resistance regulated with great nicety.

An improved form of the apparatus, constructed by M. Kagenaar,

consists of a copper plate, 20 cm. by 10 cm., supporting at one end the lamp as described above, and on the rest of its length a horizontal complementary rheostat. The latter consists of a long tube of serpentine inclosing 120 discs of graphite, and gives a range of resistance from 1/4 ohm to 1000 ohms.

LEACH, W.—**A substage Condenser for the Microscope.**
Trans. Manchester Micr. Soc., 1888, pp. 76-8 (6 figs.).

MILES, J. L. W.—**Sub-stage Illumination by simple devices.**
Ibid., 1888, pp. 78-80 (1 pl.).

(4) Photomicrography.

"**Artistic Photomicrography attained.**" *—Dr. W. X. Sudduth recently gave a lecture on histology before an American Dental Society, illustrated with the aid of the stereopticon, which is reported as follows:—

"He exhibited the results of his experiments in colouring slides in facsimile of the stained specimens which had been photographed. The Microscope is undoubtedly valuable in investigating tissues; nevertheless the reported discoveries of microscopists are not always reliable. Great obstacles arise in the use of the instrument, even after the specimen has been mounted, not the least being the fact that focusing is necessary, and that no two men see exactly alike. Therefore, when A focuses on a specimen to show a certain peculiarity, which he claims to be able to discern, he finds it difficult to demonstrate his discovered fact to B, because B cannot tell when he focuses whether he is viewing the same plane seen by A. Of course, when examiners are experienced microscopists the difficulties are lessened, because the trained eye is familiar with the appearances of different tissues, and this materially assists in obtaining the true focus. For example, suppose A claims to show lacunæ and canaliculi in a specimen of cementum. B is acquainted with the microscopic appearance of dentine, and in focusing aims to get the tubuli of the dentine which is adjacent to the cementum distinctly outlined, and having done so, knows that the cementum also is in focus, and should be able to see the lacunæ if present. Again, it is only the trained eye which is able to distinguish breaks, tears, or foreign bodies (as shreds of lint, &c.), and the surfaces of the tissues from the sides or thickness; profile views look flat, not only at the edges of the specimen, but at all points over the surfaces; shadows become lines, and resemble special features of tissues. To lessen these difficulties various methods of staining are resorted to, it being known that different kinds of tissues are differently acted on by the same agent, thus producing various tints, and materially aiding in the differentiation of tissues, which may thus be recognized by their known colours if the stain used be known. It also shows plainly breaks, tears, and foreign bodies.

"Having prepared and mounted a specimen, in order to show what he sees with his instrument, the investigator may reproduce as accurately as possible with his pencil the picture in the field of his vision. These drawings from specimens, however, only carry weight in proportion to the honesty and ability of the artist. Therefore, as Dr. Sudduth truly says, drawings made by photolithographic processes are the more valuable, being above suspicion of inexactness or perversion through

* Odontographic Journal, x. (1889) pp. 44-8.

bias. The tissues themselves have been used as lantern slides, but high lantern power and intensity of light are requisite, and he knows of but two lanterns capable of such demonstration, one being the Stricker lantern. . . . .

"Having stained a specimen, and thus made distinct the differentiation of tissues, the advantage is again lost in the photomicrograph, because, of course, the colouring is not reproduced, the picture being only one of lights and shades. This has been remedied to some extent by having the lantern-slides painted by hand, and by re-touching, thus making more prominent the outlines. Some have attained high excellence in this art, but it is open again to the objection of bias. An artist might colour his slide to prove his theories. Dr. Sudduth has experimented arduously, hoping to find a method by which he could colour slides by such a process as would dispose of this objection, and enable him to project on the screen facsimiles of the stained specimens, making the lantern picture appear as does the specimen itself under the Microscope. His exhibit proved that he has succeeded marvellously well. He has done this not by hand-work, but by a process of toning in the dark room. He has been specially successful in reproducing the purple and pink of hæmatoxylin and eosin, Bismarck brown and gentian-violet.

"He showed on the screen not only coloured slides, but also some untinted. Conspicuous among these were beautiful specimens of the forming blood-corpuscles in the mesoblast of the pig embryo, white and red corpuscles of human blood, oval corpuscles from the thrush, similar but larger ones from salmon, oyster-shaped corpuscles from the frog, and a most beautiful slide showing the enormous corpuscles from the *Amphioma* (a species of lizard). As showing comparative analogies and differences between blood of various species these slides were specially gratifying. . . .

"Then began the specimens in colour. A slide showing stellate reticulum exemplified how well he reproduces the hæmatoxylin and eosin stains. Next followed the apex of a tooth, showing Tomes's fibres retouched. Several slides were shown of the rete Malpighii coloured by hand, and also by the Doctor's method, which latter seemed vastly more satisfactory and truthful. One of these in Bismarck brown demonstrated how a single stain may be used, the lights and shadows being differently affected; for which reason he thinks this particular stain will prove most valuable. A specimen showing the pigment layer of the retina in gentian-violet was much admired. A segment from the mesentery was very clear and distinct. Stained with silver the result was dark lines against a yellow background. Nuclei show as brown points. A few slides in gentian-violet were shown, but this we were told is the most difficult of the colours to manage. A very beautiful slide was from a macroscopic specimen, stained methyl-green, a section of the finger showing the soft tissues and the bone, also the forming nail of a three months' human fœtus. This was shown because it is the only colour with which he has succeeded in differentiating the nail, which usually appears so light that it is very indistinct. In this picture it was quite plainly seen. Some slides followed showing developing bone, cartilage, &c., and then one of special interest, showing the mesoblastic tissue forming periosteum and pericementum, which is the first differentiation into a membrane; these two tissues, which so many claim to be different, are shown to be similar, being similarly developed.

"In the discussion which followed the termination of Dr. Sudduth's talk, Dr. Allen admitted that much credit was due to Dr. Sudduth for his success in colouring slides, but whilst the staining of specimens was of value as aiding the differentiation of tissues, he, Dr. Allen, could not see what was gained by colouring slides. Whilst this is undoubtedly true, the plain photomicrograph being perfectly intelligible to the trained eye, it was the general opinion among the members present that the coloured pictures were more satisfactory to those not so well acquainted with the tissues."

Photomicrography and the Chromo-copper Light-filter.*—Dr. E. Zeltnow claims that his light-filter fulfils the two conditions required of it, namely, it only allows rays clearly visible to the eye and those of a definite wave-length to pass through, and when used in a concentrated form wave-lengths of from 570 to 550 only traverse the filter, so that the light may be fairly called monochromatic. With ordinary objectives perfectly sharp negatives are obtained. The filter is made by dissolving 160 grm. of pure dry nitrate of copper and 14 grm. of pure chromic acid in water up to 250 ccm. A solution more easily made and sufficient for almost all cases in a layer of 1 to 2 cm. thick is composed of 175 grm. sulphate of copper, 17 grm. bichromate of potash, and 2 ccm. sulphuric acid in water up to 1/2 litre. With a mineral-oil lamp the latter fluid may be diluted with an equal or double volume of water.

Since ordinary dry plates are but little sensitive to light which has passed through this filter, erythrosin plates must be used. These are produced by bathing the former in a weak solution of erythrosin (1 grm. erythrosin dissolved in 500 ccm. spirit and 5 ccm. of this solution with 200 ccm. of water are used for each bath). These plates will only keep for three or four weeks at the most, but erythrosin plates can be obtained from the makers which will last from three to six months. Owing to the erythrosin the plates are very sensitive to yellow-green rays with a wave-length of 560.

A fluid very similar in outward appearance to the chromo-copper filter can be made by the supersaturation of copper salts with ammonia and dilution with chromate of potash. This, however, only allows such green rays (510–455) to which the erythrosin plates are little sensitive to pass through. Preparations stained red, blue, green, blue and violet, are easily photographed by aid of the chromo-copper filter, since in consequence of the extinction of these colours the preparations appear black on a green ground.

SIMMONS, W. J.—**Magnification in Photomicrography.**
Amer. Mon. Micr. Journ., X. (1889) p. 180.

(5) Microscopical Optics and Manipulation.

Simple Apparatus for measuring the Magnification of Optical Instruments.†—The usual method of measuring magnifying power consists in comparing the image of an object of known dimensions, seen by one eye through the instrument, with another object seen at the same time by the other eye. By a simple optical arrangement, however, both can be seen simultaneously by the same eye, which is the principle of the apparatus constructed by Dr. A. Oberbeck. Two rectangular mirrors

* Eder's Jahrb. f. Photogr. u. Reproductionstechnik, 1889.
† Central.-Ztg. f. Opt. u. Mech., x. (1889) pp. 176–7 (3 figs.).

(fig. 92), 25 mm. long and 15 mm. broad, are set in a rectangular frame at a distance of 6 cm. apart. They are movable about the axes A B and C D and can be fixed in any required position by means of the screws A and C. The frame is fastened to a stand adjustable in height, and is movable about the axis E F. The mirror A B has a portion in the middle plain. For determining the magnifying power of a Microscope the frame is set horizontally, and both mirrors are fixed at 45° to the horizontal with A B directly above the eye-piece, and C D above the object intended for comparison which lies by the side of the Microscope and is seen by double reflection at the same time as the image of the

Fig. 92.

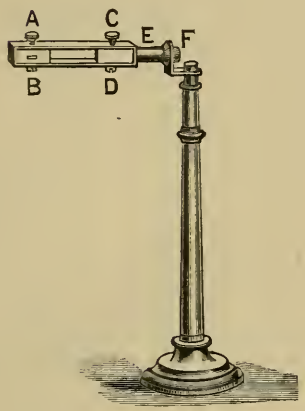
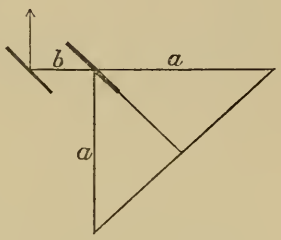


Fig. 93.

Fig. 94.



object beneath the Microscope. For the latter the author uses a micrometer scale with lines at distances of 1/10 mm. and 1/100 mm., and for the comparison object an isosceles triangle, with base 20 mm. and height 100 mm., printed on grey paper. It is easy to see how many micrometer divisions correspond to one of the triangle, thus in fig. 93, 4 mm. divisions fall on the No. 8 division which would correspond to a magnification of 20 times where the micrometer divisions are tenths. The proper magnifying power is then this number multiplied by the ratio of the distance $(a + b)$ of the object of comparison from the eye to 25 cm. (least distance of distinct vision). (Cf. fig. 94.)

Brady, N.—**Illustrations of Diffraction.**

["My purpose this evening is to show by actual experiment how even a simply constructed Microscope may be made a most valuable instrument in examining the phenomena of this branch of Physical Optics, and to illustrate how cheaply and how easily many interesting diffraction experiments may be made."]

Paper read before the Western Microscopical Club, March 4th, 1889, 10 pp.

Lighton, W.—**Instantaneous Changes of Field.**

[Instantaneous changes from dark field to light field and back again with the largest numerical aperture possible.]

Amer. Mon. Micr. Journ., X. (1889) p. 164.

Nelson, E. M.—**Diatom Structure.**

Trans. Middlesex Nat. Hist. Soc., 1889, 13 pp. and 1 pl. of photomicrographs.

Nelson, E. M.—**On the Formation of Diatom Structure. II.**
Journ. Quek. Micr. Club, III. (1889) pp. 308–9 (1 pl.).
„ „ **An instrument for exhibiting the 1/2500 in. without a lens.**
Journ. Quek. Micr. Club, IV. (1889) pp. 20–1, 46–7.

Neudorf, F., Jr.—**Charles Fasoldt Sr.'s Rulings.**
[Claim to have resolved 220,000 lines to the inch.]
The Microscope, IX. (1889) pp. 157–9.
Editorial Note, pp. 148–9.
See also *St. Louis Med. and Surg. Journ.*, LVI. (1889) pp. 289–90.

Pettigrew, J. B.—**On the use of the Camera Lucida.**
Trans. Manchester Micr. Soc., 1888, pp. 80–3.

Royston-Pigott, G. W.—**Microscopical Advances. XLVII.**
[Apochromatic Eidolic dots and Chromatic Beads.]
Engl. Mech., XLIX. (1889) p. 315–6 (3 figs.).

Smith, T. F.—**On the Abbe Diffraction-plate.**
Journ. Quek. Micr. Club, IV. (1889) pp. 5–8.

Thompson, J. C.—**President's Address to the Liverpool Microscopical Society.**
[Deals largely with Prof. Abbe's theory of the Microscope, "the distinguishing feature of the microscopical science of the last twenty years."]
Journ. Liverpool Micr. Soc., I. (1889) pp. 1–24 (2 figs.).

Ward, R. H.—**Micrometry by the Camera Lucida.**
Queen's Micr. Bulletin, VI. (1889) p. 24.

Wenham, F. H.—**Large Apertures in Microscopy.**
[Characteristic letter in reference to the old aperture controversy. "I have long since turned out or destroyed every paper or journal that contained matter relating to the subject."]
Engl. Mech., XLIX. (1889) pp. 438–9.

(6) Miscellaneous.

Celebration of the Third Centenary of the Invention of the Microscope.—The executive committee of the International Exhibition of Geographical, Commercial, and Industrial Botany, which will be held at Antwerp in 1890, have decided to celebrate the third centenary of "one of the most fruitful inventions of which science can boast, that of the Microscope."

With this object the committee propose to organize (1) a retrospective exhibition of the Microscope; (2) an exhibition of the instruments of all existing makers, of accessory apparatus, and of photomicrography.

A series of lectures, illustrated by the photo-electric Microscope will be given during the exhibition. They will include (1) the history of the Microscope; (2) the use of the Microscope; (3) the projection Microscope and photomicrography; (4) the microscopic structure of plants; (5) the microscopic structure of man and animals; (6) microbes; (7) the adulteration of alimentary substances, &c., &c.

It is intended to place the exhibition under the patronage of a "Comité d'honneur," which will be "composed of persons who have rendered the greatest services to microscopical science, and who hold the most honoured rank."

Cronin Mystery, the Microscope in the. *Amer. Mon. Micr. Journ.*, X. (1889) pp. 187–8.

Dallinger, Rev. W. H., an Interview with—Science and Christianity.
Quiver, 1889, pp. 351–5 (3 figs.).

Deby, J., **Bibliotheca Debyana**, being a catalogue of books and abstracts relating to Natural Science, with special reference to Microscopy, in the Library of. (Vol. I. 1. Serial and Periodical Publications. 2. The Microscope and its Technicalities. 3. The Protozoa.) iv. and 151 pp. 8vo, London, 1889.

Fasoldt, Charles—Obituary Notices of. *The Microscope*, IX. (1889) pp. 173–4.
Queen's Micr. Bulletin, VI. (1889) p. 22.
St. Louis Med. and Surg. Journ., 1889, p. 366.

Laboratoires de Micrographie à l'Exposition universelle de 1889. (Microscopical Laboratories at the Paris Exhibition of 1889.)
Ann. de Micrographie, II. (1889) pp. 426–8, 483–5, 520–3.

MARTIN, N. H.—**A Plea for the Microscope**, being the Annual Address delivered before the North of England Microscopical Society by the President.
16 pp. 8vo, private circulation, 1889.

MASCART, M. E.—**Traité d'Optique.** (Treatise on Optics.)
[Microscopes, p. 137.] Vol. I., viii. and 638 pp. (199 figs.). 8vo, Paris, 1889.

PELLETAN, J.—**La Micrographie à l'Exposition universelle de 1889.** (Microscopy at the Universal Exhibition of 1889.)
Journ. de Micrographie, XIII. (1889) pp. 366–9, 403–7, 430–6, 464–7.
„ „ **[Distinction between "micrographes" and "microscopistes."**
English and American Microscopy compared with French and German.]
["For the one the microscopic object is the subject of study, the Microscope is the means. . . . For the others the object is only the means, the subject of study is the Microscope itself."]
["In England and in America the Microscope is not in the same hands as with us. Whilst in France and in Germany the Microscope is only in the hands of professional scientists, and amateurs are rare, it is quite the contrary with the English, where the Microscope is much more common. The world of amateurs is there extremely numerous, fervent, and, it must be recognized, generally rich. These devotees of the Microscope form many powerful societies and clubs, and support numerous microscopical publications, often luxurious, always prosperous."]
Ibid., pp. 225–9, 321–6.

Royston-Pigott, the late Dr.—Obituary Notice.
Journ. of Microscopy, II. (1889) p. 254.
Engl. Mech., L. (1889) pp. 89–90.

SCHOTT—**Ueber Glasschmelzerei für optische und andere wissenschaftliche Zwecke.** (On glass-melting for optical and other scientific purposes.)
Central-Ztg. f. Opt. u. Mech., X. (1889) pp. 221–3 (1 fig.), 232–4 (1 fig.).
Cf. also *Queen's Micr. Bulletin*, VI. (1889) p. 15, from 'Science of Photography'
and 'Ber. Vereins Förderung Gewerbfl.,' 1888, p. 162.

TYSON, J.—**Ignorance of the Microscope among Physicians.**
St. Louis Med. and Surg. Journ., LVI. (1889) pp. 368–9, from 'Philadelphia Med. News.'

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Culture of Infusoria.†—M. E. Maupas recommends as damp chambers low flat-bottomed dishes with vertical sides, about 20 cm. in diameter. The dish is partly filled with fine well-washed sand, and in this are planted longitudinally two upright strips of glass, of such a height that the superior edge is 4 or 5 mm. below the level of the edge of the dish.

On these upright pieces as supports are placed three others, the middle one having a width of 4–5 cm., the two others 2 cm. only. It is on these three slips that are placed the slides bearing the infusoria. The whole is covered by a glass plate fitted as hermetically as possible to the edge of the dish. The dish being filled with rain-water up to the horizontal strips, the air-space is reduced to a layer of 4 or 5 mm. in thickness. This layer of air is always saturated with moisture, and the preparations suffer only an extremely feeble evaporation.

After each operation with a pipette, it should be washed with care, by forcing fresh water through it several times. Some infusoria have a strong adhesive power, and it often happens that they are left adhering

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Arch. Zool. Expér. et Gén., xvi. (1888) p. 179.

to the internal surface of the tube; hence the importance of washing after each experiment.

In order to supply carnivorous species easily with food, it is necessary to find among the more common infusoria a species of small size that can be readily cultivated. *Cryptochilum nigricans* answers perfectly these conditions. It is herbivorous, and occurs everywhere in abundance. In order to utilize it as food for carnivorous species proceed as follows:—Prepare an infusion by cutting up a few pinches of hay in water, and heat the same for a few minutes to a temperature of 60° C. for the purpose of destroying strange species. Allow the infusion to stand two, three, or four days, according to temperature, until Schizomycetes have developed in it, then sow some *Cryptochila* in it, taking care not to introduce other species at the same time. The vessel containing the infusion should always be covered by a closely fitted plate of glass. The *Cryptochila*, finding abundance of food in the Schizomycetes, thrive and multiply by myriads. When the culture begins to decline, as it always will in regular course, it can be revived two or three times by adding crumbs of bread in small quantity. Too much bread causes acid fermentation, which destroys the infusoria. Instead of hay, pepper might be employed for these infusions, but it would be necessary to determine by experiment the quantity that could be safely mixed with a given volume of water. Too large quantities have been found to give infusions that checked the development of the infusoria.

Having thus obtained a well-stocked infusion, the mode of serving the *Cryptochila* to the carnivorous species isolated in the manner above described is as follows:—Place a drop of the infusion on a slide, and cover it with a cover-slip. It will then be seen that the *Cryptochila* collect round the edge of the cover, and in this position they are easily drawn into a pipette, and then delivered over to the carnivorous species. This mode of feeding enables one to make sure that no foreign species is introduced into the culture. Other species would undoubtedly serve the purpose of food as well as *Cryptochilum*—for example, *Colpidium colpoda*.

In the culture of herbivorous species, M. Maupas used boiled flour as food. A pinch of flour is placed in a sufficiently large quantity of rain-water, and boiled two or three minutes. With this pap one can easily supply the needs of *Paramæcium*, *Colpidium*, *Glaucoma*, *Vorticella*, and probably all species that ordinarily feed almost exclusively on Schizomycetes. This food is easily prepared, and is readily served by allowing it to flow in small quantity under the cover-slip of the preparation. It keeps only a short time, and hence must be renewed every day or two.*

Foster, R. A.—**Investigation of Bacteria by means of Cultivation.**
Amer. Mon. Micr. Journ., X. (1889) pp. 124–6.
Foureur, A.—**Étude sur la culture des microorganismes anaérobies.** (Culture of anaerobic micro-organisms.) 73 pp., 25 figs. 8vo, Paris, 1889.
Jeffries, J. A.—**A new method of making Anaerobic Cultures.**
Med. News, 1889, pp. 347–8.

(2) Preparing Objects.

Preparing Eggs of Petromyzon.†—Dr. A. A. Böhm treats artificially fertilized eggs with Flemming's fluid, containing a larger admixture of osmic acid than is prescribed in the original formula.

* Amer. Nat., xxiii. (1889) pp. 277–9.
† Arch. f. Mikr. Anat., xxxii. (1889) pp. 634–5.

After thirty minutes the eggs are washed in distilled water, passed through 30 per cent. and 70 per cent. alcohol (three hours in each), preserved in 90 per cent., and cut in paraffin. The sections are fixed to the slide with albumen, stained with safranin, and mounted in xylol balsam.

Preparing and Mounting with Pressure Insects entire, as Transparent Objects.*—Mr. T. W. Starr adopts the following method:—

After procuring the insect, place it under a tumbler with a few drops of ether. When dead, wet it with alcohol, and place it in liquor potassæ, U.S.P., and let it soak until the skin is soft, and until, on slight pressure, the contents of the intestine can be pressed out through the natural or, if necessary, an artificial opening. This is best done under water in a white plate.

When this is effected the object is to be cleaned. Have a camel's hair brush in each hand; with one hold the object, and with the other brush every part of the insect on both sides. Float it on to a glass slide, and dispose each part in a natural position, either creeping or flying. Cover this with another glass slip of the same size, and press gently together, using only sufficient force to make it as thin as possible without crushing or destroying it. Confine the glasses, with the insect between them, with a fine brass wire, and place them in clean water, to remain twenty-four or thirty-six hours; this will give the insect a position that is not easily changed, and it is therefore proper that the position be such as you desire when the insect is finished. Remove the wire and open the glasses carefully under water, and float the insect off; give it another brushing, and let it remain a few hours to remove the potassa. Transfer it to a small but suitable vessel containing the strongest alcohol that can be obtained, pursuing the same course as with the water, placing the specimen between glass slips tied together, and let it remain about twenty-four hours.

Transfer to a vessel containing spirits of turpentine. It is to remain in this, kept between the glasses, until all the water is removed. While in the spirits of turpentine the insect is to be released several times, and the moisture removed from the glasses, and the insect again confined. When no moisture is seen to surround the insect, heat the glass slips containing the insect over a spirit-lamp until the contained turpentine nearly boils, when, if any moisture is present, it will show its presence when the glasses are cold.

If free from moisture it is ready for mounting. Float it on to a suitable glass from the turpentine, drop a sufficient quantity of balsam upon it, examine and see that no foreign substances are present, heat the cover slightly, and apply in the usual way. After a day or two heat the slide moderately, and press out the surplus balsam, and place a small weight upon the cover while drying. After the lapse of a suitable time remove the surplus balsam, and clean the slide.

In all the operations the utmost cleanliness is essential. The liquids should be frequently filtered and kept from dust, and a large share of patience will be found necessary.

After sufficient time has been given to allow the balsam to harden, so that the cleaning will not displace the cover, remove the surplus from around the cover-glass with a warm knife, and then moisten a soft tooth-

* Queen's Micr. Bull., vi. (1889) p. 29.

brush with a mixture of equal parts of alcohol and aqua ammoniæ, and a slight rubbing will clean the slide with very little danger.

After removing the superfluous balsam and cleaning the slide, finish by spinning a ring around the cover with a transparent cement.

Preparing Central Nervous System of Lumbricus.*—If the earthworm is to be sectioned *in toto*, it is necessary to remove the sand from the alimentary canal. For this purpose, place the worm in a glass cylinder partly filled with fine bits of wet filter-paper. As the paper is swallowed the sand is expelled, and at the end of about two days the alimentary tract is cleansed.

In the study of the ventral cord, Dr. B. Friedländer employed the following methods:—

Place the worm in water, to which a little chloroform has been added, and it soon becomes stupefied in an outstretched condition. Then cut open the body-wall along the median dorsal line, and pin the edges down in a dish covered with paraffin or wax. After removing the alimentary canal, the specimen may be treated with a preservative fluid.

1. Osmic acid 1 per cent. After an exposure of about half an hour, the worm is sufficiently stiffened to allow the pins to be removed, and it may then be cut into pieces of any desired length. The pieces are then left twenty-four hours in the same solution, then washed and passed through the usual grades of alcohol. Preparatory to imbedding in paraffin the pieces are saturated with chloroform or toluol. This method is excellent for the study of the neuroglia-like elements, and is the best for the brain.

