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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FELLOWS OF THE SOCIETY.

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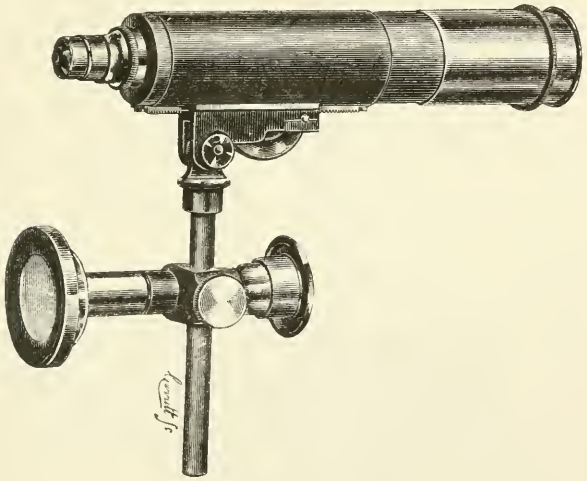
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Collins's Aquarium Microscope.—Mr. C. Collins's Aquarium Microscope (fig. 1) differs from all other forms in that it is applied to the side of the aquarium itself. This is accomplished by making use of a sucker apparatus. The head of the sucker is shown on the left of

Fig. 1.



the drawing, with an indiarubber ring surrounding a central piston. The ring is applied to the glass surface of the aquarium, and the air is exhausted by screwing round the head of the piston seen on the right. Two turns are sufficient to fasten the sucker securely. The rod to which the support of the body-tube is attached passes through the sucker-arm, and can be clamped at any height desired.

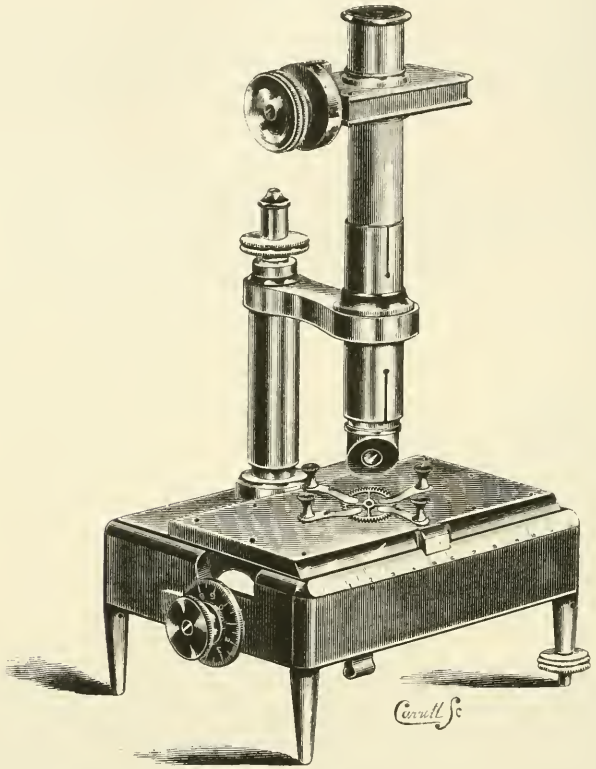
Golfarelli's Micrometric Microscope for Horologists.—This Microscope (fig. 2), made by the "Officina Galileo" of Florence, after the design of Prof. I. Golfarelli, is intended for the use of clock- and watch-makers, enabling them to ascertain, for instance, that the teeth of chronometer and duplex escapement wheels are regularly cut.

The upper part of the Microscope is screwed to a metal stage 5 in. × 4 in., supported on four feet, and having a graduated scale on its front side. In a wide groove in the stage slides a metal plate, with four spring clips to hold the object examined. The clips can be variously applied in fourteen different holes. The plate is moved by 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.

fine screw, which extends beneath the stage for its whole length, and is actuated by the milled head on the right. To this is attached a graduated disc, which reads against a fixed index, the movable plate having also an index. Over the front of the objective is a plane mirror of polished silver, with a central aperture through which the object is

Fig. 2.

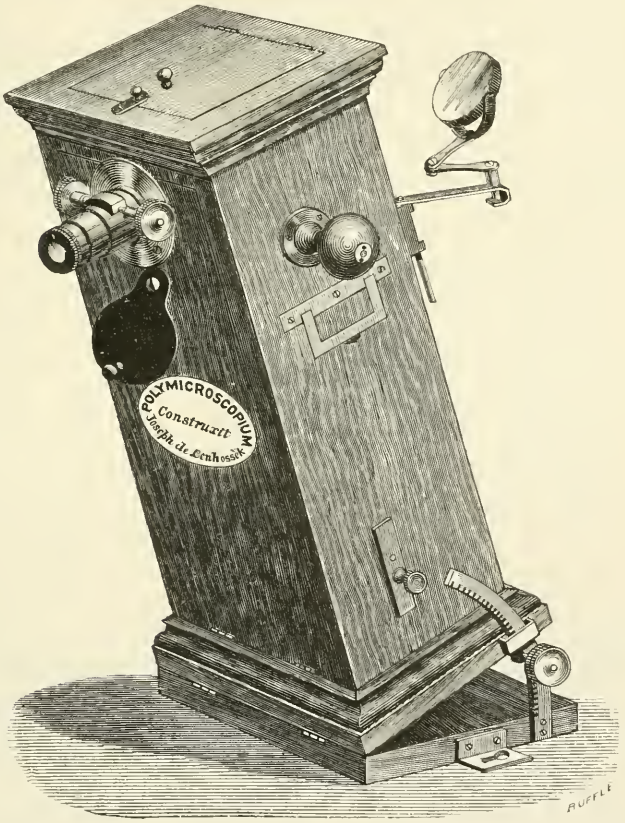


viewed. The mirror being inclined at 45°, reflects the light upon the object on the stage, which is always viewed as an opaque object. The mirror rotates in a collar socket to vary the illumination. There is a fine-adjustment screw (usual Continental form) at the top of the pillar, and a screw eye-piece micrometer forms part of the body-tube. For levelling the instrument one of the feet has a screw by which it can be lengthened or shortened.

Lenhossék's Polymicroscope.—Dr. J. v. Lenhossék has applied the principle of the revolving stereoscope to the Microscope in a very ingenious manner. The instrument is shown in perspective in fig. 3, in profile in fig. 4, and in section in fig. 5. The essential feature consists in an endless band M M (fig. 5) turning on the upper and lower axles K L, and carrying 60 ordinary 3 × 1 in. slides, N. The slides lie horizontally, but as each slide comes to the top it stands vertically, and the object is observed through the opening H, in the side of the box A, by the Micro-

scope I, which is necessarily of somewhat low power, and has a focal distance of 53 mm. The endless band is moved by two handles at the sides of the outer box, which turn the upper axle. The slides can be illuminated by direct light through the opening F, in the opposite side of the box, or by the mirror R, shown in figs. 3 and 4. The Microscope is focused by the milled head at *q*. The slides can be placed in position

Fig. 3.



by raising the top of the box B (fig. 5), or if a more extensive inspection of the interior of the box is required both front E and back G (hinged at the bottom at *e* and *g*) can be turned away as shown in fig. 5.

The manner of fixing the slides is shown in fig. 6, A from in front, B from above. *a a* in the one fig. and *b b* in the other are the two spring jaws which hold the slides firmly in position. A disc with four notches is attached to one end of the upper axle, and a spring falling into a notch, indicates when a slide is exactly vertical.

An arc-piece with rack and pinion (B *c*, fig. 4), enables the whole instrument to be inclined to suit the convenience of the observer.

The lenses can be attached to a special stand, and used as an ordinary Microscope.

With the Microscope Prof. Lenhossék sent a portfolio of manuscript

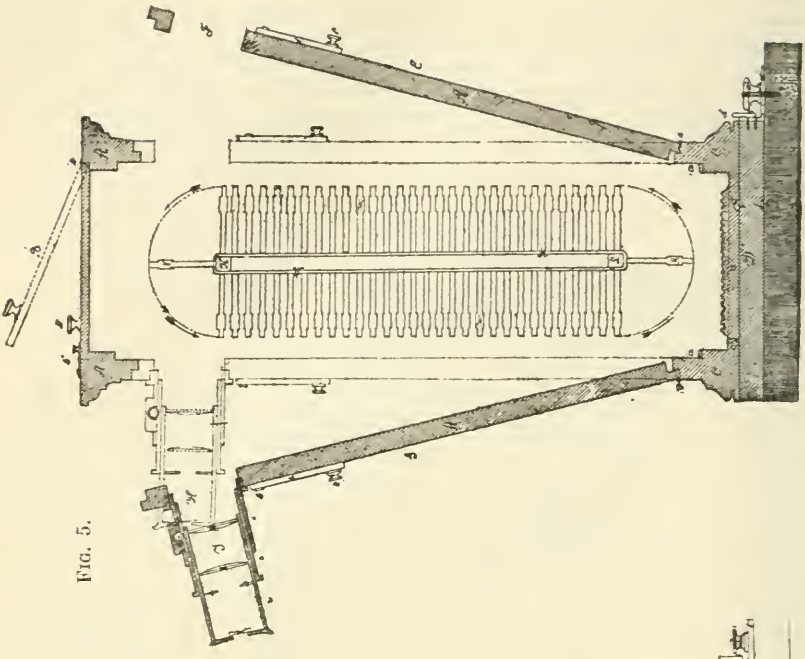


FIG. 5.

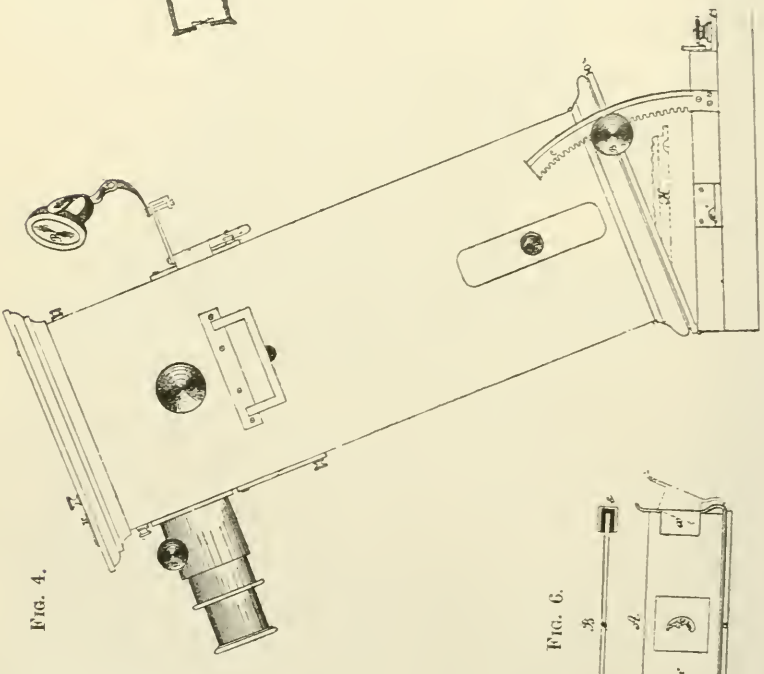


FIG. 4.

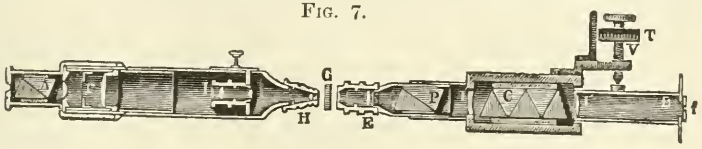
FIG. 6.

and drawings, giving the most elaborate and complete account that perhaps has ever been given of any Microscope.*

Prof. Lenhossék recommends the Polymicroscope especially for a continuous series of objects.

Dufet's Polarizing Microscope.†—This instrument (figs. 7–9) was designed by M. H. Dufet to show the interference figures of crystalline

Fig. 7.



fragments, and to allow of the accurate measurement of the axial angle for different colours of the spectrum. G, fig. 7, is the plate of crystal

Fig. 8.

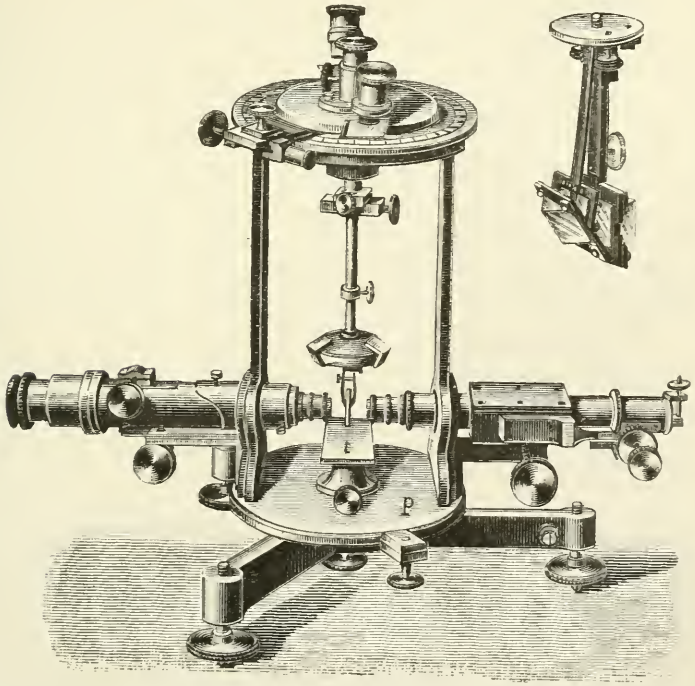


Fig. 9.

which receives a pencil of convergent light polarized at P. The rays which traverse the objective H (No. 9 of Nachet) form at its principal focus the real image of the isochromatic curves; and these are examined by a Microscope composed of the objective I (No. 0 of Nachet), and of

* Cf. also 'Ein Polymikroskop von Dr. Joseph von Lenhossék,' 25 pp., 1 phot., and 2 pls., 8vo, Berlin, 1877 (from Virchow's Arch. f. Pathol. Anat. u. Physiol., lxx.).

† Journ. de Physique, v. (1886) pp. 564–84. Bull. Soc. Franc. de Minéral., ix. (1886) pp. 275–81 (2 figs.).

the eye-piece *r* with cross wires; the analyser is at A. The image is much improved by the use of microscopic objectives (of which the principal focal surfaces are practically plane), instead of simple lenses. The instrument is focused by moving the objective I and then shifting the eye-piece. The apparatus for concentrating the light consists of a microscopic objective E placed behind a nicol. To use rays of any required refrangibility, a direct-vision spectroscope is employed. The collimator B is moved by a micrometer screw V with divided drum T. The rays, after traversing the prism C and the lens *l*, form a real spectrum at the principal focus of the objective E. The isochromatic curves are then projected upon the spectrum, and a movement of V brings the different colours in succession into the field; the graduation on the drum will, by previous experiment, give the exact wave-length of the light corresponding to any position of the collimator.

Fig. 10.

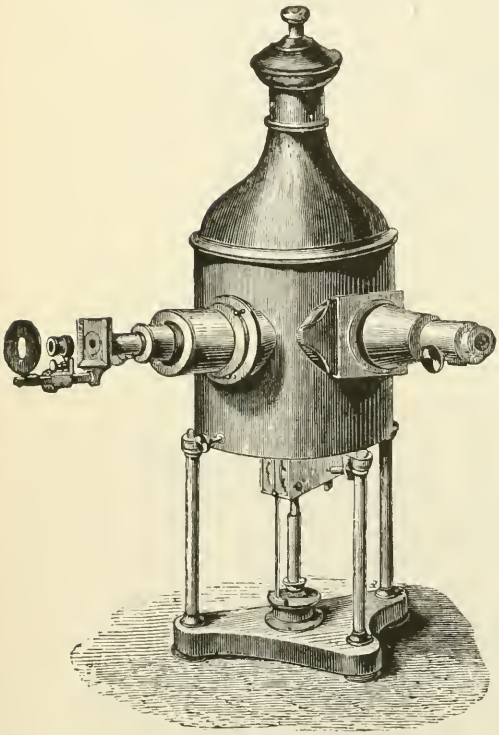


Fig. 8 represents in 1/5 the natural size the apparatus used for the measurement of axial angles; it is practically that of von Lang. The crystal fragment is held in a spring clip with spherical and rectilinear adjustments, and moves under a divided circle reading with verniers to 20″. Measurements in oil can as usual be made by the help of the small stage *t* below the crystal. This apparatus may also be used to measure indices of refraction by the method of total reflection; for this purpose the spectroscope is removed, and the clip is replaced by the two prisms represented half-size in fig. 9, which inclose the section surrounded by a layer of some liquid having a higher refractive index than the section itself. Finally, this part of the apparatus may be used, like the similar Universal Apparatus of Groth, as a Wollaston goniometer.

Duboscq's Projection Microscope.*—M. Duboscq's projection Microscope (fig. 10) is arranged to carry three objectives, two shown in the fig., the third being at the opposite side of the lantern. This enables different magnifying powers to be used by simply turning the lantern round and without having to screw and unscrew the objectives. Electric light is used for the illumination.

* Stein, S. T., 'Das Licht im Dienste wiss. Forschung,' v. (1887) pp. 303-5 (3 figs.). Also 'Die Optische Projektions-Kunst im Dienste der exakten Wissenschaften,' 1887, pp. 94-6 (3 figs.).

Campani's Compound Microscopes.—With reference to the note on pp. 643–4,* we have since found that a figure of a nearly similar Microscope was published in the 'Acta Eruditorum,' Lipsæ, 1686, Tab. x. (pp. 371-2), where it was designated "Novum Microscopium

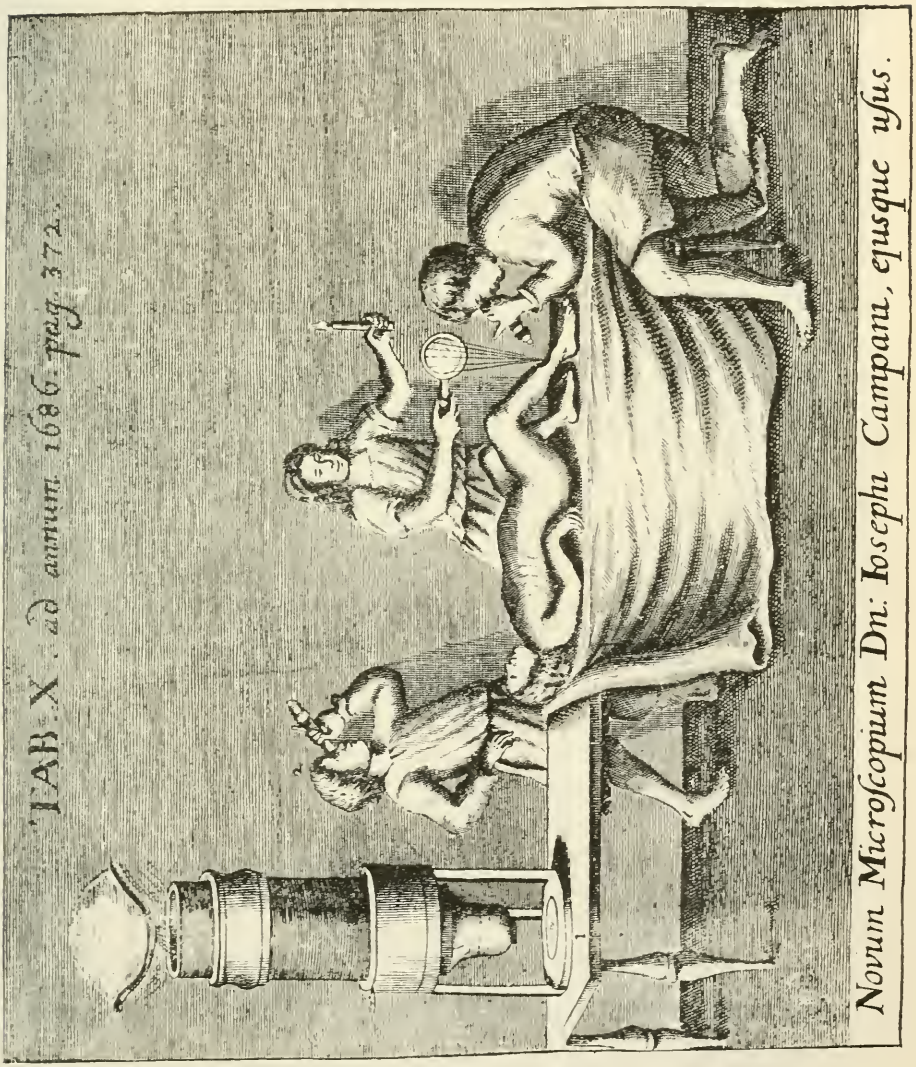


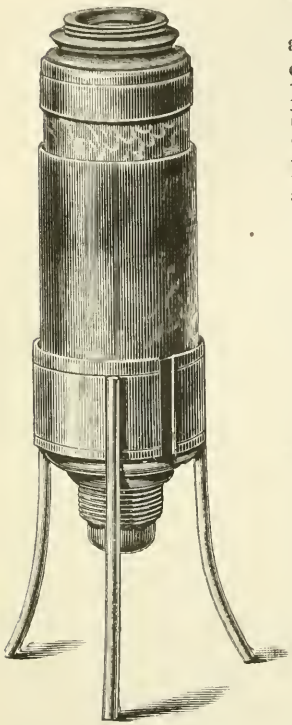
FIG. 11.

Dn: Iosephi Campani, ejusque usus," the figure also showing the employment of the instrument for viewing transparent and opaque objects. This figure was reproduced in the 'Opuscula omnia Actis Eruditorum Lipsiensibus inserta, &c.,' tom. ii., Venetiis, 1740, p. 439.

* See this Journal, 1887, p. 643.

Our fig. 11 is copied from the original. It will thus be seen that our conjecture as to the early date (*ante* 1665) of the construction, based upon the absence of a field-lens, may possibly need qualification in the face of the publication (apparently the first of *this* form of Microscope) in 1686.

Fig. 12.



From various references we have met with, and notably from the paper 'Nvove inventioni di tubi ottici' (a contribution to the 'Accademia Fisico-matematica,' of Rome, in 1686, by—we believe—Ciampini, the then editor of the 'Giornale de' Letterati,' of Rome) Campani's Microscopes appear to have been well known at that date, so well known, indeed, that any resemblances to them in more recent models were at once noted.

Attention may be called to the curious mixture of scales in the drawing. The large Microscope on the left is the same instrument as is represented by the two small ones in the centre and on the right. The artist, it will be seen, has introduced a diagram of an eye above the large Microscope, a proceeding which, although it looks very odd in such a picture, had the useful effect of checking the scale and preventing the instrument from being taken to be of the same proportions as the men who accompany it in the drawing. It will be remembered that it was the blunder of an artist in substituting a man for an eye, that led to the ludicrous misinterpretations of Schott's Microscopes on which we commented in this Journal, 1887, p.148.

In a more recent visit to Italy than that referred to in our previous note on this subject, we met with the very early form of Microscope shown in our fig. 12. The body-tube is of cardboard covered with marbled paper, and slides in the split ring-socket on the top of the tripod for focusing. A draw-tube of cardboard carries an eye-piece with a field-lens—the lenses mounted in wood cells. The instrument is in the "Museo di Fisica," Florence, where apparently nothing definite is known of its origin. We are, however, able to assign the construction with considerable probability to Campani from the fact that at the "Conservatoire des Arts et Métiers," Paris, there is a practically identical Microscope bearing the inscription, "Giuseppe Campani in Roma 1673." It is thus evident that Campani constructed eye-pieces with, and also without field-lenses.

L., A. S.—**Differential Screw Slow Motion**—To Mr. Crisp.
[Claim to have anticipated by sixteen or seventeen years Campbell's differential screw fine-adjustment. Cf. this Journal, 1887, p. 324.]
Engl. Mech., XLVI. (1887) p. 416.

Rousselet, C.—**On a small Portable Binocular Microscope and a Live-box.**
[Microscope not figured. Live-box, *infra*, p. 112.]
Journ. Quek. Micr. Club, III. (1887) pp. 175–7 (1 fig.).

(2) Eye-pieces and Objectives.

NELSON, E. M.—**On a new Eye-piece.**
[Cf. this Journal, 1887, p. 928.]
Journ. Quek. Micr. Club, III. (1887) pp. 173–4 (1 fig.).

PELLETAN, J.—**Les Objectifs.** (Objectives.) *Contd.*
Journ. de Microgr., XI. (1887) pp. 546–9.

(3) Illuminating and other Apparatus.

Zeiss' Iris Diaphragm.—Dr. C. Zeiss has designed an Iris diaphragm in which the aperture is approximately circular for all diameters.

Fig. 13 shows the apparatus in its natural size with the six crescent-shaped metal plates, which form the aperture. These slide over one another by the handle on the right. The internal mechanism is shown in fig. 14; one end of the plates is pivoted on the upper plate of the diaphragm case, and at the free end is a straight prolongation which is

FIG. 13.

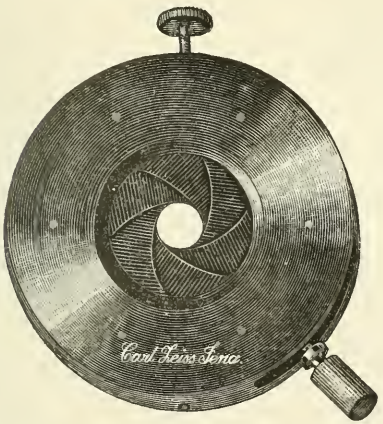
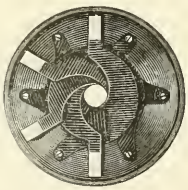


FIG. 14.



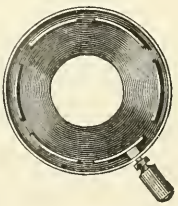


FIG. 15.

inserted between the raised pieces placed round the circumference of the second disc shown in fig. 15; when this disc is rotated by its handle the six plates turn on their pivots. With a turn of the handle to the left the aperture is reduced, and enlarged with one to the right.

By means of the screw (fig. 13) the diaphragm may be fixed to the Abbe condenser and substituted for the ordinary diaphragms. It can be worked with the little finger of the left hand, so that the other fingers can move the slide while the right hand is available for focusing.

We gather that Dr. A. Zimmermann, who describes the apparatus,* is not very familiar with the English and American forms of Beck, Wale, and others. He points out that Iris diaphragms are of advantage in drawing with the camera lucida.

Edmonds's Automatic Mica Stage. — The purpose of Mr. J. Edmonds's apparatus is to rotate a mounted film of mica between the prisms of the polariscope and beneath the object exhibited in the Microscope, producing by the rotation of the mica alone all the colour effects usually obtained by revolving the polariscope by hand. As pointed out by

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 313–5 (3 figs.).

Dr. Carpenter, "The variety of tints given by a selenite film under polarized light is so greatly increased by the interposition of a rotating film of mica, that two selenites—red and blue—with a mica film, are found to give the entire series of colours obtainable from any number of selenite films, either separately or in combination with each other." *

The apparatus is contained in a flat box or case forming a loose stage intended to be laid upon the permanent stage of the Microscope, and the object under examination being placed upon it may be observed and adjusted, or changed from time to time, without disturbing the Microscope or its accessories. The automatic rotation is effected by a specially constructed train of wheelwork which, on being wound up, continues in action for an hour, and when set in motion requires no further attention, enabling the observer to watch the varying effects without touching the instrument. It can be used with any Microscope having polariscopic attachments, is self-contained, and removable at pleasure, and does not interfere with the substage appliances.

Fig. 16.

The designer claims that "the beautiful and interesting phenomena observable in polarizing objects under various aspects, may, with the aid of this self-acting arrangement, be exhibited to a number of persons in succession, with an ease and a readiness not attainable by any other means."

Rousselet's Life-box.†—Mr. C. Rousselet describes a life-box which for pond-life he considers works better than any other contrivance of the kind he has seen. The old life-box, which has done duty for so long, has, in his opinion, the very great defect that the object placed thereon is totally out of reach of the substage condenser, and, therefore, incapable of being properly illuminated.

Some years ago Mr. Swift made an improvement by fixing the glass plate, on which the object is placed, nearly flush with the plate of the life-box, as is shown in fig. 17. But this, however, introduced another defect, "that any objects placed in the box could be examined, over the

Fig. 17.

whole field, only with low powers, whilst with high powers only those objects placed near the centre could be reached. Now, it is very frequently desirable to examine an object with a high power after it has been found with a low one, and we all know how very fond living

* Carpenter on the Microscope, 6th ed., 1881, pp. 132–3.
† Journ. Quek. Micr. Club, iii. (1887) pp. 176–7 (1 fig.).

creatures are of getting to the edge of the drop of water in which they are placed, and to shift them to the centre is frequently a very tedious work, and is often fatal to the animal."