2. Preparations treated thirty minutes with osmic acid (1 per cent.) are transferred to a dilute solution of pyroligneous acid (one part to three parts water), which reduces the osmic acid very quickly. This is followed by alcohol as before. The ganglion cells are well preserved.

3. The preparation is first treated with weak alcohol, then with stronger grades. After half an hour in 70 per cent. alcohol, it is stiff enough for removing the pins and for cutting into small pieces. Nerve-fibres are somewhat contracted by this method, and are thus more easily distinguished from the surrounding connective tissue.

4. Corrosive sublimate (aqueous sol.) and 50 per cent. alcohol in equal parts (thirty minutes) gave good preparations of the nerves and the neural tubes.

For preparations according to No. 3, the best stain is a modified form of Mayer's alcohol-carmine, absolute alcohol being substituted for 80 per cent. Sublimate preparations are successfully stained with Grenacher's hæmatoxylin. After half an hour in this staining-fluid, the preparations are transferred to acidulated alcohol (50 per cent., with a little hydrochloric acid) half a minute, then placed in alcohol containing a few drops of ammonia. Connective tissue and nerves are unstained, while ganglion cells are stained deep blue.

The last two methods of staining may be followed by picric acid, which stains the uncoloured elements yellow. The process is as follows:

After the sections have been fixed to the slide with collodion and the

* Zeitschr. f. Wiss. Zool., xlvii. (1888) p. 48.

paraffin dissolved with turpentine or xylol, the slide is placed in turpentine containing a few drops of a solution of picric acid in absolute alcohol. In a few seconds, nerve-fibres, connective tissue, and muscles are stained yellow. The slide is next to be placed in turpentine containing a few drops of alcohol, to wash away the excess of picric acid, then in pure turpentine or xylol preparatory to mounting in balsam.*

Preparing Sections of Spines of Echinus.†—Mr. J. D. Hyatt says that it is much easier to grind down a number of such sections at one time than to grind one singly, and he therefore fills a glass tube with spines, cementing them in place with balsam, and then by means of a circular diamond-saw slices both tube and contained spines into thin discs. A number of these discs are cemented by balsam to a glass slip, and all are ground down together. In order to successfully turn them over to continue the grinding, they are cemented to the first slip with thin balsam. The slip to which they are to be transferred is supplied with thick balsam and inverted over the sections, whereupon, with proper manipulation, the sections will leave the first slip and adhere to the second. He mounts seven or eight sections of spines under one cover, returning them to their desired positions, if displaced in mounting, by inserting under the cover a needle ground flat and very thin upon an emery wheel.

Examining a Shell-bark Hickory Bud.‡—Dr. H. Shimer writes:—Cut a longitudinal section near the middle (a somewhat thick section, 1/100 to 1/300 in., is easily cut), transfer it to a slide, apply glycerin with a brush; after it has pretty well soaked, drain off the superfluous fluid, warm the slide, apply glycerin-jelly, or better, the author's new mounting formula:—Glycerin-jelly, 1 part; Farrant's medium, 1 part; glycerin, 1 part, thoroughly mixed. Apply a heavy cover-glass, press it down a little, at length seal the edges with cement, and the result is a very beautiful specimen permanently mounted.

Examine it with a 1 in. objective, the stand being in the sunshine with a piece of sky-blue blotting-paper over the mirror for a background, and we have a more beautiful and instructive specimen than a 1/1000 in. section made in celloidin. The arrangement of the leaves and the hairs are all that could be desired. Even the cellular structure can be studied. This process is given, not to supersede other fine methods, but only as an easy method to aid in the study of a beautiful bud. If it is a side bud it will show the origin of the bud in the side of the limb and its progress to the surface.

White's Botanical Preparations.§—Mr. C. W. Smiley describes the botanical preparations of Mr. Walter White. Though not pretending to take the place of objects mounted in the usual way, yet, being inclosed in a transparent envelope, they are available for immediate examination, either without or with magnification, in many cases even with the higher powers of the Microscope.

* Amer. Nat., xxiii. (1889) pp. 189-90.
† Journ. New York Micr. Soc., v. (1889) p. 44.
‡ Amer. Mon. Micr. Journ., x. (1889) p. 104. See also p. 136.
§ T. c., pp. 110-1.

The following items from the catalogue will give some idea of the objects prepared:—

3. Orchid leaf. Fibro-spiral cells.
19. Yew. Isolated wood cells.
27. Brake fern. Scalariform vessels.
53. Pampas grass. Closed vascular bundles.
75. Mistletoe. Thickened cuticle cells.
99. Eucalyptus. Oil glands in leaf.
134. Begonia. Axile placentation.

In many cases the objects have been stained, either singly or doubly, and some stained three years ago have not faded. Their very low cost commends them to every student of biology or collector of microscopic objects.

They may be mounted in either resinous media (dammar, benzol-balsam), or glycerin or glycerin-jelly. Mr. White's instructions for mounting are as follows:—"Carefully separate the inclosing films, and remove the object. If for resinous media, soak in spirit of turpentine till clear, rinse in a fresh portion of the same, then drain, transfer to the cover or slide, and finish in the usual way. For glycerin:—If the object be oily, first wash out the oil with strong methylated spirit till clear, transfer to a mixture of glycerin and water, equal parts, in which let it remain an hour or two, then mount.

"Minute objects, such as isolated cells, should be transferred on the point of a scalpel to a slide (or cover), and separated with a needle in a drop of spirit; then, if for glycerin, mount while still moist; but if for resinous media, allow to dry, then moisten with a drop of turpentine before applying the medium. Spiral and other vessels, and long fibre cells, which mat together, should be soaked in a drop of weak spirit, and a few of the most perfect picked out under a simple lens."

Bacteriological Technique.*—Dr. C. Günther suggests that agar plate cultivations may be preserved on slides by cutting out a thin layer and then imbedding in glycerin. The specimen is to be mounted on the slide in the usual way.

The author also suggests that the condensation water of potato cultivation in test-tubes may be prevented from coming in contact with the potato by resting the latter upon a piece of glass tube about 2 cm. long. The latter lies on the bottom of the test-tube. In other respects the author advises Hueppe's technique.

Beck, J. D.—**A Slide of Hints and Suggestions.**
[Cleaning slides—How to dispose of excess of media on slides—Clipping covers—Centering and ringing clipped covers—Cements—Final cleaning of slides—Double-staining animal tissues—Pale copal varnish—Black elastic varnish—Aluminium palmitate copal varnish.]
The Microscope, IX. (1889) pp. 205–12.

Canfield, W. B.—**On the Microscopical Examination of Urinary Sediment.**
Queen's Micr. Bulletin, VI. (1889) p. 26.

Chadwick, H.—**Mounting Insects in Balsam without pressure.**
Queen's Micr. Bulletin, VI. (1889) pp. 31–2.

Dufour, L.—**Revue des travaux relatifs aux Méthodes de Technique publiés en 1888 et jusqu'en avril 1889.** (Review of the works relating to methods of Technique published in 1888 and down to April 1889.)
[1. Methods of preservation and culture. 2. Processes for treating the sections. 3. Microscopy. 4. Photomicrography. 5. Various.]
Revue Gén. de Botanique, I. (1889) pp. 280–92, 343–56 (4 figs.).

* Deutsch. Med. Wochenschr., 1889, No. 20.

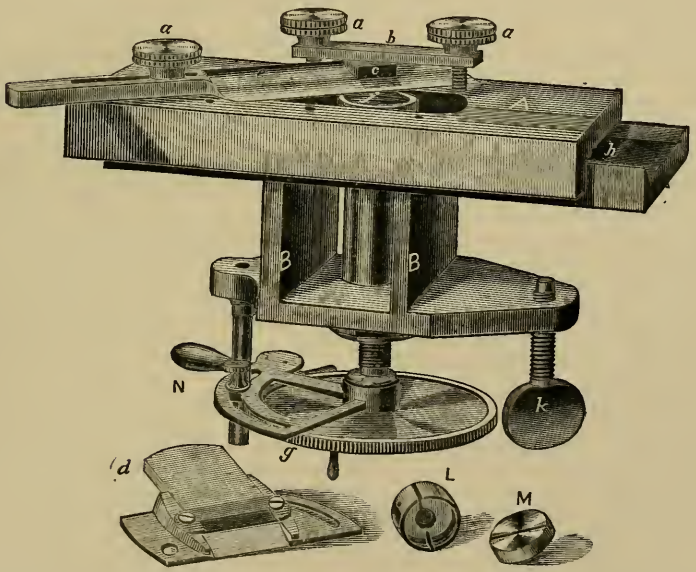
HALKYARD, E.—**The Collection and Preparation of Foraminifera.**
Trans. Manchester Micr. Soc., 1888, pp. 53–9 (1 pl.).
LATHAM, V. A.—**Histology of the Teeth—Notes on Methods of Preparation.**
Journ. of Microscopy, II. (1889) pp. 137–52.
RANVIER, L.—**Traité technique d'histologie.** (Treatise on histological technique.)
2nd ed., 870 pp. and 444 figs. 8vo, Paris, 1889.
ROGERS, F. A.—**Preparation of Drug Sections for Microscopical Examination.**
Queen's Micr. Bulletin, VI. (1889) pp. 12–3,
from 'Rocky Mountain Druggist.'
TYAS, W. H.—**Methods of Hardening, Imbedding, Cutting, and Staining Animal Sections, and Methods of Mounting the same.**
Trans. Manchester Micr. Soc., 1888, pp. 83–5.
WHITELEGGE, T.—**On Collecting, Cleaning, and Mounting Foraminifera.**
Ibid., pp. 12–4.
„ „ **Notes of a Method of killing Zoophytes and Rotifera.**
[Chloroform and spirits.] *Ibid.*, pp. 14–5.

(3) Cutting, including Imbedding and Microtomes.

King's Microtome.*—Mr. J. D. King claims for his microtome no superiority over other first-class instruments for ordinary histological work in animal tissues, but it is designed especially for hard service in botanical work or for cutting any hard material, which requires absolute rigidity in the instrument.

The knife *e* is attached to a heavy nickel-plated iron carriage A, by a

FIG. 95.



steel clamp and shoe *b* and *c*, with milled-head screws *a*. The carriage runs on a solid iron track *h* and B, which is held to a table by clamp screw *k*.

For cutting very hard objects, like the wiry stems of plants or the

* The Microscope, ix. (1889) pp. 76–7 (1 fig.).

chitinous skeletons of insects, there is an attachment with a very stout blade, on the principle of a carpenter's plane *d*, which screws on to the carriage in place of the knife, and like the knife it can be used straight across or obliquely.

Diameter of well *j*, 7/8 in.; depth of well, 1¼ in.; depth of well with chuck L, 1 in.

For cutting soft material, paraffin may be cast directly into the well, or into a chuck (not shown) which is held firmly by being screwed into the bottom of the well. The adjustable chuck L is intended for harder material.

Microtome No. 1 gauges to 1/10,000 of an inch by turning the rachet *g* one click, but can be set to any desirable thickness less by the adjustable arc N. No. 2 gauges to 1/2000 inch, adjustable like No. 1.

Paoletti's Improved Microtome.*—In Sig. V. Paoletti's improved microtome the advantage aimed at consists in reducing the number of movements, and thus to diminish the tendency to inequality in the thickness of the sections. With this intent the knife is kept fixed, and the object-carrier alone moves. The microtome stand consists of a heavy cast-iron base, to which is fixed a vertical upright. To this latter is pivoted a largish steel plate at the end of two horizontal arms. To this plate is fixed the object-carrier, which receives horizontal and vertical movements from a micrometer screw placed beneath it, and with which it is connected by means of a special arrangement.

The knife is fixed by a clamp in any desired position to the vertical upright.

On a dial-plate, the index of which points against the steel plate, are marked numbers from 1–12; these correspond to hundredths of a millimetre, and serve to indicate how far the object-carrier ascends while it is moving horizontally at the same time.

Method for keeping Serial Sections in order during manipulation.†—Dr. L. Darkschewitsch has used the following method for four years for keeping sections of brain and cord in their proper order. A glass tube or wine-glass of the diameter of the sections to be cut is filled with spirit. Discs of filter-paper are also cut of the size to conveniently fit within the vessel. These paper slips are numbered, and having been arranged in their proper order, soaked in spirit. As the sections are made, the paper slip is laid thereon, the two drawn off together, and laid in the vessel, the paper side downwards.

When the vessel is full of the serially arranged sections, the whole series may be stained *in situ*. For this purpose the spirit is poured off, and, if necessary, the series is washed with distilled water before the staining solution is poured in. If Weigert's hæmatoxylin method is to be used, the solution is poured in after the spirit has been removed, and the glass vessel is then placed in a hot box for twenty-four hours. The staining solution is then poured off, and the series washed with distilled water until no more dye is given off. The sections are next taken out separately, and placed on a flat vessel (e. g. a plate) filled with the decolorizer, wherein they remain until the decoloration is complete. After having been thoroughly washed they are returned to the glass

* Atti della Società Toscana di Scienze Naturali, vi. (1888) p. 180.

† Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 43–5.

vessel, where they are dehydrated with spirit. The rest of the treatment (clearing up and mounting in balsam) is done in the usual way.

SHIMER, H.—**Section-cutting in the Cold.** *The Microscope*, IX. (1889) pp. 275–7.

(4) Staining and Injecting.

New Method of Staining the Flagella and Cilia of Micro-organisms.*—Prof. F. Loeffler has devised a new method for staining micro-organisms, and which is especially intended to demonstrate cilia and flagella. That the method is successful is shown by the results, and in photographs the flagella are perfectly seen, as also are cilia of infusoria and monads. The method essentially depends on submitting the preparations to the action of a mordant.

From previous experience it had been found that the capsule of pneumonia cocci were stained grey by ink. Hence tannate of iron suggested itself, and after many trials the author hit upon the following procedure which he pronounces to be satisfactory.

The mordant is prepared by adding a watery solution of iron sulphate to an aqueous 20 per cent. solution of tannin, until the whole fluid turns a black violet. To this fluid is then added 3–4 ccm. of log-wood solution (1 part wood to 8 parts water). The solution should be kept in well-stoppered bottles and 4–5 ccm. of a 5 per cent. solution of carbolic acid added in order to keep it.

The staining fluid is made by adding 1 ccm. of a 1 per cent. hydrate of soda solution to 100 ccm. of anilin-oil water. This alkaline anilin water is then mixed with 4–5 g. of methyl-violet, methylen-blue, or fuchsin (solid) in a flask, and the ingredients mixed by shaking. When required the requisite quantity of fluid is filtered off.

The material to be examined must form a very thin layer upon the cover-glass; hence the fluid, &c., containing the bacteria must be diluted with distilled water, and from the solution the specimen taken, so that the film upon the cover is very thin.

After having been dried in the air and fixed in the flame, the mordant is poured over the film, and then the cover is held over the flame until the fluid begins to evaporate. The mordant is then washed off with distilled water, especial care being taken to remove all traces from the edge of the cover.

The next step is to filter a few drops of the stain (fuchsin best) upon the film. This is allowed to act for a few minutes and then the cover is very carefully warmed over the flame. As the fluid becomes warm the film darkens, and when it is of a black-red hue the stain is washed off with distilled water, and the preparation is then ready for microscopical examination.

Such is the principle of the author's method, but certain variations are also given. One of these is for showing delicate spirals in preparations of typhoid and potato bacilli. Here a few drops of acetic acid 1½ per cent. are added to the solutions. It was also noticed that ferri-tannate gave more satisfactory results with these bacilli than ferro-tannate, but with other bacteria, such as those of cholera, the reverse was the case.

* Centralbl. f. Bakteriol. u. Parasitenk., vi. (1889) pp. 209–24 (8 photos.).

Staining differences in resting and active Nuclei in Carcinoma, Adenoma, and Sarcoma.*—Dr. A. Kossinski who has been investigating the chromoleptic substances in cell-nuclei, comes to the conclusion that the resting nucleus is differently constructed from the active one. The author examined twenty different tumours, and pieces of these were hardened in sublimate solution or 97 per cent. alcohol, imbedded in paraffin and cut up into sections 0·01 mm. thick. Of the numerous stains used the preference is given to safranin and dahlia. The former was used in a 0·5 per cent. watery-spirituous solution; the latter in concentrated alcoholic solution. If, however, a double stain were used, a combination of hæmatoxylin with after-staining with safranin gave by far the best result. With this method the resting nuclei were coloured blue-violet, the karyokinetic or active nuclei a deep red. The method adopted was to stain the section which had been fixed on the slide for nearly a minute with the logwood solution: then to wash it with a 1 per cent. watery alum solution for two to four minutes, then with distilled water for three to five minutes, and lastly with alcohol for one to three minutes. The safranin solution was then allowed to act for twenty to thirty minutes, after which the excess was extracted with alcohol.

Other combinations such as nigrosin and safranin, indigo-carmine and safranin, and eosin or crocein with dahlia sometimes gave fair results.

Rapid method of Staining the Tubercle Bacillus in liquids and in tissues.†—This method, the invention of Dr. H. Martin, depends on the combination of heat and the proper dyes. The pigments used are crystal violet (hexamethyl violet) and eosin as a contrast stain. The stain is made in two solutions:—(1) Crystal violet, 1 g.; alcohol, 95 per cent., 30 ccm. (2) Carbonate of ammonia, 1 g.; distilled water, 100 ccm. Some of solution 2 is poured into a watch-glass, and so much of No. 1 added until the mixture stains filter-paper deeply. This solution is heated until it almost boils.

Cover-glass preparations put up in the usual way are stained in this solution for about one minute, and are then decolorized in 10 per cent. nitric acid (four to five seconds), washed in 95 per cent. spirit, dried or after-stained with the following solution:—Eosin, 1 g.; alcohol, 60 per cent., 100 ccm. This last stain only requires half a minute (cold). The staining of sections is the same as the foregoing, except that the author recommends that after alcohol the sections should be passed through oil of cloves, then turpentine and xylol. The solution of nitric acid should be 25 per cent. instead of 10 per cent.

Staining and Detection of Gonococci.‡—Dr. J. Schütz gives the following process for differential staining of gonococci:—Prepare the cover-glasses in the ordinary manner and immerse them for from five to ten minutes in a saturated solution of methyl-blue in a 5 per cent. aqueous solution of carbolic acid. Wash in distilled water and immerse for a few seconds in very dilute acetic acid (one minim of the acid to a drachm of water). Washing in distilled water completes the process, though if desired, a dilute solution of safranin may be employed as a

* Wratsch, 1888, Nos. 4, 5, 6. Cf. Zeitschr. f. Wiss. Mikr., vi. (1888) pp. 60–2.

† Annales de l'Institut Pasteur, 1889, p. 160.

‡ St. Louis Med. and Surg. Journ., lvii. (1889) p. 44, from 'Müncher Med. Wochenschrift,' 1889, No. 14.

complementary stain. Otherwise the gonococci will appear stained blue on a quite decolorized background.

Dr. F. L. James says * that this process differs in scarcely any degree from that which he has used for a long time for staining gonococci, and he has found it quite good. The ordinary alkaline solution of methyl-blue stains the gonococci a deeper blue than the surrounding tissues, and does not readily bleach out from the latter.

Simple and rapid Method of staining Bacillus tuberculosis in sputum.†—M. E. Dineur gives the following as being a very convenient method for clinical purposes for staining the tubercle bacillus:—

(1) Saturated alcoholic solution of fuchsin.
(2) 25 per cent. solution of carbolic acid in glycerin.
(3) Pure glycerin (or diluted with an equal quantity of water).
(4) Sulphuric acid, 1 in 5.

Several drops of sputum are placed in a watch-glass and then mixed with two or three drops of the fuchsin solution. A drop of the carbolated glycerin is then mixed up with the stained sputum. The mixture is then heated for several minutes to a temperature of 80°–100°. A piece the size of a pin's head is then removed with a needle to a drop of glycerin, placed on a slide, and the cover-glass imposed. A drop of the sulphuric acid is then run under the cover-glass. As the acid eats its way in, everything but bacilli are decolorized. These retain the stain sufficiently long to be easily recognized by microscopical examination made in the usual manner.

New Method for staining the Tubercle Bacillus.‡—Dr. K. A. Norderling has devised the following method, which he states is very safe and easy:—

The staining is done in the usual way by means of the Ehrlich fuchsin solution. The cover-glass is then washed in distilled water and afterwards immersed in a saturated solution of oxalic acid. It must remain therein until it is completely decolorized, when it is taken out, dried, and immersed in a weak solution of methylen-blue until it has received a light-blue colour (about one-half to two minutes). After this it is dried again and finally mounted in balsam. All is now coloured blue except the bacilli, which have a beautiful red colour.

Staining and mounting Elements which have been treated with Caustic Potash or Nitric Acid.§—At the Buffalo meeting of the American Society of Microscopists, a communication was read on this subject from Professor Simon H. Gage and Mrs. S. P. Gage. The main features of the technique of mounting histological elements which have been treated during the process of isolation with either nitric acid or potassium hydrate, is as follows:—

When nitric acid has been the agent in isolating the elements, the first step is to soak the latter in water, to remove all traces of free acid; then transfer to a slip of glass on which has been placed a drop of picrated glycerin. Separate or arrange the fibres, and remove excess of glycerin with blotting-paper. If desired to stain, place in Koch's red

* St. Louis Med. and Surg. Journ., lvii. (1889) p. 44, from 'Muncher Med. Wochenschrift,' 1889, No. 14.

† Bull. Soc. Belg. Micr., xv. (1889) pp. 59–62.

‡ Queen's Micr. Bulletin, vi. (1889) p. 21, from 'Medical Record.' St. Louis Med. and Surg. Journ., lvii. (1889) p. 233.

tubercle bacillus stain (dilute), and leave for twelve hours, remove to a slip containing alcohol of 20°; replace latter by alcohol of 50°, and finally of 90°; clear, and fix with clove-oil collodion and mount in Canada balsam. If it is not desired to mount the object at once, it can be placed in saturated alum water after removal of the glycerin, afterwards stained with hæmatoxylin and mounted in any way desired.

Where caustic potash has been used as the isolating material the latter may be neutralized by the use of a 60 per cent. solution of acetate of potassium. There should be a plentiful supply of the neutralizing agent used, changing the charge two or three times. After pouring it off for the last time, wash with plenty of a saturated aqueous solution of alum, stain with alum carmine, or hæmatoxylin, and mount as desired.

Staining the Walls of Yeast-plant Cells.*—In demonstrating the two membranes of the cell of the yeast-plant, Prof. S. H. Vines found that, by first staining the cells in methyl-violet, washing in distilled water, and then transferring to anilin-green for some hours, in some instances the inner membrane appears of a violet colour, while the outer layer takes a slight green.

Solubility of Fat and Myelin in Turpentine Oil after the action of Osmic Acid.†—Prof. W. Flemming states that fat having been blackened with pure osmic acid never loses colour, even though exposed to direct sunlight for hours and afterwards treated with turpentine. This statement is made in consequence of a communication of M. C. Dekhuyzen, who found that preparations treated with Flemming's chrom-osmium-acetic acid mixture became decolorized when treated with turpentine oil or turpentine balsam. M. C. Dekhuyzen's explanation of the action is that turpentine oil acquires oxydizing properties by exposure to direct sunlight. This may or not be, but if the author's observations are correct it is obvious that the decoloration must be due to the association of the acetic or chromic acid.

Cole's (A. C.) New Slides.

["New method of staining tissues, and particularly nervous structures. This method is strikingly brought out by the slide showing sections of the lumbar and dorsal region of the human spinal cord in four colours. This new stain is particularly effective for photomicrography, as is proved by another slide mounting a transverse section of the left median human nerve. The other slides, mounted with the new staining, are very interesting:—Transverse section through the spinal cord and stomach of a snake, showing a semi-devoured lizard, and also section of the lizard's spinal cord; section through the cervical region of snake, showing spinal cord, œsophagus, &c.; and an effective mount (for microscopic purposes), giving vertical and horizontal sections of the human scalp, showing the hair-follicles, &c."]

Sci.-Gossip, 1889, p. 184.

Staining Tubercle-Bacilli. *Journ. of Microscopy*, II. (1889) pp. 165-6, from 'National Druggist.'

(5) Mounting, including Slides, Preservative Fluids, &c.

Hints on Mounting Objects in Farrant's Medium.‡—Mr. C. M. Vorce writes:—Attention is being turned again to this old but too much neglected medium, the preparation of which by all the published formulæ is attended with much trouble and vexation. The chief difficulty is in

* Journ. of Microscopy, 1888, p. 12.
† Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 39-40.
‡ Amer. Mon. Micr. Journ., x. (1889) pp. 149-50.

filtering the viscous mass, for, notwithstanding the caution always given against stirring the mass to mix it thoroughly, in my own experience the bubbles formed in stirring have uniformly disappeared on long standing in a warm room. Air-bubbles in the completed mount, however, exhibit all the obstinacy with which they have been credited when the mass is prepared on the formula commonly given, viz. two parts each by weight of gum acacia and distilled water, and one part of glycerin. The gum is dissolved in the water, the glycerin added, the mass filtered, and a little camphor added to prevent mould. This makes a quite viscous mass which quickly dries around the edge of the cover, but from which air-bubbles cannot be driven out nor poked out if once imprisoned under the cover.