To remedy this defect, Mr. Rousselet "had a life-box constructed in which the glass tablet is somewhat reduced in diameter, but the outer ring is enlarged sufficiently to allow any high power to focus to the very edge of the glass tablet, and the result is very satisfactory. An object lying anywhere in the life-box can be reached by the condenser from below, and by both low and high powers from above; besides which, it acts as a very good compressor, capable of fixing, without hurting, the smallest rotifers, and, when you know how to do it, it is also possible to get a rotifer in so small a drop of water that it is unable to swim out of the field of view of a 1/4 in. objective." He has had it in constant use for animals of all sizes, from the smallest infusoria to tadpoles.

Mr. Rousselet has also had a small screw compresser, made on the same principle; "it is very simple and effective, and allows of regulating the pressure to a nicety."

Large form of Abbe Camera Lucida.*—Dr. Zeiss makes a form of this camera lucida with a larger mirror and a longer arm than the one first issued.† The larger form (only made to order) is recommended by Dr. P. Mayer. The advantage of it he considers to be that it enables the whole field of vision to be utilized without any perceptible distortion of the image, and it is thus especially useful in drawing comparatively large objects with low powers. With the smaller camera the whole field can be projected on the drawing-paper only by giving the mirror an inclination differing so much from the angle (45°) required for accurate drawing that the image is more or less disproportioned. Dr. Mayer further says that "the Abbe camera is superior to that of Oberhäuser in two important particulars: it gives a much larger field of vision and better light. Its construction does not admit of use with the Microscope-tube in a horizontal position. This is a defect which ought to be at once corrected. The Abbe cameras, especially the larger one, can be used to great advantage with the embryograph of His. It is only necessary to add to the stand a horizontal arm, to which the camera can be fastened."

May's Apparatus for Marking Objects.‡—Mr. R. Hitchcock, in reference to Schiefferdecker's apparatus,§ calls to mind a "much simpler, but no doubt quite as efficient device for the same purpose," that he has used for years, made by Mr. May, of Philadelphia. It consists of a simple rod of brass about 1/4 in. in diameter, with a screw at the top that fits into the nose-piece in place of an objective. A tube fits loosely over this rod, bearing a diamond point below, slightly eccentric. This is turned by a milled collar, so as to scratch minute circles on the cover-glass.

Simple Method of Warming and Cooling under the Microscope.‖—Herr H. Dewitz describes a very simple apparatus for warming and cooling objects under the Microscope. It only cost 2*s*., and for many purposes proved entirely satisfactory.

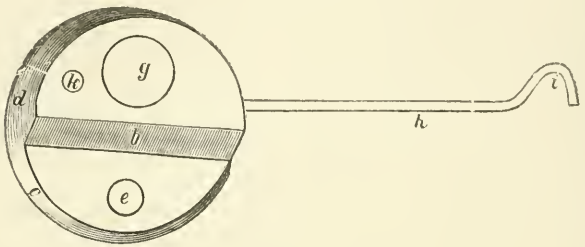
Take a round leaden box, 0·08 m. in diameter, 0·03 m. in height at

* Amer. Natural., xxi. (1887) pp. 1040-3 (1 fig.).
† Cf. this Journal, 1883, p. 278.
‡ Amer. Mon. Micr. Journ., viii. (1887) p. 207. § See this Journal, 1887, p. 468.
‖ Arch. f. Mikr. Anat., xxx. (1887) pp. 666-8 (1 fig.).

the middle; suppose the lid cut away so as to leave an opening 0·08 m. in length and 0·023 m. in height. This opening is closed by soldering a piece of lead *b* in such a way that the box is divided into two communicating portions, one *c* lower than the other *d* (fig. 18).

On the floor and roof of the flatter half two opposite circular openings *e* are made. These are covered with a cemented glass. The whole is

Fig. 18.



arranged on a metallic circle beneath so that the lower glass is not rubbed or injured by moving the apparatus on the stage.

On the roof of the deeper half a large hole is made for pouring in water and inserting ice fragments. A smaller hole receives a thermometer. Finally, just above the floor of the higher portion, the end of a tube *h* is inserted. The free end *i* of this tube, which is about the size of a goose-quill, is curved so that water cannot flow out.

Before use, the apparatus is half-filled with water poured in by the large hole, air-bubbles under the glass are got rid of, and a drop of fluid medium containing the object to be observed is placed on the upper glass, and carefully covered in familiar fashion.

The projecting tube is then warmed by a spirit-flame till the thermometer in *k* indicates the desired temperature. A glass should be placed below the free end to receive expelled drops.

For cooling purposes the apparatus is filled a third full with water at the temperature of the room or higher, and ice particles are inserted at the opening *g*. An overflow can be emptied out, viâ the long tube, by inclining the Microscope and without disturbing the arrangements. The layer of water between the two glass plates is quite thin, so that the strength of the light is but slightly altered.

Apparatus for determining Sensibility to Heat.*—An apparatus for the investigation of the heat sensibilities of the cockroach is described by Prof. V. Graber. A trough of tin is divided into two end chambers and a middle chamber whose floor is of wood, and which can be separated from the end chambers by sliding doors. All three are covered by sliding lids of glass or of tin at pleasure, and the whole is surrounded by water-baths, two lamps placed underneath these enabling the end chambers to be kept at temperatures differing by any wished amount. The lamps are prevented from interfering with each other's action by a wooden block under the middle chamber, which serves also as a stand

* Arch. f. d. Gesammt. Physiol. (Pflüger), xli. (1887) pp. 241-3.

for the whole apparatus. In each chamber one thermometer takes the temperature of the air, while the bulb of another is imbedded in felting so as to give the temperature of the walls.

(4) Photomicrography.

Israel and Stenglein's Photomicrographic Microscope.*— Dr. O. Israel's photomicrographic apparatus (fig. 19) may be used either in a

Fig. 19.

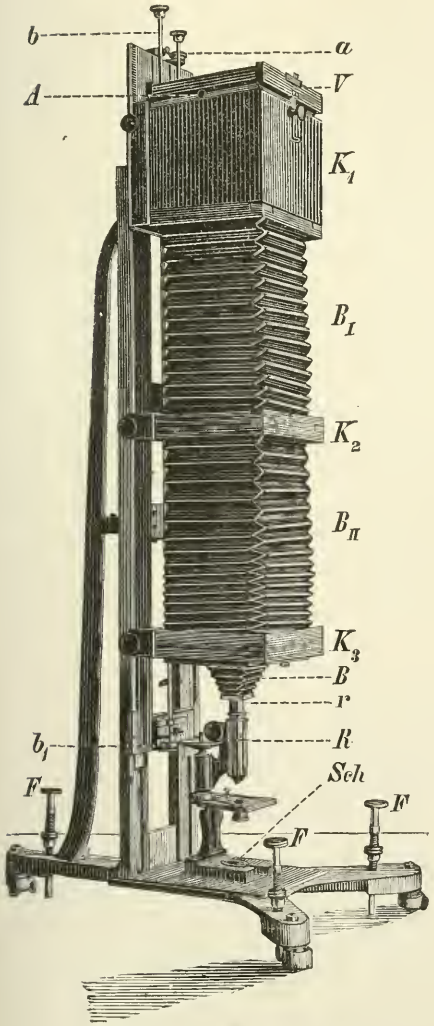
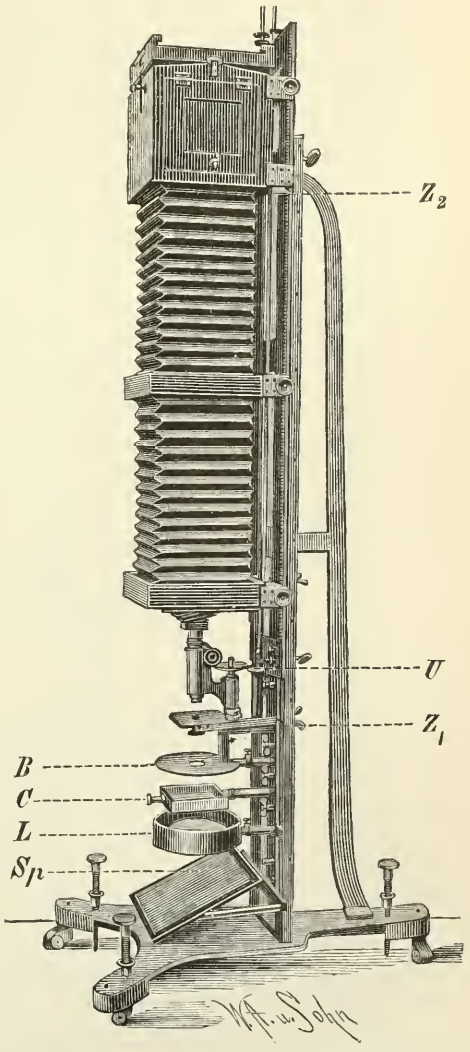


Fig. 20.



* Stenglein, M., and Schultz-Henecke, 'Anleitung zur Ausführung mikrophotographischer Arbeiten,' 8vo, Berlin, 1887, pp. 4–12 (2 figs.), 14-6 (1 fig.).

horizontal or a vertical position; in the former, the iron frame to which it is attached is fixed upon a table, using an inclining Microscope; in the latter the instrument is supported as shown in the figure upon an iron stand, which runs upon wheels, but can be fixed in any position by means of the three screws F. The apparatus consists of two parts, the Microscope and the camera; V is the focusing screen, upon which the image is focused by means of the rod $b\,b_1$, terminating in a toothed wheel b_1, which works into a similar but larger toothed wheel R, occupying the place of the usual micrometer-screw. B is the light-proof connection between the camera and Microscope, and consists of a leather bag fixed to the Microscope by the ring *r*. The camera consists of the three mahogany frames $K_1\,K_2\,K_3$, united by the leather bellows $B_1\,B_2$, which can be extended to the length of a metre; the focusing screen can be rotated about an axis A, perpendicular to the axis of the instrument. *a* is a screw spindle, placed close to *b*, by means of which the camera may be clamped in any desired position to its iron standard. When the apparatus is used in the vertical position the Microscope simply stands upon its iron base, and is fixed below the camera by means of a screw-clamp *Sch*, which grips its horseshoe stand. The size of the plates used with this apparatus is 15 × 15 cm.

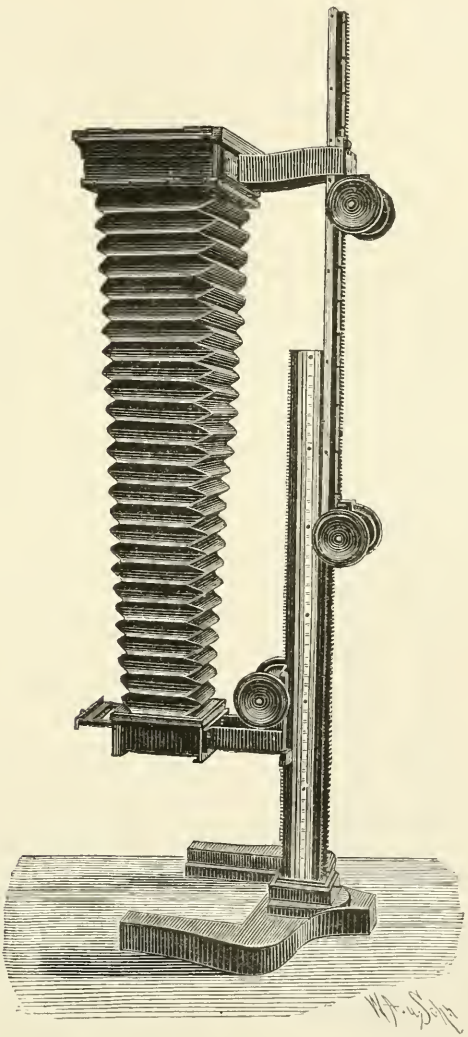
Fig. 20 represents the similar instrument of Herr M. Stenglein, which carries its own illuminating apparatus. For this purpose the height of the instrument is considerably increased; a space of 66 cm. at the lower end of the standard serves to carry the movable parts which constitute the illuminating apparatus, namely a plane mirror 20 cm. square *Sp*, a condenser of 10 cm. radius and 21 cm. focal length L, a light-filter C, to secure monochromatic light, consisting of a vessel filled with ammoniacal solution of copper oxide, and Abbe's illuminator; to these may also be added, if necessary, a diaphragm B, which is to be employed when electric light is used, and in this case the mirror is replaced by the electric lamp. To preserve the centering, the illuminator and the Microscope not only slide along the upright, but are provided with a slight lateral adjustment, and the apparatus is centered by using the smallest diaphragm of the Abbe illuminator and a diaphragm of equal size, which is made to be attached to the condenser.

Stegemann's Photomicrographic Camera. — The instrument represented in fig. 21, and devised by Herr A. Stegemann, corrects, it is claimed, a defect of the ordinary apparatus by supplying the means of adjusting the distance between the objective and the focusing screen, upon which depends the relative size of the photographic image, and by measuring this distance upon a fixed scale. A square pillar rising from an iron foot carries the camera, with the objective-frame and the focusing screen which slide upon it; the pillar is graduated, and by means of a vernier attached to the adjustment-screw of the camera gives the exact distance between objective and focusing screen. The apparatus can be used either to photograph objects in their natural size, in which case the object is placed on a glass plate fixed to the foot; or with the Microscope, which is then placed in the forked support which serves to carry the glass plate.

In this instrument the stratum of liquid which is used as a light-filter for monochromatic light is contained in a vessel which slides into

the case of the objective-frame close to the objective, so that all rays which reach the sensitive plate must of necessity have passed through the solution.

Fig. 21.



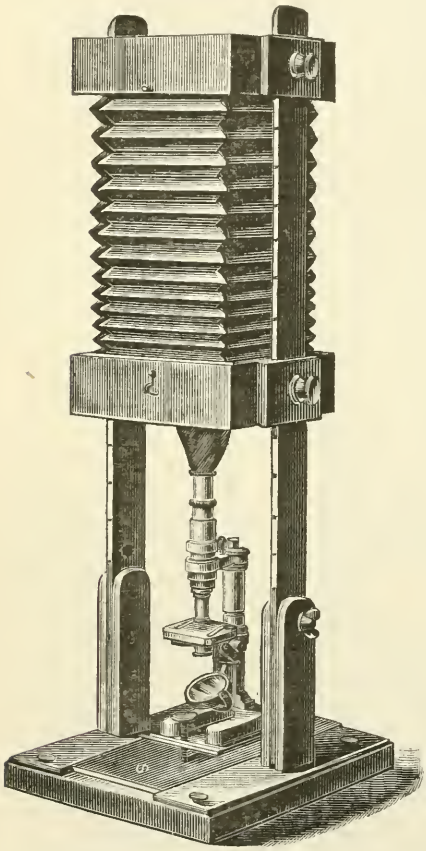
Marktanner's Photomicrographic Cameras.*—Herr T. Marktanner describes two photomicrographic cameras which he has devised.

The first is made on the Gerlach system, and consists of a wooden chamber, not made to draw out, which is placed upon the body-tube. It is distinguished from the camera of Gerlach by the basal table, which is

* Bull. Soc. Belg. Micr., xiii. (1887) pp. 188-91 (2 figs.).

made of two equal-sized plates united by a hinge. The upper plate forms the base of the camera, which is pyramidal in shape; the lower is provided with a brass tube, accurately centered, by which the camera is adapted to the tube. If the preliminary adjustment is made by means of rackwork, the brass tube may be an elastic cap which is fixed to the upper part of the Microscope by a screw clamp. To secure greater stability, it is better to apply this camera to a stand, with which the preliminary focusing is made by a sliding movement. In this case the use is recommended of a strong brass tube of the same size as the body-tube, ending in a screw-thread similar to that of the objectives. If it is desired to use objectives of different screw-threads, it will be better to employ several brass tubes of 8 cm. length, which can slide into the tube fixed at the centre of the lower plate. This camera will be especially useful in obtaining plates which give the full views so useful as aids towards drawing. As the amplification will never be more than 200 times, cardboard holders will be quite sufficient. The size of the plates is 6 cm. by 6·5 cm., and they are made by cutting a plate of 13 cm. by 18 cm. into six parts. The slide for the transparent glass is made of cardboard; the glass is covered with a fine network of lines. The hinge which unites the two basal plates enables the camera to be lowered beside the Microscope. This arrangement is very useful when the apochromatic objectives of Zeiss are used, and also with the projection eye-pieces constructed for photomicrography. The eye-pieces can then be easily changed. This arrangement was formerly less necessary than now, for with the objectives then used, photographs were almost always taken without the eye-piece.

Fig. 22.

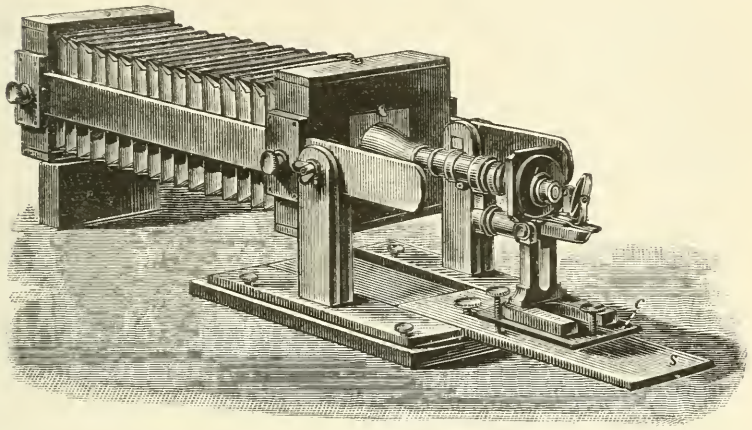


The second camera (fig. 22) is sufficient for all the purposes of photomicrography. It is similar to that of Nachet, from which it is only distinguished by the bellows, by a slide in the basal plate, and by a levelling apparatus formed of a plate of zinc upon three screws.

This camera can be used in the horizontal (fig. 23) as well as in the vertical position. In the former it draws out to 90 cm.; in the latter to 50 cm. The transparent glass is made as in the preceding camera.

If the projected image is exactly focused, it ought to be seen with the lens at the same time with the fine lines traced upon the glass. In this

Fig. 23.



apparatus the size of the plates is 12 cm. by 16 cm., a size which is recognized as sufficient by all who have had experience in photo-micrography.

Nelson's Photomicrographic Focusing Screen.*—Mr. G. Smith, in reference to Mr. Nelson's suggestion † for ruling the focusing screen with metrical and English scales, considers that if diamond lines are used they should be ruled horizontally and vertically about $\frac{1}{20}$ in. apart; but better still, every third line should be missed. The cross ruling thus forms a kind of plaid pattern, and any decided pattern materially assists the eye in keeping to the proper plane instead of seeking a focus on either side. The eye-piece must of course be first adjusted exactly to these lines for the operator's eye.

Another very simple and effective plan (applicable to other cameras too) is to rule diagonals in blacklead pencil across the ground glass, and over the centre cement a thin cover-glass, taking care to put there a few grains of dust, or say, cotton fibre. Both these plans he has used for many years, and can recommend both; with either it is easy to focus the darkest interior.

Neuhauss, R.—**Anleitung zur Mikrophotographie für Aerzte, Botaniker, &c.** (Guide to Photomicrography for Physicians, Botanists, &c.)
32 pp., 8vo, Berlin, 1887.

Sternberg, G. M.—**Photo-micrography in Medecine.**
Reference Handbook of the Medical Sciences (*U.S.A.*) 1887, pp. 647–58 (7 figs.).

(5) **Microscopical Optics and Manipulation.**

Histological Structures and the Diffraction Theory.—Hitherto the examples of the action of diffraction in microscopical vision have been almost entirely confined to diatoms, objects which more than any others are suited to illustrate the principles on which the theory is founded,

* Eng. Mech., xlvi. (1887) p. 394. † See this Journal, 1887, p. 1028.

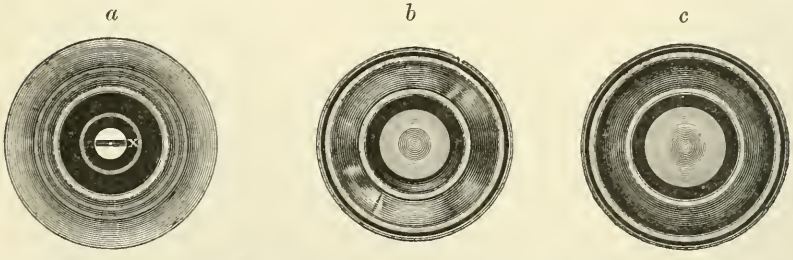
viz. that in the case of minute objects which are less than a few wave-lengths in diameter the laws of geometrical optics no longer apply, that is, the structures are no longer imaged according to the laws which govern the delineation of objects observed with the naked eye, but that the delineation is dependent upon the rays which are diffracted by the object. The matter is, however, obviously of more importance to histologists than to the observers of diatoms. In the case of histological structures the conditions are, of course, much more complicated than with diatoms, but the principles remain the same, and if they are not taken into account very false deductions may be made. A notable instance of this was the case on which we commented in 1881,* where Mr. J. B. Haycroft † put forward an explanation of the appearances presented by muscle-fibre which, while an eminently simple one, was unfortunately entirely founded on the supposition that the fibres acted in the same manner as cylindrical threads of larger size.

Prof. S. Exner, who has recently investigated the question of muscle-fibre, has published an article on the subject, in the course of which he deals fully with the operation of diffraction on such structures. This article from the point of view we are now considering is a very interesting one, and we have translated his remarks without abridgment.

In order that the subject may be fully understood, we have prefaced the translation by notes on (1) the appearances presented by air-bubbles and oil-globules, by solid and hollow fibres, and by depressions and elevations where the objects are larger than a few multiples of a wave-length, and (2) the appearances presented by *Pleurosigma angulatum* under different optical conditions.

(1) *Appearances presented by Air-bubbles and Oil-globules, by solid and hollow Fibres, and by Depressions and Elevations of relatively large size.*‡—The accompanying figs. 24 and 25 supplement those given at

Fig. 24.



Air-bubbles under the Microscope. Focus, *a* below the centre (at the focal plane), *b* to the centre, *c* the same with oblique light stopped off.

p. 743 of Vol. II. (1882), *a* in fig. 24 representing an air-bubble when the Microscope is focused below its centre (*x* being the image of a window bar), *b* when focused to the centre, and *c* the same with oblique

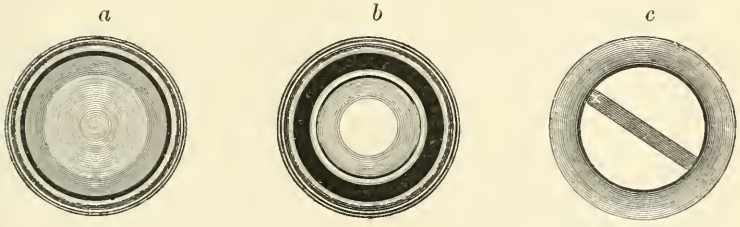
* See this Journal, 1881, p. 964.

† Proc. Roy. Soc. Lond., xxxi. (1881) pp. 360–79 (1 pl.).

‡ Cf. Dippel, L., 'Das Mikroskop und seine Anwendung,' 1867, pp. 313–4 (4 figs.), pp. 355–60 (9 figs.), and 2nd ed. 1882, pp. 822–4 (4 figs.), pp. 852–6 (6 figs.).

light stopped off. Fig. 25 represents an oil-globule, *a* with the focus on the margin, *b* somewhat higher, and *c* at the focal plane of the bubble.

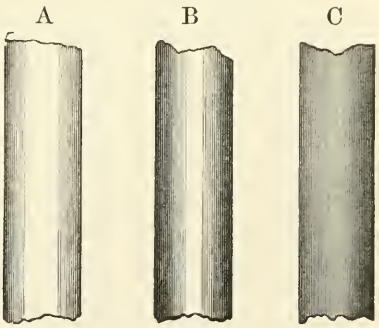
FIG. 25.



Oil-globules under the Microscope. Focus, *a* on the margin, *b* somewhat higher, *c* higher (at the focal plane).

Solid fibres, fig. 26, in a medium of lower refractive index (as a glass thread in air or water) show a diffused moderately bright appearance A at medium focus; a bright central line B when the tube is raised; and a dull appearance C when the tube is focused below the centre. The reverse of course takes place if the surrounding medium is of higher refractive index, as glass threads in monobromide of naphthalin or biniodide of mercury and potassium. If, again, the fibre is surrounded by a fluid of about the same refractive power, as in the case of a glass thread in Canada balsam, it will then have the appearance of a flat band.

FIG. 26.



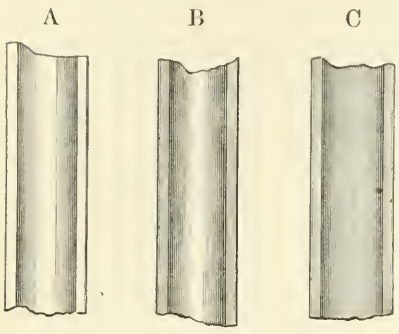
Glass threads. Focus, A medium, B higher, C lower.

Hollow fibres charged with air, fig. 27 (or a fine capillary tube of glass), present with medium focus nearly the same appearance as the solid fibres, from which they are only to be distinguished by the fact that at both edges the double outline of the section of their solid walls will be seen as in A. In other respects the appearances are reversed; the raising of the objective giving a dull image C, whilst on sinking it we have the central bright line B. Fine tubes in a denser substance produce the same effect as hollow fibres. Semi-cylindrical channels or furrows act as concave lenses, whether the hollow side is turned from or to the observer. The only distinction between the two positions is, that in the former case the tube must be focused lower than in the latter, in order to obtain the greatest degree of brilliancy in the central line.

If instead of the hollow fibre, or capillary tube charged with air, one filled with a fluid is substituted, this produces the same effect as a solid fibre, provided the contained and the surrounding fluid are nearly the same, or if the former has a greater refractive power. Solid and hollow fibres can then only be distinguished from each other in the medium focus, showing the optical section of the solid walls. On filling with a

fluid similar to that surrounding the fibre, an effect is produced more or less similar to that of the air-charged fibre, for if the refractive power of the contained and the surrounding fluid is greater than that of the solid walls, the latter will appear as hollow spaces in the stronger refracting medium, as would be the case with glass capillary tubes filled and surrounded with monobromide of naphthalin.

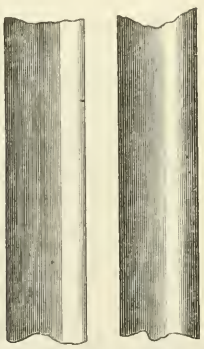
Fig. 27.



Glass capillary tubes. Focus, A medium, B lower, C higher.

If oblique illumination is employed instead of central, the appearances just described are not essentially altered; a displacement of the illuminated line to the one side or the other is simply produced, according as the mirror is moved out of the axis to the right or left. With objects which act as convex lenses it is generally displaced to the side of the object which is turned away from the source of light, and with objects acting as concave lenses to the side nearest to the light; and therefore, as the compound Microscope inverts, it will appear in the first case on that side of the image which is turned towards the mirror, and in the latter case away from it. The glass thread or the solid fibre will therefore show the line of light on the side turned towards the mirror, when the illumination falls obliquely and the tube is raised; hollow cylinders and furrows will show it, when the tube is lowered, on the side of the image which is turned away from the mirror. The division of light and

Fig. 28.



Glass threads with oblique light incident from the right. Focus, A high, B somewhat lower.

Fig. 29.

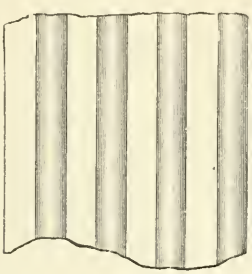
Glass capillary tubes with oblique light incident from the right. Focus, A low, B a little lower.

shadow will appear as in A, figs. 28 and 29. If a more medium focus is taken, the conditions are so far altered, that now half of the object is

in shadow, while the other half is illuminated as strongly or even stronger than the field B, figs. 28 and 29.

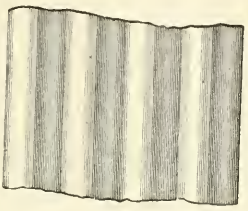
If depressions either with spherical surfaces or furrowed or bowl-shaped (fig. 30) are found on the surface of a membrane, they produce the same effect as concave lenses, and show their greatest brightness when the tube is lowered. If, however, there are spherical, hemispherical, or semi-cylindrical elevations, they act as convex lenses and

Fig. 30.



Semi-cylindrical elevations or depressions.

Fig. 31.



Cylindrical elevations and depressions.

show their greatest brilliancy when the tube is raised from a medium focus. If furrow-like depressions alternate with semi-cylindrical elevations, the surface presenting a wavy appearance, the former appear bright when the tube is lowered, the latter when it is raised, and when the former show the highest degree of brilliancy the latter has a dull appearance (fig. 31).

With wave-like membranes the result is somewhat different, since here both of the undulations, as well those which have their convex side towards the observer, as those with the concave side so turned, act as concave lenses. They therefore show their greatest brightness on lowering the objective, and the same differences in the extent of the lowering as in the case before mentioned of the semi-cylindrical tubes.

From what has been said of glass threads and hollow cylinders filled with fluid, it follows that more and less strongly refracting (i. e. dense and less dense) parts of one and the same object, will act similarly to the cylindrical elevations or depressions of a membrane. In observing, therefore, in water the differences thus presented in the microscopical image, it is necessary, in order to decide whether these depressions or elevations are caused by variations in *structure* or in *density*, to change the fluids, and particularly to use such substances as possess a greater refractive power than the object under examination, whereby the image is either (in the first case) changed according to the altered conditions, or (in the latter case) is substantially unchanged. If the greatest brilliancy appears when the tube is lowered, we have to do with an elevation, but if when the tube is raised, it must be a depression. In order to facilitate the determination of the position of the tube, we can either start with a medium focus, or the tube may be lowered from a point at which no distinct image of the object is obtained. Depressions are then first bright on a dark ground, elevations, on the contrary, dark on a bright ground, till after further lowering of the tube the image is exactly

reversed. For accuracy in the determination, the object must be in its natural condition, and must not have been disturbed by any changes in density, or by any previous preparation, drying, &c.

(2) *Appearances presented by Pleurosigma angulatum under different optical conditions.*—Hugo v. Mohl and Schacht regarded the markings as formed by three intersecting sets of lines; to Max Schultze and others they seemed to be six-sided depressions; to some English microscopists they appeared to be six-sided elevations, while Schiff and Dippel recognized a chess-board pattern. Stein, Pelletan, and Kaiser have recently referred to round protuberances, while Dr. Flögel has proved, by means of transverse sections, that at any rate the upper surface of the valve (with the exception of the central rib and the edge) is to be regarded as flat, but that it is full of cavities between its upper and under surfaces.

If we look more closely into *Pleurosigma angulatum* by the light of the diffraction theory, we obtain the following result:—Using purely central illumination, i. e. a very narrow illuminating pencil, if the numerical aperture of the objective is sufficiently large, and is at least 0·90 to 0·95, we have six spectra a_1–a_6 (circle A, plate III. fig. 1), which are arranged regularly round the direct image of the source of light, while the six spectra of the second series a_1–a_6 fall outside the aperture even with very large numerical aperture. If the aperture is so small that with purely central illumination no one of the six least deflected pencils is admitted, the valve appears to be without markings, while with a larger aperture of above 1·00 N.A. the three systems of striæ I.–III. (plate III. fig. 2) make their appearance at the same time, and according to the excess of the aperture above unity give rise to a fainter or more sharply defined pattern. Each one of these systems of striæ can also be made visible with a numerical aperture of 0·50 when oblique light is used; in that case two spectra a and a_1 or a and a_2 (circle B, plate III. fig. 1) always fall within the aperture. They may also be obtained in the same way with objectives of greater numerical aperture when all the other spectra, with the exception of one of those mentioned, are excluded by suitable diaphragms. With an objective of 0·7 to 0·8 N.A. as soon as the light is oblique enough, three pencils are included, the direct and two diffracted pencils (circle C, plate III. fig. 1), and then the two sets of striæ I. and II. intersecting at 60° are obtained.

If the direct pencil is excluded and only two opposite spectra a_1 a_4–a_2 a_5, a_3, a_6, allowed to operate, there appear in succession three new sets of striæ IV.–VI. which owing to the exclusion of a are bright upon a dark field; and the striæ are brought nearer to one another in the ratio of 2:1, so that they appear twice as fine as I.–III. though they coincide with the latter in direction.

The systems of striæ vii.–ix. which are at right angles to the ordinary sets I.–III., and of which the lines are closer together in the proportion $\sqrt{3}$: 1, are obtained in a bright field when with objectives of very large aperture, the spectra of the first series a_1–a_6 are intercepted by suitable diaphragms, and the objective receives the direct pencil a together with one of the spectra of the second series such as $a\,a_1$, $a\,a_2$ . . . $a\,a_6$. The striation IX. can be obtained by $a\,a_2$ and $a\,a_5$ when oblique light is allowed to fall upon the central rib.

The same sets of striæ can be produced upon a dark field when, using central light and an objective of large numerical aperture, a and

Fig. 1.

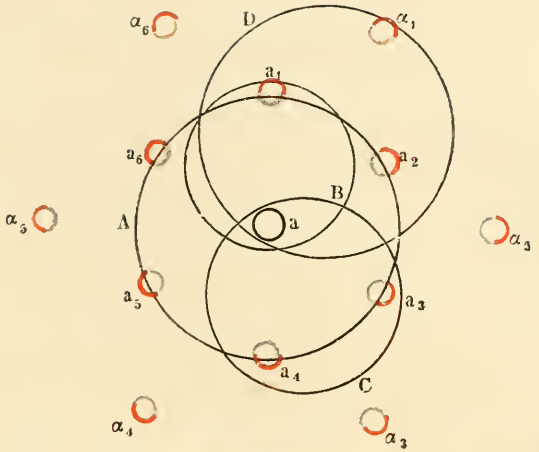


Fig. 2.

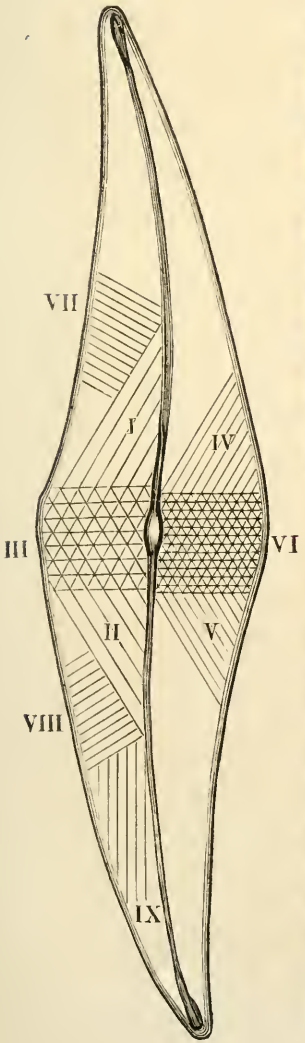


Fig. 3.

Fig. 4.

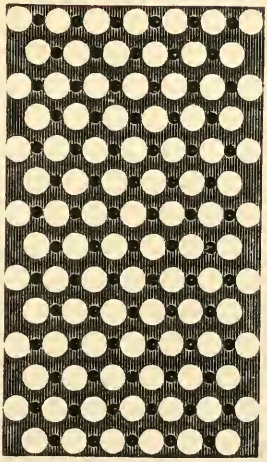


Fig. 5.

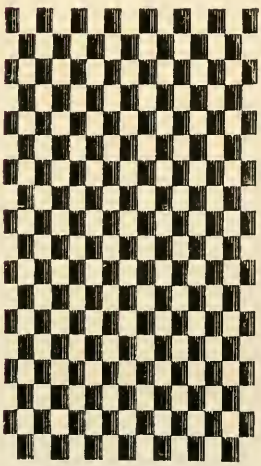
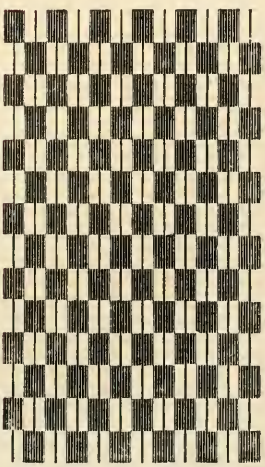


Fig. 6.



Pleurosigma angulatum.

all the other spectra are shut off with the exception of two belonging to the series $a_1\ a_3$, $a_2\ a_4$ . . . $a_4\ a_6$. The striation IX. is then repeated twice by $a_2\ a_6$ and $a_3\ a_5$.

Since the distance of the spectra $a\ a_1$, $a\ a_2$ . . . or $a_1\ a_3$, $a_2\ a_4$ . . . is greater in the ratio $1 : \sqrt{3}$ than that of $a\ a_1$, $a\ a_2$ . . . the lines of the striæ VII.–IX. must be closer to one another than those of I.–III. in the ratio $\sqrt{3} : 1$. The new striations IV.–IX. called into existence by the above arrangements possess the same sharpness of outline as those which have been long known, namely I.–III.

The above appearances serve to explain the different views which have been held with regard to the structure of diatoms, when they are observed with different modes of illumination. Dry and water-immersion objectives of no great numerical aperture show the well-known hexagons (plate III. fig. 3) when the illumination is central and with a not very minute diaphragm, or when the illumination is oblique if e. g. $a\ a_1\ a_2\ a_3$ or $a\ a_1\ a_5\ a_6$ are operative. Large numerical aperture with central illumination gives bright circles arranged in lines which intersect at 60°, and between which with very sharply defining objectives (homogeneous-immersion for instance) dark spots are also visible (plate III. fig. 4). Oblique illumination and the action of $a_1\ a_2\ a_3$, $a_1\ a_5\ a_6$, with a numerical aperture up to 1·10 shows a chess-board pattern as described by Schiff and Dippel (plate III. fig. 5). Very oblique illumination and the action of $a\ a_2\ a_3\ a_2$ or $a\ a_5\ a_6\ a_5$ with objectives of very large numerical aperture give the peculiar figure first observed by Stephenson and Abbe, in which the bright rectangular spaces are traversed by a small dark line and are accompanied by dark markings equal to the first in size and lying above and below them (plate III. fig. 6). Other forms may be obtained on a bright or dark field by the use of various modes of illumination and of diaphragms which intercept certain spectra of the first and second series and only allow the remainder to operate.

That the ordinary markings which are seen with an objective of large numerical aperture and with central illumination are more nearly related to the true structure than the other images, can only be concluded from conditions of their production, and not from the images themselves. These markings appear when the largest possible part of the total spectrum of the *Pleurosigma* valve is in operation, and as little as possible (i. e. only the furthest fainter pencils of the second and third series) is lost; while each of the other images is produced by a much smaller part of the total diffraction spectrum. For this reason it may be concluded that the former image is less dissimilar than the others from the image which corresponds to the complete diffraction action of the valve, and which is unattainable by any Microscope.*

(3) *Prof. Exner's remarks on the Optical character of living Muscle-fibres.*†—Prof. S. Exner employed his micro-refractometer ‡ to determine the refraction and double refraction of living muscle-fibres, and to answer the question whether transversally-striated fibres have their refractive index increased or diminished during contraction. The paper, as we have above stated, is more particularly interesting to microscopists from the observations which the author makes on the application of the

* Dippel's Das Mikroskop, 1882, pp. 158-61 (6 figs.).
† Arch. f. d. gesammt. Physiol. (Pflüger), xl. (1887) pp. 360–93 (2 pls.).
‡ See this Journal, 1886, p. 328.

diffraction theory of microscopical vision to the examination of such minute objects as muscle-fibre.

In the first place, the examination by the instrument of muscle from the femur of *Hydrophilus piceus* showed, beyond a doubt, that the contracted portions of a fibre have a higher refractive index than the remainder; but, on the other hand, Prof. Exner claims to have proved that this is only the case with abnormal contraction, whereas when the contraction is normal, no change is produced in the refractive power. The immersion fluid used to determine the index was either white of egg concentrated over sulphuric acid in the receiver of an air-pump, and treated with acetic acid, or the liquid obtained by pressure from the eye of an ox or sheep. The refractive index of the former can be raised to 1·4053, and that of the latter to 1·42–1·43. A number of trials with these fluids led to the result that the stationary living muscle of *Hydrophilus* has an index of refraction which varies slightly on either side of the value 1·363, while the same muscle may have slightly different values in different parts. As regards what may be called the ordinary and extraordinary rays for light traversing the fibres in a direction perpendicular to their length, measurements of the indices in the sartorius muscle of a frog led to the approximate values $n_o = 1{\cdot}368$ for the ordinary ray, and $n^e = 1{\cdot}370$ for the extraordinary ray.

When the screen of the micro-refractometer is placed with its edge at right angles to the length of the fibres, a peculiar striped appearance is produced, which the author explains as due to the obliquity of the layers constituting the fibre, so that a ray of light is deflected or not according as it does or does not pass through layers of varying refractive index. Now when the waves of contraction which traverse the living muscle of an insect isolated in an inactive fluid of equal or greater refractive index are examined with the micro-refractometer, the screen having its edge parallel to the length of the fibres, it is found that the contracted portions become dark on the side of the screen and light on the opposite side, in other words, the index of refraction in these parts is diminished; if the index were increased, the first effect would be an illumination of the fibre as far as the sarcolemma, and this is never observed.

On the other hand, the permanently contracted and transversally striated parts found in fibres which are still living, especially near the torn ends, do exhibit a marked increase of refractive power; these, however, are regarded by the author not as normal contractions but as a change which accompanies the death of such parts of the fibre; they do not recover their previous character, because the muscular substance has been partially destroyed, and this is proved by three facts—(1) the permanently contracted parts are smaller than those of which the contraction is normal. (2) the death of a fibre is accompanied by the emission of a certain amount of liquid, as may be proved by examining the fibre in liquid paraffin (refractive index = 1·4712), when the micro-refractometer indicates that the contracted portion is surrounded by a liquid of less refractive index than the paraffin; (3) it is only necessary to examine a free fibre under the Microscope, when it will be found after a few hours to have contracted and to be surrounded by liquid, and a contracting portion may be occasionally seen during a few minutes to surround itself with a ring of liquid as it contracts.

It may be concluded therefore that there is an absolute distinction to

be made between the normal living contractions and the permanent contractions which are accompanied by a partial destruction of the muscle-fibre, and that the latter only are marked by an increase of refractive power.

So far we have given an abstract only of the author's paper. His "Remarks on our Knowledge of the Structure of the Transversally Striated Muscle-fibres" which follow, we translate *in extenso*.

"It seems to me therefore that the very contradictory data concerning the anatomical relations of a muscle-fibre during contraction require revision. It will be asked why I do not undertake this revision. The answer is, that such a revision is not possible without an accurate knowledge of the relaxed muscle-fibre, and that I feel myself unable to form an opinion as to whether certain results of late investigations on this subject are reliable or not. I regard not only myself but others also provisionally as unable to form this opinion for reasons which will be explained in the following remarks.

Where twenty years ago a distinction was only drawn between singly and doubly refracting substance in the muscle, there is now recognized a sequence of the parallel layers (using Rollett's nomenclature) Z, E, N, J, Q, *h*, J, N, E; nine layers in place of two; these layers are conveniently described as of a thinness which approaches 'the limits of the perceptible.'

If we consider that the whole of geometrical optics, i. e. the recognized laws of the formation of images, only holds good so long as the relation between the magnitude of the object and the wave-length of light does not fall below a certain limit;* and if we consider, further, that the wave-length of light in air (e. g. for the line C†) is 0·000589 mm., and in muscle-fibre ($n = 1{\cdot}363$) is 0·000432 mm., and that these numbers are greater than the thickness of the single layers, we must ask ourselves whether these anatomical results have any value at all.

To this it must be added that Abbe, the first living authority on the theory of the Microscope, says with regard to the diffraction-images produced by the transverse striation of the muscle-fibres, 'The manifold changes in the character of the image' (produced by the transverse striation) 'explain to some extent the well-known difference between the observations of various investigators with regard to these appearances, but prove also the impossibility of acquiring any definite knowledge about their actual physical structure' (i. e. of the fibres) 'in the sense of the attempts which have hitherto been made.'‡

Thanks to the investigations of the same physicist, we now know that the formation of a true microscopic image depends upon whether all those rays contribute to the formation of the image on the retina which are diffracted by the boundaries (whether sharply defined or gradual) between parts of the object of different refractive powers, or by inequalities of the object, &c. If this is not the case we may receive illusory images; the finer the structure which we attempt to resolve by the Microscope, the greater is the probability that a portion of the diffracted rays will not reach the eye. Beyond a certain limit of fineness this probability becomes a certainty, and Abbe concludes 'that no Microscope has ever shown, or will ever show, anything actually existing in the

* Cf. Helmholtz, "Ueber die Grenzen der Leistungsfähigkeit des Mikrokopes," SB. Berliner Akad., 1873, p. 625.

† According to Ditscheiner.

‡ Arch. f. Mikr. Anat., ix. (1873) p. 454.

object which cannot be clearly distinguished by a normal eye with a sharp immersion amplification of 800.'

To many microscopists the physical deductions will perhaps be less accessible than the experiments which show that the lines of a microscopic grating are doubled when a portion of the diffracted rays are prevented from reaching the eye; that by screening off another part lines can be seen running in a direction different to those of the lines of the grating, &c.

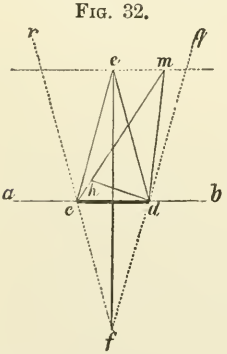
Even the microscopist who has no desire to work at the theory of these phenomena must at least be made anxious by them, and his anxiety is the more justified by the fact that there is no criterion by which we can know whether some of the rays have been lost to the retina or not.

It is this feeling of anxiety with which I am concerned. How many pages have been written upon the structure and the linear markings of *Pleurosigma angulatum!* We now know that various authors have seen the markings differently, and we know why this is so, and that we may perhaps learn the true structure in some other way, but never by simple microscopic observation as has been attempted. Are we not upon similar ground in the case of the muscle-fibres? In any case it seems to me that we must tread it with caution.

Now it is this caution and this feeling of anxiety which I miss in the later investigations on muscle-fibres; although our knowledge of the relation between the diffraction phenomena and the microscopic image is old enough, I do not remember to have ever found in the literature of the subject a clear and definite expression which would indicate any fear of falling into the error which I have pointed out.† Yet facts so glaring as those which I have adduced, and such authors as Helmholtz and Abbe, cannot be overlooked.

There is a special group of diffraction phenomena to which I will draw attention. The rays which traverse the object naturally interfere in the wide space between the retina, the object, and (according to the usual optical mode of expression) beyond the latter.

Fig. 32.



Let $a\,b$ (fig. 32) be a plane wave-surface, $c\,d$ a small opaque particle. In e will meet rays without difference of phase, which have passed c and d and have been diffracted at those points. If then the Microscope is focused upon e a bright spot is seen. As the objective is moved towards $c\,d$, i. e. as it is adjusted for successive points in the line $e\,f$ which lie between e and $c\,d$, the conditions are the same for all these points until the rays $d\,e$ and $c\,e$ have so great an inclination, that with the particular aperture in use they no longer contribute to the formation of the image. If the Microscope-tube is depressed until it is adjusted for a point below $c\,d$, the bright spot returns and is now due to the rays $r\,f$ and $q\,f$ which have no difference of phase. With regard to points lying on either side of the median line $e\,f$ the case is different. If m is a point at which the diffracted rays $c\,m$ and $d\,m$ meet, with a difference of path equal to a half wave-length $c\,h$, they destroy one another; e will

* See *infra* as to the fear of similar dangers entertained by Heppner and Dönitz.

therefore be surrounded by a dark ring; all points which satisfy the same conditions as *m* and which lie in the plane of the figure belong to a hyperbola whose apex lies in *a b*; as the tube is raised the dark ring will therefore increase.

According to the conditions *e* will be surrounded by a certain number of dark rings corresponding to differences of path, which are an unequal number of half wave-lengths, and between them will lie bright rings. These diffraction phenomena may be well seen with particles of Indian ink in water when a round opening of 1 cm. in a screen before a gas-flame is used as illuminator; the same thing may also be seen with ordinary illumination.

Certain interference-bands lie in the immediate neighbourhood of the object, and are seen when the Microscope is focused close to the object; and when the latter has, as is the case with the muscle-fibres, a considerable thickness, the diffraction images may even lie inside the object, and thereby considerably increase the danger of error. Now, as has been said above, the image is no longer reliable when the object attains a certain minuteness, so that in such cases it may be uncertain whether the Microscope is focused on the object or on the diffraction appearances. As is well known, the different interpretations put by Engelmann and Meyer upon the process of contraction in muscle-fibres depend on the different modes of judging what is meant by the 'true' focal adjustment of the object.*

In working with the Microscope we see every day examples of these diffraction images; a sufficiently minute drop of mastic emulsion has naturally a definite outline and a transparent interior, like a larger drop, but this cannot be *seen;* in general, what is seen is a dark point, or with a different focus a bright point surrounded by a dark circle. Whether the object consists of a transparent liquid or a black pigment we cannot say, since the diffraction phenomena are the same in the two cases. With a sufficiently fine thread a similar figure is produced.

The practised microscopist, although he only sees the diffraction phenomena, and even in consequence of them, will realize the existence

* Cf. Merkel in Arch. f. Mikr. Anat., ix. (1873) p. 299. Merkel here attempts to settle the question by examining the primitive fibrillæ in polarized light, and since the ordinary illumination gives no result he employs direct sunlight. I cannot regard this as satisfactory, for in this case the small angular size of the source of light introduces conditions peculiarly suitable for diffraction phenomena. In fact it is impossible to ignore the fact that if the double-refraction has not been essentially altered in the balsam preparations, and there is no reason to believe this to be the case, Merkel's results cannot be attributed to this cause; a single fibrilla is too thin.

If the fibrilla is only visible in blue light upon a dark field the difference of path of the two rays must amount to $\frac{\lambda}{2}$ of this light. According to Ketteler, for the line G in vacuum

$$\lambda_v = 0{\cdot}000430409 \text{ mm.}$$

So that with the above values of n for the ordinary and extraordinary rays in a living muscle-fibre

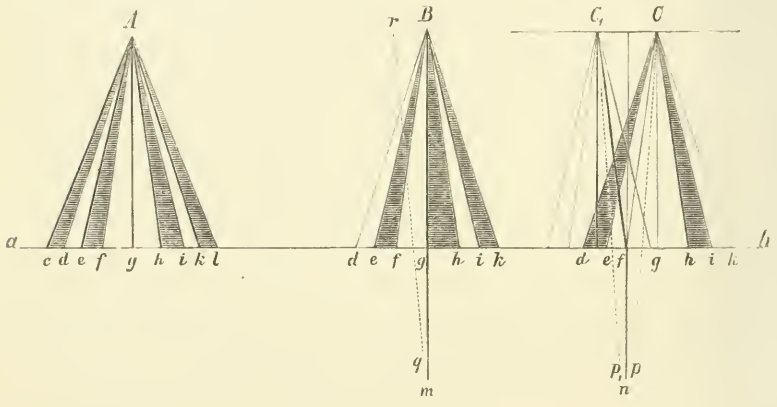
$$\lambda_o = 0{\cdot}00031463 \text{ mm.}$$
$$\lambda_e = 0{\cdot}00031417 \text{ mm.}$$

Assuming for the fibrilla the considerable thickness 0·002 mm. it contains 6·356 waves of the ordinary and 6·366 waves of the extraordinary ray; that is, the difference of path is only 1/100 of a wave-length; and this is not in harmony with the effect described.

of a small particle. But how is he to gain the practice to explain diffraction phenomena in objects of complicated structure, and which he cannot, like a drop of mastic, reproduce artificially? It is scarcely possible either as the result of practice, or on the basis of theoretical treatment, to arrive at a clear explanation of all the images produced by different focusing, thickness of fibre, illumination, &c. The conditions are too complicated, but I will endeavour to make the essential points more clear.

Let $a\,b$ (fig. 33) be the boundary of a muscle-fibre, and $m\,g\,f\,n$ the visible portion of a disc of the same which has a different refractive index from that of the next disc. If A is a point outside the fibre, the intensity of vibration at A of a plane wave of light which traverses $a\,b$ is, according to Huyghens's principle of the elementary zones of spherical

Fig. 33.



waves, the result of the interference of $g\,h$ with $q\,f$, of $f\,g$ with $e\,f$, of $e\,f$ with $d\,e$, of $d\,e$ with $c\,d$, and of similar portions on the other side which reach A. If the path from $g\,h$ to A is a half wave-length smaller than that from $h\,i$ to A, and similarly in the remaining parts, the result of the interference is the extinction of the portion of the wave which is the more remote from A g, and the rectilinear propagation of the ray g A. The shaded portions may represent those parts where wave-troughs reach A at the same moment at which wave-crests arrive from the unshaded parts. If the pencils whose inclination is that of l A, or of the rays beyond l A which are not represented in the figure, do not enter the Microscope, then the above-mentioned case of an incomplete image is realized, which is of course in the present example without signification, since no part of the structure is included.

If the cylindrical form of the fibre is neglected this method of treatment may be applied to any point g of a line which is perpendicular to the axis of the fibre, and Huyghens's elementary zones become elementary stripes parallel to this line.

Consider next the case (marked B in fig. 33) in which the point g falls on the boundary between two discs of different index. Let the shaded parts represent as before the wave-troughs which reach B, and the

unshaded parts the wave-crests; then the figure indicates the altered conditions as compared with the first figure for the case in which, corresponding to the different refractive indices of the two discs, the portion of the light-wave which has traversed one of them is retarded by an uneven number of half wave-lengths behind the other. It will be seen at once that $g f$ and $g h$ in their action on B cancel each other, as do also the other elementary strips, just as in the first case. Further, it will be seen that this extinction takes place for every point of the line independently of the distance g B, and that with an alteration in the thickness of the fibre a periodic alternation between light and partial darkness must take place. The case is different when we consider a point which is not at right angles to the bounding surface, e. g. C, fig. 33. The vis viva to be transferred from $f h$ to C is neither cancelled as in the second case, nor weakened in the same degree as in the first case by the neighbouring elementary stripes, whose phase is shifted through a half wave-length, but it reaches C, so far as concerns the portion $f g$, in its full extent, the action of $e f$ and $g h$ being added with positive sign to that of $f g$, though each of the first is weakened to a certain extent, it is true, by the slight action of $d e$ and $h i$. While therefore, the point B remains undisturbed, C receives an intensity of vibration, and a ray travels in the direction p C. This corresponds to the first diffraction pencil.

Supposing that the muscle disc $m g f n$ were much smaller, and extended from f only to a point, o (not shown in the figure), between e and f, if this thin layer is to have any effect upon the microscopic image it must, at least, contribute a diffracted pencil to the production of the image. The smaller $f o$, the farther must C travel from C_1, that the difference of path between the portions of the wave $f o$ and $f g$ may attain a half wave-length, and the larger, therefore, must be the angle made by the diffraction pencil with the perpendicular $n f$. When $f o$ is nearly a half wave-length, then this angle is nearly a right angle, and we get the law discovered by Helmholtz, that microscopic delineation ceases when the detail to be observed diminishes to the size of a half wave-length, presupposing an aperture of the Microscope of 180°. In this case one, at least, of the pencils of light diffracted by the structural element still enters into the microscopic image.

If we consider the boundary of the disc more closely, it is clear that there will be a similar interference upon the other side of $f n$. Here also there will be a ray in the direction p_1 C_1. Now, the two rays p C and p_1 C_1 have a difference of phase equal to $\frac{\lambda}{2}$. Focusing, therefore, upon the point of intersection of these two rays, we shall see a dark line under the upper surface of the fibre. If we focus the intersection of p C with the corresponding line $r q$ from the other surface of the disc, a bright band must be visible, as will also be the case when the Microscope is focused on the point above the fibre in which p_1 C_1 intersects the corresponding line (not shown) upon the other side.