For such objects as are usually mounted in pure glycerin a much thinner preparation of Farrant's medium is very convenient, and is made by simply increasing the proportion of glycerin to gum. Another useful medium, which dries readily but shrinks more than the others, is made by taking by weight 6 parts gum, 4 parts white sugar, 16 parts water, and 6 parts glycerin, prepared as described. A still further modification is made by taking 8 parts gum, 4 parts white sugar, 2 parts gelatin, 20 parts water, and 12 parts glycerin. Dissolve the gelatin first, then add the gum and sugar, and lastly the glycerin. This mass never dries completely hard, but only to a tough, leathery consistence. In all cases a little gum camphor, phenol, clove-oil, or thymol should be added to the completed mass to prevent fungoid growth.

In the preparation of Farrant's medium on any formula, much time and annoyance may be saved by making the watery solution of gum, &c., much thinner than it is required to be, and after filtration evaporating it to the consistence desired, and then adding the glycerin. I always add to the water in the beginning an ounce or so of a weak solution of chloral hydrate, and add gum thymol to the finished mass; a piece the size of a large pin-head will do for an ounce of medium.

In mounting in any of these gum media, much trouble is saved by first macerating the object in some of the thin medium for a longer or shorter time according to its nature—longer for dense objects than for thin ones—and then arranging the object on the slip in some of the thin medium, allowing most of the water to evaporate (protected from dust), and then adding the thick medium and applying the cover, using a light spring clip to retain it in place. Air-bubbles will not be included by this method.

If a surplus of the medium was used so that much has escaped around the cover, this excess should be cleaned away within twenty-four hours after the cover was placed, while it is still soft and tough. If the cleaning is delayed until the mass outside the cover is hard, the cover will often be moved or pulled out of position by the removal of the outer mass. As soon as the partially cleaned slide has become quite dry, the slip should be placed on a turntable, and the slide cleaned close up to the cover, using a knife-blade or chisel-point to cut away the gum, and a moist rag or folded blotter to finish. Then add successive finishing rings of some resinous cement. Objects thus mounted will prove as durable as balsam mounts; there will be no shrinkage or distortion of soft parts, as often occurs with objects in glycerin; the most delicate and colourless of structural details are well shown, and the objects photograph extremely well.

Air-bubbles need not be included in the mounts, but if unfortunately

present they may be removed by placing the slide in a beaker or glass vessel in which it can lie flat, putting in distilled water to cover the slide, and after standing a few minutes, place the vessel on a sand-bath, when the bubbles will soon emerge from under the cover and rise to the surface of the water. The slide is then to be carefully removed, wiped, and some of the thick medium spun round outside the edge of the cover, which will in drying fill the space under the cover without admitting any air. This is much better than to remove the cover or to try to poke out the bubble, as the removal or displacement of the cover is very likely to tangle up and destroy the object.

New Cell.*—Mr. C. H. H. Walker, of Liverpool, has devised a new cell for large mounts. They are rectangular in shape, and are made of one standard size, 1¼ in. by 5/16 in. They are also made with three sides only for use as live-troughs, &c. The thickness varies from 1/24 in. to 1/12 in. If a deeper cell be required, two or more can be cemented together.

Mounting in Fluosilicate of Soda.†—Mr. E. P. Quinn states that sodium fluosilicate, which is sold as a disinfectant under the name of Salufer, is a very good medium for preserving the green colouring matter of plants, and that owing to its slight solubility in water (0·4 parts in 100) it possesses the further advantage of causing little alteration in the shape of the cells.

The Bidwell Cabinet.‡—In this cabinet, the invention of Dr. W. D. Bidwell, "the drawers contain twelve slides each, and are made of a single piece of seasoned black walnut, 7½ in. by 8 in. and 3/8 in. thick. The compartments are made with a 1-in. chisel, making six cuts 1/4 in. apart and 1/4 in. from the side on each side, and then cuts corresponding to these 3 in. towards the middle of the drawer. Then a piece is easily chipped out between each pair of cuts, leaving twelve drawers which easily hold the slides, separated down the centre by a ridge 3/4 to 1 in. wide. Taking a single cut with a gouge out of this ridge opposite each trough makes a convenient place to slip in the finger-nail to raise a slide. Then the drawers are complete, strong and firm, and very easily and cheaply made. Cut a shoulder on each side of the drawer, and a cabinet is made which will take less than half the time or expense to make of any other, and when done the slides are firmly held, each in its own compartment, and available for inspection or removal, and no danger of removing the cover-glass or label by hasty removal or the motion incident to carrying."

(6) Miscellaneous.

Microscopical Atlas of Bacteriology.§—Dr. C. Fraenkel and Dr. A. Pfeiffer are issuing in parts an atlas which is intended to show the microscopical appearances of micro-organisms. The illustrations have been reproduced from photomicrographs, and possess at the same time the faults and virtues of this process. The cover-glass preparations are shown under a magnification of 1000, and sections of 500. Colonies

* Sci.-Gossip, 1889, p. 184. † Trans. Manchester Micr. Soc., 1888, p. 75.
‡ Amer. Mon. Micr. Journ., x. (1889) pp. 184–5.
§ 'Mikroskopischer Atlas der Bakterienkunde,' 8vo, Berlin, 1889 (pls.).

from plate cultivations are represented under a low power, and those from test-tube cultivations of the natural size.

As the authors of the work are Koch's assistants, their work may be accepted as representing micro-organisms faithfully.

Detecting Alterations in Manuscripts.*—As an accessory to the use of the Microscope, photography is recommended by Mr. G. G. Rockwood. He has for years been in the habit of photographing manuscripts, models, books of accounts, cheques, and drafts, whenever their genuineness was questioned. The process sometimes makes legible figures, amendments, and alterations which even the Microscope does not fully bring out. This is due to the extreme sensitiveness of photographic plates to shades of colour. With the new "auto-chromatic" or colour-sensitive plates almost imperceptible stains on old yellow paper have been made clear and legible.

Cock, G. B.—**The Microscope in the Mill.** *Queen's Micr. Bulletin*, VI. (1889) p. 10.

* Amer. Mon. Micr. Journ., x. (1889) p. 126.

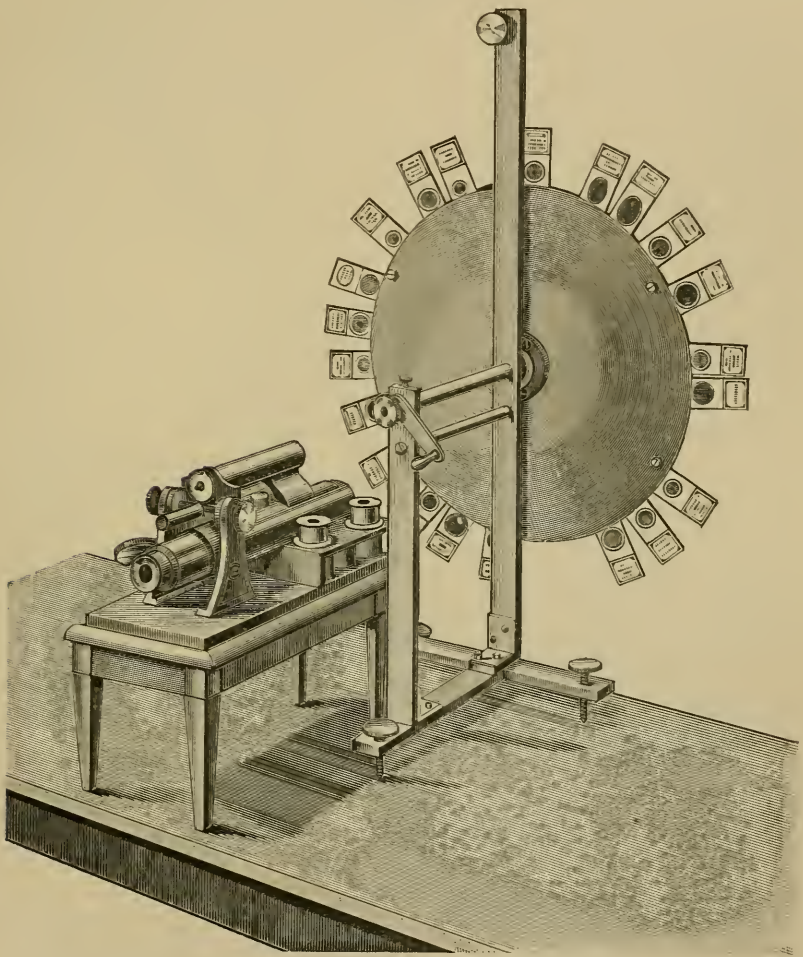
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Anderson's "Panoramic Arrangement for the Microscope."†— Prof. R. J. Anderson's apparatus (fig. 97) "consists of a circular disc,

Fig. 97.



which is made to revolve by means of a handle. The disc is fixed to one extremity of an axle, and the handle to the other. The axle has a

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Internat. Monatschr. Anat. u. Physiol., vi. (1889) 2 pp. and 1 pl.

telescopic arrangement by which the disc is approximated to the handle or removed farther from it. The disc is brought near to the handle by means of a screw-nut fixed at the end of the inner part of the axle, and it is moved away by means of a concealed spring. The amount of this motion is not more than three millimetres. The disc and axle are fitted on a strong iron stand, supplied with levelling screws.

The frame is so arranged that the disc may be used in the vertical or in the horizontal position. The vertical position is, perhaps, the most convenient for museum demonstration. The apparatus, when used in this position for museum demonstration, is placed in a closed case. The handle, with its binding screw and focusing button, are the only parts of the apparatus outside the case.

The disc is furnished with slides. These are clipped to the face of the disc by means of a segmented ring. The upper surface of each specimen is turned towards the observer, so that the thickness of the slide is not involved in the focusing adjustments. The disc must be so placed that it will be perfectly parallel to the front of the case, and the light must fall on the face of the disc. The former condition is secured by means of the levelling screws and a square, and the latter by having the case in front of a window.

The Microscope is fitted to a brass plate which slides in a second plate fixed to the front of the case on the same level as the axle of the apparatus, and at a distance equal to the semi-diameter of the disc. A lateral motion of the Microscope is best caused by a wheel and rachet arrangement. The possible movement is one inch.

The Microscope, then, being fixed for any specimen, it is evident that the screw button on the axis serves to focus the specimen, and is similar to a fine-adjustment. Secondly, a specimen may be examined from side to side by means of the lateral motion of the Microscope. Thirdly, the specimen may be swept from above down by the handle moving the disc; and lastly, a whole series may be examined one after another. It is quite safe to place the instrument in a museum case. No one can injure the slides or spoil the Microscope, as the limits of motion are fixed, and the student can thus study a series of specimens without supervision.

The instrument may be used in the same position for class demonstration, or it may be turned, levelled, and thus used in the horizontal position by means of an ordinary arrangement for reflected light.

The Microscope tube is, under ordinary circumstances, so close to the vertical portion of the stand, that a special stand is necessary for use in the horizontal position.

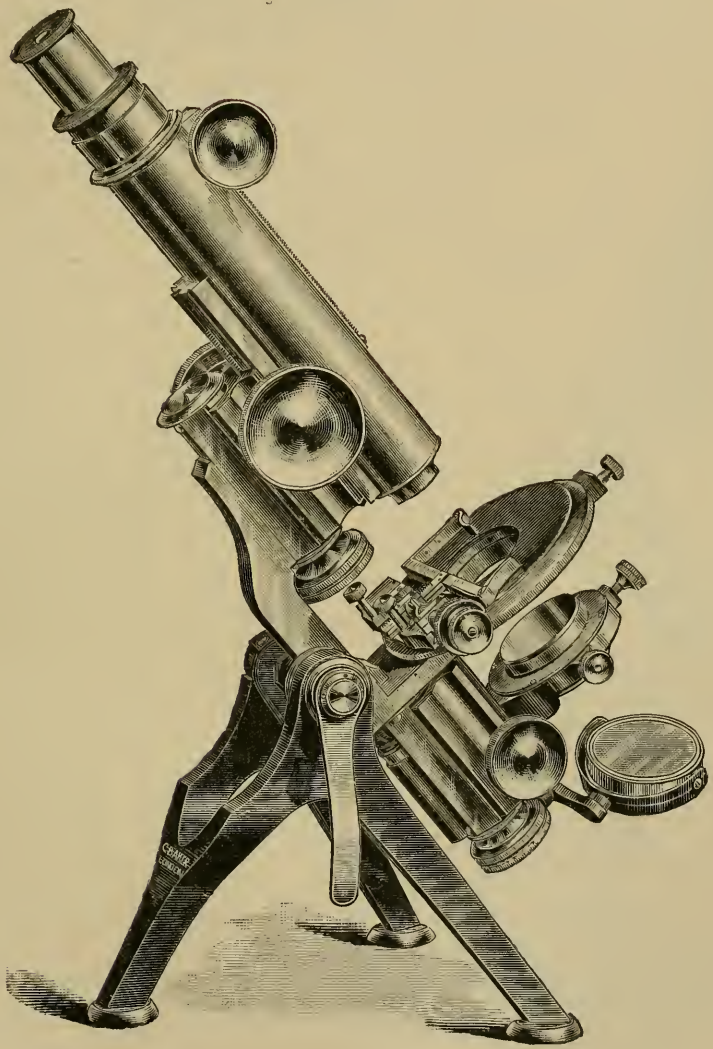
The museum case should be provided with curtains, as some preserved specimens are injured by the light and heat."

Nelson-Curties Microscope (Large Model).—This Microscope (fig. 98) is the joint production of Mr. E. M. Nelson and Mr. C. L. Curties.* It stands on a firm tripod foot, the extremities of which are plugged with cork, diminishing vibration and preventing it slipping or injuring a table. Depending from the trunnions is a kind of stirrup, to which the Microscope is attached. This stirrup lowers the centre of gravity when the Microscope is vertical or in an inclined position, and gives a better balance when the instrument is horizontal for photo-

* See this Journal, 1888, p. 691.

micrography or other purposes. The body can be clamped by means of a lever attached to one of the trunnions. The body is specially constructed to work with Abbe-Zeiss apochromatic objectives, and is fitted with a rackwork draw-tube for lens adjustment; it will rack out sufficiently to adjust these lenses on the thinnest covers.

FIG. 98.

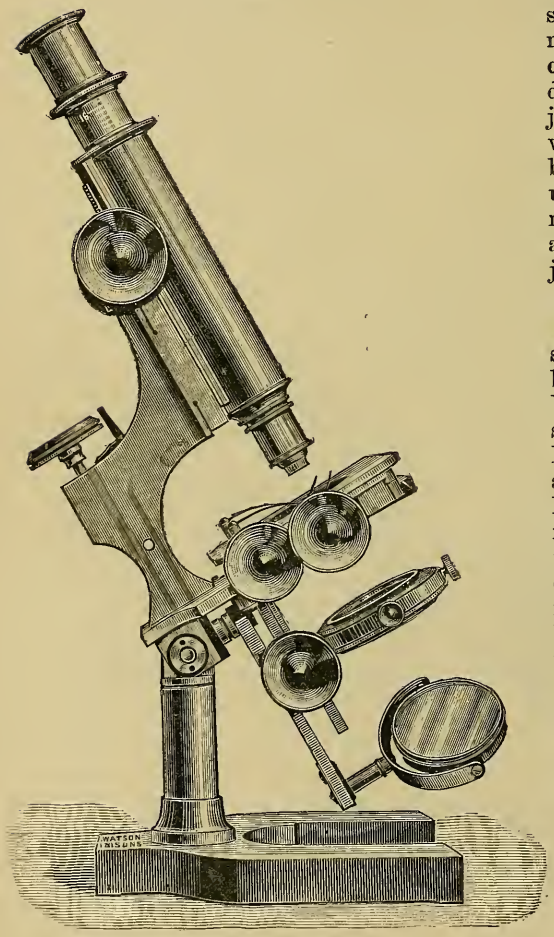


There is the usual rackwork coarse-adjustment. The fine-adjustment is a Campbell differential screw. This fine-adjustment, while being very strong, works with great smoothness and delicacy. It is claimed that the differential screw solves the difficulty which has always

existed with direct-acting screw fine-adjustments, viz. that of providing a slow movement by means of coarse strong threads; in all other direct-acting screw fine adjustments, if they are slow enough to work wide-angled oil-immersion objectives, the movement is obtained by means of a micrometer-screw with a very fine thread, which is too weak to stand the usual wear and tear. The milled head of the fine-adjustment is placed below the limb. In this new position it is found to be quite convenient for ordinary work, while it is steadier when a cord is attached for photomicrography.

The stage is plain rotary, having Mayall's mechanical movement attached; it can be clamped by the screw in front. The substage has centering movements, rack-and-pinion coarse-adjustment, and differential-screw fine-adjustment, admitting of wide-angled condensers being easily focused. The usual plane and concave mirrors on a double-jointed arm are carried on an adjustable hinged tail-piece.

Fig. 99.

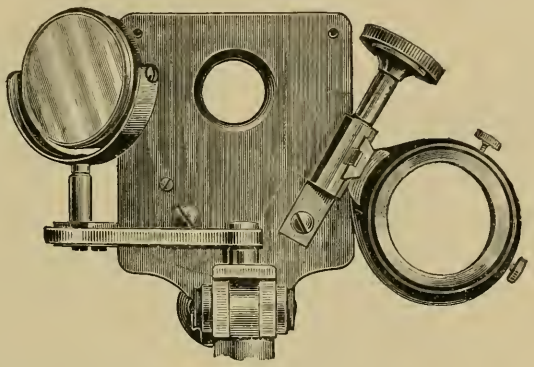


Edinburgh Student's Microscope.—This Microscope (figs. 99 and 100) has been made by Messrs. W. Watson and Sons, on lines suggested by Dr. Edington, Lecturer on Bacteriology at Edinburgh University. Fig. 99 shows the instrument in its simplest form, with sliding body for coarse-adjustment, Continental horse-shoe foot, and body-tube of the Continental size, fitted with draw-tube, which, when extended, gives the full English length of 10 in. The fine-adjustment—a part often neglected in instruments of Continental make—is worked by the rotation of a milled head acting on a lever moving the entire body. A tenth of a turn of the milled head only moves the body 1/3000 in., so that a precise adjustment can be made.

Another point is the hanging of the under-stage, fitted on a pivot so that it can be lifted aside with a condenser in it, and direct light

from the mirror obtained at once. Fig. 100 is view of the under side, and shows the way in which it is done. This is a distinct advantage, and workers with the ordinary form of instrument, in which the con-

Fig. 100.



denser must be withdrawn if direct light from the mirror is required, will at once appreciate it. The stage of the instrument is $3\frac{1}{2}$ in. square, permitting of the use of large slips. The eye-pieces supplied with the instrument are nickel-plated.

Leach's Improved Lantern Microscope.—The principle upon which this Microscope (figs. 101–103) is constructed, was briefly described in a paper which Mr. W. Leach read before the Manchester Microscopical Society in 1887, an abstract of which appeared in this Journal.* There was no thought when this paper was read of placing the Microscope in the market; but the great amount of private correspondence which followed its publication, led to the instrument being manufactured for sale.

The stage used in it was an old and well-known form; but it failed to give satisfaction on account of the obstacles which the object-holder, with its four arms and the springs coiled round, offered both to the changing of the sub-condensers through the stage, and to the attachment of a rotating tube for polarizing prism. To get rid of these obstacles a new arrangement of object-holder has been devised and placed underneath the stage, the arms passing through slots in the bottom, so as to hold the objects against the inside surface of the front of the stage. The new object-holder is thus placed out of the way of all the mechanism and all the material used in the stage. In changing the sub-condensers, all which it is now necessary to do is to take out the one in use and substitute the other, neither object, objective, nor wheel of diaphragms being disturbed in doing so.

The compound wheel of diaphragms is peculiar in its construction. One part of it has a large single aperture, and moves by means of an arm upon a pivot, so that it can be lifted up out of the field or dropped into it, just as it is or is not wanted. A spring catch holds it up in its place, so that it cannot fall by its own weight. To the armed wheel is attached a second wheel with five concentric apertures, any of which can

* See this Journal, 1887, p. 1019.

be turned into the centre of the field at pleasure. When the compound wheel is lifted up as shown in fig. 103, the whole field of the Microscope can be utilized for showing objects up to $1\frac{1}{2}$ in. diameter. Thus the compound wheel, $2\frac{1}{2}$ in. diameter, yields just as large a field as can be obtained by one of the ordinary form when 5 in. diameter.

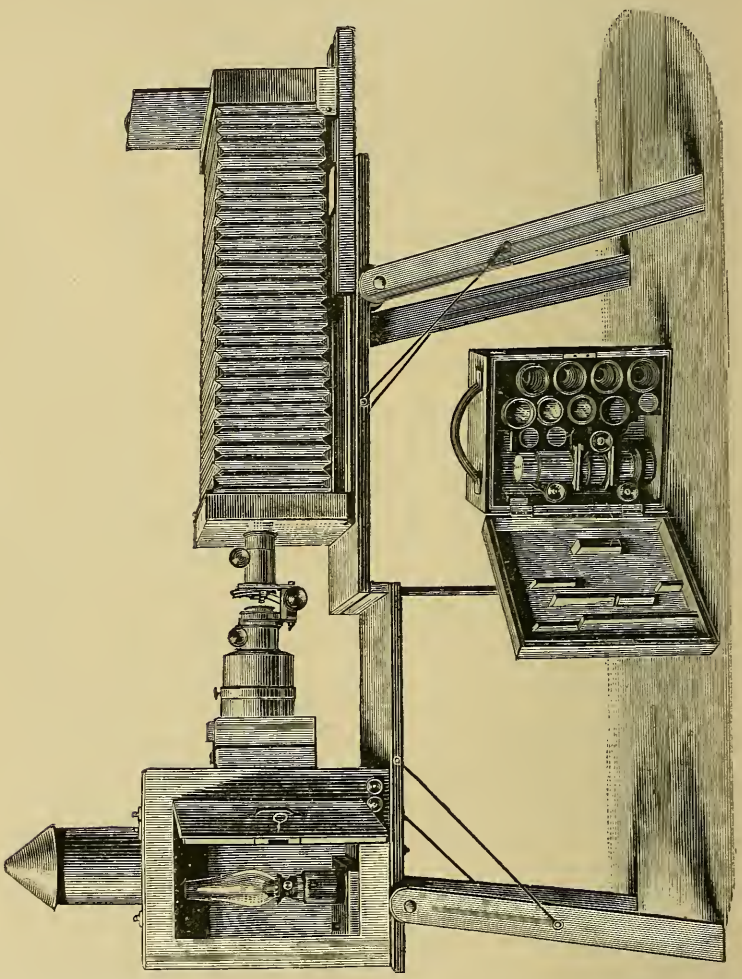


Fig. 101.

When, as in using polarized light, it is not desired to be incommoded with the wheel of diaphragms, the detachable plate carrying the compound wheel can be instantly taken out of the stage, and when taken out can be as quickly put in again. It should be noted that one stage serves for all classes of objects, whether ordinary slides or polariscope crystals shown with narrow-angle rays or the convergent system of lenses. The tube for the polarizing prism is fitted for entire rotation, and all the phenomena of polarized light can be demonstrated by the

instrument. It is also equally useful for photomicrography, as the optical principle is based upon the system introduced by the late Rev. T. W. Kingsley, but greatly improved in both optical and mechanical effects.

Fig. 101 will give an idea of the way in which the arrangement is made, a paraffin lamp with 1/2 in. wick being the source of illumination

Fig. 102.

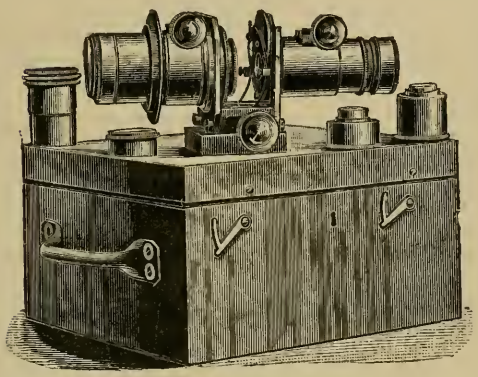
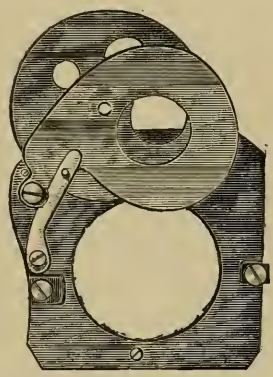


Fig. 103.



for this purpose. "The instrument having been constructed by a working man (an operative photographer) who has devoted to it all his leisure hours for a period of over ten years, it has been deemed only fair that he should seek some remuneration for his labour, and he has therefore secured his improvements to himself by a patent." *

"Amateur."—**Notes on the Microscope Stand and some of its Accessories. III.** *The Microscope*, IX. (1889) pp. 330–6.