The phenomena here described bear some relation, on the one hand, to the interference phenomena of the so-called 'mixed scales' discovered by Young, which are explained by the retardation of a part of the light-waves which traverse a medium of different refractive index from the rest; and, on the other hand, with the 'lamellar diffraction phenomena'

more recently investigated experimentally by Quincke and theoretically by Jochmann.*

The phenomena are, beyond comparison, more complicated in the muscle-fibres, as must be at once apparent if it is remembered that the conditions described do not depend upon $a\ b$ being the surface of the fibre, so that the above treatment holds good for any plane within the fibre for which the portions of the wave that traverse the different discs have a difference of phase equal to $\frac{\lambda}{2}$; and when it is remembered also that the phenomena must change with the thickness of the layer, that the source of light is not a point, but a bright surface (a portion of the sky or its image), that the light used is mixed light, &c.

The case may also be made clear in the following way:—When a plane wave traverses discs of unequal refractive index, it acquires parallel ridges corresponding to the layers of smaller index. The problem then consists in the determination of the resultant of the interference of the elementary waves proceeding from a surface of this form.

Some years ago Heppner † suspected that a certain layer of the muscle-fibre, identical with Rollett's N, does not in reality exist, but is confused through a reflex. Sachs ‡ and others opposed this idea. Dönitz § seems to have been the first who thought of diffraction phenomena as the explanation of certain striations. He was followed by Schäfer, and Ranvier made experiments upon the diffraction spectra obtained from stationary and contracted fibres in which the transverse striations acted as a diffraction grating.

I have, in the above remarks, raised the question whether, in the light of this optical treatment, the results of recent investigations have any value as regards the distinguishing of several layers in the muscle-fibres where previously two alone were recognized, or whether we must, with Abbe, for ever despair of recognizing such minute details.

My answer amounts to this, that without doubt the greater part of the recent results deserve complete trust. All those layers which have been distinguished, not only in the optical image, but also by maceration and staining experiments, are free from the suspicion of being only the impression of incomplete delineation. Rollett, who seems to have been thoroughly aware how slippery is the ground of simple microscopic examination, has recently, as I think, trodden the path here indicated with the best results. The same has been attempted, it is true, by many inquirers before him, but no one has worked in this direction with such a variety of methods or obtained such promising results.

When for example the layer N under the action of acid behaves in an essentially different way from the layer Q, there can be no doubt that a distinction is here established. But the case is different with certain details, where one meets with the above-mentioned want of care against incomplete delineation, in consequence of which one can see even *more* than is really present. I may be here allowed to give examples; but I may first state that in the absence of a true criterion for a correct and complete representation of the object, the following may serve as a criterion. A detail of the microscopic image is to be regarded as

* Cf. Verdet, 'Vorlesungen über die Wellentheorie des Lichtes,' German translation, by K. Exner, i. (1881).

† Arch. f. Mikr. Anat., v. (1869).

‡ Du Bois Reymond and Reichert's Arch., 1872.

§ Ibid., 1871.

existing in the object when its character is not altered by an inclination of the incident pencil of light (oblique illumination). If the character is altered in passing from central to oblique illumination, we may conclude that in the latter, diffracted rays enter the Microscope which were unable to do so in the first case. When this happens, it indicates that a complete representation is not obtained by central illumination, and it must be doubtful whether it is so by oblique illumination.

We may obtain a good idea of the optical processes which form the basis of this rule by means of the Abbe diffraction plate. If any line-system of the plate be so focused that the central image of the whole diffraction spectrum visible in the focal plane of the objective lies in the axis of the Microscope (direct illumination), and one entire half of the diffraction spectra be then screened off by a suitable diaphragm (with the exception of the central image for which the semicircular diaphragm must have a piece cut away), the microscopic image will not suffer any essential change. It is also possible, as may be easily seen, to set the mirror so obliquely (or to obtain oblique illumination by Abbe's condenser), that the rays which have not been diffracted still contribute to the microscopic image, the image of the source of light then falling at the margin of the diffraction phenomena visible through the tube. In this case still further diffracted rays may become visible in the diffraction image, and may contribute to the delineation if such rays are present to a considerable extent.

I cannot help calling attention to two other possible sources of error. It is not impossible that the discs of unequal index of which the muscle-fibre is constructed, are not separated from one another by sharp boundaries, but the optical density may change gradually from one to another. Such layers have in fact been described.

Now a disc in which the refractive index is a maximum or a minimum at the centre, acts like a cylindrical lens upon light which enters it parallel to its plane ends (independently of the cylindrical surface). The parts of a wave surface which traverse layers of smaller index, travel more rapidly than those which have to traverse layers of greater index, so that there results a cylindrical curvature of the wave surface.* In this way focal lines may be produced which are parallel to the layers in the muscle; they need not be outside the fibres, but may lie within them; in the first case they alter their position as the thickness of the fibre increases.

It is evident that stripes which are produced in this way, as well as those which result from diffraction, must undergo various changes if an alteration takes place in the refractive indices, owing to the separation of a liquid from the muscle-fibre. Since such changes do take place during the life of the muscle, it is not a matter for surprise if the fibres which are still contracting change their appearance. Rollett has in fact described and figured a series of such changes, but whether they are due to the causes here indicated, I must, in the presence of such a number of possibilities, leave undecided.

Mention has repeatedly been made of darker and lighter layers in the fibre, and Rollett, in treating of the transverse striations of the fibres, likes to give two figures beside one another, one taken with high,

* Cf. S. Exner, 'Ueb. Cylinder welche optische Bilder entwerfen.' This Journal, 1886, p. 1062.

the other with deep focusing, which bear the same relation to one another as the positive and negative of a photograph. They show that we have here a case of an optical effect. There are, however, frequently to be found figures in which the dark appearance of the striations is to be regarded as a true darkness of the anatomical structure; not the expression of diffraction, but an absorption of the light-rays. Sachs * says, 'The dark colour of the contractile substance rather depends principally upon the opposition offered by the very dense gelatinous mass to the passage of light; the greater part of the incident light between σ_1 and σ_3 is absorbed.'

Sachs is here speaking of the fresh living muscle-fibre,† in which the doubly refracting substance, at least under ordinary conditions and with the ordinary adjustment, does in fact appear dark. I must, however, deny this and similar statements to the effect that there is anywhere in the living muscle-fibre a substance which 'absorbs the greater part of the incident light.' All parts of the fibre which are not granular are rather to be regarded as absolutely transparent in layers of the thickness with which the Microscope is concerned, i. e. if there is an absorption it is not appreciable. The 'dark layers' which are not granular, and also, of course, the 'bright layers,' are always optical effects. If there were an appreciable absorption it would also be observed when the light travels parallel to the axis of the fibres. Since a reflection of the rays must take place where there are granules in the fibre, it is an open question whether light is absorbed by the granules.

The second source of error, which seems to me to be too much overlooked, takes effect when the fibres are examined in polarized light; not every bright line which is seen between crossed nicols is necessarily to be regarded as the expression of a doubly refracting layer.

The plane of polarization is also turned by diffraction, and it is impossible to say whether in this case the rotation of the plane of polarization does not also take place by refraction and reflection. In some fibres examined for this purpose I have found the maximum brightness from Q and Z between crossed nicols to be always in the same azimuth, which contradicts such an explanation of the layer Z which is generally regarded as doubly refracting.

Finally, there is one remark which I cannot refrain from making. It is fully established, in my judgment, as I have said, that there are living muscle-fibres for which the old idea of composition by alternate layers of singly and doubly refracting substance does not hold good; several layers can be distinguished. On the other hand, however, we must not ignore the fact that living fibres are observed in which only two old layers can be seen with certainty, and that this is the more certain in proportion as the fibres (assumed to be living) are more fresh.

It may well be asked what then is essential and typical in muscle-fibres. One may well hold the view that it is more natural to assume that in certain cases we fail to distinguish a part of the layers than to imagine an irregularity in the structure of the fibres. We must remember, however, that Rollett's investigations did not in general establish a type of numerous layers, but that the image varies from one

* Reichert and Du Bois Reymond's Arch., 1872, p. 633.

† This is not expressly stated, but follows from the fact that in the passage quoted he is opposing Heppner, who speaks expressly of the living fibre. Arch. f. Mikr. Anat., v. (1869) p. 139.

species to another, and what is not to be overlooked, that it varies considerably during the survival and decay, and during the process of hardening. In one preparation of living muscle-fibre from *Hydrophilus* I saw fibres in which the discs Z and E were well developed, by the side of others in which the distinction could not be seen.

With this want of constancy it seems to me to be dangerous to regard the fibre with nine layers as the type,* without granting that there also exist fibres with two layers. I am rather inclined to see the type in the fibres with two layers, and to regard the appearance of more layers as something secondary."

Method of Representing and Calculating the Magnification of Microscopic Objects in the projected images.†—Dr. P. de Vescovi has published a paper under this title, which seems to us to contain a great many elementary facts and statements. Divested of these, the following extracts appear to contain the pith of the paper.

The statement of the amplification rarely corresponds to the truth, and generally deviates widely from it, since the methods ordinarily used to calculate and to indicate the enlargement are defective, or at least fail in something. The amplifications given in the tables which are supplied with Microscopes are mostly obtained by multiplying the magnifying power of the eye-piece by that of the objective—an inexact method.

More exact are those who give the system of lenses used, and the names of the makers of the Microscope; but in this case if one considers the factors (such as length of tube), which contribute to the variations in size of the image, the indication is still inexact; as it may easily happen that with a given eye-piece and objective, and upon the same instrument, different amplifications may be obtained either of the real or of the projected image.

"To remove all uncertainty and possible difficulties, it is necessary that the explanation of every figure should give the following data:—

(1) The eye-piece and objective used.
(2) The maker of the Microscope.
(3) The length of the tube.
(4) The true dimensions of the object.
(5) The ratio of the dimensions of the object to those of its projected image, or the amplification of the drawing.

Example:—

Eye-piece 3. Objective AA Zeiss.
Length of tube = 17 cm.
Greater diameter of the object = 0·026 mm.
Amplification of the drawing = 95."

Measurement of Magnifying-power of Objectives.

[Replies to query by J. S. Hewitt, T. F. S., "Practical," E. M. Nelson, E. Holmes, "Gamma Sigma," J. D. M., and "Decem."]

Engl. Mech., XLVI. (1887) pp. 325, 341-2 (2 figs.), 365 (1 fig.), and 417.

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* So far as I know, no one has done this. Different authors have rather founded different types which always, however, have a considerable number of layers.

† Zool. Anzeig., x. (1887) pp. 197-200.

(6) Miscellaneous.

Development of the Compound Microscope.*—In the course of Mr. E. M. Nelson's paper on this subject he makes the following remarks :—"Let me preface the few remarks I have to make on the Development of the Microscope, by pointing out to you the important place the Microscope holds in our social economy. Up to a very few years ago the education of the nation was confined merely to a knowledge of Greek and Roman mythology. This was the key-note given by our two Universities, which as a natural consequence was followed up by the public schools, whose masters are all graduates of one of these Universities. The knowledge of a dead language depends more on an effort of memory than on a use of the reasoning faculty. As a development of the reasoning faculty is of vastly greater importance than the memory power, so dead languages are most unsuited for the training of the young. To educate according to its derivation, means to lead out; to educate a boy therefore, is to lead out his mind; in other words, to draw out something which is there. According to the popular notion it is to put in something which is not.

The only way to procure growth in an organism is to supply it with food it can readily digest, so the only way to develope the brain is to supply it with digestible food. Further, as one man's meat is another's poison for the body, so also is it for the mind. But what have the great educators of our nation done but force every one through the same classical diet, to the exclusion of everything else? In doing so they have ruined thousands of minds by arresting the development of the reasoning faculty, and by filling them with what is, in most cases, indigestible matter. There is necessarily a certain percentage of minds to whom classical lore is a food capable of ready assimilation; they consequently may be benefited by it, but we may assume the percentage is small.

You will be asking what all this has to do with the Microscope. To which I reply, that I wish to see Liddell and Scott's Lexicon dethroned, and the Microscope put in its place as a national educator. Of late a change has taken place. Since my schooldays, science has been introduced. This is the thin end of the wedge; let it by all means have full scope, and I have little doubt but that that science which was ridiculed by the schoolmasters of my day, will eventually supplant the Olympian mythology as a pabulum on which to feed the young mind. The Microscope and the telescope hold the same relation to science as a knife and fork do to beef. If science is a food for the mind, a little time devoted to the knife which makes it capable of assimilation will, I hope, not be in vain. Therefore, without further digression, I will at once pass to the instrument. The telescope, dealing as it does with extra-mundane things, cannot have the same interest for us as the Microscope. The one fact, that the Microscope has revealed the pestilence which has walked in darkness all these ages, is sufficient to place it above all other scientific instruments in importance. An unseen foe is a bad one to fight, but now that his lurking-place has been unmasked by the Microscope, we may look for some victories over our enemy. Have not some indeed been already gained?"

"We have now come to a period when the Microscope object-glass was achromatized, and from this date spring the great improvements

* Trans. Middlesex Nat. Hist. and Sci. Soc., 1886–7, pp. 103–11.

which have brought the instrument to its present state of perfection. It would, indeed, take several evenings to systematically examine the great number of forms which have been introduced since that time. It is my intention, however, only to notice three, as most of the others, not being of any practical value, have speedily become obsolete. We need no diagrams of the three forms which have survived, as I have actual examples in the room. First there is this, which is known as the "Hartnack," or "Continental Model," it is a lineal descendent of the "Oberhauser." I have little hesitation in saying that nine-tenths of all original microscopical work has been done by these Microscopes, but at the same time I maintain that that statement does not prove it to be the best model. It is a model which is incapable of doing critical work with low powers, and of working any high power at all. The reason why so many discoveries have been made with it is due to the fact that nine-tenths of the things discovered lie among low-power objects. Another point must be borne in mind, viz. that a quarter-inch lens uncritically used will as readily discover an object as a half-inch critically used.

The interpretation of images with low powers is easy, and requires very little training; critical images, therefore, are not so essential. Most of the fine high-power work which has been carried on with these instruments has been erroneous, and has had to be corrected with other instruments. As time goes on, discoveries with the low powers become less and less possible, and instruments of greater precision will become necessary."

"The importance of a condenser cannot be over-estimated. I have always held that Microscopy begins with a condenser. An instrument however well designed and well constructed, if it has not a condenser, is nothing more than a magnifying glass, while on the other hand, a simple stand like this iron one of Powell's, with a condenser, forms a very efficient Microscope."

'**Student's Handbook to the Microscope.**' *—This little book fulfils its purpose in a very creditable manner, and will be a useful guide for a large number of Microscope owners. It is a decided advance on the author's previous venture, 'My Microscope,' the publication of which was, we thought, to be regretted.

Even in these days it is, we suppose, hopeless to expect the question of aperture to be dealt with without a mistake, and therefore we find on p. 37, the statement that among the drawbacks to an excess of aperture is "a loss of defining power, that is distinctness of the image." This arises from an entire misunderstanding of the principles of aperture. The larger the aperture, the less the penetrating power, or the power of seeing a given depth of the object with the same focus. But the definition of the particular plane, whatever its depth, which is seen by the large aperture is not in any way impaired; in fact the definition of what is seen is more complete and perfect with the "high angle" objective than with one of smaller aperture.

"**Microscopical Advances.**" †—"T. F. S.," writing on one of a series of articles under this heading by Dr. G. W. Royston-Pigott,

* A Quekett Club-man, 'The Student's Handbook to the Microscope. A Practical Guide to its Selection and Management,' vii. and 72 pp. (30 figs.) 8vo, London, 1887.

† Engl. Mech., xlvi. (1888) p. 435.

points out that he has mixed up the "villi" on butterfly scales—which point to real structure—with the old vexed question of the beading of the *Lepisma* and *Podura* scale, "discrediting the whole thing with those who have knowledge of the subject, and giving utterly false impressions to those who have not."

Having carefully examined many scales of *Lepisma* with a fine 1/12 oil-immersion by Swift and Son, "T. F. S." is prepared positively to state that there is not the slightest existence of beads in any of them, although it is easy to see what caused the appearance of beads to Dr. Pigott with the dry 1/16 in. which he used. "Please remember," T. F. S. writes, "that it is a dry glass against an oil-immersion, and I need not tell any expert microscopist that if certain appearances which present themselves with a narrow aperture of the objective vanish when another of larger aperture is screwed on, that of itself is sufficient to disprove the existence of the apparent structure.

"Now for the real structure. The scale itself is composed of two membranes, in one of which is imbedded the longitudinal ribs; the other is corrugated, and the corrugations cross the longitudinal ribs at an oblique angle, giving under a low power the appearance of spines. Between the two membranes, and over the whole scale, is a net-like looking structure, perforated in all directions, and where this also crosses the oblique corrugations there is the appearance of beads. This appearance of beading, however, is confined to the sides, and not even Dr. Pigott himself could conjure any appearance of beading out of the centre, and in the drawing he has confined himself to the side only. Some of the small scales have only small straight hairs between the long ribs, and here it is easy to produce beautiful beads by using the smallest hole in the diaphragm of the condenser; but they all disappear on producing more light. On the *Podura* scale I have not been able to produce the slightest appearance of beading, although I have tried very hard to do so. The "villi" in the butterfly and moth scales stand on quite a different footing, and answer the purpose of keeping the two membranes more or less apart; but even here I can see no evidence of isolated beading. I can see them (the villi) on any scale with a dry 1/6 in. and 1/8 in.; but here the evidence is confirmed tenfold by substituting an oil-immersion 1/12 in."

"**The Microscope and Kidney Disease.**"—Most readers of newspapers are by this time sufficiently on their guard against the insidious paragraphs to be found at the bottoms of columns, the titles of which appear to promise a very interesting piece of news, but which ultimately end in an advertisement of some nostrum sold by the advertiser; such, for instance, as the "False Swain and Deluded Spinster," which in the last few lines is discovered to be an advertisement of a hair restorer.

A particularly flagrant example of this trap for the unwary was presented by the 'Norfolk News' of the 24th December last. The paragraph was not at the bottom but at the top of the column, and it was not printed in the usual smaller type, but in similar type to that used elsewhere in the paper. Being headed in capitals "The Microscope," and "The many Puzzling Secrets Revealed by this Wonderful Instrument," we naturally proceeded to read it with much interest, and that our readers may be able to participate in the feelings with which we followed the development of the atrocious nonsense thus

heralded we print it here, with the exception of the advertiser's name, for which we have substituted "Smith."

"No medical man of skill and ability considers his study at the present time complete unless it contains a first-class Microscope. This wonderful instrument by its marvellous power makes clear to our eyes a world of which, prior to its invention, we knew nothing. Its introduction into medicine is only of late years, and has been mainly brought about by the competition of practitioners in their endeavour to find some aid that would enable them to detect the presence of disease when hidden or masked; to diagnose with greater accuracy, and so secure that prominence in their profession upon which their fame and emoluments rest. But its use has been more particularly applied to the examining of the fluids of the body to determine the state of the kidneys, and to decide if the latter are in a state of disease, and, if so, its stage. It has already been the means of saving many a life in foreshadowing the advent of that stealthy and fatal disease to which Dr. Richard Bright gave his name, and which prior to the introduction of 'Smith's Cure' was always regarded as incurable. In all the history of the Microscope its use was never so prevalent, its study never prosecuted with so much vigour, as it is to-day; and science through its means is ever revealing something fresh and new in relation to its powers. For instance, a noted physician and German scholar has recently discovered that by its aid the presence of a tumour forming in the system can be detected, and if certain appearances are visible it is proof positive that the tumour or growth is of a malignant character. Uric acid, which is a rank poison, is one of the substances which arise from destructive waste of our body, and must be thrown off daily or we die. Now before we understood the Microscope it was impossible by any means at our command to know what was being passed out of our body, or from whence it came; and one great benefit which this instrument has conferred upon humanity is in the relief of headaches, malaise, indisposition, and other diseases, which are now known to be caused by the retention of uric acid in the body. When an analysis of the fluid is made by a micro-chemical examination this substance can be traced in its proper quantity, and when the proper remedy is applied relief is soon secured, the cure being effected almost immediately. . . .

As we said before, medical science has been unable to cope with this disease, and neither homœopathics nor allopathics are prepared with a cure for deranged kidneys; and all the world has long since recognized, and many medical men who are without bias and without prejudice, liberal minded, and anxious to cure, admit and prescribe 'Smith's Cure' as a specific for all diseases of the kidneys. . . .

'Smith's Cure,' like the Microscope, was found out by a layman outside the medical code. The universal testimony of our friends and neighbours shows it to be alone the remedy for all diseases of the kidneys, their prevention and cure. Their statements are sufficient explanation and endorsement of its extraordinary growth, and conclusive proof that it is perhaps the most munificent remedy known to the medical world since the Microscope revealed to us the all-important nature of the organs which this medicine is specifically designed to benefit."

Although from one point of view it may not be very complimentary, yet we must express a hope that the editor of the 'Norfolk News' when

he inserted this advertisement really believed that he was imparting to his fellow countrymen a sound and valuable piece of microscopical information.

"**Curiosities of Microscopical Literature.**"—In the last volume of the Journal, p. 830, we had occasion to comment upon a paper by Mr. H. Morland, in which a fundamental point of microscopical optics was the subject of an extraordinary misapprehension.

In the last number of the publication in which the original paper appeared, we find the following entry: *—

"Mr. Morland read a reply to a criticism in the Royal Microscopical "Society's Journal for the current month on his paper on 'Mounting "Media so far as they relate to Diatoms.'"

Neither the reply nor even an abstract of it is, however, printed, and no communication has reached us as to the nature of it. This is the funniest way of dealing with a "reply" that we can recall; it is framed somewhat on the principle of Leech's celebrated cartoon of Lord John Russell chalking "No Popery" on Cardinal Wiseman's door, and then running away!

Bary, A. de, Hon. F.R.M.S. Obituary Notice.
Athenæum, 1888, Jan. 28th, pp. 118–9. *Nature*, XXXVII. pp. 297–9.

Dancer, J. B., Death of.
["The death is announced of Mr. John Benjamin Dancer, a Manchester optician, to whom many important inventions are due. Mr. Dancer was born in London in the year 1812. He settled in Manchester in 1835, and soon made his mark in scientific circles. He was elected a member of the Literary and Philosophical Society, and a Fellow of the Royal Astronomical Society. He was the first to suggest the application of photography in connection with the magic lantern, and he followed it up by other improvements. He also constructed the optical chromatic fountain, an idea which has since been further developed at South Kensington, and Old Trafford, Manchester. Mr. Dancer's services in connection with electricity and photography were of a valuable and important nature. Further, Dr. Joule states that the first thermometer made in England with any pretensions to accuracy was constructed by the deceased. He was also successful in producing Microscopes which, while fully equal to the requirements of original research, were within reach of working-men naturalists. During the later years of his life Mr. Dancer's pecuniary circumstances were of a straitened character, and he also suffered from the terrible affliction of total blindness."]
Times, 7th December, 1887.

EDMUNDS, J.—**Theory of the Microscope—Nägeli and Schwendener.**
Engl. Mech., XLVI. (1887) p. 365.

ERRERA, L.—**La Micrographie à l'Exposition de Wiesbade.** (Microscopy at the Wiesbaden Exhibition.) *Bull. Soc. Belg. Micr.*, XIV. (1887) pp. 22–35.

EWELL, M. D.—**A Manual of Medical Jurisprudence for the use of Students at Law and of Medicine.**
[Contains chapters on the part which the Microscope may play in determining medico-legal questions.]
414 pp., 12mo, Boston, 1887.

FELL, G. E.—**Exhibition of "Letter O occupying space of 1/1,000,000 in. magnified 3200 times."** *Amer. Mon. Micr. Journ.*, VIII. (1887) p. 209.

HITCHCOCK, R.—**Reminiscences and notes on recent progress.**
Amer. Mon. Micr. Journ., VIII. (1887) pp. 205–7.

Mayall, J., Jun.—**Conférences sur le Microscope.** (Lectures on the Microscope.) *Contd.*
[*Transl.* of the Cantor Lectures.]
Journ. de Microgr., XI. (1887) pp. 544–6 (6 figs.).

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* Journ. Quek. Micr. Club, iii. (1887) p. 197.

McIntire, S. J.—**Another Evening at the Royal Microscopical Society.**
[Description of the first Conversazione of this Session.]
Sci.-Gossip, 1888, pp. 19–20.

Nelson, E. M.—**The Microscope—Nägeli and Schwendener—English Translation, 1887.** *Engl. Mech.*, XLVI. (1887) pp. 325, 364–5 (2 figs.), 393–4.
Also comments by "Practical," who finds it "far too abstruse to be of practical value to the general body of microscopists" (*Ibid.*, p. 341), and reply by Dr. J. Edmunds (*Ibid.*, p. 365).—"A Fellow of the Royal Astronomical Society," who prefers Heath's 'Geometrical Optics' (*Ibid.*, p. 390).—Review by Dr. W. H. Dallinger (*Nature*, XXXVII., pp. 171–3).

Reichert, C.—**Directions for using the Microscope.** *Transl.* by A. Frazer.
[In the Translator's Preface acknowledgments are made to "Mr. A. Schulze (Fellow of the Royal Microscopical Society)." No such name appears, however, in the Society's List of Fellows.]
12 pp. and 2 figs., 8vo, Edinburgh, 1887.

Royston-Pigott, G. W.—**Microscopical Advances.** XXIX., XXX.
[Butterfly dust; bars, villi, and bacilli; latticed and beaded ribs.]
Engl. Mech., XLVI. (1887) pp. 357, 379–80 (4 figs.).

Vorce, C. M.—**The Meeting of the American Society of Microscopists.**
Amer. Mon. Micr. Journ., VIII. (1887) pp. 207–9.

Waterhouse, G. R., Hon. F.R.M.S. Obituary Notice.
Athenæum, 1888, January 28th, p. 119.

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Cultivation of Saccharomycetes.†—Some fermentation experiments with which Mr. W. E. Stone has been engaged required the application of pure yeast, free from other organisms capable of producing fermentation, and the following was the method of separation and cultivation employed:—

A few drops of fresh beer-yeast were shaken in a test-tube with sterilized gelatin, which had been melted and cooled again until it was barely fluid. This flowed upon sterilized plates gave in twenty-four hours, at ordinary room temperature, a great number of colonies of Schizomycetes and Saccharomycetes, from which, with the aid of an ordinary dissecting Microscope, it was easy to inoculate new cultures. The gelatin was of ordinary composition in daily use in the laboratory, viz. 10 per cent. gelatin, 10 per cent. grape sugar, Liebig's "Fleisch Extract" added to give a yellowish-brown colour, and neutralized with sodium carbonate. Such a mixture is solid at 25° C.

For further culture the isolated gelatin-plate colonies were inoculated into sterilized solutions consisting of an extract made by boiling 200 grams of yeast in a litre of water, filtering, and adding 10 per cent. of grape-sugar. In such a solution an inoculation of a few yeast-cells usually increased in from twenty-four to forty-eight hours sufficiently to cover the sides and bottom of an ordinary 200 c.cm. flask with a thick white sediment. The cultures were most strong and active at the end of forty-eight hours. The supernatant fluid was then poured off, leaving the yeast deposit comparatively dry, 20 c.cm. of sterilized water added, and in this condition transfer to the sugar solution undergoing observation was easy by means of a pipette. By this method, and the use of the extract of yeast as a nutritive solution, pure cultures were repeatedly

* 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.

† Bot. Gazette, xii. (1887) pp. 270–1.

obtained which excited as active a fermentation as the fresh yeast from the breweries, a result not always obtained by the use of artificial nutritive solutions. The original gelatin plate-cultures, on account of their rapid growth, were useless after thirty-six hours, and to avoid a constant renewal of the process, as well as the introduction of different species of Saccharomycetes, inoculations were made into gelatin tubes. The cultures thus obtained produced characteristic, elegant, ivory-white colonies of 3–6 mm. in diameter, and then further development ceased. In this state they retained their vitality, and were constantly referred to as a source of inoculating material for two months. Probably they remained vigorous much longer, as Saccharomycetes are well known to do, but at this time the author's need of them came to an end.

Improvement in the method of preparing Blood-serum for use in Bacteriology.*—Dr. A. C. Abbot fills a large vessel, which can be hermetically sealed, with blood taken directly from the neck of an animal, with the usual antiseptic precautions. It is then quickly closed and allowed to stand for 15–20 minutes until coagulation takes place; a sterilized glass rod is then introduced in order to break up any adhesion of the surface to the glass vessel. The vessel is then placed in a cooler temperature which should not be too low lest coagulation be interrupted. In 24–36 hours the serum is withdrawn with a pipette, and placed in a vessel closed with cotton wool. The latter is then packed in ice for at least three days in order to allow the coloured particles to subside. The clear part of the serum is then transferred in quantities of 60–75 c.cm. to sterilized flasks of 100 c.cm. contents. Discontinuous sterilization is then begun and continued for an hour a day for six consecutive days. For this, the temperature should never be higher than 64° C., nor lower than 58° C.; for at higher temperatures the serum loses its transparency, and at a lower one the microbes are not destroyed. Thus prepared, serum has been kept for a whole year in the laboratory of the Johns-Hopkins University.

Improved method for cultivating Micro-organisms on Potatoes.†—Dr. O. Katz recommends the following procedure for cultivating micro-organisms on potato, which he has found to give satisfactory results, especially in cultivations from dejecta of typhoid patients.

Test-tubes, 10·5 cm. high and 2·5 cm. in diameter, are plugged with cotton-wool and then sterilized in the usual manner. Potato slices cut out of medium-sized, oval-shaped, perfectly healthy potatoes, and about 1 cm. thick, are placed with forceps in the test-tubes, to the width of which they are made to fit. The tubes are then sterilized again at 212° F.

There is no fear of desiccation of the potato surfaces, as after boiling in the steam sterilizer, there is sufficient fluid at the bottom of the tube to keep the contents moist for a considerable time at a temperature from 20°–25° C. (68°–77° F.). At higher temperatures the development of micro-organisms is so much accelerated that there is no danger of desiccation, but if there should be any fear of its occurrence, the cotton-wool plug may be covered with an indiarubber cap.

In practice both sides of the potato are inoculated either from the same or from different colonies.

* Medical News, 1887, i. p. 207.

† Proc. Linn. Soc. N. S. Wales, ii. (1887) pp. 187–90 (2 figs.).

Method of preparing Potatoes for Bacterial Cultures.*—In order to meet the objections raised by E. Esmarch to the ordinary method of potato cultivation, Mr. M. Bolton, as he could not procure the Esmarch cells in America, adopted the following method in place of that proposed by Esmarch.

In test-tubes 4½ in. to 5 in. long, of 1 in. or more in diameter, were accurately adapted pieces of potato 2–3 in. long. The skins having been removed, the potatoes were cut up in an ordinary apple-corer. It was found advisable that one end of the potato-pieces should be cut obliquely, so as to offer as large a surface as possible, as in agar or serum tubes. At the bottom of the tube a drop of water is placed in order to prevent the potato from drying up. The tube is then carefully sterilized by steam.

Cultivation-bottle.†—Dr. H. Wilfarth uses, instead of the ordinary plate, for separating different kinds of bacteria, a flat flask of thin glass, much like an ordinary brandy bottle. The sides are round, parallel to one another, about 2–2½ cm. apart, and run pyriformly to a neck about 16–18 mm. wide, and sloping obliquely upwards. The neck is closed with a cotton-wool plug. The sterilized medium having been introduced and the inoculation made, the flask is laid on the flat side, and for microscopical examination under moderate powers it is turned over so that the gelatin layer is uppermost.

For liquefying colonies and for agar cultivations the bent neck of the flask renders it inconvenient for removing colonies for inoculation. The flask is filled by means of a separating-funnel, which only allows a certain quantity to flow in at a time.

Collecting and Cleaning Diatoms.‡—Mr. K. M. Cunningham, who states that he has been able to demonstrate 300 distinct species of diatoms from the immediate neighbourhood of Mobile, says that the first requisite in the preparation of marine diatoms is to secure a quantity of mud, and the subsequent treatment as pursued by the writer is as follows:—

Take at least half a pound of hard or soft mud to begin on, and soften it into a uniform liquid paste, and to hasten and assist its liquidity, add about a teaspoonful of aqua ammoniæ, which liquid will be useful in the initial steps of cleaning, as it cuts and dissolves slimy and gelatinous impurities, and cleans the sand-grains, and enables the bulk of the material to be cleaned to settle quickly and compactly, as well as having distinct lubricating properties. Next transfer the liquid mud to a suitable vessel of tin or china of at least six or more inches in diameter, and not over 5 or 6 in. deep; put therein as much liquid mud as will fill 1 in. in depth, and fill up the vessel with clean water, and stir rapidly the contents to liberate the flocculent matter from the heavier contents. After allowing the contents to settle for ten minutes, with a piece of rubber tubing, at least 18 in. in length, siphon off the water to within 1/2 or 3/4 in. of the bottom of the vessel, renew the water, and then stir quickly, and after five minutes again siphon off the water to within 1/2 in. of the bottom. The sediment left is transferred to any shallow tin or other vessel for convenience.

* Medical News, 1887, i. p. 318. † Deutsch. Med. Wochenschr., 1887, No 28.
‡ Microscope, vii. (1887) pp. 331–6.

The next step is to place in a shallow concave glass used by photographers for crystal photographs, size about 4 by 6 in., a shallow layer of the diatomaceous mud, and, adding water, gently gig the glass to and fro, making the waves run from end to end, and tilting the off or front end. This manipulation forces the large and small sand-grains to densely cake and pack together, and at the same time forces to the surface a large percentage of the diatoms, and most of the vegetable débris. After a few moments of gigging, the surface fluid is gently poured off, and caught in a separate settling vessel, and the heavier sand dropped into a waste receptacle. It may here be observed that a very small percentage of matter would be the outcome of the first manipulation, and that the bulk of the material was removed from the crystal glass as rejected sand. It can generally be relied upon that what is left on the gigging-glass would not do to manipulate again, and the diatoms must be looked for in the light, coherent, flocculent, vegetable débris that floated over in the first removal of the surface fluid. Repeat substantially the same manipulation until the whole of the mud has been gone through, and in the little that is left of the original half-pound the coveted gems will be found, or do not exist. The next step is to deal with what has been saved in the various partial concentrations, transferring all of it to the crystal glass, adding clean water, and gigging it again several times in succession to remove additional sand, and to get a further concentration of the desirable material. An occasional wet test under the Microscope will show whether the indications of diatoms are good. If so, the material is then transferred to a small holder with a spherical bottom, so that it may quickly settle, and with a rubber bulb pipette all water is carefully removed. Should there appear to be about 1/2 in. deep of material as the result of all previous manipulation, add to it an equal bulk of sulphuric acid, intimately mix, and by the aid of the pipette transfer it to a 1/2 or 3/4 in. diameter glass test-tube of about six inches length; boil for fifteen minutes over a candle or spirit-lamp: in that time it is probable that all organic matter will be reduced or carbonized. At this juncture add carefully, a drop at a time, several drops of nitric acid, and boil continuously for ten minutes longer, when it will soon be noted that the blackness is discharged, transparency restored to the boiling fluid, a partial or complete bleaching of the material having occurred, together with a remarkable reduction in volume. If there have not been a complete reduction of all vegetable or other organic matter, it may be necessary to add a few drops more of sulphuric acid and boil it a while longer. Should the preparation at any time not yield satisfactorily to the bleaching process, pour out the contents in a spherical-bottom vessel, and allow time to settle; pipette off the acid, and add a fresh quantity of sulphuric acid, and boil a few moments, and finally add a few more drops of nitric acid to oxidize the remainder of the carbonized substances.

All acid-boiling processes should be conducted in an open fireplace if practicable, so that the irritating gases may pass up the chimney. The above apparently long or double boiling process is rarely required, but must be resorted to if the organic material to be reduced is refractory. Where boiling first in sulphuric acid, and later adding nitric acid, is applied to the cleaning of all diatom gatherings not badly mixed with sand or vegetable débris, or is applied to pure gatherings, it acts very rapidly, giving promptly a snowy-white cleaning of the diatoms. In

case of the marine or fresh-water diatoms, a final bleaching may be accomplished by pouring the diatoms, while still in acid, into a shallow and contracted glass or china saucer, and adding thereto a few drops of Darby's prophylactic fluid, which actively effervesces and liberates the bleaching gas. While the boiling alone, first in sulphuric acid and later adding some nitric acid will be sufficient, yet a greater whiteness is produced by the addition of the prophylactic fluid as a bleaching substance.

The boiling process above described dispenses with the addition during the cleaning of any powdered crystalline salts, and is also operated with a minimum of acid fluids, and to purify the diatoms from acids, it is merely necessary to allow the preparation to settle a few minutes and carefully draw off the bulk of the acid and allow the diatoms to settle in shallow china saucers, 1/2 in. preferably; draw off and change the water after one minute intervals, and repeat for four changes. A trial test made on a slide, dried over a flame, will show that all acid has been removed from the diatoms. At this stage there is a rich concentration of the diatoms, but included therein some sand-grains and flocculent soil; the flocculent matter is removed by repeated shakings and settlings through a few inches in depth of clean water at three minutes intervals, until when tested under the Microscope a satisfactory appearance is reached. The acid-cleaned diatoms are again transferred to the crystal gigging-glass and water added, and then very gently gigged for a final concentration of the diatomaceous forms and a further portion of fine sand removed. The finishing touch to the cleaning for concentration of the forms is done by placing a small quantity of the acid-cleaned and concentrated diatoms into a concave black or dark glass, such as is used in tourists' eye-glasses, and the contents gently oscillated from side to side and to and fro, when the diatoms will be found richly aggregated on the centre of the containing glass. The glass is then tilted and the diatoms removed by the gentle suction of a pipette, the dark glass enabling the mass of diatoms to be distinguished from the fine grains of sand adherent to the bottom of the glass. In lieu of the dark concave eye-glass, a deep bull's-eye watch-crystal makes a good substitute for the final act of concentration.

Diatoms are also richly concentrated from sand by simply spreading the containing fluid over either a six-inch square of smooth or ground glass, and gently gigging it while tilting it in the direction of one of the corners and allowing the fluid to run off into a proper receptacle. A large percentage of the sand-grains remain *in situ*, or adherent to the glass surface.

The author refrains from alluding to boiling in alkaline solutions to neutralize traces of acids as he has not found it desirable or necessary to do so; nor does he refer to flannel or silk strainers for the final cleaning and separation of diatoms.

Birch, H.—**Ueber Züchtung von Spaltpilzen in gefärbten Nährmedien.** (On the cultivation of Schizomycetes in coloured media.)
Tagebl. 60. Versamml. Deutsch. Naturforscher u. Aerzte, 1887, pp. 275–7.

Raskin, M.—**Zur Züchtung der pathogenen Mikroorganismen auf aus Milch bereiteten festen und durchsichtigen Nährböden.** (On the cultivation of pathogenic micro-organisms on solid and transparent media prepared from milk.)
St. Petersb. Med. Wochenschr., 1887, pp. 357–60.

(2) Preparing Objects.

Preparing Ova of Amphibia.*—Dr. O. Schulze places the ova of amphibia (the investment derived from the oviduct having been removed) for twenty-four hours in chrom-osmium-acetic acid, or in chrom-acetic acid, and then washes them well with distilled water. At this point they are available for surface study. They are next immersed every twenty-four hours in spirit of 50, 70, 85, and 95 per cent., the latter being changed several times. Next in turpentine for one to two hours, according to the size of the ova. They are then transferred to paraffin (50°), whereof they have sufficiently imbibed in a half to one hour. It is noted that the time given must be carefully observed. The sections were fixed to the slide with some thin adhesive, and then after evaporation of the water treated in the ordinary way. Borax-carmine was used as the stain, and decoloration effected with acidulated 70 per cent. spirit (5 drops HCl to 100 c.cm.). By frequent change of this the yolk-granules were decolorized, and only the chromatic substance remained red.

Chrom-osmium-acetic acid cannot be used for fixing substances lying centrally in the egg.

Preparing Testicle for observing Nuclear Fission.†—Dr. W. Flemming's recent examination of cells was made on the testicle. The organ was very rapidly teased out on a slide, and the fixative dropped over it. Chrom-acetic-osmic acid five times diluted or Brass's mixture for Protozoa, used rather strong, were the media employed for fixing. The preparation having been repeatedly wetted with this fixative was transferred to a moist chamber for several hours; the preparation was thereby hardened on the slide, and bore washing with a gentle stream of water for half an hour. Staining was performed by dropping on a safranin or gentian solution, and then allowing the slide to stand in the moist chamber for some hours. The preparation was then washed, and dehydrated with absolute alcohol, to which a trace of hydrochloric acid was added if the osmium mixture had been used for hardening.

The advantages of this method are that the cells lie pretty close together, and are often very beautifully stained. On the other hand, the nuclear figures may be destroyed by the teasing, and the contents of various cysts are so commingled that the various stages of fission cannot be compared. For making sections the testicles were placed in strong osmic acid. Then prolonged and careful saturation with celloidin, for the capsule after hardening in osmic acid is penetrable with difficulty. Sections were stained with gentian or safranin. Hæmatoxylin was fairly successful, but the nuclear staining was rather dull. Removal of the celloidin improved the clearness of the pictures. For this purpose the section was first treated with bergamot, and this having been removed by drainage and bibulous paper, was replaced by oil of cloves, which gradually dissolved the celloidin. Then dammar. Before cutting, the lobule of the testicle was examined for evidence of nuclear fission; if found it would be present in the other lobules.

Demonstrating Cell-granules.‡—Dr. R. Altmann demonstrates cell-granules in the following manner:—The paraffin sections, stuck on mica-scales with alcohol in which a little gun-cotton is dissolved, are freed

* Zeitschr. f. Wiss. Zool., vi. (1887) pp. 177–226 (3 pls.).
† Arch. f. Mikr. Anat., xxix. (1887) pp. 389–463 (4 pls.).
‡ 'Studien über die Zelle,' 1886, Heft 1, 53 pp., 1 pl.

from the paraffin by means of xylol and alcohol, and then stained for about three minutes in a solution of acid-fuchsin (10 grm. of the dry stain dissolved in 66 grm. of water and 33 c.cm. of absolute alcohol added), and afterwards differentiated in a solution of picric acid (10 grm. picric acid, 150 c.cm. absolute alcohol, 300 c.cm. water). Over-action of the picric acid is prevented by the absolute alcohol. From the spirit the sections are transferred to bergamot oil and xylol. The mica-scale is not detrimental beneath the cover-glass, provided the preparation lies above it. Thus stained, the cell-granules are to be examined with oil-immersion lenses, weak ocular, and a powerful illumination. For demonstrating the granules by means of this staining process, fixation methods which the author is to describe in future are necessary.

Methods of Preparing Muscle for investigation.*—Mr. C. F. Marshall, in his investigations into the distribution of striped and unstriped muscle (see this Journal, 1887, p. 935), chiefly made use of Melland's method of gold-staining. The gold stains and renders evident the intracellular network of most cells, and especially the network of the striped muscle-cells. Melland's method consists in placing the muscle in 1 per cent. acetic acid for a few seconds; then in 1 per cent. gold chloride for thirty minutes, and then in formic acid (25 per cent.) for twenty-four or forty-eight hours in the dark. For more delicate organisms, such as *Hydra* or *Daphnia*, and the heart muscle of invertebrates, one hour's immersion in formic acid, exposed to strong sunlight, is the best treatment, as longer immersion in formic acid may lead to disintegration of the tissues. Control preparations were made with osmic acid. In many cases the examination of fresh tissues was useless; the special action of the gold-staining is to soften the fibre and so swell it out, while at the same time staining the network. With regard to this reagent, it is to be noted that the results obtained are somewhat uncertain; care must be taken with the time of action of the acetic acid.

Permanent Preparations of Tissues treated with Potassium Hydrate.†—Mr. B. L. Oviatt uses a solution of potassium hydrate of from 36–40 per cent. (potassium hydrate 40 grams, water 60·00); then this is replaced by a saturated aqueous solution of potassium acetate. Then add the staining agent, and then glycerin as a permanent medium. Heart muscle treated in this way five months ago is as perfect as ever.

Preparing Sections of Bone.‡—Dr. G. Chiaragi decalcified a strip of quite fresh bone (bird) in picro-nitric acid diluted with two volumes of distilled water and then placed it in spirit of increasing strength. The sections were then immersed for some minutes in a 1 per cent. solution of eosin and afterwards washed in a 3 per cent. hydrate of potash solution. The eosin stained the bone-cells and their processes, the rest of the bone being uncoloured. In order to fix the eosin, the sections were washed in a 1 per cent. alum solution. The sections were mounted in the alum solution.

Method of investigating Cristatella.§—Herr M. Verworn gives an account of his methods of working with *Cristatella*. The colonies were treated with 10 per cent. chloral hydrate solution for the purpose of

* Quart. Journ. Micr. Sci., xxxviii. (1887) pp. 81–2.
† St. Louis Med. and Surg. Journ., liii. (1887) p. 289.
‡ Bull. Soc. Cult. Sci. Med. Siena, iv. (1886) Nos. 8 and 9.
§ Zeitschr. f. Wiss. Zool., xlvi. (1887) pp. 100–1.

obtaining the polyps in an extended condition; they were put directly from the water into the solution, when the separate individuals generally contracted. But in a short time they gradually extended themselves again, and soon became insensible. In some cases chloral hydrate was added by drops. They were then put into a saturated solution of sublimate; after being for ten minutes in this, they were washed in water for half an-hour and then preserved in alcohol. The best preparations were thus obtained, and this method was distinctly preferable to killing them directly by alcohol or with osmic acid. Borax-carmine (with a small quantity of acetic acid) gave the best staining results, the preparations being subsequently treated with 70 per cent. alcohol and a few drops of hydrochloric acid. In the investigation of the living animals, F. E. Schulze's horizontal Microscope was found to be of great service.

Methods of studying Development of Eye of Crangon.* — Dr. J. S. Kingsley, in his investigations, hardened his eggs by Perenyi's fluid, followed by alcohol of increasing strengths; this is a process which works well with almost all arthropod tissues. In most cases they were stained entire with Grenacher's alum-carmine, but sometimes Grenacher's borax-carmine or Kleinenberg's hæmatoxylin was used. In later stages, when the deposition of pigment in the eye interfered with clear vision, the eggs were cut into sections, which were fixed to the slide with Mayer's albumen fixative. After melting the paraffin and allowing the sections to drop into the adhesive mixture, the imbedding material was dissolved in turpentine, and this was washed away with 95 per cent. alcohol. The sections were then covered with a mixture of equal parts of 95 per cent. alcohol and nitric acid, and after ten to fifteen minutes the pigment was removed. The slide was next washed with strong alcohol, and the sections stained deeply with Kleinenberg's hæmatoxylin, the excess being removed with acid alcohol in the usual manner. The sections were then mounted in balsam.

Preparation of Ascaris megalocephala.† — Prof. O. Zacharias, believing that the conjugation of male and female chromatin elements must be a very rapid process, was naturally led to distrust the slow fixing methods hitherto practised, and sought for a better. Fresh females were laid on a piece of wadding damped with 3 per cent. salt solution, covered with another of the same, put under a bell-glass, and incubated at 20° R. for two or three hours. Polar body formation and segmentation are thus stimulated. The separated organs are then placed in a fixing medium, the period being varied according to the age of the different regions of ova, and according to the character of the host. The youngest ova were only exposed for 5–7 minutes, the oldest for at least 25. After fixing in a mixture of acids (not yet disclosed), the ova were removed for 2–3 hours to absolute alcohol, and then placed in weaker spirit. Schneider's acetic carmine, and acidified aqueous solution of methyl-green, were also used. The ova were cleared in two volumes of glycerin to one of water.

Preparing Tape-worms for the Museum and the Microscope.‡ — Mr. J. M. Stedman fills a hypodermic, or other syringe possessing a fine

* Journ. of Morphology, i. (1887) p. 49.

† Arch. f. Mikr. Anat., xxx. (1887) pp. 111–82 (3 pls.). Cf. *supra*, p. 43.

‡ St. Louis Med. and Surg. Journal, liii. (1887) p. 291.

sharp canula, with fine injecting mass, then the canula is inserted in the generative cloaca or opening of the vagina, thus cutting the excretory canal. If the canula is inserted the proper distance, the entire caudal portion of the water-vascular or excretory system can be injected. The injecting mass does not flow towards the head on account of the opposing valves. For the museum nothing further is done, except to wash the worm with water and suspend it in a bottle of 75 per cent. glycerin, to which has been added a few drops of acetic acid. The worm will soon clear up and show all the structures with the greatest clearness.

For microscopical preparations, one and a half or two segments, after treatment as above, are mounted on a slide in a cell of glycerin jelly. For the most satisfactory microscopical preparations, the ovaries and uteri, as well as the excretory system, should be injected. This is accomplished by first injecting the excretory system with one colour as described above, and then by employing another colour and forcing the canula further into the worm than when injecting the excretory system. Segments so injected may be preserved in glycerin jelly, or after gradual dehydration, in Canada balsam. Uninjected segments may be hardened in Müller's or Ehrlich's fluid, and then in alcohol, and made into serial sections to show the finer structural details.

Methods of studying Sphyranura.*—Prof. R. Ramsay Wright and Mr. A. B. Macallum found that specimens of *Sphyranura* were rarely too large to prevent complete study in the fresh condition. The most completely satisfactory reagent was Flemming's chrom-osmic-acetic mixture: an example being placed in water sufficient to cover it, a drop of the reagent was placed beside that in which the worm lies and the two were allowed to mingle, with the result that in five or ten seconds death, but not complete fixation, occurs. The greater part of the fluid being drained away the worm was gently straightened out with a needle, and a second drop of the reagent added for two or three minutes. The specimen must now be transferred to a larger quantity of the reagent, in which it must remain for thirty minutes, and it must then be passed through various strengths of alcohol from 30 to 90 per cent. Lang's Planarian fluid, and solutions containing picric acid cause shrinkage. Delage's osmic carmine has no advantage over Flemming's fluid. The process of imbedding used was the chloroform-paraffin method, the substitution of chloroform for turpentine having been found to obviate shrinkage of some of the delicate cells. Alum-cochineal was most satisfactory for staining specimens *in toto*.

Histology of Echinoderms.†—In making his observations on the minute anatomy of Echinoderms (see *supra*, p. 53), Dr. O. Hamann found that Flemming's chrom-osmic-acetic acid mixture was useful with the organs attached to the body-wall. With young and small animals chromic acid was used. Urchins preserved in strong alcohol were decalcified by placing small pieces in a 0·3 per cent. solution for a day, and washing them for twelve hours; these preparations took well the hæmatoxylin-stain. The pedicellariæ were either decalcified and cut, or were cut after treatment with Flemming's solution. The staining reagents used were, generally, carmine solutions; in the examination of glandular organs the anilin colours were useful. After treatment with

* Journ. of Morphology, i. (1887) pp. 4–6.

† Jenaische Zeitschr. f. Naturwiss., xxi. (1887) pp. 88–9.

absolute alcohol the preparations were cleared with bergamot oil or xylol, imbedded in paraffin, which was removed by xylol, and put up in Canada balsam to which xylol had been added. Xylol is to be preferred to such fluids as turpentine or chloroform.

Preparing Moulds.*—Mr. E. B. Wilson considers that although it is well known that the study of moulds may be greatly facilitated by following their development in gelatin films, or other solid substrata, spread on glass slides, yet that the value of the method for classes in elementary biology has not been sufficiently recognized. He therefore calls attention to the following application of the method, as simple and practical, and especially as affording a ready means of making very clear and beautiful permanent preparations.

The spores are sown with a needle-point in films, consisting of a modification of Pasteur's or Mayer's fluid (with pepsin) thickened with Iceland moss. In this medium moulds grow freely in the moist-chamber. They may be examined either fresh or after treatment with iodine, which scarcely colours the substratum. For the purpose of making permanent preparations the culture-slides are transferred directly from the moist-chamber to a saturated solution of eosin in 95 per cent. alcohol, a fluid by which the moulds are at once fixed and stained. After twenty-four hours (or, preferably, three or four days), the preparations are washed in 95 per cent. alcohol until the colour nearly disappears from the substratum, cleared with oil of cloves, and mounted in balsam. All stages may thus be prepared. The mycelia, conidia, &c., appear of an intense red colour, while the substratum is scarcely stained. Alcoholic fuchsin may be used instead of eosin, though inferior to it; but other dyes (of which a considerable number have been tested) colour the substratum uniformly with the moulds, and are therefore useless. Eosin preparations made more than a year ago do not yet show the slightest alteration of colour. The best results have thus far been obtained with *Penicillium*, *Eurotium*, and certain parasitic forms. *Mucor* gives less satisfactory preparations, since it is always more or less shrunken by the alcohol. Fair preparations of yeast may be made by mixing it with the liquefied medium and spreading the medium on glass slides, which, after solidification of the films, are placed in the eosin solution, as in the case of mould-cultures.

For preparing the cultures, Pasteur's or Mayer's fluid, with pepsin (see Huxley and Martin's 'Practical Biology'), but not containing more than 5 per cent. of sugar, is heated with Iceland moss until the mixture attains such a consistency that it will just solidify when cold (fifteen to thirty minutes). It is then filtered by means of a hot filter into small glass flasks, which are afterwards plugged with cotton-wool, and sterilized at 65° to 70° C. by the ordinary method. When required for use the mass is liquefied by gentle heat, poured on the slides, and allowed to solidify. The spores are sown by a needle-point, touched once to a mass of spores, and thereupon drawn across several films in succession, the spores being thus scattered along the track of the needle, and more or less completely isolated. Care must be taken that the quantity of sugar be not too great. The films should be tolerably thick, and the atmosphere of the moist-chamber such that the films neither dry nor liquefy.

* Amer. Natural., xxi. (1887) pp. 207–8.

Technique of Bacteria.*—M. Kunstler reports that either the vapour of osmic acid or the concentrated acid is a good fixing reagent for Bacteria. To show the flagella of *Spirillum tenue* it is necessary to mix a drop of osmic acid with a drop of the water containing the microbe, and to allow of a quarter of an hour's evaporation. Having covered it with a slip, a very small drop of a saturated solution of "noir Collin" is added near the middle of the four sides. The preparation is then carefully closed with wax, so as to prevent any evaporation. After some eight to fifteen hours the *Spirilla* become intensely coloured, and the flagella may be seen with moderate powers. At the extremity of the microbes there are four to six flagella. If, in addition to the "noir Collin," we add a little chromic acid, the body of *Spirillum tenue* presents a vacuolated, reticular, or areolated structure; the areolæ often contain granules. These appearances are best seen in specimens which are about to divide. In the other process of reproduction, M. Kunstler thinks the term of monosporous cysts to be preferable to that of spores. Good results are got by the use of a concentrated solution of hæmatoxylin, to which a little glycerin and chromic acid have been added. In some cases traces of potash are preferable to chromic acid.

(3) Cutting, including Imbedding.

Myrtle-wax Imbedding Process.†—Prof. W. H. Seaman says that Mr. J. H. Blackburn, in attempting to carry out the Reeves process of mounting,‡ failed entirely to get satisfactory results with what was sold to him by the local druggists as myrtle-wax, which he desired to try on the suggestion of Dr. Miller. On returning the wax, and stating that there must be some other substance called myrtle-wax, he received an article that gave perfect satisfaction, so much so, indeed, that he found it better than paraffin, and substituted it for that. Having been furnished with specimens, a short examination of its fusing point, &c., showed that it was the Japan wax obtained from the *Rhus succedanea*, now an extensive article of commerce. This substance is very peculiar in its great latent heat, giving it a wide range between the fusing and solidifying points. It solidifies without wrinkles, and sticks close to an imbedded object, qualities that render it especially valuable to the section-cutter. It is not strictly a wax at all, but a fat, since it consists chiefly of palmitic acid, and is capable of saponification. Mr. Blackburn showed whole brains saturated with it so perfectly, and preserved so naturally, except colour, that there seemed no reason why they could not be employed as models for class demonstration. To all appearances at the present time they are permanent. The substance may easily be obtained from the wholesale druggists.

Homogeneous Paraffin.§—Dr. G. A. Piersol says that much has been written regarding the necessity of having paraffin of the right consistence to insure success in cutting ribbon sections, but the desirability of having it *homogeneous* has been but little emphasized. The selection of a pure paraffin, freedom from turpentine or chloroform used in imbedding, and a very *rapid cooling* after the tissue is arranged, appear to be the essential conditions for securing this desirable character to the

* Comptes Rendus, cv. (1886) pp. 684–5.
† Queen's Micr. Bulletin, iv. (1887) pp. 33–4.
‡ See this Journal, 1887, p. 1048.
§ Amer. Mon. Micr. Journ., viii. (1887) p. 155.

imbedding mass. With a homogeneous paraffin it is surprising to see with what wide latitudes as to melting-point the chains of sections will come off.