Crisp, F.—**Ancient Microscopes.** *Proc. Royal Institution*, XII. (1889) p. 201.

Seibert's Microscope.

["By means of an improved Microscope made by Seibert of Wetzlar the internal structure of the anthrax bacillus can be made out. This consists of a series of pearl-like corpuscles, which can be plainly seen to undergo division. The magnifying power of the Microscope is said to be 2250 diameters."] *Lancet*, II. (1889) p. 887.

(2) **Eye-pieces and Objectives.**

1/10 in. Apochromatic Objective of N.A. 1·63.—Prof. Abbe has designed, and Dr. Zeiss has produced a 1/10 in. apochromatic objective of the large numerical aperture of 1·63, the limit hitherto reached having been N.A. 1·50 in the case of an objective made by Mr. T. Powell. Monobromide of naphthaline is used as the immersion fluid, and the slides and cover-glass are made of flint glass.

An immersion condenser of N.A. 1·60 has also been constructed by Dr. Zeiss in order to secure approximately the full aperture of the objective.

Dr. H. van Heurck reports † that the objective allows of the resolution of all known tests by axial illumination, and shows new details in certain Bacteria.

* Cf. Eng. Mech., l. (1889) pp. 242–3 (3 figs.).

† Bull. Soc. Belg. Micr., xv. (1889) pp. 69–71.

Dr. J. Pelletan refers* to the price of the objective as being 10,000 francs, or 400*l.*, but we have no verification of this statement.

Apochromatic Objective stolen. ["From the K. mechanisch-technischen Versuchs-Anstalt in Berlin-Charlottenburg has been lately stolen an apochromatic objective of Carl Zeiss of Jena, homogeneous immersion, numerical aperture 1·30, focal length 2 mm. Besides the name of the firm and the usual data, the objective has the maker's number 555 engraved in small figures. It is requested that the objective may be retained should it be offered for sale."]

Central.-Ztg. f. Optik u. Mechanik, X. (1889) p. 143.

HEURCK, H. VAN—**La nouvelle combinaison optique de Zeiss et les perles de l'Amphipleura.** (The new optical combination of Zeiss, and the beads of *Amphipleura*.) *Bull. Soc. Belg. Micr.*, XV. (1889) pp. 69–71.

(5) Microscopical Optics and Manipulation.

Diffraction Theory.—Prof. B. T. Lowne and Mr. E. M. Nelson have been in controversy on this subject, the former attempting to explain the phenomena of microscopic vision on a dioptric basis, while the latter supports Prof. Abbe's views.

Prof. Lowne explains as follows† the advantages arising from the use of lenses with a large numerical aperture, and of immersion lenses respectively.

"The images seen with the Microscope are either brighter or darker than the illuminated field. An opaque object appears black, when illuminated from below it gives a negative image. A transparent object seen by transmitted light is less bright than the field, i. e. gives a negative image, whenever it absorbs much light, and whenever it has a lower refractive index than the medium in which it is mounted, except when it acts as a concave lens; it is brighter than the field whenever it has a higher refractive index than the medium in which it is mounted, except when it acts as a concave lens, i. e. it gives a positive image.

Diatoms have a lower refractive index than balsam, and seen by transmitted light should give, in the majority of cases at least, a negative image. Such a negative image is always complicated with diffraction images, and is only seen with object-glasses having a low numerical aperture. The dioptric image is necessarily feeble, as the diatom permits much light to pass through it, and delineation is only possible by means of diffraction images.

The case is, however, very different with high angles of aperture, and especially with immersion lenses; the diatom image is then positive; it is brighter than the field. How can this arise? The diatom is self-luminous, i. e. in the same sense as a piece of white paper is self-luminous. Every point of the diatom radiates light, and every point is an independent source of light, that is, the light radiates independently from every point, the vibrations proceeding in every possible phase at every instant, such light producing no visible interference phenomena.

The cause of the positive image is that the diatom is illuminated from above, not from below. It is illuminated by reflected light from the upper surface of the front lens of the objective.

It is well known that the pencil of light which falls upon a plate of glass is partially reflected chiefly from the surface of emergence. This surface of emergence of the front lens is a concave mirror, which condenses the reflected pencil upon the object. A very simple experiment

* Journ. de Microgr., xiii. (1889) pp. 481–2.

† Journ. Quek., Micr. Club, iii. (1889) pp. 360–72 (4 figs.).

will convince the most sceptical of the great illuminating power of the back of the front lens of an objective. Take a black-handled pocket-knife, the smaller the better, with a bright stud upon it, hold it up between the eye and a gas-burner, near the source of light; the stud is invisible. Take an ordinary pocket-lens of an inch focal length or thereabout, and without moving the knife, focus it upon the stud; it will be brilliantly illuminated.

Any convex lens will give a brilliant inverted image of a flame upon a small screen placed between it and the source of light, by reflection from its back surface. Moreover, if we look at the lens the virtual erect image of the flame seen on its back surface is nearly as bright as the source of light, although, of course, much smaller.

With objectives of large numerical aperture, the working distance is short, and with a large pencil much light is reflected upon the object. With immersion lenses the reflection from the cover-glass and the front of the objective is practically done away with, so that all the light reflected from the upper face of the front lens falls upon the object.

Five per cent. of the light which falls normally on the back surface of a glass lens is reflected, whilst the quantity which is reflected by oblique incidence rapidly increases; much light is totally reflected, the whole converges after reflection once, twice, or thrice towards the object, and it must be remembered that only the centre of the pencil falling upon the back surface of the front lens is transmitted to the eye, whilst the whole pencil is concerned in the illumination of the object from above.

I believe that this is the great advantage derived from high angles of aperture, and more especially from immersion objectives. The elimination of the false diffraction images resulting from the large illuminating pencil, and the reflection of light from the object, appear to me to be the causes of the great increase of definition attained by their use. The view propounded by Professor Abbe that they collect outlying diffraction pencils, appears to me quite inadequate to explain the increase of definition."

Mr. E. M. Nelson refutes Prof. Lowne's suggestion by the following considerations:*—"One great objection to the dioptric theory is, that it is unsupported by experiment. The single experiment put forward may be said to touch the subject only in an indirect manner. I allude to the reflex from the objective front, to which I shall refer later.

(1) The point with regard to the images of the condenser diaphragm at the back of the objective has nothing to do with the question.

Let us take a simple case—viz. an oil 1/8 of large angle focused on a *P. angulatum*, illuminated by edge of flame, centered and focused by stopped-down condenser on object in usual manner. Now, if we examine the back of the objective we shall see the usual picture of the dioptric beam and the six spectra round it. The size of the dioptric beam—i. e. the disc of light at the back-lens of the objective—will depend on the size of diaphragm and angle of condenser. The size of the spectra will equal the size of the dioptric beam. If the object be now taken away, we shall lose the spectra, but not the dioptric beam. Now, no one imagines for a moment that this image of the diaphragm is projected to a focus at the objective conjugate; what is projected there is an erect image of the edge of the flame. If the object be replaced, there will be

* Eng. Mech., xlix. (1889) pp. 425-6 (4 figs.).

an inverted image of it, in the erect image of the flame, independently of any spectra.

Now with regard to the spectra. I well remember that the first experiment I performed when the diffraction theory was new was to receive the images on a piece of oiled tissue-paper at the objective back. If my memory serves me right, you can trace an image of *P. angulatum* about half an inch from the objective back. The images will necessarily be much out of focus, but, nevertheless, they can be made out. There were black outlines on a light ground in the dioptric beam, and a green image in each of the six spectra. Remove the greased paper screen further back from the back lens, and the six spectral images were seen to coalesce with the central dioptric image. The point to be learned from an examination of the back of the objective is the size of the cone, or cones, which form the image at the objective conjugate.

Thus, the dioptric image of a point in the object is formed by a cone, the base being the bright disc at the objective back. A spectral image is formed by a cone, the spectral disc being its base, and so on. I am of opinion that Prof. Abbe has established experimentally and theoretically that the delineation of this microscopic image of the fine structure of *P. angulatum* depends on the fusion of these green spectral images with the dioptric beam and with one another.

(2) The next point is the extinction of the spectra by the dioptric beam, or, more correctly, the effect of the spectra is so feeble in comparison to that of the dioptric beam, that their power to influence the image is practically *nil*.

The answer to this is, that just as much as you increase the diameter of the dioptric beam, so do you increase that of the spectra—a fact which may be experimentally verified in two minutes. Thus, expand the illuminating cone until it nearly touches the expanded spectra, now stop out the dioptric beam, and look at the brightness of the spectral image. Then, without moving the stop, reduce the illuminating cone, and watch the diminution in the brightness of the spectral image.

Of course, it is impossible to carry on the experiment when the dioptric beam overlaps the spectra, as it is impossible to cut out the dioptric beam without cutting out the spectra as well. But it is for the "dioptricians" to show why the brightness of the spectral image should cease to increase at the point when the dioptric beam overlaps the spectra. The brightness of the spectral image most certainly increases as you increase the dioptric beam as far as you can carry on the experiment, and I can see no possible reason why it should not go on increasing until you reach your maximum cone.*

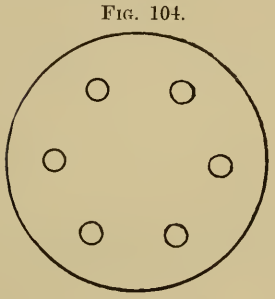
(3) The following experiment, although not proving the matter, points very strongly in favour of the diffraction and against the dioptric theory. Examine a *P. angulatum* with a lens which, when illuminated by a narrow pencil, will not grasp the six first-order spectra, and enlarge the cone until the dioptric beam occupies, say, 3/4 of the back. Now, if a lens of suitable angle has been chosen, the expanded spectra will just cut into the peripheral zone of the objective. If the eye-piece is replaced, delineation will be seen; but if a stop be placed over that peripheral zone, although the large dioptric beam remains the same, the delineation will have vanished. If the image is a dioptric one, why, in the presence

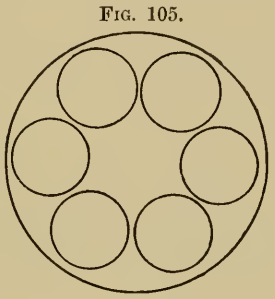
* Unless the experiment has been tried, one would hardly believe the great brilliance of the spectral image when the dioptric beam has been stopped out.

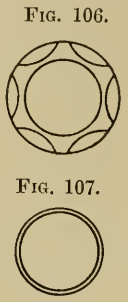
of such a large dioptric beam, are those little edges of spectra in the peripheral zone so supremely important?

(4) You cannot have an irregular picture from a spectral image. A short time ago I also held this view, and I used to assign the irregularities in the microscopic image to a function of the dioptric beam; but special experiments, made with a view to determine this point, have altered my opinion. In a purely spectral image I have seen irregularities in the microscopic image, such as a missing dot, &c. These differences are not clearly seen, and yet they are seen. I do not for one moment say that the dioptric beam has no influence on the image—it has a very great influence; in fact, a greater influence than perhaps any spectrum taken by itself; but that is quite another matter altogether to saying that the microscopic image is a purely dioptric one.

(5) The reflex from the front lens. This is the only part of the dioptric theory which has been supported by experiment. It is very well







Explanation of Figs.

Fig. 104.—Shows back of objective, with spectra of first order of *P. angulatum*, the dioptric beam of small angle being stopped out. The diatom will be resolved on a dark ground, and will be fairly bright.

Fig. 105.—The same, with a dioptric beam of larger angle. The diatom will be resolved and intensely lighted on a dark ground.

Fig. 106.—The same, with a smaller aperture, so as to admit only the edges of the expanded spectra. The dioptric beam is now present, and the diatom is resolved on a light ground.

Fig. 107.—The same, aperture of lens reduced, so as to cut out the edges of the spectra; dioptric beam same as in fig. 106. The diatom is not resolved.

known that an object, such as a diatom, illuminated by a central axial cone, appears brighter than the field.

The "dioptricians" explain this fact by saying it is caused by light reflected from the front lens of the objective, and this statement is supported by the experimental examinations of opaque objects mounted in balsam.

I have very grave doubts as to the opacity of some of these objects which shine so brilliantly; therefore, let us pass on to one object upon which there can be no doubt—viz. the mercury globule.

On examination, a mercury globule exhibits a feeble illumination from the reflected light. A great deal depends, however, on the curvature of the front lens, which, of course, differs in lenses of different constructions. It was found on trial that a certain dry 1/4 gave brighter illumination than another dry 1/4, also both 1/4's gave more brilliant results than a certain oil-immersion 1/8. It was also found that the

effect was heightened by racking up the condenser much within its focus.

It is not difficult to calculate to what focus light, radiating from the principal focus of the lens, will be brought by reflection from its posterior surface.

Let us examine a particular case, say a hemispherical lens of 1/10 in. radius, of crown glass, ref. index 1·5. Then by ordinary formula—

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{r} + \frac{1}{s}\right)$$

$$f = 1/5.$$

Now we have to find the apparent curvature of the concave surface as seen through the plane.

By formula— $$R = \frac{Ff}{F - f}$$*

where R is radius of curvature, F principal focus, and f the apparent radius of reflecting surface seen through the plane—

$$1/10 = \frac{1/5\, f}{1/5 - f}$$

$$f = 1/15.$$

The next point we have to determine is the focus of a concave mirror of 1/15 radius for rays coming from a radiant 1/5 in. in front of it. By formula for a concave mirror—

$$\frac{1}{p} + \frac{1}{p^1} = \frac{2}{r}$$

$$\frac{1}{p} + \frac{1}{1/5} = \frac{2}{1/15}$$

$$p = 1/25.$$

Therefore we see the reason why the illumination by reflection from the posterior surface of the lens should be feeble; because it is brought to a focus within the lens, and by the time the rays come to the object they are greatly dispersed.

When the condenser is racked up, the radiant is placed nearer the concave surface, and its conjugate focus brought nearer to the object, and consequently the illumination of it is strengthened. Therefore we can see that the single experiment put forward in support of the dioptric theory fails.

6th and last point. It is an established fact that the most critical of all images are those on a dark ground. Here an objective is put on its mettle, and its resolving power strained to the utmost, It is a great pity that certain technical difficulties come in the way of this kind of illumination with wide-angled lenses. Here we have no dioptric beam, nothing but spectra, and we get a "true" image—i. e. one that

* Formula by C. V. Boys, F.R.S., in "Measurement of Curvature and Refractive Index," 'Philosophical Magazine,' July 1882.

behaves like a daisy under a 4-in. on focal alteration. Such a case is quite inexplicable by a dioptric theory; but is quite consistent with the views put forward in my last paper. When the back of the objective is examined, it will be seen entirely covered with spectra, so no zonal differences can exist, and consequently focal alterations will not produce different images. The above seem to me to be the chief objections to the dioptric theory.

In conclusion, let me say that the author of the dioptric theory has done excellent work, although according to my own view he has failed to establish his case. First, he has given the most concise and lucid explanation of the interference phenomena that is extant in our language. Secondly, he has given testimony to the fickleness of images derived from a small cone of illumination."

Mr. L. Wright * also writes on the same subject:—"I have myself very grave doubts if this new theory is correct; but it is a singularly interesting one. I draw attention to it partly as a proof that speculation is not yet at an end, but chiefly to point out that there is one most simple experiment, easily made, which will determine it with absolute certainty. That is, to *silver the back* of the front lens, and then remove the silver from the centre of the back only. The reflection from the margin will be, if anything, rather increased; and whatever becomes of the theory in question, I believe the expedient may prove of some service as an illuminator of certain objects, and may give valuable resolution of structure by the modification in this point. But the silver will really stop off all but the central pencil, which it will allow to pass unaltered; and if Prof. Lowne's theory is correct, the 'high' resolution will be unaffected. I hope such an experiment will be made without delay, and it will be well worth while merely as one in illumination, if no one has attempted it before. I am afraid, however, it will demolish the theory, for if the latter be sound, one would say that *all* lenses with hemispherical fronts ought to give equal resolution, irrespective of aperture, which belongs to the *back* portion of the lens. This is not the case, and I fear we have yet to find a theory which shall reconcile the undoubted facts with conclusions that seem forced upon us by the phenomena of physical optics."

In reference to Mr. Wright's suggestion, Mr. Nelson † points out a way in which the experiment may be performed without silvering the front lens of an objective.

An inch objective with a Lieberkühn ought to resolve more than the same lens without a Lieberkühn with transmitted light, supposing the hypothesis to be correct. If the increase of aperture is only useful for illuminating the object by reflected light, and no rays pass through the increased portion to the eye, it is abundantly evident that those conditions are fulfilled by a Lieberkühn. The experiment can therefore be easily tried.

Prof. Lowne remarks ‡ on Mr. Wright's paper as follows:—"I fear the theory which I have suggested to account for the efficacy of large apertures in microscopy cannot be so easily verified or disposed of as Mr. Lewis Wright supposes. Before giving my reasons, I must correct the impression which may evidently be made by an expression of mine, and which it was far from my intention to convey.

* Engl. Mech., xlix. (1889) p. 391. † T. c., p. 416. ‡ T. c., pp. 437-8.

In using the words quoted by Mr. Lewis Wright, 'Only the centre of the pencil falling on the back surface of the lens reaches the eye,' I was speaking of the intensity of the light illuminating each portion of the object, and all I meant was that the effective emergent pencil which enters the pupil is small as compared with the angular aperture of the object-glass.

I admit that the sentence is ambiguous, and should have been more clearly worded; but I never intended to convey the idea that the back face might be silvered, leaving only a small aperture.

The idea of silvering the lens, as Mr. Lewis Wright suggests, did cross my mind when I was working at the subject, but I saw at once that it could not be used as a means of settling the question, and for this reason. The object-glass is made experimentally, and the outer zone is of the utmost importance, as it is far more easily corrected to give a sharp image than any other part of the lens.

It will be readily seen that if the lens surface be divided into a number of concentric zonular elements, the more nearly these approach the centre of the lens, the less the angle their normals make with direct incident light.

If the aperture were small enough the lens would have practically plane surfaces, and could not give any distinct image other than that given by a pinhole. The outer zones are so corrected that the pencils passing through them come to the same foci as the central pencils—that is, their chromatic and spherical aberration is reduced to a minimum, whilst the intermediate zones are left uncorrected. If by any diaphragm or other appliance the outer zone is rendered ineffective, the next outermost zone must be corrected.

I do not know whether it would be possible to reduce the apertures of an objective, and re-correct the glass without increasing its working distance. If this were possible, the glass might regain the definition lost by the reduction of aperture, provided this reduction were not great; but the experiment would be one of great practical difficulty, and could only be carried out by one of the best makers of lenses, and then only with great expenditure of time. I fear we shall have to be satisfied with some less direct method of settling the question.

In my own mind there is no doubt whatever that all definition would be destroyed by silvering the back face and reducing the aperture, which is practically the same thing as putting a diaphragm behind the objective, whether the image is a purely dioptric or a diffraction phenomenon, unless some compensatory change could be made in the glasses without altering the curve of the front lens or its working distance.

I would remind microscopists that what I have said applies only to critical images with high powers, and I would ask them to compare such images with those seen by dark-ground illumination and lower powers. The resemblance between the images produced by the two methods of illumination is very striking."

Prof. Abbe himself has also sent a paper to the Society (now in process of translation) refuting Prof. Lowne's suggestions.

Ultimate Structure of the Pleurosigma Valve.—At the October meeting Mr. T. F. Smith read the following paper:—

Twelve months ago I had the honour of bringing before you some

researches on the valve of *Pleurosigma*, and claimed to have discovered that what up to that time had been considered a single plate of silex was really built up of two or three layers of structure. I also claimed to be the first to call attention to this fact, but this claim I must now withdraw, for the simple reason that I find on page 680 of the Journal of this Society for 1879 the following passage from a paper by Herr Grunow—with additional notes by Mr. Kitton—on the Diatomaceæ of the Caspian Sea:—

Speaking of *Pleurosigma attenuatum* and *P. hippocampus*, Herr Grunow says:—"The structure of these allied forms under high powers appears very similar; between the strongly marked lines of beads faint outlines of other beads may be seen. Whether these delicate puncta belong to a second valve or are an optical delusion must remain for the present undecided; it is certain, however, that the valves of *Pleurosigma* are composed of two layers, which separate when acted upon by long boiling in acids." And then between brackets, I suppose by Mr. Kitton, "I have seen this in *P. angulatum*." Then follows this note by Mr. Kitton:—"The faint markings here alluded to have been seen by other observers. It is most probable that the valves of *Pleurosigma* have a similar structure to many other diatoms in possessing what I call secondary valves, which in some genera are like, and in others unlike the primary valve."

The above passages show how remote the chances are of any single individual being the sole discoverer of any new fact, whether important or trivial; and although the only positive evidence given here is the separation of the layers by boiling in acids, it is enough to bar my claim to be the first to call attention to the compound structure. I think, however, I may still claim to be the first to figure the structure of the different layers, and am pleased to feel that my attempts in this direction will derive additional weight from being corroborated by the testimony of two such eminent observers as Herr Grunow and Mr. Kitton.

It is almost necessary to apologize for bringing this subject before you to-night, as for some reason the study of diatoms in the present day is almost a discredited one, and the microscopist who indulges in it is looked upon as nothing better than a trifler in science. But I think this stigma is an unjust one if we look at the important part the resolution of diatoms has played in the development of the modern objective, and thus placed in the hands of microscopists generally an efficient instrument of research, without which many pages of Nature must have remained a sealed book. The study of diatoms has also its value—and with many its chief value—in their being one link in the great chain of existence; but it is purely from a brass-and-glass point of view I wish to approach them to-night, and using them as a standard of value, try to prove by the results of my investigations on the *Pleurosigma* valve, how much further it is possible, by the use of the new optical glass and proper methods of illumination, to push our researches into the nature of all minute structures.

Practically, the resolving power of our objectives on lined objects had reached its maximum before the advent of the new glass. The *Amphipleura pellucida* marks now, as it marked then, the finest known regular structure of any regular object. There was nothing further, then, to be gained in resolution, but possession of one of the new apochromatics, with its entire absence of colour, soon convinced me that it possessed a power of separating different layers of structure altogether

outside the grasp of the ordinary achromatics. The result of this increased power in my hands was to enable me to split up the supposed one plate of silex forming the valve of *P. formosum* into three, and thus add two more vertical notches to the standard by which we measure our objectives.

The advantage of applying such increased power to the elucidation of minute structure generally is so evident, that it is only necessary for me to place the existence of the compound structure and its character beyond a doubt to leave the matter in your hands to apply for yourselves.

When I had the honour of bringing this question before you twelve months ago, I was met by the objection that the appearances I described were diffraction effects—meaning false effects—and was asked if I had examined the diatoms mounted in a dense medium as well as when mounted dry. After the exhaustive manner in which diffraction has been discussed within the last twelve months, and the modification of opinion to which that discussion points, I do not think it necessary to meet the first objection; but on the second point I may say that I have since examined a slide of *Pleurosigma formosum* mounted in phosphorus, and found all my previous opinions confirmed. There has also cropped up from time to time the objection that the interference of light coming through a grating, and the impossibility of separating two such gratings —if they existed—from each other must vitiate any conclusions that might be drawn from mere visual appearances. I recognize the force of the last objection, but at the same time beg to point out that within certain limits it applies rather to the old dry objectives of narrow aperture than to the new oil-immersions. With the latter the depth of penetration is so little that if two layers are separated by ever so narrow an interval, for all chance of interference they might as well be a mile apart. Of course, in asserting this I am supposing a large central cone of light, as being the only correct method of illumination with such a glass, the slightest deviation from which will produce error. But even with an oil-immersion of wide aperture it is still possible for two layers to be so closely connected that interference occurs, and no doubt, under such circumstances, it would be impossible to be sure of the structure. Had no other method been adopted by me than to record an appearance as true simply because it appeared such under the Microscope, I should deserve all the censure you could apply to such a method of working. Such, however, has not been my method, but when there has been the slightest doubt, I have formed no definite opinion of any structure until seeing it isolated from everything which could interfere with the definition. Thus three layers of structure have been figured by me in *Pleurosigma formosum*, because I have been enabled to isolate them, but I have never ventured upon describing more than two in the other species of this genus, although one might be led by analogy to suppose there were three. Leaving out the question, then, of the middle layer in the finer forms as one on which I can offer no direct evidence, the task is much simplified when trying to prove the existence of two layers in *Pleurosigma angulatum*, it being necessary only to deal with the two opposite sides of the valve. On looking over a spread slide of this diatom, mounted dry, we at once discover that different valves present different optical appearances, and on further examination shall also find that the different valves have different curves, and that the same curves and appearance always belong to each other. The prints here to-night marked 1 and 2

will illustrate this. Both are taken across the nodule, and while No. 1 starts straight from the median line and slopes down towards each edge, No. 2 starts straight from the edge and slopes down towards the median line. Now, if these two curves are placed opposite each other, there will be a considerable space between them, and we are driven to this conclusion, that either each side represents a different layer of structure, or we have one very thick plate of silex—a supposition quite at variance with what we know of diatom structure generally.