Schiefferdecker's Microtome for cutting under alcohol.*—Dr. P. Schiefferdecker's improved microtome (fig. 34) is now provided with an arrangement for cutting under spirit, as well as for raising the knife-carrier and automatically raising the preparation. There are, besides, numerous practical improvements, but the principle of the instrument is unchanged.

The angle of the slideway and the weight of the slide itself are more favourable. Any slipping of the band from the wheel is now prevented, and the handle can be placed in any desired position. On drawing out the slide, the band can be so fastened that it always remains in the proper position.

Bending of the metal parts owing to refractory preparations is obviated, and the knife-guard is now so arranged that the pressure on the knife is as small as possible. In the illustration the arrangement for raising the knife is not seen, as it is covered by the pan. In a very simple way the knife-carrier is raised any required height merely by the crank action when the slide is drawn backwards. As the knife requires to be raised a shorter distance for paraffin preparations than for unimbedded ones, the arrangement for raising it is so effected that this action can be made at any desired position of the slideway. The position of the preparation is automatically altered, also, in a very simple manner.

A bar, which in its turn is moved by the crank, is set in motion by a toothed wheel acting upon a micrometer screw. Upon this bar is fixed a plate for regulating the amount or distance of raising. Expressed in fractions these amounts are 0·005, 0·01, &c., to 0·05 mm. For most cases these are sufficient, but if any other size be required the automatic arrangement may be dispensed with, and the preparation raised by turning the milled head of the micrometer screw with the hand. Of course any other denominator than 200 can be used for the fraction. For the automatic motion of the micrometer screw a new striking mechanism has been constructed, and this is found to be more effective than the catch arrangement.

The immersion apparatus is a flat quadrangular pan, in the bottom of which, and just above the preparation-clamp, is a circular hole for the preparation to pass through. The clamp, with the screws necessary for the two turns, is placed within a cylinder, the upper edge of which, by means of a short and wide caoutchouc tube, is united with a projecting rim running round the hole in the bottom of the pan, so that, when the spirit fills the pan and cylinder, the preparation always lies in the alcohol, and yet can be pushed up and down with the cylinder without difficulty. The screws which alter the clamp are turned with keys. The knife, which has a straight handle, is fastened by means of two screws to a thick metal-piece (the connecting-piece), and this in its turn is united by screws with the plate of the knife-carrier. The connecting-piece, to the under surface of which the knife is fastened, passes over the pan in such a way that it projects into the spirit.

UNDERHILL, H. M. J.—**Section-cutting applied to Insects.**
Sci.-Gossip, 1888, pp. 1–4.

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 340–3 (1 fig.).

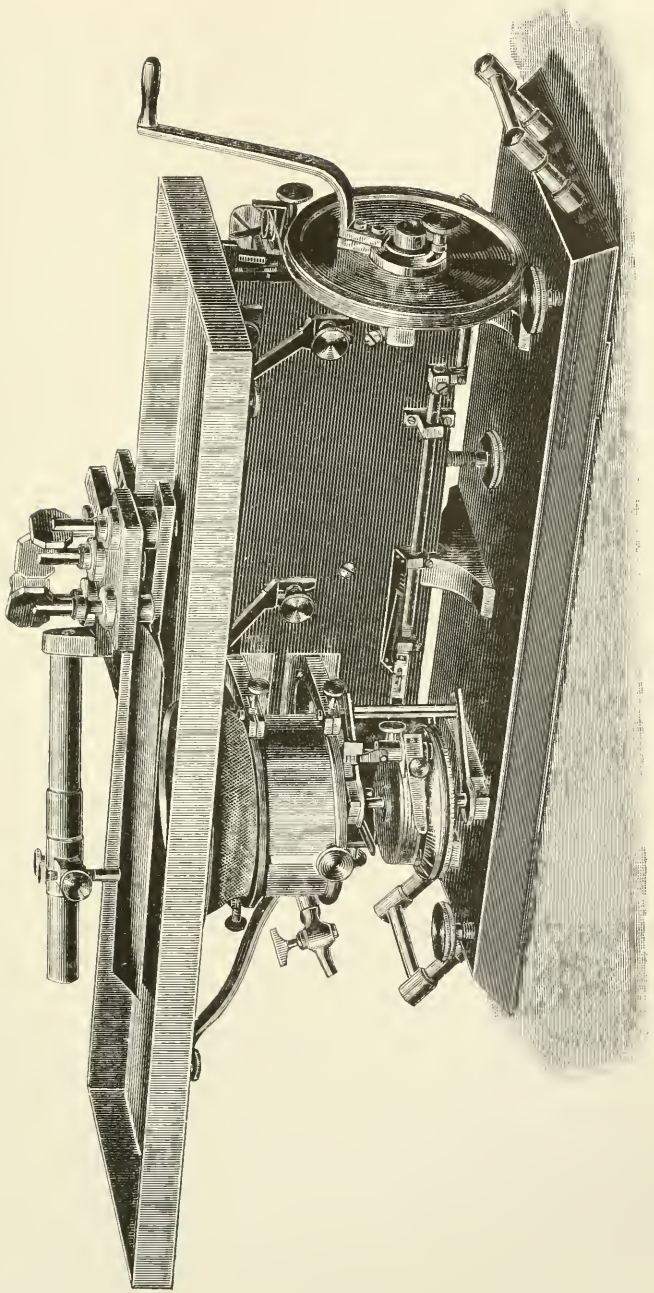


Fig. 34. Schiefferdecker's Microtome for cutting under alcohol.

(4) Staining and Injecting.

Methods for Pathological Investigations.*—Dr. V. Babes uses a strong watery solution of safranin by dissolving the dye in distilled water to which 2 per cent. anilin oil is added. The mixture is then heated to about 60° C. and filtered while warm. The solution stains in about one minute; the sections are then passed through alcohol and oil of cloves and mounted in balsam. Hardening with Flemming's fluid is suitable for this method. According to the author this stain colours calcareous infiltration a red-violet, and is especially suitable for tissues containing bacteria.

The use of this safranin is also adapted for demonstrating certain pathological changes. For this purpose the tissues are thoroughly stained with safranin and are then placed for a minute in Gram's iodine solution. After passing through spirit and being mounted in balsam the colour is withdrawn, except from certain elements. For example, parts infiltrated with chalk and such as have undergone a colloid change remained stained. The iodo-safranin treatment is especially valuable for staining the club-shaped elements of the *Actinomyces*. The pus or the crushed *Actinomyces* is dried rapidly on a cover-glass and treated with anilin safranin for twenty-four hours, decolorized with the iodine solution, and mounted after dehydration and clearing up in clove oil.

The author also recommends a neutral anilin stain made up of a mixture of basic and acid anilins. This neutral stain consists of equal parts of acid fuchsin, methyl-green and orange, and is made by mixing 125 c.cm. of a saturated watery orange solution with 125 c.cm. of a saturated solution of acid fuchsin dissolved in 20 per cent. alcohol; to this 75 c.cm. of absolute alcohol and 125 c.cm. of a saturated watery solution of methyl-green are then added gradually. The sections are left in this staining fluid for half an hour, then washed and treated with alcohol and bergamot oil.

In sections thus treated the blood-corpuscles are orange-yellow, the nuclei of the polynucleated leucocytes green, and their cell-substance deep violet, the cell-substance of the eosinophilous cells blackish-brown.

Staining of Ossification Preparations.†—Dr. H. Klaatsch remarks that it is advantageous to possess a simple and reliable method for demonstrating the process of ossification to classes, for showing students the remains of cartilage in the newly-formed osseous tissue, and for distinguishing the difference between periosteal and cartilaginous ossification.

These objects may be attained by staining with logwood and decolorizing with picric acid. Grenacher's or Böhmer's hæmatoxylin may be used. Overstaining is of no advantage, but if it occur the section must be left for a longer time than usual in the picric acid. Students leave their sections overnight in a watchglass in a mixture of a little aq. destil. plus 6 drops of Böhmer's hæmatoxylin and 3 drops of glycerin. After being washed in distilled water the sections are transferred to a saturated solution of picric acid until they assume a yellowish-brown colour. They are next placed in glacial acetic acid for about half a minute, and are then washed in distilled water until the yellow colour is no longer

* Virchow's Arch. f. Pathol. Anat. u. Hist., cv. (1886) pp. 511–26 (1 pl.).
† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 214–5.

given off. They are then dehydrated, cleared up, and mounted in Canada balsam.

The preparations show the epiphysial cartilage to be of a dull pale blue, while the remains of the cartilage between the lines of ossification is of a deep blue colour. The newly-formed bone stains yellow, and the blood-vessels have a brownish hue. The permanence of the stain seems fairly good, as the author possesses specimens made six months ago which have undergone no perceptible change.

A modification of the foregoing method is also given. Instead of with hæmatoxylin the sections are deeply stained with methyl-violet and decolorized with picric acid until the blue colour is no longer given off. After being mounted in Canada balsam the sections look green to the naked eye. The cartilage remains, even to their least ramifications, are stained deeply blue and surrounded by yellow layers of bone. In the periosteal region the young bone-cells are of a greenish colour. The epiphysial cartilage is pale yellow. In this modification the histological details are wanting, and it is chiefly useful for demonstrating the difference between periosteum and cartilage ossification under low powers.

Staining the Elastic Fibres of the Skin.*—Dr. K. Herxheimer hardens his preparations in Müller's fluid; his method will, however, give good pictures after spirit, picric acid, and the chrom-osmic-acetic acid mixture. The sections should not be more than 0·2 mm. thick. They are stuck on with celloidin, and then stained for three to five minutes with hæmatoxylin (1 c.cm. hæmatoxylin, 20 c.cm. alcohol absolute, 20 c.cm. H^2O, 1 c.cm. lithium carbonate), but other watery solutions may be used. The sections are then treated for five to twenty seconds with chloride of iron solution. This last step requires some care. Mount in balsam. The elastic fibres stain a bluish-black or black, while the surrounding tissue is grey or bluish. By longer action of the iron, so that the connective tissue is quite decolorized and a part of the elastic fibres slightly pale, a contrast stain with carmine or Brunswick brown may be used with advantage. The method can be employed for staining the nervous system; for this two hours are required. Instead of hæmatoxylin the author also uses anilin water gentian-violet.

Staining Nerve-terminations with Chloride of Gold.†—Dr. G. Boccardi recommends the reduction of objects impregnated by Ranvier's or Löwit's gold chloride method to be done with oxalic acid of 0·10 per cent., or of 0·25–0·30 per cent. Another favourable reduction fluid consists of 5 c.cm. pure formic acid, 1 c.cm. oxalic acid of 1 per cent. and 25 c.cm. aq. destil. Pieces impregnated with gold chloride are to remain in this fluid in the dark not longer than 2 to 4 hours.

Demonstrating the Membrane of the Bordered Pits in Coniferæ.‡—Dr. A. Zimmerman states that this membrane only requires staining for its demonstration, and that hæmatoxylin is the best dye for the purpose; Bismarck-brown and gentian-violet are also capable of staining this tissue, but are inferior to logwood.

Material which has been preserved in alcohol is to be preferred. The sections are placed in Böhmer's hæmatoxylin for 2–5 minutes only, as a longer time stains the rest of the membrane, and it is advisable to

* Fortschr. d. Med., iv. (1886) pp. 785–9.
† Alboni Lavori eseg. nell' Istit. Fisiol. Napoli, 1886, Fasc. 1, pp. 27–9.
‡ Zeitsch. f. Wiss. Mikr., iv. (1887) pp. 216–7.

stain the cell-nuclei and the investing membrane of the bordered pit only. The preparation is then washed in water, dehydrated in alcohol, and cleared up in oil of cloves. Clearing up acts very beneficially, because the optical effect produced by the curvature of the pit is diminished.

The reaction of the bordered pit membrane to dyes undoubtedly shows that it differs in its chemical and physical relation from the rest of the membrane substance. The circumstance that membranes of the cambium cells and the membranes consisting chiefly of pure cellulose stain deeply with hæmatoxylin might lead to the conclusion that in the pit membrane we have to deal with a pure cellulose. This, however, is contradicted by the fact that it stains deep red with phloroglucin and hydrochloric acid.

Staining Diatoms.*—Prof. O. Drude discusses the method of staining diatoms as a suitable means for obtaining proper microscopical preparations. The methods which merely preserve the siliceous valves, and which at one time was the only object aimed at, have since Pfitzer's systematic classification (cf. Hanstein's 'Beiträge' and Schenk's 'Handbuch der Botanik,' ii. p. 403) have been recognized and adopted, no longer suffice, and must give way to a method which clearly shows and permanently retains in the microscopical preparation, the cell-nucleus and the endochrome-plates.

Such a method was communicated by Pfitzer four years ago,† and has been employed by the author with great advantage. It consists in staining the fresh material with picronigrosin: to a saturated watery solution of picric acid is added as much of a saturated watery solution of nigrosin as causes the mixture to assume a deep olive-green hue. This solution is poured over the fresh Bacillariæ, or the rotting leaves, stems, &c., of water plants on which they are found are placed in test-tubes filled with the picronigrosin solution. The first kills and fixes, the latter stains, the nucleus most strongly, less so the endochrome-plates, and very faintly the thin layer of protoplasm.

The stained valves are best mounted in balsam, after having been thoroughly washed with spirit, then dehydrated with absolute alcohol, and cleared up in oil of cloves. Thus are obtained very useful preparations which show beautifully the nucleus and nuclear fission, and also the endochrome plates which formerly soon lost colour or altered in form and position. Glycerin may be also used for mounting.

Stained Yeast-preparations.‡—Dr. P. Lindner states that the behaviour of yeast-cells to dyes is the same as occurs in Bacteria. If yeast-cells dried on cover-glasses be placed in solutions of methylen-blue, gentian-violet, fuchsin, Bismarck-brown, &c., they greedily pick up the dye. If the preparation be over-stained the mistake is easily obviated either by prolonged washing with distilled water, or by the application of spirituous or slightly acidulated water. The spores too behave in a manner similar to the resting spores of Bacteria. They are stained with difficulty; if this, however, take place, it is extremely permanent. For example, if they be stained with fuchsin, they may be washed for a long time, without being decolorized, while everything except the spores quickly loses its colour. In order to stain the mother and the sporeless cells e.g. blue, it is merely needful to immerse the

* SB. u. Abh. Naturwiss. Gesell. Isis, 1887, pp. 8–9.

† See this Journal, 1883, p. 445. ‡ Wochenschr. f. Brauerei, 1887, p. 773.

preparation in a solution of some blue dye. The red spores do not take up the blue pigment at all, while everything else is stained deeply blue.

Staining Lepra and Tubercle Bacilli.*—Dr. F. Wesener makes another reply to Prof. Baumgartner's criticisms on the methods for distinguishing between leprosy and tubercle bacilli. Throughout the controversy, no new facts have been adduced, and the gist of the whole seems to be that the one learned stainer prefers his own method to that of the other. They both seem to agree that tubercle, like leprosy bacilli, can be stained with simple solutions of fuchsin and methyl-violet; that there are, however, certain gradual differences between them, the leprosy bacilli taking up the stain somewhat more easily than the tubercle bacilli. Dr. Wesener distinguishes his position from that of Baumgartner by insisting that these gradual differences are very fluctuating, and not always constant, and on this ground that they are insufficient for a reliable diagnosis: the two methods given by Baumgartner for sections are specially unreliable.

As both these learned dyers have admitted that other data besides those of various stains (in so many words, it must be known beforehand which is tubercle and which leprosy tissue) are necessary for a certain diagnosis, it must be acknowleged that the main point in the controversy is one which requires special mental acuteness for its comprehension.

Specificness of the Tubercle Bacillus Stain.†—It is well known that Bienstock and Gottstein demonstrated the fact that certain non-pathogenic bacilli which stain in the ordinary way with anilin dyes could be so altered that they were able to be stained in the same way as tubercle bacillus. To effect this they were bred in agar-gelatin medium, to which about 20 per cent. of fat was added. Dr. A. W. Grigorjew has now tested Bienstock's conclusion, according to which tubercle bacilli owe their peculiar staining property to an investment of fatty matter, which prevents the decolorizing action of acids. The author cultivated in fatty media (1–20 per cent.) *Bacillus anthracis*, *B. subtilis*, *Clostridium butyricum*, *Bacterium termo*, *Staphylococcus aureus*, and *S. albus*. All these cultivations gave similar results. Bacteria lying in the fat stained as tubercle bacilli; those above or in islets free from fat stained in the usual way. Again, if the former class were acted on by potash, alcohol, or ether, their power of assuming the specific stain vanished, and they coloured in the usual way. The author further points to the significance which the mixing of a little fat with the bacteria on the cover-glass has. In this case the specific nature of the stain is lost. In this way it is even possible to impart the specific tubercle stain to a streak of albumen, and the author concludes that his experiments justify him in disbelieving Bienstock's explanation, and in supporting the existing theory as to the staining of tubercle bacilli.

New Staining Fluid.‡—Mr. J. W. Roosevelt recommends an iron stain, consisting of 20 drops of a saturated solution of iron sulphate,

* Centralbl. f. Bacteriol. u. Parasitenk., ii. (1887) pp. 131–5.

† Ruskaja Medizina, 1886, Nos. 42 and 43. Cf. Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 251–2.

‡ New York Patholog. Soc., 9th March, 1887. Cf. Medical Record, ii. (1887) p. 84.

30 grams water, and 15–20 drops pyrogallic acid. The preparation assumes a brownish-grey colour. It is specially suitable for photo-micrographic purposes, because, when united with albuminous tissues, it undergoes no further change.

Benda's Modified Copper-hæmatoxylin.*—Dr. G. A. Piersol calls attention to the excellence of this reagent; though the method is troublesome the results amply repay where a careful study of cells under high powers is proposed.

Tissues treated with chromic acid or Flemming's solution stain readily, as well as do those hardened in alcohol or any other of the usual fluids. For careful examination, staining after cutting is advised: the sections on the slide or cover are placed for 8–12 hours in an almost saturated solution of cupric acetate (to which a few drops of acetic acid may be added) in the oven at 50° C., washed a few minutes in two changes of distilled water, and stained with 10 per cent. alcoholic solution of hæmatoxylin until very dark blue; transferred *directly* to hydrochloric acid solution (1:350), where they remain until bleached to a straw tint; after being rinsed in water they are placed in *fresh* copper solution until again blue. Should the sections be too dark they may be again bleached in the acid and passed through the copper solution as before; if too pale they are placed again in the hæmatoxylin and carried through the solution as at first.

The advantages of the method are certainty of good results after chromic acid, control of the intensity and ease of correcting faults of the stain, and above all, the excellent results. While the colour is less brilliant than the usual alum-hæmatoxylin stainings, the crisp, sharply-defined pictures furnished leave little to be desired, and to those seeking a precise and reliable stain after Flemming's solution this method is confidently recommended. Since the hæmatoxylin with care and occasional filtering may be repeatedly used, and as the copper solution is readily prepared and inexpensive, the method will be found economical and by no means as complicated in practice as on paper.

Action of Staining.†—Dr. M. C. Dekhuyzen holds, in opposition to Griesbach,‡ that staining is rather a physical process, as in the majority of cases only molecular combinations take place. He classifies the tissues (material hardened in 96° alcohol) as follows:—Mucin, primitive cartilage capsules (Ranvier), gland cells of fundus, cells of pyloric glands, Neumann's pericellular substance in cartilage, an imperfectly known constituent of nerve, and Henle's layer of the internal sheath of the hair-root are basophile, that is, possess an inclination for basic and a disinclination for acid dyes. The "acidophilous" constituents of tissues show the opposite behaviour, protoplasm especially, in covering cells ("Belegzellen") and in the lunules of Gianuzzi, connective-tissue bundles, elastin, decalcified bone, muscle, axis-cylinder, the peripheral layer of cartilage where the cells are flattened, and the secondary capsules of Ranvier which lie immediately upon the cartilage cells. Chromophilia is the property which both classes may have in common, although it is more marked in one of them. Chromatin and cleidin are chromophilous, and both have a preference for basic dyes.

* Amer. Mon. Micr. Journ., viii. (1887) pp. 153–5.
† Med. Centralbl., 1886, No. 51, pp. 931–2, and No. 52, pp. 945–7.
‡ See this Journal, 1887, p. 1058.

Modification of Schiefferdecker's Celloidin Corrosion Mass.*—Dr. F. Hochstetter has devised a modification of Schiefferdecker's celloidin corrosion mass, whereby crumbling of the mass and any brittleness after the addition of a large quantity of dye are prevented.

It is recommended to mix washed porcelain earth (kaolin) with celloidin. The porcelain earth is rubbed up with ether, to which cobalt blue, chrome yellow, or cinnabar is added. To this celloidin of the consistence of honey is added. The quantity of the kaolin to be used depends on the size of the vessel to be filled. If the whole distribution area of a vessel is to be injected, the syringe should at first be filled with a thin injection mass containing less porcelain; afterwards a thicker mass should be used. Teichmann's screw-syringe is the most suitable instrument for the purpose. A small quantity of pure ether is first injected; this done the mass is squirted in, at first pretty quickly, but afterwards more slowly, and the pressure of the piston-rod is kept up until the mass begins to set in the large vessels. This method may be advantageously employed for demonstrating the vessels in bone or those lying immediately upon it, but for "parenchymatous" organs this mass is not to be recommended. The preparations are macerated in the cold, bleached, &c.

Hamilton, D. J.—**Method of combining Weigert's Hæmatoxylin-Copper Stain for Nerve-fibre with the use of the Freezing Microtome.**
Journ. of Anat., XXI. (1887) p. 444.

Lighton, W. R.—**Notes on Staining Vegetable Tissues.**
[Cut a fresh green stem and place the newly cut end in one of the usual staining solutions. The colouring matter will gradually be absorbed and distributed through the tissues.]
Amer. Mon. Micr. Journ., VIII. (1887) pp. 194–5.

Wasserzug, E.—**Principaux procédés de Coloration des Bactéries.** (Principal processes of staining Bacteria.) *Journ. de Bot.*, I. (1887) pp. 299–303, 321–4.

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

Fixing Sections.†—Of the three fixatives now in general use—shellac, collodion, and albumen—shellac is considered the best for objects coloured *in toto*. The carbolic-acid shellac introduced by Dr. P. Mayer has been found to be unreliable in some respects. Carbolic acid warm is injurious to some tissues, e. g. the dermis of vertebrates. The alcoholic solution is a perfectly harmless fixative. The method of using, now described by Dr. Mayer, and which differs in important points from the one prescribed by Giesbrecht, is as follows:—

(*a*) The object-slide, heated to about 50° C., is coated with shellac in the usual manner, by drawing a glass rod wet with the solution once or twice over its surface. As soon as the slide is cool and the film of shellac hard and no longer sticky, the sections are arranged dry, and then gently pressed down by means of an elastic spatula (horn or metal) until they lie flat and smooth on the slide.

(*b*) Expose the slide thus prepared to the vapour of ether. For this purpose the slide may be placed in a glass cylinder of suitable size, and closely stoppered. The cylinder is placed in a horizontal position, or, at

* Anat. Anzeig., 1886, pp. 51–2.

† Internat. Monatsschr. f. Anat. u. Physiol., iv. (1887) Heft 2. Cf. Amer. Natural., xxi. (1887) pp. 1040–1, and this Journal, 1887, p. 853, where the author's name was omitted through the note being separated from others in printing.

least, so inclined that the slide lies wholly above the ether. The saturation of the sections will be sufficiently complete in about half a minute.

(*c*) The slide is next to be warmed in the water-bath in order to evaporate the ether. The paraffin is then removed, and the mounting completed in the usual manner.

It is best to use balsam dissolved in turpentine or benzole rather than in chloroform, as the latter softens the shellac, and thus often loosens the sections.

One great advantage of this method of using shellac is that it permits of arranging and flattening the sections on the slide. Ordinarily sections are placed while the adhesive coating is soft, and must then lie as they fall.

With reference to collodion, Dr. Mayer remarks that it depends entirely upon the quality of the gun-cotton employed whether the sections bear well treatment with alcohol and aqueous fluids. When sections are to be stained on the slide, the albumen-fixative is preferred to collodion. The mixture is prepared as follows:—White of egg, 50 grm.; glycerin, 50 grm.; sodium salicylate, 1 grm. These ingredients are mixed and thoroughly shaken together, then filtered and kept in a well-cleaned bottle. Dr. Mayer has kept this mixture three years in a good condition. Other antiseptics have proved far less efficient than salicylate of sodium.

Substitute for Clearing.*—Dr. G. A. Piersol says that clearing with oil of cloves or other oil can be omitted where the sections are thin, especially when numerous and fixed to the slide or cover. If the sections be thoroughly dehydrated in strong or absolute alcohol, they may be mounted directly in balsam. The slide with the dehydrated section is removed from the absolute alcohol, hastily drained, a drop of balsam added, and the clean cover which is for a moment held over the flame is applied, when the slide is *gently warmed* over the lamp. There may be cloudiness at first towards the edges of the cover, but in a few minutes (with large sections somewhat longer) this all disappears. After a night in the oven at 40° C. these slides come out with covers so firmly fixed, that oil-immersions may be used and the covers cleaned with little fear of shifting.

Mounting in Canada Balsam by the Exposure Method.†—It has been a matter of surprise to Mr. G. H. Bryan that amongst the various methods of preparing microscopical slides, the so-called "exposure" method (due to Mr. A. C. Cole) of mounting in Canada balsam or other gum-resins, in which the balsam is partially dried before the cover is finally placed on the slide, has received so little notice, and he therefore desires to call attention to the advantages of this process for mounting almost all classes of objects, and also to describe a slight modification of it, by which means such arranged objects as sections in series, the various parts of an insect or other groups of objects may be mounted in balsam without difficulty.

The following is a brief outline of the exposure method:—Breathe thoroughly on a glass slip, and on it drop three clean covers, which will thus adhere temporarily to the slip, or, if preferable, each may be let fall

* Amer. Mon. Micr. Journ., viii. (1887) p. 155.
† Scientif. Enquirer, ii. (1887) pp. 184–6.

on the tiniest drop of water. On each cover let an object be arranged in a moderately convex drop of balsam, extending *to* but not *over* the edge of the cover. Then put the specimens away for the balsam to dry for at least twelve hours in a dust-proof box.

When the covers have been exposed long enough, they may be turned over on to warmed slides, but must not themselves be warmed first. The danger of large air-bubbles is diminished by placing or smearing a little fresh balsam on the slide, and this *must* be done if there is not enough balsam on the cover. If possible, the cover should be held in a pair of forceps and lowered *horizontally* over the slip, not on one side first. It is then less liable to tilt, and the fresh balsam is squeezed out symmetrically round the edge on pressing the cover down, and can mostly be at once taken off with a knife, and the slide then cleaned with spirit, the part under the *middle* of the cover being filled with the exposed balsam, which is generally firm enough to keep from slipping. In any case, the small amount of soft balsam around the edge will soon dry after the rough scraping, thus avoiding the long waiting required before cleaning slides mounted in the usual way.

For mounting arranged objects, we may proceed as follows:—The cover being stuck by breathing to a slip as before, the objects are all neatly arranged on it in the layer of balsam, which should not be too thick. The cover must now be exposed till the balsam is nearly or quite *hard*—a week's exposure or longer may be requisite. The covers must be turned over on to a *cold* slip into a drop of soft balsam and pressed down, the objects being fixed in their places on the cover by the hardened balsam, which is undisturbed. Scrape off the superfluous soft balsam, and put away to dry. The streaky appearance due to the two densities of balsam will soon disappear.

The author has tried the above methods with great success for mounting whole insects, and parts of insects, under pressure. For preparing whole insects for mounting, it is best to soak in potash, wash in water with a few drops of acetic acid, flatten out with two pieces of glass, which are tied together while the specimen is soaked for a further period in acidulated water, then in alcohol. Untie the glasses, float the insect on to a cover-glass and take it out, drain off superfluous alcohol, lay the cover on a slip, add a drop of clove-oil, which will permeate the object, and the alcohol will mostly evaporate in half an hour or more. Most of the superfluous clove-oil may then be drawn off with a pointed tube and the balsam applied. Parts of insects may be lifted from the alcohol into a vessel containing clove-oil, and afterwards taken out and laid out in the balsam on the cover. In this way he has mounted twelve parts of a honey-bee neatly grouped on one cover, and several other "type" slides, and he thinks it will be found that these methods remove the chief difficulties of mounting in balsam, and especially of mounting arranged slides.

BUFFHAM, T. H.—[Arranging Slides.] *Engl. Mech.*, XLVI. (1887) pp. 396–7.

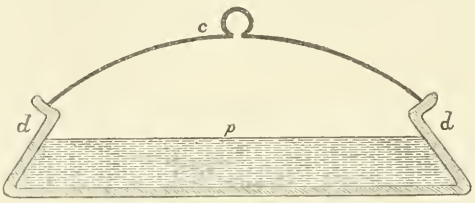
(6) Miscellaneous.

Dissecting Dish.*—The following is taken from one of a series of articles on "the Naturalist's Laboratory" in course of publication in the journal noted at foot.

* Knowledge, xi. (1887) pp. 278–9 (1 fig.).

The dissecting dish, as its name implies, is useful for animals of small size only, such as earthworms, snails, frogs, &c. Although an ordinary pie-dish can be, and has largely been, used for this purpose, it is unquestionably a very imperfect article. Let us take, for example, a frog: to learn its anatomy thoroughly, several days of work should be spent upon its dissection. The dish should be filled to the depth

Fig. 35.



c, cover; *d*, body of dish; *p*, bed of paraffin.

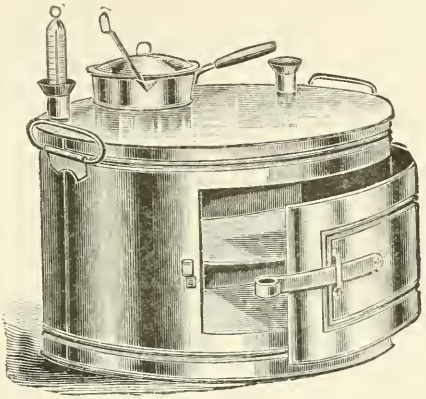
of about $1\frac{1}{2}$ in. with a suitable mixture of paraffin wax and hog's lard, melted together at a low temperature, and poured, whilst still fluid, but on the verge of becoming solid, into the dish; this will prevent any marked after shrinkage. The animal should next be fastened upon the paraffin when solid, with pins, and covered, or partially covered, with dilute spirit. After a day or two, when some critical portion is about to be examined, the student often finds, to his chagrin, that the liquid around his dissection has insinuated itself between the sides of the dish and the edges of the paraffin bed, by an almost imperceptible shrinkage of the latter, sufficient, however, to render it so unsteady as to preclude the possibility of work except with the utmost difficulty. To obviate any such mishaps, the (anonymous) author has devised a dish, shown in section at fig. 35. It may be oval or oblong (preferably the latter) in shape; its sides slope upwards and inwards, and thus effectually prevent the bed of paraffin from shifting or floating during the dissection. The upper rim of the dish should be indented, so as to admit of a cover which will not easily slip off. Both dish and cover may be made of earthenware, of indurated wood, or the new paper bottle material invented by Mr. H. L. Thomas.

Artificial Serum for Computation of Blood-corpuscles.*—M. Mayet finds that the disadvantages of deformation, &c., which attend the use of all the liquids employed in the computation of the number of blood-corpuscles, may be avoided by using an artificial serum of the following composition:—distilled water, 100 gr.; pure anhydrous neutral phosphate of sodium 2 gr.; and cane-sugar to raise the density to 1085. The form of the elements is preserved; the density, slight viscosity, and the presence of a neutral alkaline salt secure uniform distribution of the elements; the differences of level avoided in a less dense medium are of little importance; by altering the focus the leucocytes appear quite distinct as brilliant bodies.

* Comptes Rendus, cv. (1887) pp. 943-4.

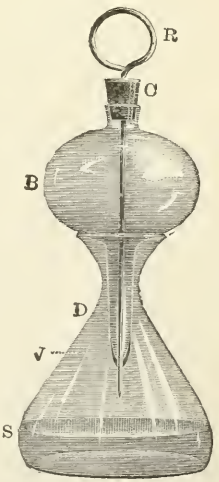
Reeves's Water-bath and Oven.—The arrangement of Dr. Reeves's apparatus sufficiently appears from fig. 36. It is heated by a gas-burner, or placed over a coal-oil flame.

Fig. 36.



Doty's Balsam Bottle.—Most of the methods for the manipulation of Canada balsam are open, it is said, to the objections of inconvenience, wastefulness and slowness which Mr. Doty's bottle, fig. 37, is intended to obviate.

Fig. 37.



The reservoir B is a turnip-shaped bulb, through the stopper C of which passes a wire R. One end of the wire is then bent into a ring for the finger, and the other is tapered and ground into the lower end of the stem of the bulb, thus forming a valve V.

In preparing for use, first put a small quantity of the solvent S, which is used to dilute the balsam, into the bottle D, being careful that not enough is used to touch the valve; remove the wire and stopper from the bulb and close the valve end; fill the bulb with balsam diluted so as to flow or drop freely, and replace the wire and stopper.

The advantages of the bottle are:—The bulb can be taken from the bottle and operated with one hand; the balsam is always ready to flow and will not harden at the exit of the bulb; the flow can be perfectly controlled; it may be operated continuously; it is cleanly and durable; the balsam being delivered from the lower end of the tube is free from bubbles, and being always protected is free from dust.

Eternod's Apparatus for stretching Membranes.* — Professor A. Eternod's apparatus for stretching membranes consists of a nest of rings

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 39–41 (2 figs.).

(fig. 38), each of which is slightly conical (fig. 39), so that the one fits into its neighbour very easily. The upper side has a bevelled edge *c*, which prevents too extended a contact of the membrane with the inner ring when the membrane is stretched. The rings are made of vulcanite, a substance which is not attacked by the ordinary reagents, such as spirit, Müller's fluid, acids, &c. When stretched on these rings, the object M—mesentery, epiplasm, &c.—may be placed beneath the Microscope and subjected to stains or fixative or other reagents, such as nitrate of silver.

Fig. 38.

Fig. 39.

Determination of the Number of Trichinæ or other Animal Parasites in Meat.*—This is thus effected by Prof. H. Gage:—After meat has been found to be infested with parasites, if it is desired to determine the number in a kilogram, pound, or any other weight, a section of the meat is made with some sharp instrument, and the thickness of the section is measured by placing it between two cover-glasses whose thickness is known, and then, after pressing the cover-glasses quite firmly together, measuring the entire thickness. The thickness of the section of meat is then easily determined by subtracting the thickness of the cover-glasses from the number representing the thickness of the cover-glasses and the meat. The sections may be from 0·1 to 0·3 mm. in thickness. Remove the upper or eye-lens of the ocular of the Microscope, and place on the diaphragm a piece of paper in which a small square opening has been made, thus converting the diaphragmatic opening from a round to a square one. Replace the lens, and by the aid of a stage micrometer determine the value of one side of the square field thus made. The opening need not, of course, be square, but it is much easier for most persons to determine the area of a square than a circle—hence a square is recommended. Put the section of meat under the Microscope and count the number of parasites in the field, moving the specimen and making twenty or more counts, in order to get an average which shall fairly represent the number of parasites in one field. Find the cubic contents of one field by multiplying the thickness of the section by the number representing the value of the sides of the square field. From this compute the number of parasites in an entire cubic centimetre. Divide this number by the specific gravity of muscle (1·058), and the result will give the number of parasites in one gram of the meat. From this the number in one kilogram may be obtained by simply adding three cyphers (multiplying by 1000), or in one pound avoirdupois by multiplying by 453,593, which is the number of grains in one pound. The following is an example:—

The thickness of the section was 0·27 mm., and the value of the square field as seen in the ocular was 1·5 mm. The average number of *Trichinæ* seen in this field in twenty observations of different portions of the meat was three. The cubic contents of the field was $0{\cdot}27 \times 2{\cdot}5 \times 1{\cdot}5 = 0{\cdot}6075$ cub. mm. If 0·6075 cub. mm. contains three *Trichinæ*, one cub. mm. will contain 4·038 of them, and a cubic centimetre or gram would contain 1000 times as much, or 4938 *Trichinæ*, providing it weighed only as much as distilled water at 60° F. But as muscle weighs

* St. Louis Med. and Surg. Journal, liii. (1887) pp. 289–91.

1·058 as compared to water, the true number would be 4937 × 1·058 = 4667·3 in one gram, or 4667·300 in a kilogram, or 4667·3 × 453·593 = 2,117,054 in one pound avoirdupois.

Models in Metal of Microscopical Preparations.*—Prof. E. Selenka prepares metal models from microscopical preparations in the following way:—To obtain a plaster representation of the brain of a vertebrate embryo, the outlines of the head, the external and internal boundary lines of the brain are drawn on paper from the specimen with a camera lucida. According to the size of the separate sections, every second, third, or fourth section is selected, the drawings are numbered, and then carefully stuck on cardboard of the necessary thickness; the reverse side of the cardboard is covered with glue. The separate figures are then carefully cut out. Small strips for joining must of course be left in the brain. The different layers of cardboard are then glued together in their proper order, and thus a case model of the head is obtained. Any gaps or seams on the surface are filled in with plaster of Paris, and then the hollow model, which is open behind, is filled with Wood's metal heated to about 75° C. When cool the cardboard is softened in lukewarm water and then stripped off. The model is next cut in two with a fret-saw and the internal surface of the brain freed from the cardboard. Unevenness of the surface and holes are easily got rid of with a heated needle or knife, or by touching up with a stick of Wood's metal which has been softened at a gas jet. It is necessary to leave vent-holes in the cardboard model.

New Reagent for Albuminoids.†—Dr. M. Kronfeld proposes a new test for the presence of albuminous substances, viz. *alloxan* (= mesoxalylurea). This substance forms crystals which are readily soluble either in water or alcohol. From a *hot* solution there are deposited small permanent crystals with 1 equivalent of water; the larger crystals which are obtained from a *warm* solution deliquesce in the air. Solutions of alloxan produce, with albuminoids, and with some of the products of its decomposition, a red colour, which passes into purple, with an unpleasant odour. The reaction is obtained with tyrosin, very intense with asparaginic acid and with asparagin; apparently with all those compounds which contain in their molecules the group $CH_2.CH(NH_2).CO_2H$.

Solutions of albuminoids give the reaction more slowly than when in the solid form. In order to be certain of success it is necessary to operate in the cold, and to exclude as much as possible the presence of ammonia; solutions in alcohol, water, or in caustic soda may be used. Free acids prevent the reaction. The endosperm of seeds, which contains aleurone and sphærocrystals, is very convenient for experimenting with the alloxan-reaction.

White's Elementary Microscopical Manipulation.‡—Whilst it might be thought that the ground was already fully occupied for works on microscopical manipulation, Mr. T. Charters White's excellent little book will be found to meet a distinct want. More extensive treatises of course exist, but this, in the words of the author, "is designed with the aim of affording the youngest beginner such directions for preparing

* SB. Physiol. Med. Soc. Erlangen, 1886, Heft 18.

† SB. K. Akad. Wiss. Wien, xciv. (1887) p. 135.

‡ White, T. C., 'A Manual of Elementary Microscopical Manipulation for the use of Amateurs,' iii. and 104 pp., 1 pl. and 6 figs. 8vo, London, 1887.

objects of interest and instruction in an elementary but at the same time such a complete manner that, be he the merest tyro, he may grasp their details and work out his studies with the most satisfactory results."

Brun, J.—**Notes sur la Microscopie technique appliquée à l'histoire naturelle.** (Notes on microscopical technique applied to natural history.)
Arch. Sci. Phys. et Nat., XVII. (1887) p. 116.
Journ. de Microgr., XI. (1887) p. 178.

Harris and Power.—**Manual for the Physiological Laboratory.**
4th ed., 266 pp. and figs., 8vo, Paris, 1887.

Hitchcock, R.—**The Biological Examination of Water.** III.
Amer. Mon. Micr. Journ., VIII. (1887) pp. 203–5.

Miller, M. N.—**Practical Microscopy.**
217 pp. and 126 figs., 8vo, New York, 1887.

[Osborn, H. L.]—**Microscope in Medecine.**
Amer. Mon. Micr. Journ., VIII. (1887) p. 217.

Piersol, G. A.—**Laboratory Jottings.**
[Fixing reagents (chromic acid the best). Benda's modified copper-hæmatoxylin (*supra*, p. 158), Celloidin *v.* Paraffin. Homogeneous paraffin (*supra*, p. 151). Dispensing with clearing (*supra*, p. 160).]
Amer. Mon. Micr. Journ., VIII. (1887) pp. 153–5.

Strasburger, E.—**Microscopic Botany.** A Manual of the Microscope in Vegetable Histology. *Transl.* by A. B. Hervey.
[Translation of 'Das Kleine Botanische Practicum.']
382 pp., 8vo, Boston, 1887.

Taylor, T.—**The Crystallography of Butter and other Fats.** IV.
Amer. Mon. Micr. Journ., VIII. (1887) p. 226 (2 pls.).

Ziegler, E.—**Die Technik der histologischen Untersuchung pathologisch-anatomischer Präparate.** (The technique of the histological investigation of pathologico-anatomical preparations.) 8vo, Jena, 1887.

Zune, A.—**Cours de microscopie médicale et pharmaceutique.** (Course of medical and pharmaceutical microscopy.)
Moniteur du Praticien, III. (1887) pp. 125 and 158.

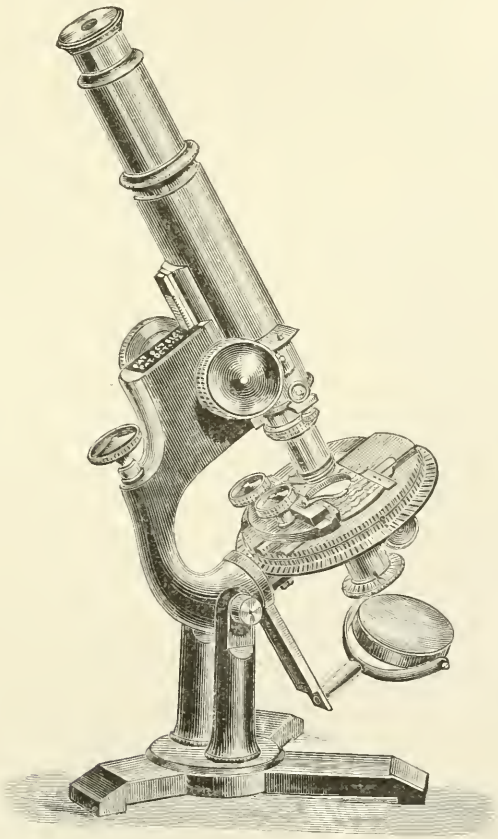
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Bausch and Lomb Optical Co.'s Petrographical Microscope.—This instrument, fig. 40, was founded on suggestions of Dr. G. H. Williams, Associate Professor of Mineralogy and Inorganic Geology in the Johns-

Fig. 40.



Hopkins University.† The general form of the stand is the Bausch and Lomb Optical Co's "Model" Microscope,‡ with their watchspring fine-adjustment, and the mechanical stage described in this Journal, 1887,

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

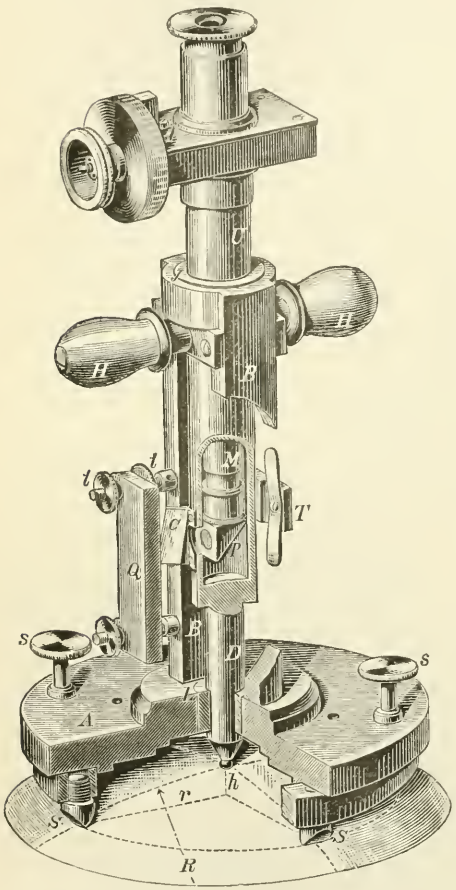
† Cf. Amer. Journ. Sci., xxxv. (1888) pp. 114–7 (1 fig.).

‡ It can also be applied to the "Universal" and "Professional" forms.

p. 651, with graduated scales for the rectangular movements and graduated circle and index.

The nose-piece is provided with a special adapter to which the objective may be screwed, and into which slide the four following accessories, each mounted in a separate brass frame: (*a*) Bertrand lens; (*b*) quarter undulation plate; (*c*) quartz wedge; (*d*) Klein's quartz plate. The nose-piece has also centering screws. The analyser is inclosed in one side of a double-chambered box, the other side being left vacant, so that it may be slid in or out of the tube at will without at any time leaving an opening through which dust may enter.

Fig. 41.



Bamberg's Spherometer Microscope.*—Dr. S. Czapski describes this intrument (fig. 41) as follows:—B B is a strong brass frame fixed in a circular disc A, to which spherometer rings of different diameters can be fastened by the screws *s s*. Complete centering of the rings is secured by circular projections of rectangular section turned upon the under surface of A. The spherometer ring is either entire or consists (as in the figure) of four hard steel segments S S, which form parts of a complete circle turned upon the lathe. J and L are steel guides for the strictly cylindrical steel tube U, which contains the micrometer Microscope M. U terminates below in a steel cylinder D, at the end of which is a small sphere. P is the reflection prism placed under the objective, and in front of it is an aperture in U through which a scale Q, divided to 0·2 mm., and illuminated by the mirror C, is viewed in the Microscope. The scale Q is attached to the frame B by four screws, and adjusted by the nuts *t t* to the focus of the Microscope. Any vertical movement of the Microscope in its bearings can be measured by the divisions of the scale, which are then seen to travel across its field. The drum gives thousandths of a millimetre direct, and tenths of these can be estimated with safety. Behind U

* Zeitschr. f. Instrumentenk,, vii. (1887) pp. 297–301 (3 figs.).

is a crosspiece T, which at one end presses directly against the frame B, acting at the other by means of a weak spring. This is designed to keep the tube firm in its bearings, to prevent any rotation, and to make it impossible for the tube to leave the frame altogether. The instrument is carried by the wooden handles H H.

In using the instrument it is placed gently on the spherical surface to be determined, which, if a thin lens, is supported on a ring of the same diameter as the spherometer ring. The Microscope is focused, and a reading is taken on the scale by the micrometer. The zero-point having been found by placing the spherometer on a true plane surface, and the difference of readings being = h, then R the radius of the sphere = $\frac{h^2 + r^2}{2h}$ where r is the radius of the ring.

A better method of determining h is to dispense with the plane surface, and to take half the difference between the readings for the spherical surface, and for another spherical surface of exactly equal and opposite curvature. In this way it is possible to eliminate the error due to the fact that a ring which has not a perfectly fine edge rests upon a concave surface with a greater diameter, and upon a convex surface with a less diameter than the measured diameter of the ring.

If such an equal and opposite surface cannot be obtained, the curvature of another lens of nearly the same radius which has an equal and opposite surface is first determined in the above way; this is compared with the curvature as determined by the aid of a plane surface, and so the error for a lens of nearly the given curvature is ascertained. The given lens is then measured by means of a plane surface, and the known correction applied in estimating the value of h.

Galland-Mason's Microphotoscope.—If it is true that the world sometimes knows nothing of its greatest men, it would appear to be also true that the world sometimes may be ignorant of its greatest inventions. At any rate, although we are always on the look-out for all that is novel, and much that is curious in microscopical matters, we have only now become acquainted with Mr. R. Galland-Mason's patent for the "Microphotoscope." The instrument which the patentee gives this name consists of a pair of spectacles with a number of microphotographs arranged along the upper part of the rims, and placed in front of minute magnifying glasses by which they are made visible to the wearer of the spectacles. The rims being detachable, the microphotographs (of written or printed matter, maps, or other objects) can be changed as desired. As the patentee says, "a lecturer might have his lectures photographed and placed in the rim of his spectacles, an actor his plays, a lawyer his briefs, a clergyman his sermon, a tourist, maps, views, and plans of the country through which he travelled, a shopkeeper a ready reckoner, calendar, &c., a timber merchant cubes, measurements and rules, and so forth."

In the first patent, which was taken out in 1884,* the patentee had provided a separate lens for each microphotograph. This he subsequently found to be superfluous, and in the following year he obtained a second patent † for the "Improved Microphotoscope" in which only one lens is used. There are occasions, and this is one of them, when (like the

* 1884, 8th January, No. 912. † 1885, 24th January, No. 1027.

stigma of treachery applied to translators) to abstract would be to betray, and we therefore give the specification in full.

"The improved microphotoscope consists in arranging microphotographs in spectacles, eye-glasses, or hand-glasses, in concentric circular groups, so that each microphotograph may be brought separately under or before a single minute Microscope instead of each microphotograph being provided with a separate lens.

The Microscope may be placed in a radial slide. This radial slide is to enable the Microscope to be moved opposite to any circle of microphotographs; or it may be let into the rim of the spectacle glass, and provided with a minute screw for focussing for varying sights.

The microphotographs would be taken upon a piece of circular glass, gelatine, or any suitable transparent substance; in photographing them it would not be necessary to take each microphotograph separately.

If the models from which the microphotographs are taken were arranged in a circle, the whole circular group of microphotographs could be taken on one negative.

The gelatine film or other material upon which the microphotographs are taken (and also the microphotographs themselves) may be protected from injury by friction, &c., by being placed between two very thin pieces of glass, talc, or any other suitable transparent substance, and the whole cemented together with transparent cement so as to form one piece.

These circular pieces of glass or other material upon which the microphotographs are taken, may be made to fit into loose frames in such a manner that they may be taken out at will, and others put in their places. These frames have several small catches or claws, by which they may be made to spring or clip on to spectacles, eye-glasses, or hand-glasses of a circular form.

The edges of these loose frames may be milled, which when taken between the thumb and finger, enables them (the loose frames) with the glasses they contain to be turned round and adjusted with the utmost nicety; or the spectacles, eye-glasses, or hand-glasses, may have catches on their rims into which the circular glasses containing the microphotographs may themselves be sprung, or taken out at will; thus dispensing with the loose frames. In this case the glasses containing the microphotographs would be a little larger than the spectacle glasses, to enable the thumb and finger to take hold of them when turning them round.

This is the movement which brings each of the circularly grouped microphotographs under or before the small Microscope which is fixed in the rim of the spectacle glasses—on the side next the eye—in such a manner that it may either be used radially or focussed for varying sights by means of a minute screw.

This circular movement is preferably obtained by the above method, but may also be obtained by revolving with the thumb and finger a minute rubber or other roller attached to the spectacles, eye-glasses, or hand-glasses, and pressing upon the glass or other substance containing the microphotographs, or upon the loose frame in which the glass or other substance is fixed; or this movement may be obtained by a worm fixed on the spectacles, eye-glasses, or hand-glasses, and working into teeth in the loose frame; or again the movement may be given by depressing a minute spring-stud on the rim of the spectacles, eye-glasses,

or hand-glasses, which acting upon teeth in the rim of the loose frame, turns it round a tooth at the time.

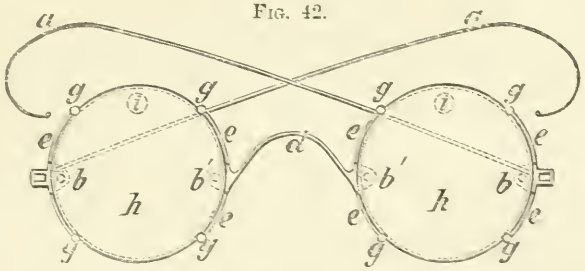
In the case of hand-glasses the radial slide which holds the Microscope, may be attached to the centre of the glass, or other material around which the microphotographs are grouped.

The spectacle glasses may be sighted for those who require them sighted, and plain clear glass for those who do not.

In order that the practical application of my invention may be clearly understood, I have annexed hereto a sheet of drawings in which (for the sake of illustration) my invention is shown as applied to a pair of spectacles of the kind ordinarily designated 'frameless.'

Fig. 42 illustrates the appearance of the improved microphotoscope when worn, differing very slightly in appearance from an ordinary pair of 'frameless' spectacles. Fig. 43 is an end view of the same enlarged.

FIG. 42.



a, *a* are the ear-pieces, *b*, *b* the plates to which the ear-pieces *a*, *a* are hinged. *c*, *c* are the spectacle glasses * to which the plates b^1, b^1 attached to the nose-piece *d* are also screwed.

The arms *e*, *e* spring from the plates *b* and b^1 (see also fig. 44 which is a front view of the metal parts detached from the glasses) and follow the curve of the spectacle glasses *f*, *f*. These arms *e* are bent at their ends, and provided with small round knobs *g*, *g* which act as spring clips, holding the glasses *h*, *h* which contain the microphotographs securely, and at the same time allowing them to be sprung out and replaced by others with the greatest ease; *i*, *i* is the minute Microscope before which any one of the circularly grouped microphotographs on the glass *h*, *h* may be brought by moving the latter round between the thumb and finger.

For this purpose the glass *h*, *h* is made slightly larger than the spectacle glass *f*, *f*.

The microphotographs may be copies of books, pamphlets, newspapers, or any written or printed matter, maps, charts, views, landscapes, pictures, or any object or group of objects from which photographs can be taken.

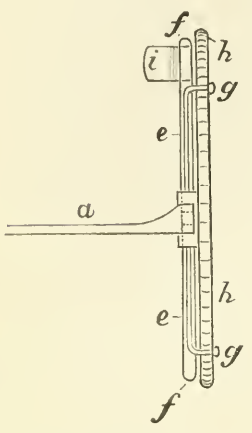
The uses to which the improved microphotoscope could be put would be similar to those described in my specification of the microphotoscope above referred to, but in a more enlarged or extended sense, as a pair of glasses *h*, *h* which slip into the spectacle frames would be capable of holding from two to three hundred microphotographs.

If these were copies of the leaves of a book, then in one pair of

* There is no *c* in the drawings.

spectacles or eye-glasses, a person would be able to carry the contents of a whole volume, and as the glasses are detachable and very thin, a person would be able to carry from fifty to a hundred pairs of these in a case less than an ordinary pocket-book.

Fig. 43.



The glasses might be numbered, and the case contain an index of the subjects; thus a person would be enabled to carry from fifty to a hundred volumes in his waistcoat pocket.

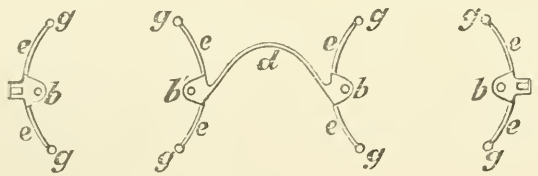
By the aid of the type-writer in preparing the text, books instead of being printed could be published microphotoscopically with greater expedition than at present, for the known resources of the modern photographer are so great that within twenty-four hours of receiving the text, he would be able to place numbers of microphotoscopical copies in the market.

Microphotoscopical books would be almost indestructible, would never become mouldy or worm-eaten, and would take up so little space that a very large library could be contained in a small cabinet.

The postage and carriage of books so published would be very small, and would be a great gain to those who had to send them abroad.

The captain of an ocean-going vessel could have copies of his charts, maps, &c., in his spectacles, and in times of danger and peril would not require to leave the bridge for the chart room. In the darkest and stormiest night, by looking towards any of the lights that a vessel

Fig. 44.



generally carries, or by looking towards the moon or even the stars, he could see his charts and maps as distinctly as in the daylight; for the matter contained in the microphotoscope can be read in a light so dim that ordinary printed matter cannot be seen.

The University student would be able to carry all his text-books in his waistcoat pocket, however diversified his studies were; the doctor, lawyer, or literary man would be able to have always with him microphotoscopical copies of all the works of reference he could possibly require. A man with a bad memory might have microphotoscopical copies of a whole encyclopædia always before his eyes. In a single pair of glasses the leader of an orchestra could carry more music than he would be able to get through in one evening; a continental traveller, a whole pronouncing dictionary; a cyclist or tourist, maps of every road in the United Kingdom or other country; a member of parliament or

other public speaker, the whole of his speech *; a lecturer, the whole of his lecture; and a detective the features of three hundred criminals, and so on, to an almost indefinite extent.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:

The combination in the instrument called the 'microphotoscope' of a single fixed or adjustable lens or Microscope with movable or detachable circular glasses or other media containing one or more circular or concentric groups of microphotographs, so arranged that each or any microphotograph may be brought separately under or before the said fixed or adjustable lens or Microscope (instead of each microphotograph being provided with a separate lens) substantially as hereinbefore particularly described and illustrated by the drawings annexed."