I have said that the same appearance is always identical with the same curve of the valve—No. 1 showing white, and No. 2 black interspaces; but this only on condition that the largest cone of light possible is poured into the objective. With a narrow cone of illumination the two sides present the same image, but by using the largest aperture of the achromatic condenser, and placing the bull's-eye condenser between it and the mirror, the valves become at once differentiated in a manner unmistakable.

I may state here incidentally that it is not possible to develope the structure such a glass is capable of showing; with only the edge of the flame and dry achromatic condenser the bull's-eye added between is necessary, and with this the use and expense of an oil-immersion condenser is quite unnecessary. Of course I am aware that the aperture is measured by the back lens of the objective. I know that the back lens of an oil-immersion of 1·4 N.A. can only be filled with the use of an oil-immersion condenser on an object mounted in the same refractive index; but I also know that the objective has not yet been made which will allow the back lens to be so filled with light without utterly breaking up the image. The full aperture of such a lens, then, can never be utilized, and the use of the bull's-eye condenser will allow as much of it to be used as is practicable.

I am aware that my prints of *Pleurosigma angulatum* do not agree with the celebrated print by Dr. R. Zeiss, exhibited here at the meeting held on April 11th of last year, and which received the highest praise at that time from some of our leading microscopists as being the greatest advance yet made in the delineation of that diatom. I admit it to be a very striking picture, that photographically it is deserving of all praise; but the conditions of its production are in violation of every principle laid down by Dr. Abbe himself in his different papers on the theory of microscopic vision. First it is a most flagrant example of what Dr. Abbe calls empty magnifying power; and secondly, the image is false, for the reason mentioned in his paper on the Relation of Aperture to Power, wherein he shows that where the magnifying power of an objective is pushed up much beyond the number of diameters necessary to show the details resolved by the aperture, all details under such circumstances, whether square, triangular, or lozenge shape, acquire the same appearance of being round or oval. What then has happened in this particular instance? The aperture of the objective by which the photograph of Dr. Zeiss was produced has been narrowed down by insufficient illumination from 1·3 N.A. to 0·70; the power has been forced up to 4900 diameters, and the result is circles where there should be squares or hexagons. 4900 diameters is more than 40 times the initial power of the objective used, even if all the aperture had been utilized; what then can be the value of such an image as a truthful interpretation of structure when produced with little more than half that aperture? In

taking up this position with regard to the relative truth of the respective prints, I am asserting nothing but what is within my own knowledge; both Mr. Nelson and myself having produced exactly the same photographic image as Dr. Zeiss with the dry apochromatic 1/4 in.

But to recur to the proofs of the compound structure of the *Pleurosigma* valve. It is not necessary that I should weary you by giving in detail all the evidence I have collected, but will call your attention to two prints only of a valve of one of the *Pleurosigma* I have taken at two different planes. In both prints a bit of the valve is shown chipped away, but while in the print taken at the lower level, the hole is clean through, in the upper a fine grating is seen projecting over the hole, and nothing, I think, can be more conclusive of different layers. Having done my best to establish the existence of different layers in the *Pleurosigma* valve beyond a doubt it now remains to determine, if possible, the ultimate structure of each layer in one species, and then to establish the nature of the ultimate structure as between one species and another in the same genus. When a number of forms agree in shape and their leading features, and the only difference between them is the relative coarseness or the fineness of their structure, you cannot draw a line and say, "Here ends truth and here begins error." It must be true throughout or false throughout, and to establish the truth of the one will establish the truth of the other. Let us see then; first, what are the leading features common to all the *Pleurosigma*, and secondly, how far we can make sure of the ultimate structure of the coarsest form, that is of *Pleurosigma formosum*. It is not necessary to say anything about the common shape which gives name to the genus, or the median line, to an assembly like this, but I may mention one peculiarity of the nodule common to all the species having the diagonal markings which I do not think has been mentioned before. On one side of the valve there is simply a cavity at that point, but on the other side the median line at the nodule is joined as in fig. 108. My attention was first called to this by examining a type-slide of the *Pleurosigma*, where I found it in form after form. Another feature common to the same forms, is two rows of perforations larger than the others running lengthways on the valve, one on each side of the median line and two similar rows, one on each outer margin. Lastly, in all the species having diagonal markings there is the common feature of the structure being composed of a square grating with a focal image formed in each alternate square. This is enough, I think, to show that whatever the structure may be it is of the same character throughout, and it now remains by examples to find out if possible, what is the unit of that structure.

Fig. 108.

Whatever difference of opinion there may be about the truth of the image of a structure when it recurs at regular intervals, there can be none when you get an isolated particle or fibril, which, existing already as a unit, cannot be the double or the quadruple of another unit. Such a unit I have found of the structure of *Pleurosigma formosum* floated entirely away from the valve. It seems to consist simply of a series of short bars of silex placed lengthways on the valve, side by side, in such a manner as to leave alternate interspaces between them (see fig. 109). It will be seen from a study of this diagram how the ordinary appearance of the *Pleurosigma* is produced. The larger interspaces, being produced

alternately, are seen running diagonally across the valve, and an image of the larger interspaces, thrown there from the under layer as on a screen, gives rise to the appearances which have produced so much controversy as to whether the "markings" are beads or perforations. As a matter of fact they are neither, but simply a collection of focal images or ghosts, and you may as well speak of the picture thrown by the optical lantern on a screen as the structure of that screen, as speak of these focal images as the structure of the diatom. I have a valve of *Pleurosigma formosum* under the Microscope here to-night which shows finely the arrangement of the fibrils on the valve. In some parts of the valve the fibrils are seen lying loose, in other parts close together, forming regular structure, while in other parts they are wanting altogether. A print of the same valve shows in parts a regular collection of white "beads," which are ghosts and utterly wanting where the outer membrane is torn away. The distance apart of the alternate squares from the centre of each other on *Pleurosigma formosum* is double that of *Pleurosigma angulatum*, and our difficulty is enormously increased when we try to determine the structure of the latter. To me it is sufficient that the two images present the same characteristics to convince me that the structure is the same, but I know that other observers want more positive evidence, which for a long time I was unable to give. What was wanting was corresponding torn structure, and at last I am able to put that in evidence also—not, I confess, in *Pleurosigma angulatum* proper, but in an allied species, which for our purpose is practically the same. The striæ are of the same fineness—50,000 to the inch; there is the same arrangement of large perforations on each side of the median line and the margins; and the finer structure shows the same focal images formed in alternate squares. On one corner of the valve of which I show a print, the outer layer is stripped off, leaving the under one intact—found on focusing down—while on the lower corner the fibrils are lying in strips, and are of exactly the same character as those we have seen in *Pleurosigma formosum*.

Fig. 109.

Disturbances of Vision consequent on Microscopic Observation.*—M. C. J. A. Leroy has noted a peculiar disturbance of vision which affects exclusively the eye which has not been employed during microscopic observation. Letters seen at the usual testing distance of 5 m. were blurred, and this effect was not corrected by spherical glasses or by efforts of accommodation. In the table of radiating lines used as diagnostic for astigmatism, the horizontal lines were disturbed while the vertical ones remained clear, and no cylindrical glasses modified the difference: thus the disturbance was not due to defect in accommodation or to simple astigmatism. The author was led to the conclusion that it is a diplopia always produced in a vertical direction by noticing the fact that the horizontal lines of the curtain traversing the top of the machine gallery in the Paris Exhibition was distinctly double. This diplopia has its origin in the dioptric apparatus (cornea or

* Comptes Rendus, cviii. (1889) pp. 1271–3.

crystalline) of the eye and not in the cerebro-retinal centres, for on examining a horizontal line through a small hole from 0·8 mm. to 1 mm. one of the images only was seen, but both became successively visible on displacing vertically the hole, and on impressing a suitable velocity on this displacement an undulatory appearance was given to the line. No phenomena of double refraction were observed on examining with a nicol. In certain instances triplopia was also obtained, the third image, however, being very pale. The energy and duration of the disturbance was naturally found to vary with the length of microscopic observation, and its disappearance was progressive and continuous. Thus, on one occasion, when the author began work (observation of diatoms) at 10 in the morning, at 10.30 there was diplopia, and at 11 triplopia. The separation of the images was then measured and amounted to 4′ for the second and 8′ for the third. At noon the triplopia had disappeared, but diplopia still remained.

Apart from microscopic observation diplopia was also found to result from observing across a small hole a phenomenon difficult to catch at the moment of its appearance or disappearance in a very limited field, and also in some degree from examining ophthalmometric images.

M. J. J. Landerer,* in reference to M. Leroy's note, claims to have been the first to call attention to this phenomenon, and adds the following remarks concerning it:—

(1) Although the effort experienced by the eye seems to be of the same nature for microscopic as for telescopic vision, yet the disturbance consequent in the closed eye is much more marked in the first case than in the second. This difference is maintained not only when the telescopic object is so difficult a one to catch with a telescope of 108 mm. aperture as the shadow of the second satellite of Jupiter as it is projected on the edge of the planet, but also when the image has considerable brightness, as when the granulation of the sun's surface or the spots are examined through only a slightly blackened glass. This difference is not due to the different inclination of the head in each case, for it still persists when the telescopic observation is made by means of the bent eye-piece.

(2) That during microscopic observation there is a crossing of the optic axes of the two eyes, producing an effect similar to that of strabism, is proved by the fact that by giving them this disposition, and then applying the eye to the eye-piece, the image is seen with perfect distinctness.

It is the simultaneous effort of both eyes which explains the disturbance undergone by the closed eye. But as this effort acts in an unconscious way, and has struck no one's attention, it has been supposed that there is here only an effect of accommodation producing the definition of the image at the distance of the *punctum proximum*. The above facts appear really to show that this is not the case, or, at least, that there is no reason to affirm that the image is not defined at the distance of distinct vision properly so called.

Amplifying Power of the Microscope.†—Dr. L. Didelot has applied to the Microscope the notions and formulæ concerning the amplifying

* Comptes Rendus, cix. (1889) pp. 74–5.

† Didelot, L., 'Du Pouvoir amplifiant du Microscope: détermination théorique et expérimentale suivie d'une table à quatre décimales des inverses des 1000 premiers nombres de 0·01 à 10·00,' 2nd ed., 8vo, Paris, 1887, 86 pp. (1 pl.).

power of optical instruments as given in the latest discussions on the subject, and gives an experimental determination of the dioptric, and thence the amplifying power of the Microscope by the methods used in the Laboratory of Medical Physics of the Faculty of Lyon. At the end of his paper he gives a table of the inverses of 1000 numbers from 0·01 to 10·00, by which dioptrical calculations are much simplified.

The conditions of visibility of an object seen by the naked eye and under constant illumination depend on the linear dimensions of the object, its distance from the eye, and on the acuteness of vision. If y is the absolute length of the object, and l its distance from the eye, the visual angle is proportional to $\frac{y}{l}$. The acuteness of vision is in the inverse ratio to the minimum visual angle under which two separated luminous impressions are distinguished, so that if v denote the degree of visibility of an object seen by an eye of acuteness V, we have

$$v = \mathrm{V}\frac{y}{l}\cdot$$

For an eye assisted by any optical apparatus, the four magnitudes v, V, l, y will take new values v', V', l' y', y' denoting the image of y. The ratio of visibility of image and object W is then given by the equation

$$\mathrm{W} = \frac{v'}{v} = \frac{\mathrm{V}'\,y'\,l}{\mathrm{V}\,y\,l'}, \qquad (1)$$

which may be written

$$\mathrm{W} = \frac{\mathrm{V}'}{\mathrm{V}}\cdot\frac{\alpha'}{\alpha} \qquad (2)$$

by replacing the ratio of the trigonometrical tangents $\frac{y'}{l'}$ and $\frac{y}{l}$ by the angles α' α under which image and object are seen, or by the arcs which they intercept on the retina. For the same eye V = V' and the ratio of visibility becomes the amplifying power Γ, which M. Monoyer defines as "the ratio in which an instrument increases the apparent magnitude of objects," and we have

$$\Gamma = \frac{\alpha'}{\alpha}\cdot$$

The object of a magnifying instrument is to increase the visibility of objects. Formula (1) shows that this can be attained either by diminishing l', as in the simple magnifier, or in augmenting y' as in the projection-lens or solar Microscope, or, finally, in uniting both, as in the compound Microscope. The degree of visibility, then, does not depend solely on the *magnification* (*grossissement*), i. e. on the ratio of the absolute dimensions of image and object, but also on the distances from the eye; and it is to a confusion between *magnification* and *amplifying power* (*pouvoir amplifiant*) that many erroneous results are to be attributed. Thus, the formula given by many authors, $\mathrm{G} = 1 + \frac{\mathrm{D}}{f}$, introduces the distance of distinct vision D, but neglects the distance of the lens from the eye. The older formula $\mathrm{G} = \frac{\mathrm{D}}{f}$ in use up to the beginning of

the century, is still more inaccurate. It is of little importance, in order to distinguish the details of an object, that its aerial image should be much magnified, since it is so much the further from the eye, and so its apparent diameter is diminished. It is the image on the retina which should be magnified, and the effect of a lens will be measured by comparing the retinal images of the same object seen successively through the instrument and by the naked eye. By following up this principle, which had been previously grasped by Verdet and Guebhard, M. Monoyer has obtained a general formula applicable to all optical instruments.

Thus, taking the case of a simple lens represented by its principal planes reduced to a single plane H K (fig. 110) at a distance d_0 from the nodal points of the eye united at the point O, let P Q = y be an object situated perpendicularly to the optical axis of the eye at a distance from the lens less than its principal focal length F H = f. Join P and its image P′ to O, and prolong these lines as far as the retina; let α and α' be the angles which these rays make with the optic axis, and let l and l' be the distances of object and image from O. Then if Γ denote the amplifying power, G the magnification, and L′ the inverse of l'

$$\Gamma = \frac{\alpha'}{\alpha} = \frac{y'}{l'} \cdot \frac{l}{y} = \frac{y'}{y} \cdot \frac{l}{l'} = \mathrm{G}\, l\, \mathrm{L}';$$

i. e. the amplifying power of an optical instrument is equal to the product of the magnification by the ratio of the distances of the eye from the object and its image. In the case of the simple lens M. Monoyer distinguishes several kinds of amplifying power.

(a) Relative amplifying power, corresponding to $l = 1$, i. e. comparison of the retinal images when the object is situated at an invariable distance of 1 metre from the eye.

We have then

$$\Gamma_r = \mathrm{G}\, \mathrm{L}'. \qquad (4)$$

But

$$\mathrm{G} = q'\, \mathrm{F} \qquad (5)$$

where $\mathrm{F} = \frac{1}{f}$ and q' is the distance of the image from the second principal focus F′ and $= l' + f - d_0$.

∴ by substitution

$$\Gamma_r = (l' + f - d_0)\, \mathrm{F} \,.\, \mathrm{L}' = \mathrm{F} + \mathrm{L}' (1 - d_0\, \mathrm{F}). \qquad (6)$$

This expression is identical with that which gives the dioptric power $\Phi_{\mathrm{FL}'}$ of a binary system composed of two diopters of powers F and L′.

In the case of the compound Microscope the dioptric power and focal length are of opposite sign. Denoting these by Φ and ϕ respectively, we have

$$\Gamma r = -(\Phi - \mathrm{L}' - d_0\, \Phi\, \mathrm{L}'). \qquad (7)$$

Formula (6) serves to show the influence of accommodation; for take the case of the lens close to the eye and $d_0 < f$; then the term $1 - d_0\, \mathrm{F}$ is positive, and the amplifying power augments with L′. The accommo-

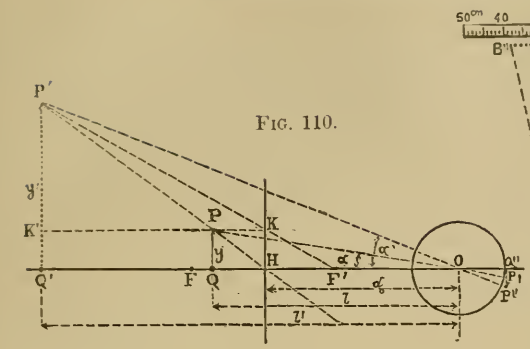


Fig. 110.

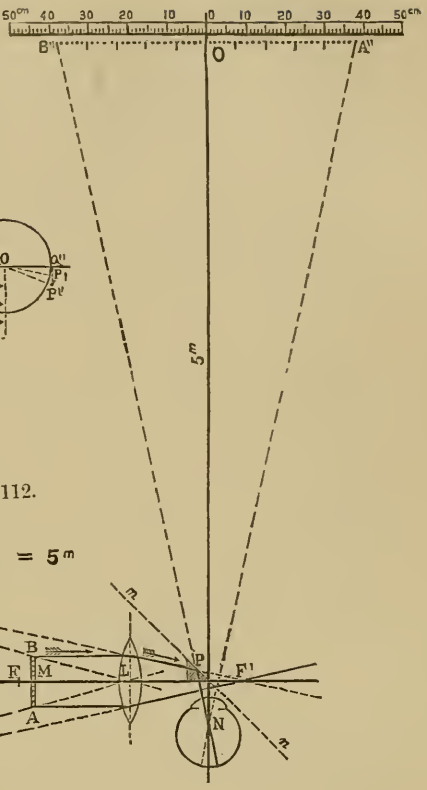


Fig. 112.

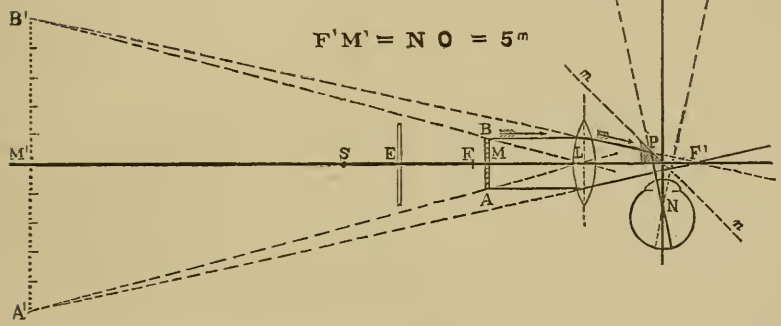
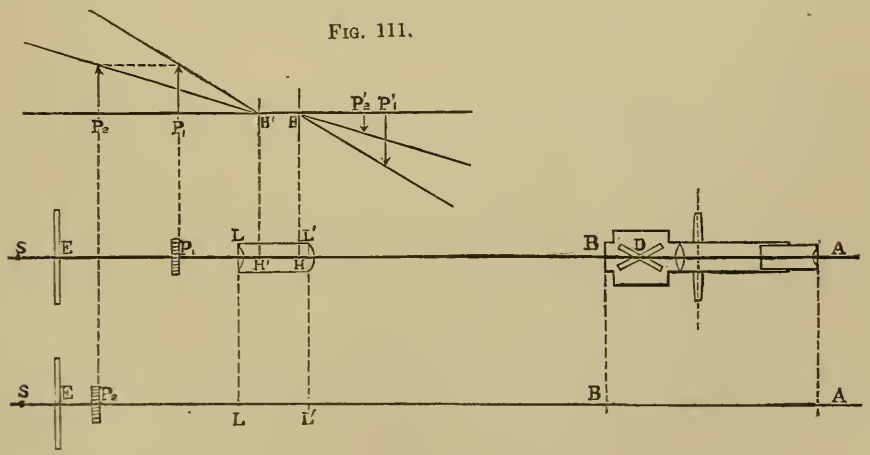


Fig. 111.



dation, therefore, should be as large as possible, so that the image might form as near as possible to the eye. If, on the other hand, $d_0 > f$, $1 - d_0 F$ is negative, and to augment the amplifying power L′ must diminish, i. e. l', the distance of accommodation, must be as large as possible. The most advantageous case is that of a hyperpresbytic eye, in which case L′ is negative. For the Microscope the conditions are inverse.

(*b*) Comparative amplifying power corresponding to the case in which $l' = l$, i. e. the image is compared with the object supposed to be placed at the same distance from the eye.

In this case we have

$$\Gamma_c = G.$$

(*c*) Absolute amplifying power, which represents the proper action of the instrument supposing the object placed at the same distance from the eye assisted by the instrument as from the naked eye.

We have

$$l = d_0 + f - q,$$

where q is the distance F Q,

$$= d_0 + f - \frac{f^2}{q'}. \qquad (8)$$

Substituting in formula (3) we have

$$\Gamma_a = G\,L'\left(d_0 + f - \frac{f^2}{q'}\right)$$

$$= 1 + d_0 F (1 - d_0 L') \qquad (9)$$

on replacing G and q' by their values q' F and $l' + f - d_0$ respectively. Where the principal space ϵ cannot be neglected,

$$l = d_0 + f - q + \epsilon,$$

and the formula becomes

$$\Gamma_a = 1 + d_0 F (1 - d_0 L') + \epsilon \Gamma_r.$$

When either the relative or absolute amplifying power is known, the other can be determined by the connecting formula

$$\Gamma_a = \Gamma_r \times l. \qquad (10)$$

For the simple lens, Microscope, or ophthalmoscope the consideration of the relative is of more importance than that of the absolute amplifying power; but for telescopes or spectacles, in the use of which we are not free to modify the distance of the object from the eye, the absolute amplifying power alone can be used.

For the case of the astronomical telescope, where the dioptric power is zero, M. Monoyer * has given the formula

$$\Gamma_a = \frac{F_2}{F_1}\left[1 + \frac{1 + (d_1 + d_2) F_1}{q F_1}\right]\left[1 + \frac{(1 - d_2 F_2) L'}{F_2}\right], \qquad (11)$$

* Comptes Rendus, June 18th, 1883.

F_1 and F_2 denoting the dioptric power of objective and eye-piece, d_1 the space between the first principal point of the objective and the second principal point of the eye-piece, d_2 the distance of this latter point from the first nodal point of the eye, l' the distance of accommodation, and q the distance of the object from the first focus of the objective.

More recently M. Monoyer has arrived at a formula more particularly applicable to spectacles, viz.

$$\Gamma_a = \frac{1 - d_0 L'}{1 - d_0 L}. \qquad (12)$$

A comparison of different formulæ for the magnification shows that the majority of authors, such as Martin, Deschanel, Jamin, use formulæ belonging to the form

$$G = \frac{l' + f - d_0}{f} = 1 + \frac{l' - d_0}{f},$$

in which l' is the distance of distinct vision.

The magnification thus defined answers to the comparative amplifying power, if we make $l = l'$.

The consideration of the formulæ proposed by Rees, Verdet, and Guebhard shows that these authors, in order to appreciate the influence of the lens on the visibility of an object, have had recourse either to the magnification or to the relative amplifying power. M. Panum alone has calculated the absolute power. The conclusion drawn by the author is that M. Monoyer's formula possesses a degree of generality and simplicity which warrants its adoption in preference to all others.

In the experimental determination of the amplifying power of the Microscope, use is made of the fact shown by formula (6) that under two circumstances the amplifying power Γ_r becomes equal to the dioptric power F, viz. when $L' = 0$ or when $d_0 = f$. A determination of the dioptric power for the latter case when the second focus coincides with the first nodal point of the eye, consequently gives the amplifying power.

Two methods for determining the dioptric power are given, distinguished as the *method of precision* and the *rapid method*.

The method of precision depends on the first formula of magnification $G = \frac{f}{q}$.

Two measurements of the magnification are taken with the object placed successively at two different arbitrary distances. The corresponding magnifications are

$$G_1 = \frac{f}{q_1}$$

$$G_2 = \frac{f}{q_2}$$

whence

$$q_2 - q_1 = f\left(\frac{1}{G_2} - \frac{1}{G_1}\right)$$

and

$$F = \frac{G_1 - G_2}{(q_2 - q_1) G_1 G_2},$$

q_1 and q_2 denoting the successive distances of the object from the first focal point of the Microscope, though only their difference, i.e. the displacement of the object, need be known.

In the experimental determination the apparatus employed comprises a Helmholtz ophthalmometer A B (fig. 111), and a diffraction bank A S as constructed by Duboscq. On the bank directed parallel to the horizontal optic axis of the ophthalmometer are three vertical supports, carrying respectively the dioptric system L L′, a micrometer P, and a screen of ground glass beyond which is the source of light S. To apply the above formula a first magnification G_1 made by L L′ of the micrometer P_1 is measured with the ophthalmometer. The micrometer is then placed at P_2, and the second virtual image P_2' measured by the ophthalmometer gives the second magnification G_2. The displacement $P_1 P_2 = q_2 - q_1$ is read off on the bank.

The rapid method for determining the dioptric power, which makes use of the camera lucida to measure the magnification of a micrometer, depends on the other expression for the magnification, viz.

$$G_1 = q_1' F = (l_1' + f - d_0) F.$$

Two processes can be employed.

(1) Keeping d_0 constant and displacing the object, its image is formed at a new distance l_2' from the eye, and a second magnification is given by

$$G_2 = q_2' F = (l_2' + f - d_0) F,$$

whence by subtraction

$$F = \frac{G_2 - G_1}{l_2' - l_1'}.$$

In the experimental determination the image of the micrometer is projected by means of the camera lucida on a plane containing a divided scale, and the ratio of the lengths superposed gives the magnification.

(2) The second process consists in making $d_0 = f$, which reduces the above formula to

$$G = l' F,$$

whence

$$F = \frac{G}{l'},$$

so that only one determination of the magnification is necessary. The apparatus employed consists of a horizontal scale (fig. 112) one metre in length, a Wollaston camera P, and a micrometer M, illuminated by a source of light S situated on the other side of a screen of ground glass E. The scale, clearly graduated in centimetres and half-centimetres from 0 to 50 starting from the middle, is strongly illuminated by two gas-burners placed at each end. The camera lucida is placed at the same height as the scale on the perpendicular to its middle point, and at a distance from that point a little less than 5 metres, so that the eye at N may be accurately at that distance from the scale.

The reflecting face $m\,n$ of the camera is inclined at an angle of 45° to the axis N O, and one of the faces of the right angle only intercepts half the cone of rays falling on the eye from the scale.

The micrometer M has for weak magnification a length of one centi-

metre divided into half-millimetres; the four central divisions are subdivided into 10ths of a millimetre; it is engraved on horn. For strong magnifications the micrometer engraved on glass has a length of 1 millimetre divided into 50ths or into 100ths of a millimetre.

In order to see, before making a determination, that the camera itself gives rise to no magnification, at A′ B′ is placed a second scale 1 metre in length, of which the middle point M′ is at the same distance from the camera as the middle point O of the other scale. When M′ F′ is exactly equal and perpendicular to N O, the eye placed at N sees whether the virtual image of the scale seen by reflection in the camera is exactly superposed over the first scale seen directly.

A camera lucida in which only one reflection occurs, is more suitable than one in which two reflections take place, such as that of Oberhausser and Nachet, since in the former the exact point N occupied by the summit of the cone of reflected rays is known, whereas in the latter a graphical construction would be necessary to determine it. The author draws attention to the error which can follow from neglect of this point and demonstrates how with cameras like those of Nachet and Oberhausser two equal figures drawn in the same plane can never be exactly superposed for an eye which receives them both at the outlet of the camera.

In making a determination, the dioptric apparatus to be examined is placed in front of the camera with its optic axis F′ M′ at right angles to the line of vision N O, and passing through the middle point M of the micrometer. A preliminary observation by the aid of the sun's rays gives the position F′ of the second principal focus. The distance of the diopter from the camera is then regulated so that the focus F shall, after total reflection and deviation through 90°, coincide with the nodal point N of the eye. For systems of very short focus, the eye is armed with a spectacle-glass, as recommended by M. Monoyer.

The number of divisions are then read off on the scale which are exactly covered by a given number of divisions of the micrometer. The ratio of these two gives the magnification at 5 metres. In taking the fifth we have in dioptrics the power of the system.

The preceding method is not applicable to the eye-piece on account of the image being virtual. The difficulty is obviated in the following way. Observation is taken of the magnification of the Microscope with the eye-piece in place, which gives, say, dioptric power Φ_1. A second observation is then taken with the eye-piece completely drawn out, which gives a second dioptric power Φ_2. The extent of the drawing out of the eye-piece is measured. The formula for a system of two lenses of dioptric power F_1 and F_2, and at distances d_1 and d_2 apart, gives

$$\Phi_1 = \delta_1 F_1 F_2 = d_1 F_1 F_2 - (F_1 + F_2)$$

$$\Phi_2 = \delta_2 F_1 F_2 = d_2 F_1 F_2 - (F_1 + F_2)$$

whence by subtraction

$$\Phi_2 - \Phi_1 = (\delta_2 - \delta_1) F_1 F_2 = (d_2 - d_1) F_1 F_2$$

and

$$F_2 = \frac{\Phi_2 - \Phi_1}{(\delta_2 - \delta_1) F_1} = \frac{\Phi_2 - \Phi_1}{(d_2 - d_1) F_1}.$$

For any system of lenses on the same axis can be substituted

theoretically one single lens defined in position on the same axis by four points, viz. the two focal points and the two principal points. If one of these pairs of points has been determined, a knowledge of the dioptric power gives the other pair.

Two methods are given for the experimental determination of the focal points of a centered dioptric system.

(1) The first process depends on the formula of magnification

$$G = \frac{f}{q}.$$

If p denote the distance of the object from the nearest face of the diopter, p_f the distance of the first focal point from the first face of the diopter, we have

$$q = p - p_f.$$

Then

$$G = \frac{f}{p - p_f},$$

and

$$p_f = p - \frac{f}{G}.$$

Thus, in order to know p_f, it is necessary, during the determination of the magnification, to measure the distance p of the object from the first face of the diopter.

The determination of the second focal point is made in the same manner by reversing the system.

(2) The second method depends on the formula,

$$G = q' F$$

in which $q' = p' - p'_f$,

p' being the distance of the image from the nearest face.

The practical operation consists in the employment of a sufficiently powerful Microscope. The image and refracting surface are brought successively into focus for that Microscope; the displacement, measured by a micrometer-screw, gives the absolute position p' of the image, and thus the second focal point is obtained. The first is found in the same manner by reversing the apparatus.

The position of the focal points being known, that of the principal points is obtained by measuring off the focal length from these points. Finally, the principal space (distance between the principal points) is obtained by measuring the thickness of the system i. e. the distance between the summits of the extreme refracting surfaces. These processes for determining the optical constants have the advantage over those of M. Cornu, who uses the formula of conjugate foci, in that the apparatus under examination can be kept in a constant position.

When great precision is not required, the following simple method may be used:—An object strongly illuminated at the side of the observer throws its rays on a small plane mirror at a distance of about 5 metres. The beam reflected nearly normally traverses the Microscope under experiment, and gives a very small image of the object, as if the latter were disposed at a distance of 10 metres. The image is situated so near to the principal focus that the difference is negligible.

Finally, the focal points can be determined correct to some tenths of a millimetre, by the aid of the sun's rays without the use of a Microscope, in the following way:—The diopter under examination is fixed with wax to the slide of a slide-rule furnished with a vernier reading to tenths of a millimetre, and the optic axis is brought parallel to the rule. A piece of black paper is gummed on the rule at the zero of the graduation, and the surface of the diopter is brought in contact with it; a first reading is taken, and then, with optic axis turned towards the sun, the diopter is separated from the paper until the observer, with the aid of a lens, sees the refracted cone reduced to a brilliant point. A second reading is taken, and the difference gives the distance of the focus from the first refracting face.

Microscopes are usually provided with a set of eye-pieces and objectives, which can be associated in different ways. To calculate in advance the dioptric power of any associated system, we have the formula for a binary system of diopters F_1, F_2

$$\Phi = d\,F_1\,F_2 - (F_1 + F_2),$$

where d is the distance between the second principal point of the first diopter and the first principal point of the second. If e_1 e_2 and E denote the thickness of objective, eye-piece, and whole Microscope respectively, η_1' the distance of the second principal point of the objective to its last face, and η_2 the distance of the first principal point of the eye-piece to its first face

$$d = E - (e_1 + e_2) + \eta_1' + \eta_2.$$

Just as the dioptric power of the eye-piece was obtained from those of the objective and of the Microscope complete, so by an analogous method can its cardinal points be obtained.

Thus supposing known

E_1, e_1, e_2.
η_1 η_1' the distances of the principal points of the objective to the corresponding refracting surfaces.
Φ the dioptric power of the Microscope.
F_1 „ „ objective.
F_2 „ „ eye-piece.
p'_ϕ the distance of the second focal point of the Microscope to the last refracting surface.

We have, to determine η_2, $d = E - (e_1 + e_2) + \eta_1' + \eta_2$,

but

$$d = \frac{\Phi + F_1 + F_2}{F_1\,F_2} = \frac{\Phi}{F_1\,F_2} + f_1 + f_2.$$

Therefore η_2 is known, and by adding algebraically the focal length f_2 the distance of the first focal point from the first face is obtained:

$$p_{f_2} = -(\eta_2 - f_2).$$

To determine the second principal point, denoting by p'_ϕ and q'_ϕ the distances of the second focal point of the Microscope from the last refracting surface and from the second focal point of the eye-piece

respectively, and by p'_{f_2} the distance of the latter point from the nearest refracting surface, we have

$$p'\phi - q'\phi = p'_{f_2}.$$

But the formula of conjugate foci gives

$$q'\phi = \frac{f_2^2}{\delta} = \frac{f_2^2}{d - f_1 - f}.$$

Thus p'_{f_2} is known since $p'\phi$ is given by experiment, and so also η'_2 since

$$\eta'_2 = f_2 - p'_{f_2}.$$

In the following table are given the results of applying the preceding experimental methods and calculations to a Vérick Microscope with objective No. 2 and eye-piece No. 1.

Experimental Data.

$E = 176^{mm}$	$F_1 = 80^D$	$p'f_1 = -2^{mm}\cdot37$
$e_1 = 19^{mm}\cdot5$	$\Phi_1 = 250^D$	$p\phi = 2^{mm}\cdot78$
$e_2 = 46^{mm}\cdot9$	$\Phi_2 = 365^D$	$p'\phi = 15^{mm}\cdot15$
$d_2 - d_1 = 62^{mm}\cdot5$		

where Φ_1, Φ_2 denote the dioptric power of the whole Microscope with eye-piece in place and drawn out through $62^{mm}\cdot5$ respectively, $p\phi$ the distance of the first focal point of the whole Microscope from the first face, and $p'f_1$ the distance of the second focal point of the objective from its last face.

Calculated Results.

$f_1 = 12^{mm}\cdot5$	$q\phi = 1^{mm}\cdot15$	$p_{f_2} = 23^{mm}\cdot85$
$\phi_1 = 4^{mm}\cdot0$	$p_{f_1} = 1^{mm}\cdot63$	$q'\phi = 13^{mm}\cdot918$
$F_2 = 23^D$	$\eta = 10^{mm}\cdot87$	$p'_{f_2} = 1^{mm}\cdot232$
$f_2 = 43^{mm}\cdot478$	$\eta_1' = 14^{mm}\cdot87$	$\eta'_2 = -42^{mm}\cdot246$
$d = 191^{mm}\cdot8$	$\eta_2 = -67^{mm}\cdot33$	

where $q\phi$ denotes the distance of the first focal point of the whole Microscope to the first focal point of the objective, and pf_1 the distance of the first focal point of the objective to its first face.

The author concludes by pointing out the advantages which would result if constructors of Microscopes would take care to provide the micrometer-screws with a graduation, and would furnish with every instrument the optical constants which alone determine its scientific value.

The author arranges his conclusions under the following twelve heads:—

I. The magnification of an optical instrument does not give the measure of its useful effect.

II. The amplifying power is equal to the product of the magnification by the ratio of the distances of the eye to the object and to its image.

III. Two kinds of amplifying power may be distinguished: the absolute and the relative. For the Microscope the latter is the more important.

IV. The relative amplifying power is equal to the dioptric power

of a binary system formed by the association of the instrument with a diopter equivalent to the state of accommodation of the eye.

V. Most authors have treated the influence of an instrument on the visibility of objects by the consideration of magnification; some by the relative amplifying power; M. Panum alone has given an expression equivalent to that of the absolute power. The formula of M. Monoyer has the advantage of being more simple, of being applicable to all optical instruments, and of taking account of all conditions of distance, of the instrument, of the object, and of the accommodation.

VI. The relative amplifying power becomes equal to the dioptric power only under two circumstances; when the distance of accommodation is infinite, whatever the distance of the instrument from the eye, or when the second focal point coincides with the first nodal point of the eye, whatever the distance of accommodation.

VII. The dioptric power can then serve to measure the power of the instrument.

VIII. The dioptric power of an instrument situated at an invariable distance from the eye is obtained by dividing by the displacement given to the object the difference of the two magnifications which result from it.

IX. The dioptric power of a system of which the second focus coincides with the first nodal point of the eye is equal to the quotient of the magnification by the distance of accommodation. Thence follows a very simple method for experimentally determining the dioptric power.

X. The determination of the cardinal points of a centered dioptric system, hitherto obtained by the application of the formula of conjugate foci, is advantageously obtained by the aid of the formula of magnification.

XI. This determination can be effected by the aid of simple apparatus without making very important errors. It would be facilitated if instrument-makers would furnish the micrometer-screw with a graduation.

XII. Every Microscope offered by a maker ought to be accompanied by the optical constants most accurately ascertained, which alone determine the value of the instrument.

Royston-Pigott, G. W.—**Microscopical Imagery.**
[Brilliant miniatures and minute molecules—*Colias Cœsonia.*]
Journ. of Microscopy, II. (1889) pp. 205-9 (1 pl.).

(6) Miscellaneous.

The late Chas. Fasoldt.*—The following obituary notice is from the pen of Prof. W. A. Rogers.

"Microscopists will hear of the death of Mr. Fasoldt with unfeigned regret. The work which he has done in fine rulings and in micrometry entitles him to a better recognition than he has received. While there may be a difference of opinion in regard to his skill in the production of test-plates, as compared with Nobert, it must, I think, be admitted that he has made some plates which are quite as good as the best of Nobert's. When it is remembered that he must have been more than fifty years of age before he took up the problem of micrometric rulings, and that he had had no previous knowledge of the subject, his success has certainly been most remarkable.

Two circumstances have acted as a hindrance to the recognition to

* The Microscope, ix. (1889) pp. 174-5.

which he is really entitled. Both of these circumstances have affected his reputation abroad somewhat unfavourably.

The first is the very large claims in regard to his work put forth for Mr. Fasoldt by some of his friends, and to a certain extent, it must be admitted, by Mr. Fasoldt himself. The second is a rugged and somewhat unusual style in his public communications. The latter must be charged wholly to the fact of his inability to convert into felicitous English an essentially German style of speech.

Mr. Fasoldt was a mechanician of rare skill, and he had that element of character which is almost always found associated with real genius—supreme confidence in his own work. This striking trait of his character was of real advantage to him, since it led him to answer criticism by doing better work in new ways. The improvement in his micrometers is especially noticeable. At one time he claimed that his micrometers had no measurable errors. This was simply an expression of faith in his own work at that time. With more experience he found that he had been too sanguine, and so he set for himself the problem of finding the best way to overcome these errors. It will be admitted by all who have used his micrometers, especially those made within the last five years, that his success in this direction has been remarkable. The fact that Mr. Fasoldt, at one time, thought he had reached a degree of perfection greater than is in reality possible, ought not to be remembered against him. He is not the only person who has had, at different times, too great a degree of confidence in his own work, as the writer can testify from personal experience.

Mr. Fasoldt maintained great secrecy in regard to his methods of ruling. The writer believes that the secret of his success consisted wholly in his skill in the preparation of his ruling diamonds. There is some evidence, derived from measurements of his rulings, that he did not use a screw. According to my own experience, there is no difficulty whatever in making the mechanical subdivisions of the ruled spaces far beyond the ability of the ruling diamond to cut a clean line, which has a width less than the interlinear space. But whatever method Mr. Fasoldt may have employed, the results which he obtained must always command the admiration of microscopists, and the service which he has rendered in micrometry deserves grateful recognition."

Scottish Microscopical Society.—We are glad to note that a Microscopical Society has been founded at Edinburgh under this title with every prospect of a successful career. The following gentlemen are the office-bearers for the current year:—

President—Prof. Sir William Turner, M.B., F.R.S., LL.D., Edinburgh.

Vice-Presidents—Prof. D. J. Hamilton, M.B., F.R.S.E., Aberdeen. Adolf Schulze, F.R.S.E., F.R.M.S., Glasgow.

Secretaries—Alexander Edington, M.B., C.M., Edinburgh. George Brook, F.R.S.E., Edinburgh.

Treasurer—John M'Fadyean, M.B., B.Sc., F.R.S.E, Leith.

Curator—German S. Woodhead, M.D., F.R.C.P.E., F.R.S.E., Edinburgh.

Council—Prof. T. Annandale, F.R.C.S.E., Edinburgh; Prof. I. B. Balfour, M.D., F.R.S., Edinburgh; Prof. W. S. Greenfield, M.D., F.R.C.P., Edinburgh; Prof. J. B. Haycraft, M.D., D.Sc., Edinburgh; James Hunter, F.R.S.E., F.R.A.S., Edinburgh; Robert Kidston,

F.R.S.E., Stirling; Prof. W. C. M'Intosh, M.D., F.R.S., St. Andrews; Robert Peel Ritchie, M.D., P.R.C.P.E., Edinburgh; Prof. William Rutherford, M.D., F.R.S., Edinburgh.

The following list of papers at the second Ordinary Meeting on 15th November shows the nature of the work the Society propose to undertake:—

1. On the histology of the *Zoantharia*, with demonstration, by George Brook. 2. Demonstration of the histology of the Whale's Stomach, by G. Sims Woodhead, M.D., and R. W. Gray. 3. On the use of Blood-serum as a medium for injection-masses, with microscopic demonstration, by J. Carrington Purves, M.B., C.M., B.Sc. 4. A new Inoculating Syringe for Bacteriological purposes, with exhibition, by Alexander Edington, M.B., C.M.

American Society of Microscopists—Buffalo Meeting.
Amer. Mon. Micr. Journ., X. (1889) pp. 156, 223–35, 237–8.
St. Louis Med. and Surg. Journ., LVI. (1889) pp. 288 and 367.
The Microscope, IX. (1889) pp. 214, 244–5, 328–30.

HOVENDEN, F.—**Presidential Address to the South London Microscopical and Natural History Club.**
[A theory of the continuity of life.]
18th Ann. Rep. South London Micr. and Nat. Hist. Club, 1889, pp. 20–7.

LEWIS, W. J.—**Forensic Microscopy, or the Microscope in its Legal Relations.**
[Annual Address to American Society of Microscopists, Buffalo, 1889.]
Amer. Mon. Micr. Journ., X. (1889) pp. 197–207.

LOWNE, B. T.—**Presidential Address to the Quekett Microscopical Club.**
[On the Anatomy of Insects.] *Journ. Quek. Micr. Club*, III. (1889) pp. 373–86.

PELLETAN, J.—**La Micrographie à l'Exposition universelle de 1889.** (Microscopy at the Universal Exhibition of 1889.)
Journ. de Micrographie, XIII. (1889) pp. 481–93. (*Concl.*)

SCHOTT, O.—**Ueber Glasschmelzerei für optische und andere wissenschaftliche Zwecke.** (On glass-melting for optical and other scientific purposes.)
Central-Ztg. f. Optik u. Mechanik, X. (1889) pp. 243–5. (*Concl.*)

ZUNE, A.—**Traité de Microscopie médicale et pharmaceutique.** (Treatise on medical and pharmaceutical microscopy.)
[I. Description, choice, employment, and preservation of the Microscope and accessory apparatus, &c.]
136 pp. and 41 figs. 8vo, Bruxelles and Paris, 1889.

β. Technique.*

(2) Preparing Objects.

Demonstrating Mitosis in Mammalia.†—Dr. B. Solger recommends the amnion of the rat for demonstrating the mitosis of Mammalia to a class. The freshly cut-out membranes are placed in a saturated aqueous solution of picric acid for twenty-four hours. It is then washed in distilled water previous to immersion in 70 per cent. spirit, the strength of which is to be gradually increased. The preparations are easily stained in five minutes in Ehrlich's hæmatoxylin, diluted one-half with distilled water.

Instead of fixing with picric acid and staining with hæmatoxylin, excellent results are obtainable by means of Flemming's mixture and safranin.

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Arch. f. Mikr. Anat., xxxiii. (1889) pp. 517–8.

Mounting Fish-scales.*—Mr. F. Dubois gives the following directions for preparing and mounting fish-scales. Place the scales in a small wide-necked bottle of caustic potash for forty-eight hours, then boil for a few minutes in plain water and afterwards wash in hot water. Partially dry the scales between blotters and place in alcohol for a quarter of an hour to remove all moisture. The scales are then transferred to clove oil for clearing. Now breathe on a clean cover-glass and apply side breathed-on to a glass slip to which it will adhere. Place a small drop of benzol balsam on the cover, put the scale on this, cover it with another drop of balsam, and set aside for twenty-four hours. By the following day the balsam will have become thick from evaporation of the benzol. Now place a drop of fresh balsam on the slide, invert the cover-glass over it, and the mount is ready for ringing as soon as the balsam is dry. Dry mounts should be made on cells, the scales having previously undergone the same treatment.

Preserving Marine Animals.†—M. M. Bedot preserves Siphonophora, &c., in the following manner:—A 15–20 per cent. solution of sulphate of copper is made in distilled water. In this the colony to be fixed is immersed. At the same time as the Siphonophora are plunged in the copper solution sea-water is also poured in along with them, and in such bulk that the copper solution is ten times as great. When the animals are fixed (this happens in a few minutes) a few drops of nitric acid are added to the solution and the mixture is gently stirred up with a glass rod in order to prevent the formation of any precipitate. The Siphonophora are left in the solution for four or five hours, and may then be hardened. Hardening is best done with Flemming's mixture:—1 per cent. chromic acid, 15 parts; 2 per cent. osmic acid, 4 parts; glacial acetic acid, 1 part. In order to avoid touching the animal or removing it from the vessel, the fluids should be changed by decanting. The Flemming's mixture should be allowed to act for twenty-four hours and should be twice the volume of the copper solution.

The next operation, that of transferring the animal to alcohol, should be done very gradually. A few drops of 25 per cent. spirit are first mixed with the fluid by means of a pipette. Gradually the quantity and strength of the spirit are to be increased, until in fifteen days 70 per cent. spirit may be used. After this 90 per cent. spirit may be employed.

Examination of Protozoa.‡—The technique to be observed in the examination of the Protozoa, says Dr. Fabre-Domergue, is divisible into three heads, the examination during life, fixation, staining, and mounting.

In examining the animals while alive, should they be sufficiently large as to be visible with the naked eye, then no cover-glass is necessary, and by gradually diminishing the quantity of water, they are at last rendered sufficiently motionless to be examined with facility. If the animals be found too lively they should be left for some hours in the warm chamber until they have settled down, and this they do usually at a little distance from the edge either of the drop of water or of the cover-glass. Certain colouring matters are very useful, especially

* The Microscope, ix. (1889) pp. 184–5, from The Garner, May 1889.
† Arch. Sci. Phys. et Nat., xxi. (1889) p. 556.
‡ Annales de Micrographie, ii. (1889) pp. 545–551.

Bismarck-brown and anilin-violet. The solutions must be perfectly neutral. The Bismarck-brown stains the organisms without affecting them, while the anilin-violet stains and slowly kills them at the same time. In diphenylamine-blue in concentrated solution the animals swim about unstained and uninjured, hence they show up well against a dark-blue ground.

For fixation, the author advises osmic acid or a mixture of equal parts of 1 per cent. osmic acid and 20 per cent. acetic acid. The animal to be fixed should be placed between slide and cover-glass and observed through the Microscope. When rendered sufficiently motionless by pressure on the cover-glass this latter should be prevented from moving by drops of molten paraffin. The fixative may then be run under the cover-glass in the usual way.

For staining the author recommends picrocarmine, Beale's carmine, alum-carmine or methyl-green. If stained with methyl-green the specimens may be mounted in dilute glycerin or Bram's fluid (water 100, glycerin 10, glucose 40, camphorated spirit 10). The index of refraction of the latter is higher than that of the glycerin, and is proportionately more useful.

The specimens may be mounted in balsam; if so, care must be taken to increase the strength of the dehydrating spirits very gradually; then creosote, and finally xylol-balsam.

Investigation of Infusoria.*—Dr. W. Schewiakoff gives an account of his method of studying Infusoria. He always began his observations with living specimens, which were isolated in a drop of water and fixed to one spot. The necessary pressure was regulated by the removal or addition of water. The best water in which to place the organisms is that in which they were found, and which had been filtered. Observations can best be made on starving specimens. As soon as the animals were completely free of food, artificial feeding was commenced; this of course varies with the habit of the infusorian; those that live on unicellular plants may well be provided with drops of animal fat, which can be easily enough obtained by squeezing a small crustacean. Those that live on Bacteria were provided with indigo or carmine which showed up the characters of the digestive system. When the animals had had enough food they were again placed in clean water and observed further; by this means the position of the anus may, among other things, be made out.

By pressing on the cover-glass with a dissecting-needle the animal is forced to break itself up. As this happens the trichocysts may be observed, the mouth and pharynx be more conveniently examined, and the macro- and micro-nuclei isolated.

To kill specimens the best reagent is the vapour of 1 per cent. osmic acid; larger forms, such as *Dileptus*, must be put in fine tubes with as little water as possible and be placed for some seconds in 1 per cent. osmic acid, when death will be found to follow very suddenly. Preparations thus made are well adapted for the study of the striæ of the body and the protoplasmic structures. When cilia, setæ, or membranellæ are to be studied a 5–10 per cent. solution of soda is recommended. The organisms should be put in glycerin when we desire to study them from different sides. A solution of 1 per cent. acetic acid,

* Bibliotheca Zool., v. (1889) pp. 5–7.

to which a trace of iodine-green has been added, is a good staining reagent.

Mounting Infusoria.*—Prof. C. W. Hargitt places some water containing the animals (paramæcia, vorticella, hydroids) on a watch-glass, and removes as much as possible with a pipette, and completes the reduction by means of a thread siphon. The animals are next killed with a saturated solution of corrosive sublimate, Lang's fluid, which is essentially the same as the foregoing plus a small quantity of acetic acid, osmic acid, or picric acid. After killing, it is only necessary to harden the protoplasm by the ordinary method of alcohol of increasing strength, then to stain them, and afterwards mount in balsam.

Transference from one medium to another is best effected by means of the thread siphon. By this method the author has secured amœbæ naturally expanded, and exhibiting almost every phase of their life-history.

The final mounting may be done with equal success in glycerin or glycerin-jelly.

Medium for mounting Starches and Pollens.†—Mr. A. P. Brown advocates the use of the following medium for starches, pollens, and vegetable tissues:—Selected gum arabic, 2 oz.; glycerin and distilled water, each 1½ oz.; thymol, 1 gr. Put in a wide-mouthed well-corked bottle, and place in a warm situation. Stir occasionally until perfectly dissolved. Then strain through linen and set aside for about a week to get rid of air-bubbles, or filter through a "hot filter."

To mount starches or pollens a clean slide is breathed on and then dusted over with the starch or pollen, excess of which is to be removed by tapping the slide gently against the table. A drop of the mounting medium is then placed on the slide and the cover-glass imposed. If any air-bubbles are in the medium they must be picked out with the needle. The cover-glass may be ringed round with cement directly.

Preparing Diatoms.—Mr. C. Haughton Gill writes:—When cleaned and dry diatoms are soaked in a concentrated solution of ferric chloride (perchloride of iron) for some time all hollow spaces contained in the frustules become charged with the iron salt. If they be now transferred to an acid solution of potassium ferrocyanide, Prussian blue will be formed both outside and inside all hollows and cavities. On washing and levigating with water the outside unconfined portion of the precipitate can be washed away in great part, while those portions which are more or less surrounded by walls of silica remain in place, and serve to clearly mark the position and limits of the spaces containing them.

Evaporating a solution of sodium platinum chloride on cleansed diatoms, and igniting the whole with addition of some crystals of oxalic acid, serves to charge the minute cavities, to be described later, with a deposit of spongy platinum.

Pinnulariæ under either of these treatments show their coarse ribbing to consist of ribbon-shaped tubes contained in the walls of the frustule. *Pleurosigma*, *Stauroneis*, *Cocconema*, &c., show their "dots" to be spaces which can be filled by foreign bodies. *Coscinodisci* have the openings into their lacunæ so large that the precipitates for the most

* Amer. Mon. Micr. Journ., x. (1889) pp. 183–4.
† Amer. Journ. of Pharmacy, April 1889.

part get washed out in the course of mounting, but the cell-walls take so much of colour that their shape and parts can be clearly distinguished.

New Application of Photography to Botany.*—M. F. Fayod proposes a new application of photography for the purpose of obtaining accurate representations of leaves, &c., in order to study the arrangement of the vascular bundles. The method consists in employing the leaf itself as a negative. It is placed on a perfectly clean plate in an ordinary photographic frame, and covered by a sensitized leaf of albuminized paper, such as is usually employed for positive prints. The sensitized paper is pressed close against the leaf, and exposed to the sun in the ordinary way, generally for from 5–20 minutes. The veins being usually more translucent than the mesophyll, the portions of the sensitized paper situated immediately below them become black more rapidly than those below the mesophyll, the green colour entirely absorbing the rays of light; the leaf is reproduced in white on the black groundwork of the paper; every vein being represented by a black line of intensity in proportion to its strength.

Production and Preservation of Saccharine Crystals.†—Mr. Wright Astley states that saccharine may be crystallized by two methods and two differently shaped crystals produced. In the one they are nearly always cube-shaped, in the other nearly always rhomboidal. The first method is performed on an ordinary slide. Take about 6 grams of the pure powder and mix in a 2 oz. bottle three-fourths filled with water. Then pour two or three drops of the mixture on a slide; surmount this with a cover-glass, which clip lightly, and hold over a spirit-lamp until it just boils. It is better to have too much than too little fluid on the slide. Upon cooling crystals will have formed. A similar result is also obtained by putting 6 grains of the pure powder in a 2-oz. bottle and pouring boiling water over this and keeping up the temperature for 4 or 5 minutes. On cooling crystals will have formed.

After a good mount has been secured by crystallizing on the slide, brush off the loose powder round the edge of the cover-glass, and this, with care, will adhere while a ring of brown cement is run round; then finish in the usual way.

Crystals formed in the manner above mentioned may be kept in the mother liquid in a cell. Or make a cell and place in it a drop from the bottle containing the crystals; leave it until the water has evaporated from the cell (24 hours); then finish in the usual way.

LATHAM, V. A.—Practical Notes on Histology.
[Special methods for examination of the eye.]
Journ. of Microscopy, II. (1889) p. 217.

(3) Cutting, including Imbedding and Microtomes.

Imbedding in Glycerin Soap.‡—This method, says Prof. A. Poli, has two great advantages, the soap is very soluble in water and is very transparent. Hence for delicate botanical objects it is invaluable.

* Malpighia, iii. (1889) pp. 120–8 (1 pl.).
† Trans. Manchester Micr. Soc., 1888, pp. 15–7.
‡ Journ. de Micr., xiii. (1889) pp. 337–40, from 'Malpighia.'

The procedure for imbedding is as follows. A mixture of equal volumes of glycerin and 96 per cent. spirit are heated in a water-bath from 60°–70° C. Into this are dropped as many small pieces of glycerin soap as will dissolve. The vessel best suited for the foregoing is a flask, the neck of which may be plugged with cotton-wool in order to prevent the spirit from evaporating too rapidly. The liquid thus obtained is yellow and transparent, but with a slight opalescence. It is then poured into a capsule or paper box. While it is still warm the object to be cut, and which has been removed from strong spirit, is fixed in the desired position by means of needles until the soap has solidified. Large pieces must be soaked for some time in a cold saturated solution of soap before they are removed to the hot fluid.

The imbedding mixture, which should be kept in a stoppered bottle, melts easily at about 40° C.

Very small objects may be readily imbedded by placing them in a drop of the warm solution on a cork, and then covering them with another drop. These small quantities of soap get quite hard in about a quarter of an hour.

The sections are easily freed from the soap by merely washing them in lukewarm water, while the alkalinity of the soap aids in clearing up the specimen.

In practice it is found advisable to use two solutions, one for firm, the other for delicate objects. The ingredients of the former are :—90 per cent. spirit, 32 ccm.; pure glycerin, 32 ccm.; soap, 64 gr. The second contains only 32 ccm. of soap, and is consequently much softer. The harder mass may be sectioned in a Ranvier microtome.

Dextrin Mucilage for Imbedding.*—For those who use the freezing microtome it will be found useful, in the present high price of gum-arabic, to know that gum dextrin answers just as well as the latter, and costs only about one-fifteenth as much. Mr. T. L. Webb writes upon this point to the 'Provincial Medical Journal' as follows:—"I find that by making an aqueous solution of carbonic acid (about 1 part of the acid to 40 parts of water) and dissolving therein sufficient dextrin to make a thick syrup, a medium is obtained which is superior to the time-honoured gum and sugar in three ways. It freezes so as to give a firm support without becoming too hard; it keeps better than gum, in which several kinds of fungi are apt to grow; and it is much cheaper, costing only about fourpence per pound, while powdered gum acacia costs five shillings. Dextrin dissolves but slowly in cold water, so that a gentle heat is advisable when making the mucilage."

Wilks' Improved Microtome.†—Mr. G. Wilks describes an improved form of microtome designed by himself, the principal feature of which is that the cutting-plate, or head, is removable; it is fitted to the lower part by a socket-joint, and secured either by a bayonet-catch or a screw. The hole in the plate or head is bored taper, and is 1/16 in. less in diameter at the outside than in the well or tube of the microtome, thus effectually counteracting the effect of shrinkage in the imbedding material. The diameter of the well is also much less than in the older form of microtome.

* St. Louis Med. and Surg. Journ., lvii. (1889) pp. 231–2.
† Trans. Manchester Micr. Soc., 1888, pp. 86–7.

Thin Sections of Timber.*—For showing the structure of timber Mr. R. B. Hough employs frames made of cardboard holding three samples of wood, each being about 2 in. wide and 5 in. long, and from 1/80 to 1/200 in. thick. These exhibit the wood in three relations; one slice being transverse across the grain, another running radially from the outside towards the heart, and a third is a tangential section. The first and second show both the sapwood and the heart. They also reveal the grain and the structure of the wood in a most beautiful manner. These various frames are arranged in book form for the purposes of study and examination. They retain all the characteristics of wood and are easily recognized, while the effect of the light shining through them is to show the peculiarities of the grain even more emphatically than would be the case if one were looking at a mass of the wood.

(4) Staining and Injecting.

Iodized Hæmatoxylin.†—Sig. F. Sanfelice having noticed that tissues which had been treated with tincture of iodine stained more uniformly, devised a compound of logwood and iodine. This mixture possesses the advantage of giving the same stain as Boehmer's hæmatoxylin to tissues previously treated with tincture of iodine, and of thoroughly penetrating pieces to be stained *in toto*.

Another advantage is that, owing to its antiseptic qualities, it keeps better than most hæmatoxylin solutions. It is prepared by dissolving 0·70 gr. hæmatoxylin in 20 gr. absolute alcohol, and 0·20 gr. alum in 60 gr. distilled water. The first solution is poured drop by drop into the second. The fluid is then exposed to the light for 3–4 days; 10–15 drops of tincture of iodine are added, the fluid is shaken up and allowed to stand for some days. Tissues stain in this solution in 12–24 hours; they are then transferred to 90 per cent. spirit acidulated with acetic acid, in which they are left for the same time.

Staining the Flagella of Spirilla and Bacilli.‡—Dr. Trenkmann's method for staining flagella is as follows:—

A small drop of fluid containing spirilla is placed on a cover-glass; to this is added a large drop of distilled water, and the two intimately mixed. When dry, the cover-glass is placed at once in a fluid which consists of 1 per cent. tannin and 1/2 per cent. hydrochloric acid. In this fluid the preparation remains 2–12 hours, and then having been washed is stained in dahlia (2 drops of a saturated alcoholic solution to 20 water), fuchsin (2–4 drops of a saturated alcoholic solution to 20 water), gentian-violet (1 drop to 80 water), methyl-violet (1 drop to 80 water), methylen-blue, iodine-green, methyl-green, vesuvin, Victoria-blue. In the staining solution the preparation remains 2–4 hours, it is then washed in water and examined. By all these anilin dyes cilia are stained, most strongly by dahlia, fuchsin, or methyl-violet, but still better by carbolic fuchsin (2 drops to 20 of a 1 per cent. carbolic acid).

Another method of staining is by means of catechu. Excess of powdered catechu is macerated in water for some days and the extract filtered. To 4 parts of this catechu solution are added 1 part of a carbolic acid solution, and in this the cover-glass, prepared as before, is

* Amer. Mon. Micr. Journ., x. (1889) p. 187.
† Journ. de Micrographie, xiii. (1889) pp. 335–7.
‡ Centralbl. f. Bakteriol. u. Parasitenk., vi. (1889) pp. 433–6.

placed for 2–12 hours. The best stains after this were dahlia and fuchsin.

A third method is by using a strong solution for 2-12 hours of extract of logwood. After this mordant fuchsin is the best dye. This process is improved by the addition of acids, as hydrochloric acid, 1 per cent.; gallic acid, 1/2 per cent.; carbolic acid, 1–2 per cent.

By these methods the author has been able to show not only cilia, but tufts of them in many spirilla. The micro-organisms specially alluded to are *Spirillum undula*, *Vibrio vagula*, and small vibrios.

Impregnating Tissues by means of Methylen-blue.*—Prof. A. S. Dogiel says that methylen-blue is an excellent substitute for silver nitrate for the purpose of impregnating tissues such as those made up of connective tissue, and also serous membranes. The method of impregnation is as follows:—A 4 per cent. solution of methylen-blue is made in physiological salt solution. In this is placed the piece of tissue quite freshly cut out for 10–20–30 minutes, according as it is desired to show merely the boundaries between the cells, or to obtain a negative picture of the lymph-spaces and vessels.

In the former case it is sufficient to leave the tissue in the solution for only a few minutes; in the second it is better to remove the superficial epithelium from the serous membranes, and leave the tissue in the solution for fifteen to thirty minutes, in order that it may be thoroughly saturated with the dye. At the expiration of this time the preparation is removed and transferred to a saturated solution of picrate of ammonia, wherein after having been carefully washed, it is allowed to stay for half an hour or longer. It is then washed again in some fresh picrate of ammonia, and examined in dilute glycerin.

If it be desired to preserve the preparation for some time, it is advisable to place it in glycerin saturated with picrate of ammonia. The plate shows that the method gives satisfactory results.

Impregnation in Black of Tissues.†—M. Flot adopts the following methods for impregnating tissues, wherein a coloured chemical precipitate is formed by the reaction of two different bodies on each other, and it is therefore owing to this chemical deposit that the preparations are stained:—

(1) Perchloride of iron and tannin. In this are required a concentrated solution of iron perchloride and a solution of tannin in alcohol, made to a syrupy consistence. In a watch-glass are placed two drops of tannin, and in another three or four drops of perchloride of iron; both are filled up with distilled water. The section previously treated with hyposulphate of soda and washed is placed for a minute in the tannin, and then after being passed through water, transferred to the perchloride, whereby it is stained a deep black. As soon as this occurs, it is removed to water and left there for five minutes. Afterwards it is mounted in the usual manner.

(2) Sulphate of copper, bichromate of potash, and extract of logwood. Ten per cent. solutions of copper sulphate and of bichromate of potash are prepared. Five drops of each solution are placed in a watch-glass, and this is then filled up with distilled water. Another watch-glass is filled with a strong solution of extract of logwood. The section is first placed in the logwood solution for about five minutes, and is then

* Arch. Mikr. Anat., xxxiii. (1889) pp. 440-5 (1 pl.).
† Revue Gén. de Botanique, i. (1889) pp. 290-1.

transferred to the copper and bichromate solution, wherein it becomes stained black. Sections stained in this way are extremely valuable for photomicrography. The sections thus stained may be mounted in acetate of potash, glycerin, or in balsam.

(5) Mounting, including Slides, Preservative Fluids, &c.

Method for fixing Serial Sections to the Slide.*—Dr. Gallemaerts recommends Drash's method for fixing sections to the slide. It is performed as follows :—

(1) Make a saturated solution of gun-cotton in acetone, and then add enough absolute alcohol to the solution to make a very thin fluid.

(2) Cover the slide with a thin layer of the liquid.

(3) Arrange the sections, then moisten the slide with a brush dipped in absolute alcohol in order to dissolve the coat.

(4) Mop up the sections with blotting-paper by pressing several folds down on the slide with the finger.

(5) Warm the slide until the paraffin melts.

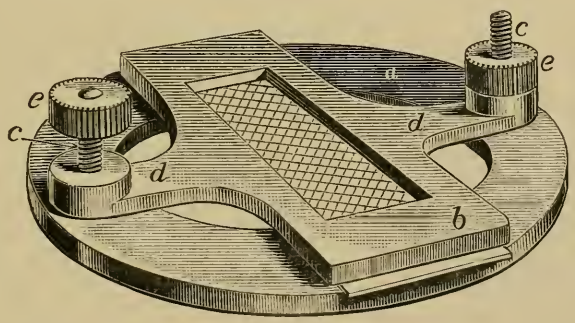
(6) When cool dissolve the paraffin in xylol and mount in balsam.

(7) If the preparations are not stained, after the xylol wash with alcohol; then place them in the stain. When stained, wash in water, and then pass through alcohol and xylol to balsam.

Apparatus for fixing down Series of Sections.†—Dr. I. Dionisio has devised an apparatus for facilitating the manipulation of series of sections. The idea of the apparatus consists in keeping the sections on the slide during the manipulation by means of a fine wire sieve, the meshes of which are proportionate to the size of the preparations.

The apparatus consists of a circular flat ring of metal *a*, upon which

Fig. 113.



lies the oblong frame *b*. From the long sides of *b* two pieces *d d* extend, and end in rounded extremities, through which pass two screws *c c*. These connect the two movable parts, and when the screw-head *e* is turned down, these two parts are firmly fixed together.

Sections fixed up in this way can be treated thoughout the various stages of staining, washing, dehydration, &c., but it is obvious that the instrument cannot be employed with reagents which act upon it (acids, &c.); hence its use would appear to be somewhat limited.

* Bull. Soc. Belg. de Micr., xv. (1889) pp. 56-7.

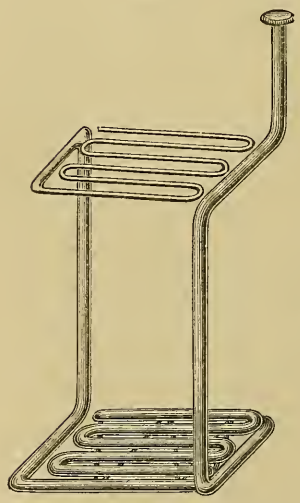
† MT. Embryol. Instit. Univ. Wien, 1888, pp. 80-4 (1 fig.).

Section-fixing.*—Dr. E. D. Bondurant suggests the following slight variation of the method generally adopted in the use of the clove-oil-collodion process, which he has found to combine the convenience and readiness of application of a liquid fixative with the undoubted advantages offered by the dry-film methods, in that it allows the preliminary arrangement of the section or a number of sections on the slide, and the easy removal of folds and wrinkles, which latter, especially with large thin sections, is often impossible if tissue must lie as it falls,

Place the section (paraffin imbedded) on a perfectly clean slide. Arrange and smooth out folds with a camel's-hair brush dipped in alcohol. Hold an instant over an alcoholic flame until the paraffin partially melts and the section adheres. Paint over the section and slide a thin film of the collodion mixture. Press down with the thumb a bit of tissue-paper coated with same mixture, in the manner recommended by Dr. Reeves, to insure close contact. Planish with mounting forceps, remove the paper, and place the slide on the brass table or water-bath at the melting-point of paraffin, until the clove oil is evaporated, when the section will be found firmly attached, and the slide can be passed through benzol, alcohol, stains, &c., without danger of separation.

Mayer's albumen process can also be used as above, and is satisfactory. Frenzel's gutta-percha and Threlfall's caoutchouc methods are also reliable, but the author thinks the collodion process, used in the manner described, is most available and most certain in its results, and he, for one, feels no need of a better plan.

Fig. 114.



Slide-rest for the Manipulation of Serial Sections.†— The apparatus invented by Dr. J. Dewitz for the manipulation of several slides at a time, is made of glass rod, and can therefore be easily constructed by any person who possesses a blow-pipe and some glass rod or tubing. An inspection of it will show at once the easiness of the manufacture. Glass rod of two different thicknesses is required; the thicker is for the external part of the frame, the thinner for the internal. The illustration shows a frame suitable for five slides, or ten if placed back to back, but of course, as any number of turns can be given to the parallel bars, an apparatus might be constructed for an indefinite number of slides. The slides are slipped in from above, and it will be seen that they can be kept in good position without danger of interfering with one another.

Mounting "selected" Diatoms.‡—Mr. H. Morland "has two methods of preparing slides of selected diatoms," one where the diatoms are gummed down, the other where no cement is used. Choose only the finer and

* The Microscope, ix. (1889) p. 191.
† Arch. f. Mikr. Anat., xxxiii. (1889) pp. 416–8 (1 fig.).
‡ Journ. Quekett Micr. Club, iii. (1889) pp. 318–30 (2 figs.).

flatter diatoms. First allow a drop of water containing the material to evaporate on a slide, taking care that the diatoms are not crowded together. By aid of a mounting-bristle, select and lay aside a number of diatoms. Transfer as many as required to the slide, placing them about half an inch to one side of the ruled glass disc in an inked square or circle, so that they can be readily found when wanted. Next breathe on a cover-glass and press it down on the slide, to which it will adhere sufficiently long and firmly for all practical purposes. Place the slide under the Microscope and then arrange the diatoms, as desired, on the cover-glass, and if necessary, owing to dirt or bits of broken diatoms, previously wash in drop of distilled water.

Should the diatoms be concave, the concavity must be placed away from the cover-glass, otherwise when the styrax is applied an air-bubble may be included.

When arranged, breathe gently on the diatoms through the breathing-tube, watching them the while through the Microscope. This causes the diatoms to adhere: too much moisture is easily removed by reversing the process.

The mounting-slip is now placed on the turntable and carefully centered, and then a small "guide-ring," about 1/10 in. in diameter, is traced round the arranged diatoms with a mixture of gum and some colouring matter, such as lampblack. The slip intended for use with the cover can also now be ringed on the under side.

The next thing is to have an iron block heated to 180° F. On this are placed two small pieces of brass about 1 in. apart, on one of which is placed the prepared cover. A drop of styrax is now placed on the centre of the slide; another is then laid on the hot block in order to remove all traces of its benzole solvent. While still hot it is turned over and lowered gently down on the cover-glass. If any air-bubbles are included, let the slide remain on the hot block until they disappear. If balsam be used instead of styrax, it must be applied cold.

If the diatoms be large, heavy, much concave, or beset with spines, they must be fixed down with some cement. The author, who recommends gum, first applies the minutest drop of gum arabic dissolved in water by means of a glass rod to the centre of the cover-glass, after this has been fixed to the ruled disc by means of the breath. This drop is then allowed to dry, and any desired consistence may be imparted to it through the breathing-tube. The diatoms are then arranged in the manner desired, and mounted in balsam.

Carbolic Acid in Mounting.*—Mr. F. T. Chapman considers that carbolic acid is superior to the ordinary media used for mounting insects. The strongest uncoloured acid should be used: small insects can be cleared therein in a few minutes, and immediately mounted in balsam without further treatment.

The solid acid may be liquefied either by the addition of 5–10 drops of water to the ounce, or if it can be used warm, by the aid of heat. The time required for clearing an object varies, the head of the common house-fly taking about a week.

Objects to be mounted in benzole balsam should be first passed through oil of cloves in which they are allowed to remain until all surface agitation has disappeared.

* Amer. Mon. Micr. Journ., x. (1889) pp. 127–8.

The disadvantage inherent to carbolic acid of becoming embrowned by time and exposure to light is retarded by using 95 per cent. alcohol as the liquefying agent instead of water.

SHERMAN, W. W.—**Notes on Balsam Bottles.**

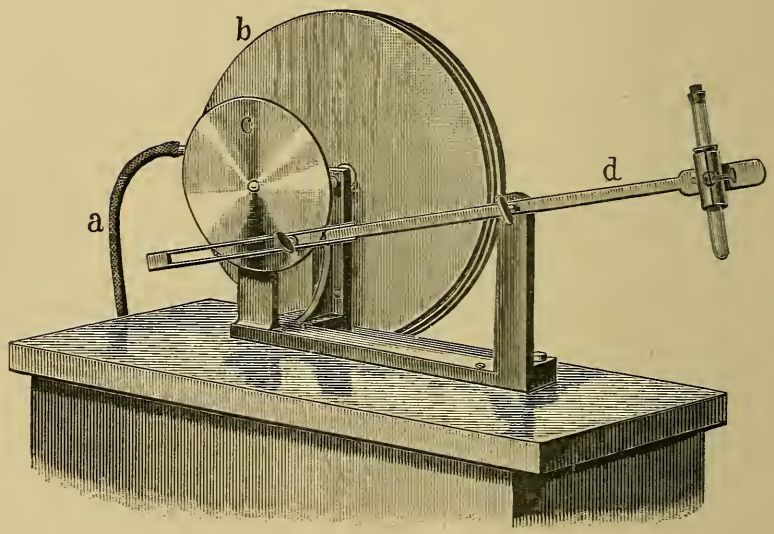
[Simple and effectual device for preventing the smearing of balsam and other resinous and sticky substances, with the consequent adhesion of the cork to the neck of the bottle. A piece of soft whalebone is bent and placed in the bottle, so that superfluous fluid may be removed on its arch. Also suggests the use of a glass-capped bottle.]

The Microscope, IX. (1889) p. 277.

(6) Miscellaneous.

Apparatus for Isolating Objects.*—Dr. W. Behrens gives an account of an ingenious apparatus intended to save the labour of shaking out or removing certain parts from a specimen. It consists of a circular tin box, fig. 115 *b*, containing a water-wheel to which water is carried

FIG. 115.



through the tube *a*, and removed by a similar tube not shown in the illustration. The water-wheel drives a circular metal disc *c*, in which, in one radius, is a series of holes. Into any of these holes is fixed a screw which connects the forked end of a long lever *d* to the apparatus. At the other end of the long piece *d* is a clamp for holding the test-tube, which is plugged when the apparatus is in motion.

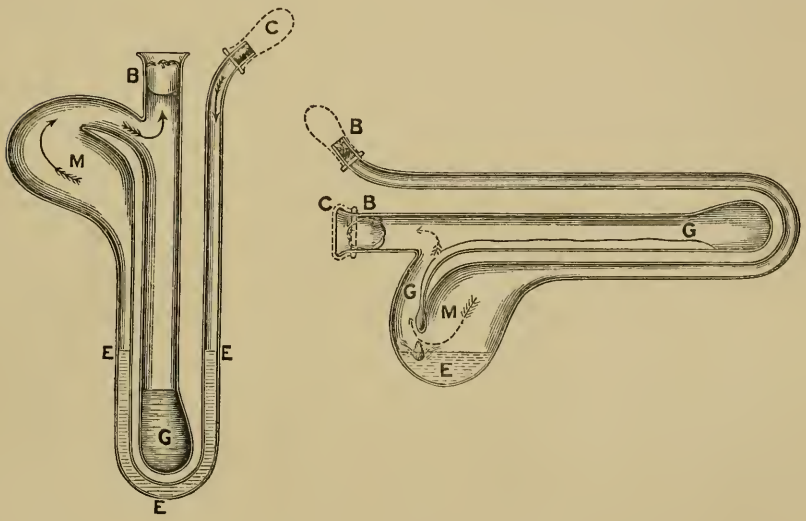
The amplitude of the movement imparted to the test-tube depends of course on the distance of the screw from the end of the lever.

* Behrens, Kossel, and Schiefferdecker, 'Das Mikroskop,' i. (1889) pp. 161–2 (1 fig.).

New Method for the Bacteriological Examination of Air.*—The microbiometer of Dr. E. Forstetter consists essentially of a U-shaped glass tube (fig. 116) E E, at one end of which is a largish bulb M. The latter is connected by a short neck with a test-tube B, the inferior extremity G of which is made bulbous in order to contain a sufficient quantity of gelatin. C is the aperture of entrance, and B that of exit.

Into the U-shaped tube is introduced about 10 ccm. of distilled water E E, and into the bulb G 15 ccm. of 12 per cent. nutrient gelatin. The apertures having been plugged with cotton wool, the apparatus is sterilized in the usual manner. When required for analysis the plug is removed from C and the aspirator fitted in B, and air drawn through at the rate of about 10 litres an hour. The experiment over, the

Fig. 116. Fig. 117.



orifices are replugged, and then the gelatin melted by the aid of very gentle heat. The instrument is then placed in the horizontal position, fig. 117, so that the water and gelatin mix together in the bulb M. When thoroughly mixed, the fluid is dispersed over plates for the cultivation of this organism. The removal of the gelatin mixture is easily effected through the opening B.

The aspirator employed by the author is a portable one capable of drawing in 20 litres of air an hour. It consists of a clockwork arrangement acting on two rubber bellows, shaped like a Chinese lantern. A needle on a dial-plate indicates the quantity of air which has passed through.

Examining thin Films of Water.†—Mr. F. Hovenden draws attention to the interesting phenomena presented by a thin film of water under the Microscope. The film may be obtained by simply breathing on the

* Annales de Micrographie, ii. (1889) pp. 567–71 (2 figs.).

† 18th Ann. Rep. South London Micr. and Nat. Hist. Club, 1889, pp. 10-1.

blade of a knife, when the steam will condense and the disappearance of the water can be observed with a half-inch power. As the globules evaporate, they appear to leap into the air, the actual point of final disappearance, however, being difficult to detect. Some curious questions as to molecular action are raised by this experiment, as well as by those which he suggested should be made in connection with thin sections of iron.

Kurz's Transparent Microscopical Plates. — Dr. W. Kurz, of Vienna, has edited plates which contain representations true to nature of typical preparations intended to produce the impression of a microscopic image. They are printed in transparent colours, and during observation are turned towards the light. The special advantages claimed for this mode of demonstration over the use of the Microscope are that a whole school can observe at the same time the object described, so that the pupils need not leave their seats and the teacher can draw their attention to every single part of the object represented.

DUNCAN, A. W.—**The Microscopical Examination of Food for Adulteration.**
Trans. Manchester Micr. Soc., 1888, pp. 49–52.
FREEBORN, G. C.—**Histological Technique of the Blood.**
Amer. Mon. Micr. Journ., X. (1889) pp. 217–22 (1 pl.).
WHELPLEY, H. M.—**Microscopical Laboratory Notes.**
The Microscope, IX. (1889) pp. 139–40.

PROCEEDINGS OF THE SOCIETY.

Meeting of 9th October, 1889, at King's College, Strand, W.C., the President (Dr. C. T. Hudson, F.R.S.) in the Chair.

The Minutes of the meeting of 12th June last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

Braithwaite, R., The British Moss Flora. Pt. xii. pp. 57–184, 7 pls. (8vo, London, 1889)	From *The Author.*
Cooke, M. C., Toilers in the Sea. viii. and 373 pp., 4 pls., and 70 figs. (8vo, London, 1889)	*The Society for Promoting Christian Knowledge.*
Deby, J., Bibliotheca Debyana. Catalogue of Books in the Library of J. Deby, M.E., F.R.M.S., vol. i., 151 pp. (8vo, London, 1889)	*The Author.*
Hudson, C. T., and P. H. Gosse. The Rotifera or Wheel-animalcules, Supplement. vi. and 64 pp. and 4 pls. (8vo, London, 1889)	*Messrs. Longman.*
Matthews, C. G., and F. E. Lott. The Microscope in the Brewery and Malt House. xxi. and 198 pp., 22 pls. and 30 figs. (8vo, London and Derby, 1889)	*The Authors.*

The President said, with reference to the 'Supplement,' that the original notion of Mr. Gosse and himself was to have made their book on the Rotifera complete; but whilst it was in progress of publication so much was done, and so many new species were added by Mr. Gosse, that they found it was not possible to include all, and the foreign Rotifera had also to be put on one side. Later on, when he had the foreign species under consideration, he began to be afraid that they would have to be permanently left out; but he found that their own list contained so many foreign forms, that it was eventually possible to include the others, and although this part had been done briefly, it had, he believed, been done completely, so that the 'Supplement' included everything which was not contained in the original work.

Mr. Crisp called attention to the confusion in 'The Microscope in the Brewery' in connection with working distance and magnifying power. He also called attention to the publication of Part 12 of Dr. Braithwaite's 'British Moss Flora,' which came fully up in point of excellence to those which had preceded it.

Mr. Crisp said he had to trouble the meeting with a personal matter, and that was to announce that he was obliged to retire from the Secretaryship of the Society, and from the conduct of the Journal. The Council had been aware for some years that his continuance in office was contingent upon certain business arrangements, and though that contingency had happily been long deferred, it had now taken effect,

and the whole of his attention was absorbed to an extent that would not allow of his offering himself for re-election. There would, he anticipated be no difficulty in continuing the Journal on its present lines, while he was sure there were many Fellows both able and willing to undertake the duties of microscopical Secretary. It was with the greatest reluctance that he had found it necessary to resign, but, at the same time, he had always felt that twelve years of one *régime* was as much as was good for a society.

Mr. John Meade's communication was read on "Stereoscopic Photomicrography," in which he claimed to have been the first to produce stereo-photomicrographs. Specimens were sent in illustration.

Mr. J. D. Hardy said he had a photo-micrograph which he had made on the same principle about seven years ago. It was of the eggs of the domestic fly.

Mr. E. M. Nelson said that the plan of taking stereoscopic photomicrographs in this way had been known for a long time. One way in which they were done, was to cover up alternately each half of the objective, taking a photograph from each, the two being afterwards mounted as a stereoscopic picture.

Mr. Crisp said the subject had been exhaustively dealt with many years ago by Dr. Fritsch in his 'Ueber das stereoskopische Sehen im Mikroskop und die Herstellung stereoskopisher Mikrotypien auf photographischem Wege" (1873), while Dr. Stein's 'Das Licht' contained a good summary of the subject.

The President said he had brought with him for inspection three photomicrographs of one of the new rotifers mentioned in his 'Supplement'—*Gomphogaster areolatus*. They were unfortunately not good specimens, but though very indistinct, they were sufficiently like the drawing shown at a previous meeting to enable the creature to be recognized as the same. It was necessarily very difficult to get a good photograph of an object of this sort.

Mr. E. M. Nelson said he had brought for exhibition a new elementary centering substage which he thought was likely to be useful. It was fitted in the simplest manner by placing two lugs under the main stage, and the movement was given to it with the finger; it was very inexpensive, and was only designed to render the ordinary student's Microscope of a higher degree of efficiency by providing it with an easy method of correctly centering the condenser and diaphragm.

Mr. J. Mayall, jun., thought that in this case Mr. Nelson had really hit upon a novelty of design. The need of a simple and accurate centering substage for inexpensive Microscopes had long been a serious impediment to the skilful use of such Microscopes. Mr. Nelson's new substage would add greatly to the efficiency of students' Microscopes at small cost. He believed that a few hours' practice would enable any one to master the use of the new substage, and he thought Mr. Nelson was very much to be congratulated upon its production.

The President said Mr. Rousselet was showing under his Microscope a specimen of *Limnias cornucella*, a new and very pretty creature which

they would find well worth looking at. In this animal the tube, instead of being made with a simple bore, sometimes with a straight axis and sometimes curved, was in the form of a screw, being twisted round upon itself. Mr. Rousselet's drawing showed this very clearly. Mr. Western also had a curious rotifer for exhibition.

Mr. Western said it was a specimen of *Rotifer citrinus* which was found by Mr. Chapman on Wimbledon Common.

The President mentioned that *Pedalion* was to be had in many places in the neighbourhood of London about a month ago, where it had not been previously found, though Mr. Shepherd had found it repeatedly in the lily tank at Eaton Hall, near Chester. It was very curious to note how, when a rotifer made its appearance in one locality it was generally found in a number of other places surrounding, as if the eggs were carried about and distributed by the wind along with the dust. He also wished to draw a picture of what Mr. Rousselet had called his attention to in connection with the small vibratile tags attached to the lateral canals, the use of which had been so difficult to make out in the case of *Asplanchna*. He had not mentioned it in the Supplement to the 'Rotifera,' but he found that in Daday's last memoir, printed in Hungarian, it was shown quite plainly. Having made and explained drawings of the structure on the blackboard, the President said that the conclusion he had come to was that the hairs were intended to protect the openings from the intrusion of any bodies which might tend to obstruct the tubes, and if this was so it would seem to demonstrate that there were openings. He had seen these hairs frequently loaded with matter apparently strained out from the water.

Mr. Ahrens's description was read of his new patent polarizing binocular Microscope for obviating the difficulty of using analysing prisms with the double tube. The inventor uses for an analyser a black glass prism, set above the objective with a horizontal side upwards. Two faces are symmetrically inclined to the optic axis at the polarizing angle. The pencil is thus reflected at the proper angle, and at the same time divided into two parts, which are then reflected up the two tubes either by prisms or by plane reflectors (*ante*, p. 685).

The President said the Fellows must have heard with great regret of the deaths of the Rev. M. J. Berkeley and Dr. G. W. Royston-Pigott, the former an Honorary, and the latter formerly an Ordinary Fellow of the Society. They were both too well known to need any statement from him as to their work.

Mr. Crisp said they had also heard of the death in America of Mr. C. Fasoldt, sen., so well known as a ruler of fine lines.

Prof. Abbe's paper, "Notes on the Effect of Illumination by means of Wide-angled Cones of Light," was read (*supra*, p. 721).

The President thought it would be obvious that a paper like that of Prof. Abbe's could hardly be followed when read to the meeting—although full justice had been done to it in that respect by Mr. Crisp. It could only be fairly dealt with when seen in print in connection with the figures which illustrated it.

Mr. T. F. Smith said that personally he had never objected to the

diffraction theory itself; but only to certain conclusions which some persons had drawn from it.

Mr. T. F. Smith read a paper "On the Ultimate Structure of the *Pleurosigma* Valve" (*supra*, p. 812).

Prof. Bell said he was disappointed to find that a specimen which he had brought for exhibition at the meeting was dead. It was a fine specimen of *Virgularia mirabilis*, which had been sent to him by post from the west coast of Scotland by Mr. Gathorne Hardy. He had to attend a committee during the afternoon, and, having the tube in his pocket, the warmth had proved too much for it, and it had broken up and disintegrated. He regretted that he was in consequence unable to show what was certainly a very interesting and beautiful organism, so that for the moment they would have to be content with the knowledge gained by his experience, namely, that it was now possible to get living specimens delivered in London from Scotland in a healthy condition by the parcel post.

The following Instruments, Objects, &c., were exhibited:—

Prof. Bell:—*Virgularia mirabilis.*

Dr. Hudson:—Three Photomicrographs of *Gomphogaster areolatus.*

Mr. J. Meade:—Stereoscopic Photomicrograph of head of Crane Fly.

Mr. Nelson:—Baker's Student's Microscope with new elementary centering Substage.

Mr. Rousselet:—*Limnias cornuella.*

Mr. T. F. Smith:—Valve of *Pleurosigma formosum* in illustration of his paper.

Mr. Western:—*Rotifer citrinus.*

New Fellows:—The following were elected *Ordinary* Fellows:—Surg. P. W. B. Smith, R.N.; and Surg. V. Gunson Thorpe, R.N.

MEETING OF 13TH NOV., 1889, AT KING'S COLLEGE, STRAND, W.C., THE PRESIDENT (DR. C. T. HUDSON, F.R.S.) IN THE CHAIR.

The Minutes of the meeting of 9th October last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Behrens, W., A. Kossel, and P. Schiefferdecker, Das Mikroskop und die Methoden der mikroskopischen Untersuchung. Band i., viii. and 315 pp., 193 figs. (8vo, Braunschweig, 1889)	*Dr. W. Behrens.*
Dowling, C. H., Series of Metric Tables	*Mr. Crisp.*

The Rev. Henry Armstrong Hall said that he had brought for exhibition a preparation which he thought would be found of interest. In January of the present year Dr. Bullock—who was at the meeting that

evening—gave him a sample of urine which, when examined under the microscope, was found to contain a particular bacillus. After the ordinary process of preparation, and after staining by the method of Neilson, on the eighth or ninth slide being examined, he found a bacillus which resembled very closely in appearance *Bacillus tuberculosis*. Having afterwards obtained another sample from the same source, he found in the albuminous residue a still larger proportion of the same bacillus; but although it showed the same beaded appearance, and had the same power of retaining the stain in the presence of nitric acid, he could not, of course, say yet that it was *B. tuberculosis*, though it very strongly resembled it in appearance. He believed that it was very rare to find it in this way in the urine, though it was said that in some cases of tubercular disease of the kidney it was to be found. The patient from whom the specimens came was alive, and the case was looked upon as one of great interest by Dr. Bullock, and if it subsequently proved that this bacillus was really identical with *B. tuberculosis*, it would show the importance of its being looked for in similar cases. The preparation shown under the Microscope in the room would be seen to be full of the bacilli, lying mostly in groups.

Dr. Bullock said the case to which Mr. Hall had referred had been under his care for some time, and had presented considerable difficulty in diagnosis. Several opinions had been taken upon it; and the question was whether it was a case of calculus in the kidney, or whether it was one of tuberculosis. This was obviously of great importance to determine, since if it was calculus it would be remediable by operation, whereas if the case was one of tuberculosis nothing could be done. After seeing the bacillus, and considering the specific gravity of the water, he was inclined to think that there was tuberculosis.

Mr. G. C. Karop said it was well known that tuberculosis of the kidney could be detected by the examination of the urine, the presence of bacilli having been observed since about 1882. The morphological characters of bacilli were, however, so very variable, that it was hardly safe to rely simply upon the appearance they presented. He would not, of course, venture to say that those which were obtained in this case were not *Bacillus tuberculosis;* but he should not like it to be thought that this method of examination in suspected cases of this disease was uncommon or usually neglected.

A Fellow asked if there had been any attempt made to cultivate the bacillus?

Mr. Hall said that this had not yet been done, though it was in contemplation. He had shown it to Prof. Crookshank, and though he very properly declined to commit himself to any opinion at present as to what specific form it was, he proposed to follow up the matter by cultivation, and eventually to test it by inoculation.

Dr. Hebb inquired if Dr. Bullock would state the age of the patient, also how long the case had been under treatment; whether there was any tubercular disease of the lungs, or any in the family history?

Dr. Bullock said that the patient was twenty-one years of age, and the symptoms were of about 4½ years' duration. The first complaint was of pain in the right kidney, and then for a long-continued period there was pain in the left kidney. He found there was lithic acid present in the urine, and there had been some symptoms of stone in the bladder, as well as several symptoms of stone in the kidney; but at present

there was the very low specific gravity of 1·0004, though some time ago it had been 1·009. There seemed no trace of tubercular disease of the lungs, and there was none in the family history, except possibly in one sister.

Mr. J. D. Hardy exhibited and described a little apparatus which he had devised for the purpose of photographing an object under the Microscope without having to alter the position of the instrument in any way. It was, in some respects, the same as one which he exhibited at the Quekett Club about three years ago; but whereas that one was made of metal, and was found to be too heavy, the one before them was made of wood, and its weight was only about 1 oz., the cost being nothing at all beyond the trouble of making it. He thought that its simplicity and lightness would hardly fail to recommend it, especially as most of the commercial instruments of that sort were evidently designed by those who did not understand the requirements of the case. Having described the *modus operandi*, and stated that with the ordinary Ilford plate the exposure required with a 1/4 in. objective was about four minutes, he handed round some specimens of the photographs taken by the apparatus.

Messrs. Watson and Son exhibited and described a new pattern microscope for students (the Edinburgh Student's Microscope), and a student's petrological Microscope, made upon the same lines. Also a small box for holding slides, which presented some features of novelty, and for which a provisional patent had been obtained by Mr. Moseley, its inventor. The slides were held in flat trays, in the usual way, but they were so arranged that upon opening the front of the box the trays were drawn forward, so as to form a series of layers overlapping sufficiently to expose the labels at the front end of each row, and enabling the position of any particular slide to be seen without the necessity for removing the trays in search of it.

Mr. Crisp said this seemed to be a real novelty in cabinets, and until he saw it he certainly had thought they must have got to the end of anything new in the way of putting objects into cabinets.

The President said the Fellows present should all take a look at the box, as it was a model of ingenuity, and met a want which all must have frequently felt.

Mr. Crisp said they had from time to time commented unfavourably upon the late Mr. C. Fasoldt, in connection with his claim to have seen lines 250,000 to the inch. He had received a copy of an obituary notice of Mr. Fasoldt, written by Prof. Rogers, which dealt with the deceased's work, and accorded him a high measure of praise for what he had done, and, under those circumstances, he thought it would be proper to read it now, and to publish it *in extenso* in the next number of the 'Journal' (*supra*, p. 829).

Mr. Crisp called attention to a statement published by M. Pelletan, on the authority of Dr. Eyrich, of Mannheim, to the effect that Dr. R. Zeiss had produced a 1/12 in. immersion objective with a numerical aperture of 1·60, using monobromide of naphthaline. This was higher than anything which had hitherto been accomplished; but

the use of such objectives was likely to be restricted, owing to the price, which was 10,000 fr. or 400*l*.

Mr. T. Powell, in reply to a question as to the possibility of producing such an aperture, said it would be quite possible to make it with such a medium as the immersion fluid named, that was, of course, supposing its refractive index was as high as 1·6.

Mr. Ingpen said that the refractive index of this medium was 1·8.

Mr. Crisp said that it would be remembered that some time ago an extraordinary description was read at one of their meetings from the Proceedings of the American Association for the Advancement of Science, a society having the same object as our British Association, in which it was proposed to convert a Microscope into a microtome by placing the imbedded substance in the lower end of the tube and cutting sections by means of a blade fitted to move upon the stage-plate, the material being moved forward by the action of the fine-adjustment. He had now brought the apparatus described for exhibition, as it might well be thought that the original account was written as a joke, and that it could not be seriously put forward. Having fitted up the contrivance in the manner described, he showed the way in which it was proposed to be used.

Mr. Karop and Mr. J. Mayall, jun., made several suggestions as to possible conversions of a Microscope to domestic and other uses if it was not considered necessary to confine it to its original purpose.

Mr. J. Mayall, jun., described the various Microscopes and accessories which he had examined at the Paris Exhibition, pointing out that whereas at former international exhibitions most of the best makers in England, America, and other countries, were exhibitors, on this last occasion they had been rather conspicuous by their absence. He had seen very little that was new in the matter of design. The French opticians were fairly well represented as to numbers, but the instruments they exhibited were for the most part of the old, not to say antiquated types. Where, perchance, one or another had ventured to add an adjustable substage to his Microscope, this had been done in what English microscopists would regard as a clumsy and ineffective way, by no means up to the standard that would be required in England. When French opticians were questioned why they did not produce Microscopes more suitable for the critical microscopy of the present day, they replied that there was no amateur scientific class in France as in England, and that they were therefore obliged to restrict themselves to what was suitable for medical use; that medical students there used the Microscopes very roughly, and the instruments had consequently to be made strong and heavy, without much regard to delicacy of adjustment. Comparing the French exhibits with those of previous exhibitions, he thought the advance shown was principally in the direction of finer lacquering or nickelizing, or more elaborate upholstery. Here and there ingenuity was shown in packing a portable Microscope in a very small space, or in making a large number of appliances fit into dainty-looking velvet-lined partitions, so that the eye at least was pleased; but the solid merits of construction and design, as evidenced by good mechanism giving the microscopist perfect command of all necessary adjustments,

seemed to be almost wholly neglected. Some little attention had been given to photo-micrographic combinations of apparatus; but here again the main essentials of steadiness and facility of adjustment were lost sight of, or were so encumbered with useless fittings that one could only view them as eccentricities of ingenuity. The German opticians were wholly absent, as also were the American. The English were represented by Ross & Co., Dallmeyer, Pillischer, and Watson & Sons. The Grand Prix had been awarded to Ross & Co., presumably for the variety and importance of their exhibits, which included a new pancratic eyepiece for the telescope, doing away with the necessity of altering the focal adjustment, sundry improved photographic lenses and cameras, and Wenham's radial Microscope. Of course the award of the Grand Prix did not commend itself to the less successful competitors, and some dissatisfaction was expressed at the appointment of M. Alfred Nachet as the microscopical expert to advise with the jury. It seemed to him, however, that no more competent man was known in Paris than M. Nachet, and it was a matter of course that the expert should be a Frenchman. He (Mr. Mayall) had endeavoured to set aside all prejudice, and to estimate the quality of the exhibits impartially, and he was bound to say the award of the Grand Prix to Ross & Co. seemed to him equitable, for their apparatus, viewed as a whole, was the most important of the optical exhibits. He could have wished there had been more of commendable novelty in the Wenham radial Microscope, as exhibited in its latest form; still, when compared with the other Microscopes in the exhibition, it had really no worthy rival. He thought it much to be regretted that Messrs. Powell and Lealand did not exhibit; had they done so they would easily have carried the palm for Microscopes. There appeared to have been a great many unnecessary difficulties thrown in the way of the English exhibitors. They were shunted up into the galleries, where their exhibits were practically unseen, and all sorts of vexatious conditions were imposed at the outset that dismayed the bulk of intending exhibitors. In the face of these unfavourable conditions he could well understand the reluctance of Messrs. Powell and Lealand, Beck, and Swift to compete, especially with the experience they had of the difficulties of being properly represented at the Paris Exhibition of 1878.

The President said they must all feel greatly indebted to Mr. Mayall for the trouble he had taken in explaining what he had seen as well as in looking at the exhibits for this purpose.

The President announced that the Conversazione would take place on November 27th.

The following Instruments, Objects, &c., were exhibited:—

Mr. Crisp:—Hart's Microtome Microscope.

Rev. H. A. Hall:—Bacillus from Urine.

Mr. J. D. Hardy:—Photomicrographic Apparatus.

Messrs. Watson and Sons:—(1) Edinburgh Students' Microscopes. (2) Moseley's Slide Cabinet.

New Fellows:—The following were elected *Ordinary* Fellows:—Mr. H. C. B. Chamberlin, and the Rev. P. W. Hart-Smith, M.A.