Bastin-Bullock Microscope.

["Designed by Prof. Bastin especially for the needs of pharmacognosists."]
Amer. Mon. Micr. Journ. IX. (1888) p. 35, from *Western Druggist.*

Electric Microscope.

["We learn that Prof. Waldeyer of Berlin is having an electric Microscope constructed in Vienna for electric light demonstrations. We presume this instrument is to take the place once occupied by the Solar Microscope."]
Scientif. News, I. (1888) p. 52.

MINOT, C. S.—**American Microscopes—A Complaint.**

[A very sweeping condemnation of American Microscopes, and a recommendation to Americans to purchase only European ones.]
Science, 1887, December 2nd.
[Comments on same in *Microscope*, VIII. (1888) pp. 20–2; *Amer. Mon. Micr. Journ.*, IX. (1888) p. 15; *Bot. Gazette*, XIII. (1888) pp. 38–9; *Queen's Micr. Bull.*, IV. (1887) pp. 41–3.]

(2) Eye-pieces and Objectives.

Apochromatic Objectives.†—We give Mr. E. Gundlach's paper on this subject *in extenso*, for, like his previous papers, any attempt at abstract would conflict with the proper appreciation of his views.

"The almost generally prevailing opinion, that the Microscope objective has been brought so near to perfection as to leave little or nothing for its further improvement, has been greatly modified by the appearance of new and superior material of which to construct optical lenses—the apochromatic glass of Schott & Co., of Jena, Germany. The fact that this new glass has solved the long-pending problem of removing or reducing the secondary spectrum, has naturally aroused the most sanguine hopes for a general improvement of the Microscope objective. These hopes would doubtless long ago have been realized, through the efforts of the able opticians of the world, if the new glass did not have, aside from the great virtue of reducing the secondary spectrum to a minimum, some serious drawbacks not connected with other optical glass. In fact, if the new glass were, or could be made, in every respect similar to the ordinary optical glass, the objectives could be made of it in exactly the same manner and after the same formulæ as they are now, and their optical qualities would be just the same in every

* In the specification to the patent of 1884 the member of parliament was only to have the "facts and figures relating to the subject of his speech."

† Read before the American Society of Microscopists, Pittsburg, August 30th, 1887. The Microscope, viii. (1888) pp. 6–8.

respect, but with the secondary spectrum considerably reduced, and, consequently, the definition greatly improved. But, unfortunately, this is not the case. In my paper at last year's meeting, I pointed out the fact, derived from figures of the refractive and dispersive powers of the new glass, as furnished by the makers, that the proportions of powers were such as to require extremely short curvatures, which would produce a very injurious amount of aberrations of the second order, and that this error would probably overbalance the advantages of the reduced secondary spectrum. Since that time, however, I have tried the glass, and found my assertion to be correct. Indeed, it could not well be otherwise, as figures seldom lie. In fact, it would be impossible to construct from the new glass Microscope objectives of superior quality after the usual or known plans. Our present low powers, for instance, from 1/2 in. down to 3 or 4 in., are now almost universally constructed after the dialytic principle, being two widely-separated systems, each consisting of a crown and flint glass of moderate optical powers and forming an achromatic lens, or nearly so, for itself. This objective has almost perfect optical symmetry, and forms, therefore, a very even and flat field of fine definition and brilliancy. No addition of lenses, nor any change of form could improve this objective, but would rather impair its quality. But the new apochromatic glass is entirely unfit for this form of objective, for the reasons heretofore given. I was led, therefore, to consider whether another form of construction could be found to which the new glass could be advantageously adapted, and I have succeeded in solving the problem so completely that, for theoretical reasons, I do not hesitate to claim my new formula to be the only proper one for the new glass. My new apochromatic objectives contain at least one triple lens of my new construction, adapted to the new glass. The 1/8 in. is a homogeneous-immersion objective of 1·42 N.A., and 1/50 in. working distance. It contains two triple systems and two single lenses, of which the back system is constructed after my new invention. Of this objective seven lenses are made of the new apochromatic, and the eighth of another new glass. The 1/4 in. is a dry working objective of 100° aperture. It is a three-system, and all but one of its lenses are made of the apochromatic glass, the back system being a triplet of my new form. The low powers are constructed after the dialytic, and consist of two triplets, both of my new form. Thus these objectives are made entirely of the new apochromatic glass. These new dialytic objectives, aside from being practically entirely free from any disturbing colour, and in every other respect fully equal to the ordinary dialytic of the best quality, are far superior to any objective in flatness of field, and are therefore, unlike the European apochromatic objectives, in less need of 'compensating eye-pieces' than the best ordinary objectives.

As a very important advantage of the new apochromatic objective over the ordinary one, I regard the absence of a separate chemical focus, which quality makes the objective especially adapted to photographic work. A 1 in. has recently been tested photographically, with a distance of $1\frac{1}{2}$ feet between the objective and the image, and not a trace of the usual difference between the visual and active foci could be found, and the resulting picture was of unusual sharpness and brilliancy."

Dr. F. L. James says* that "one immense advantage which these

* St. Louis Med. and Surg. Journ., liii. (1887) pp. 356–7.

objectives possess over those of Zeiss and other makers is that they do not require a specially constructed and corrected eye-piece, but give equally good results with any well-constructed Huyghenian ocular."

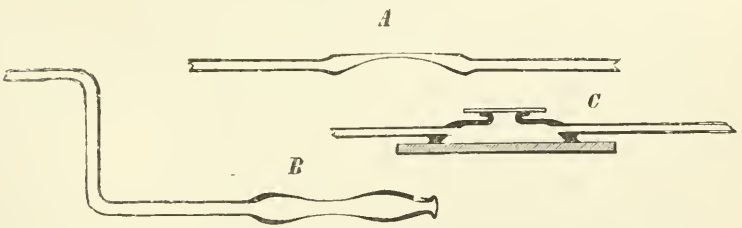
Cheap Objectives.*—Is there not a little something wanting in the following recommendation of an objective which we quote from a learned contemporary? "The oil-immersion objective is remarkable for its "powers of definition; it has been tested against many of Leitz's, which "hitherto have been the cheapest obtainable, and has been found superior "to them. *This is high praise*, as the price of the two is the same."

GIFFORD, J. W.—**Apochromatic Objectives.**
Journ. of Microscopy, I. (1888) pp. 9–11.

(3) Illuminating and other Apparatus.

Geissler's Culture Tubes.†—Dr. O. Brefeld's researches on *Bacillus subtilis* were undertaken with the apparatus of G. F. Geissler, shown in fig. 45.

FIG 45.



A glass tube of nearly capillary diameter widens in the centre in the form shown at A, the upper and lower sides approaching each other so closely, that there is only a very small space between them. A drop of liquid drawn through the tube remains, by capillary attraction, in the centre without drying up, and can thus be easily subjected to examination by the strongest objective.

Other forms have dissimilar-tubes as shown at B or C; the centre in the latter is open beneath and fastened upon a glass plate, whilst another smaller aperture above is intended to take the glass cover with the object in a hanging drop.

Gas and Moist Chambers.—It is often necessary to ascertain the influence of various gases upon the objects under examination, and for this purpose various devices have been made use of, known as "gas chambers."‡ The different forms of "culture cells" are readily convertible into gas chambers, and a great variety of suggestions have been

* Brit. Med. Journ., 1887, No. 1391, p. 470.

† Bericht ü. d. Wiss. Instrumente a. d. Berliner Gewerbeausstellung im Jahre 1879 (Löwenherz), 1880, pp. 304–5 (1 fig.).

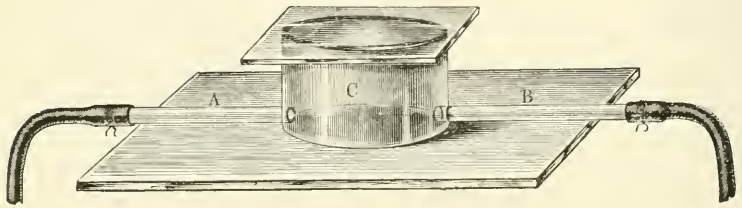
‡ C. Robin describes Poiseuille's "Porte-objet pneumatique" of 1832, as the first known "gas chamber." This was, however, a copper box (with two apertures closed with glass) in connection with an air-pump to experiment upon the effects on living organisms of condensing or rarefying the air. Cf. 'Traité du Microscope,' 1877, p. 159.

made, including those of *Stricker*,* who converted his putty cell so as to make it available for gas, by the simple process of introducing two small glass tubes through the putty, and a second form, with a mercurial valve, which he † adapted from Kühne. *Harless* used two glass slides, the sides of which were cemented together so as to keep them about 0·5–1 mm. apart; the two ends were fixed in pieces of cork, and two tubes passed through the corks communicating with the space between the slides. *Kühne's* was a small glass box into which two tubes were led. *Huizinga* ‡ used a glass tube with a bulb in the centre, ground off above and below so as to have two openings, both of which were closed by cover-glasses, the object being placed on the under side of the upper one. *Heidenhain's* § was a square metal box with apertures closed by glass plates. *T. W. Engelmann's* ‖ was also similar.

The following forms have not yet been described in English:—

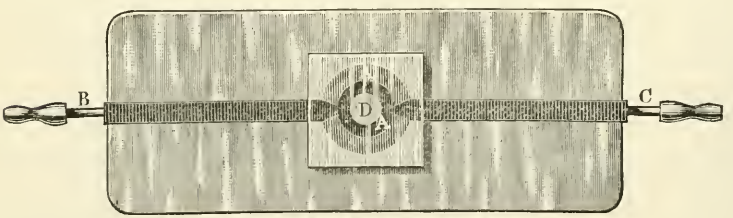
Böttcher ¶ suggests the apparatus shown in fig. 46, consisting of a short piece of tube C, and two tubes A and B, all cemented to a slide.

Fig. 46.



In *Strecker's* ** (fig. 47) a hollow space with a groove A is cut away from a thick glass plate, and is surrounded by a glass ring of pro-

Fig. 47.

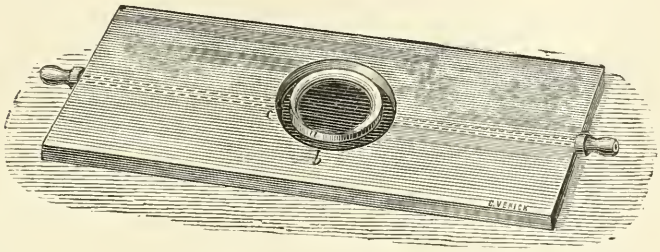


portionate height cemented to the plate. At two opposite points of the latter, and along the diameter of the plate, are shallow grooves in which are cemented the glass or metal tubes B and C extending as far as the groove A; one of these is connected with the gas reservoir by means of a guttapercha tube. The object is suspended in the central space D.

* 'Manual of Human and Comparative Histology,' transl. by Power, 1870, pp. viii.–ix. (1 fig.).
† Op. cit., pp. xi.–xii. (1 fig.).
‡ Med. Centralbl., 1867, p. 675.
§ Thanhoffer's Das Mikroskop, 1880, pp. 86–7.
‖ Jenaisch. Zeitschr. f. Med. u. Naturwiss., iv. (1868) pp. 331–3.
¶ Dippel's Das Mikroskop, 1882, p. 663 (1 fig.).
** Ibid., pp. 663–4 (1 fig.).

Prof. Ranvier * recommended the apparatus shown in fig. 48. A brass plate *b* has a circular aperture of 2 cm. closed with a plate of glass,

Fig. 48.



to which is fixed a smaller glass disc *a*, so as to leave a circular groove *c*. When the cover-glass is put on there is 0·1 mm. between it and the upper surface of the disc. Two holes pierced through the brass plate longitudinally admit and draw off the gas.

M. A. Nachet improved on this by the gas chamber shown in figs. 49 and 50, which has the advantage that the glass on which the liquids to

Fig. 49.

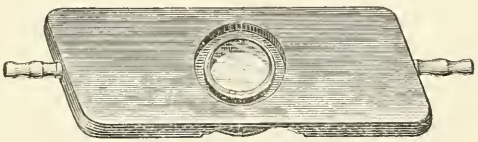


Fig. 50.

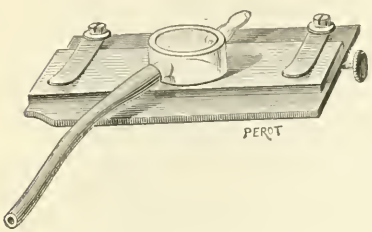
be examined are placed can be raised or lowered by a fine micrometric screw let into the thickness of the metal plate. By this means the thickness of the layer of liquid beneath the cover-glass can be increased or diminished.

The modified cells of *Nachet* (for allowing culture systems to be multiplied indefinitely) which we described at p. 708 of Vol. III. (1880) are shown in fig. 51. These were specially intended for use with the Chemical Microscope, where the objective is beneath the slide. A brass plate is attached to the stage and holds, by clips, the glass slip to which the gas chamber is attached. This consists of a glass ring and two tubes in one piece. The bottom of the ring is closed by a piece of cover-glass, and is cemented over an aperture in the slide. The body-tube and objective of the Chemical Microscope, it will be remembered,

* 'Traité technique d'Histologie,' 1875, pp. 44-5 (1 fig.).

moves over the stage, so that the complete immobility of the object is assured. "If one reflects on the necessity of attaching indiarubber tubes to two glass tubulures, and to be certain of the perfect immobility of certain anatomical elements, the advantage of such an arrangement will be readily understood. Experiments in the culture of ferments, the absorption of gases, the rarefaction and compression of air are thus greatly facilitated." *

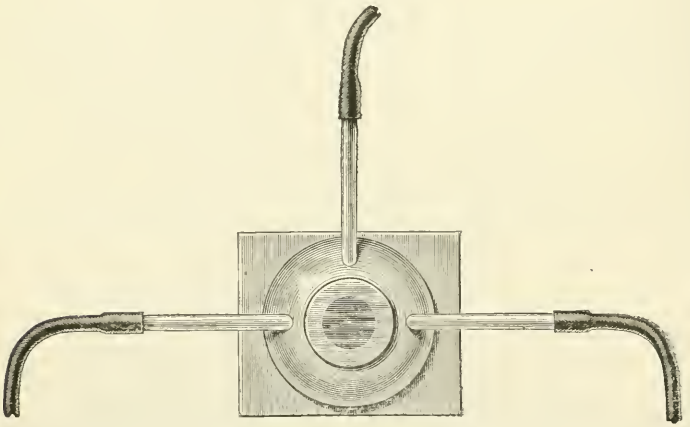
Fig. 51.



The most complete form of apparatus, however, for experimenting with gases is the *Stricker-Sanderson* hot stage, which is described and figured in this Journal, 1887, p. 309, fig. 68.

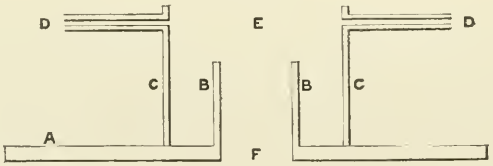
To allow of a rapid change of gases, *Lancaster's* apparatus † (fig. 52), made out of a watch-glass, had two glass tubes for the entrance of the

Fig. 52.



gases. These were connected with indiarubber tubes provided with spring clips, so that different gases could be experimented with in rapid succession.

Fig. 53.

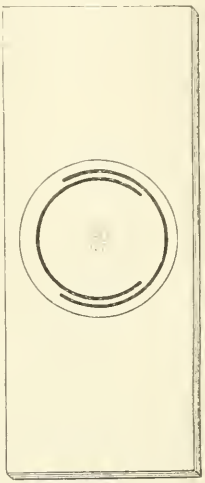


Hansen's Moist Chamber ‡ is shown in fig. 53, where A is a glass plate with a central aperture F, and having two rings C and B. The

* Catalogue, 1886, pp. 33–5 (2 figs.). † Dippel, op. cit., p. 664 (1 fig.).
‡ Meddelelser fra Carlsberg Laboratoriet, 1881, pp. 184–6 (2 figs.), with French résumé.

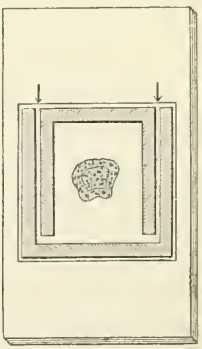
object is placed on a cover-glass, which is cemented with vaseline to the lower side of A, closing the opening. The space between the two rings is filled with water. Two tubes at D admit air or gas to the interior, and the top of the outer ring is closed at E by a cover-glass cemented on. It is claimed that it combines the advantages of the moist chambers of Böttcher and Ranvier. The nutrient fluid has a free surface, as in Böttcher's, but faces upwards instead of downwards, an advantage in many cases; and, as in Ranvier's, is steady. It resembles Ranvier's in having the water, which assists in preventing the evaporation of the nutrient fluid, separated from it. The construction allows, moreover, of a new fluid being introduced, and parts of the old one removed, without, at least in certain conditions, disturbing the vegetation. It is possible, therefore, to commence the culture with a single cell, and proceed gradually to a large mass. The chamber can be used only with Microscopes where the objective is below, and the illuminating mirror above the object which is being examined.

Fig. 54.



Dr. T. R. Lewis's Moist Slide * is shown in fig. 54. Two semicircles of asphalt varnish were brushed on the slide, one being rather larger than the other, so that the ends of one half-circle might overlap the other, but not so closely as not to permit the entrance and exit of air. When nearly dry a minute quantity of growing fluid was placed in the centre, upon which a few spores were sown, a cover-glass being placed over it, which adhered to the semi-dried varnish. The slide was placed under a bell-glass, kept damp by being lined with moist blotting-paper.

Fig. 55.



Dr. Maddox's Slide is shown in fig. 55. A strip of tinfoil is cut into two ∪-shaped pieces, one being larger than the other, so that when the smaller is placed upside down ∩ it will fit loosely inside the upright portion of the other. These are fixed in this position on a glass slide with a little varnish, over which a thin cover-glass is so arranged that the only air or foreign matter which can reach the preparation must pass up the "chimney" thus formed, between the inner margin of the larger strip of the tinfoil, and the outer one of the smaller. The arrows indicate the spaces left open for the admission of air.

Bertrand's Refractometer.†—Mr. E. Mallard finds that this instrument ‡ requires certain corrections due to the fact that the lower surface of the hemispherical lens does not pass exactly through the axis of rotation.

* 'Report on the Microscopic Objects found in Cholera Evacuations, &c.,' 1870, p. 17 (1 fig.).

† Bull. Soc. Franç. Mineral., ix. (1886) pp. 167–71. Cf. Neues Jahrb. f. Mineral., i. (1888) Ref. p. 10.

‡ See this Journal, 1887, p. 469.

If the instrument is in perfect adjustment, the readings are expressed by the formula $n = N \sin \phi$, where n is the index required, N is the refractive index of the hemispherical lens, ϕ is the angle between the position of the lens for total reflection, and that in which its base is perpendicular to the axis. The apparatus must be graduated by experiment, and the value of N is found by observing some substance whose index is known. If N′ and ϕ' are the observed values, and νf their errors, the above equation becomes $n = (N' + \nu) \sin (\phi' + f)$, or expanding and neglecting terms of the second order $\frac{n}{\cos \phi'} - N' \tan \phi' = \nu \tan \phi' + f N'$. From this formula N and f are determined by observation of a number of known substances.

In the refractometer examined by M. Mallard $f = 1° 44'$, but when the correction was applied, indices of refraction were given correctly to two or three units in the fourth place of decimals.

Apparatus for Microphysical Investigations.* — The following notes are by Dr. O. Lehmann :—

Warming and preserving the objects.—Fine wire gauze should be used with the author's crystallization Microscope to prevent the cracking of the slide during the heating of the object. To preserve the object the author runs a drop of paraffin round the edge of the watch-glass which covers it, by which it is then hermetically inclosed. For sudden cooling it is advisable to use mercury, in which the slide is immersed with the cover-glass downwards.

Change of solubility by pressure.—A Cailletet pump, filled with glycerin, is connected by means of a long copper capillary tube with a glass capillary, which is cemented on the stage of the Microscope with shellac. The glass tube is previously filled with a hot saturated solution and the end of the tube is then sealed. The capillary is placed in a drop of oil on the stage, and covered with a flat watch-glass. After waiting until the conditions are constant, the pressure is suddenly raised to 300 atmospheres, and so maintained; any crystal in the capillary is then seen to be slowly increasing in size; after a few minutes this growth ceases, and if the pressure is then withdrawn re-solution will commence, the edges and corners becoming rounded, and the faces corroded.

Microscopic determination of capillary pressure.—A fine capillary tube of a diameter less than 0·001 mm. is connected with an apparatus for regulating the pressure. The apparatus consists of two receivers, one filled with compressed and the other with rarefied air, both connected with the capillary by means of cocks. The pressure is measured by a large mercurial manometer. The end of the capillary tube having been brought into a drop of water upon a slide, and covered with a cover-glass, the pressure is regulated so that the water which has entered the tube is just driven back to the aperture. The author has used pressures of nearly five atmospheres.

It may be also proved by this apparatus that the capillary attraction and viscosity diminish as the temperature increases. The diameters of very fine tubes are determined by immersing them in a liquid having the same index as the glass of which they are made, and measuring with an eye-piece micrometer.

* Zeitschr. f. Kryst., xii. (1887) pp. 377–410. Cf. Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 115–23.

Microscopic determination of vapour tensions.—The method consists in introducing the vapour into a U-tube, one leg of which is closed, while the other is connected with two receivers containing compressed and rarefied air respectively; for microscopic measurement the U-tube is a capillary, its horizontal part is immersed in a water or paraffin bath, and examined by a Microscope with horizontal tube bent at a right angle near the objective. The use of capillary tubes has the advantage that minute quantities of the substance are employed and can be examined under very high pressures. The observation should be made when the vapour volume is as large as possible in comparison with the expansion of the liquid in contact with it.

Microscopic determination of the thermal expansion of liquids.—For this purpose a similar apparatus is used except that the U-tube is replaced by another, one leg of which terminates in a funnel and ground-glass stopper, while the other has a horizontal capillary tube projecting from it to contain the experimental liquid. This tube can be maintained at a constant temperature by a water or oil bath, and is observed by the horizontal Microscope; it is filled by heating to expel the air and then forcing the liquid in by pressure from one receiver; the superfluous liquid is then removed and the remainder of the tube filled through the funnel by suction from the other receiver with some coloured fluid. Coloured glycerin, for example, may be used in examining the expansion of carbon disulphide, the movements of the point of junction between the two liquids being followed by the horizontal Microscope.

Microscopic determination of compressibility.—For this the author uses the Cailletet apparatus; the liquid is contained in a vessel like a thermometer, the end of which is inserted into the glass capillary used for liquefying gases.

KLAATSCH, H.—**Ein neues Hilfsmittel für mikroskopische Arbeiten.** [Radial micrometer.] *Anat. Anzeig.*, 1887, pp. 632–4.

(4) Photomicrography.

Photomicrography of Chemical Preparations.*—Dr. O. Lehmann recommends the use of oblique illumination and the colouring of the preparations; in photographing crystals it is important that they should appear upon a dark ground, and this is best effected by the Töpler contrivance as constructed by Seibert, in which half the field is darkened by a screen below the stage, and the other half by a screen above the eyepiece. As crystals cannot be coloured like organic preparations, it is best to use polarized light with doubly refracting crystals at any rate. By using the nicols parallel, or not crossed, the crystals are made to appear bright, dark, or coloured upon a bright or dark field.

Neuhaus's Photomicrographic Camera.—Dr. R. Neuhaus's camera is claimed to be distinguished from others which serve the same purpose by the fact that it can be extended to the length of 180 cm., and that the focusing of the Microscope can be simply effected for any length of the camera.

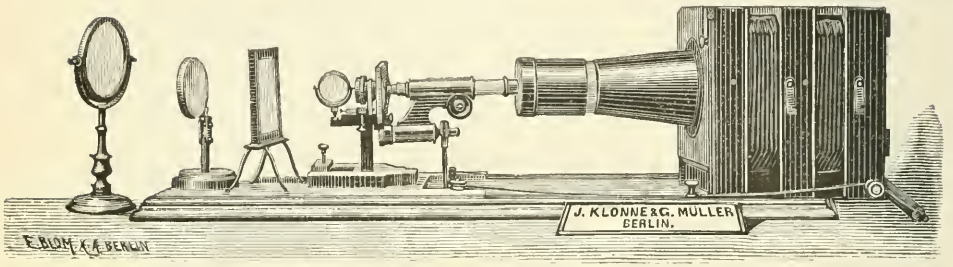
It consists of bellows $1\frac{1}{2}$ metre in length divided into two parts, so that one can be kept compressed when the other is completely extended, and it can be clamped at any desired length. The guides in which the

* Loc. cit.

bellows and its frames run are made to slide into one another, and when the camera is completely closed they can be placed under the base on which the Microscope stands, so as to be out of the way. The Microscope used for photomicrographic work is fixed to a slide which moves between guides on the base in such a way that the tube is horizontal, and is directed to the centre of the camera, the optic axis of the Microscope passing through the centre of the sensitive plate. The Microscope may at any time be removed, to be used for other purposes, and can be rapidly and easily clamped in the right position.

To adjust an object, the front of the camera which is nearest to the Microscope, together with the partly conical tube of 30 cm. length, which

Fig. 56.



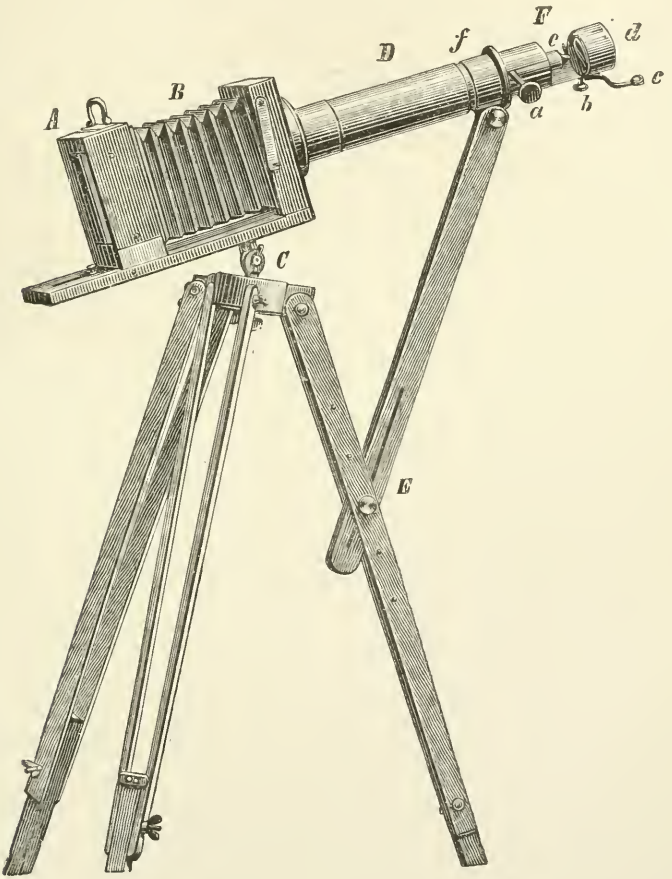
is provided with internal diaphragms, is drawn out, the Microscope is pushed in on its slide until its end approaches the aperture of the conical tube, the lamp or other source of light is then adjusted, and the object is adjusted in accordance with the directions of Dr. Neuhaus, which are supplied with the camera, the camera front is replaced and clamped, and the light-proof connection between the camera and Microscope is fixed in its place.

The fine-adjustment is effected by a curved forked clamp made of watch spring, the two ends of which take into the milling of the micrometer screw; two strings are attached to the clamp, and passing over pulleys on the right and left hand, traverse the whole length of the camera, and are fastened to a wooden rod; the strings can be rolled or unrolled upon the rod so that the latter always hangs in front of the camera. When the camera is drawn out the string is lengthened by unrolling it. By pulling upon the one string or the other the micrometer screw is made to turn to the left or right. In this way the fine-adjustment is made without any inconvenient connecting rods, and can be effected directly by one hand, while the other is engaged with the focusing lens; the motion obtained by the clamp on the micrometer screw is, it is claimed, quite fine enough to secure the complete sharpness of the image.

The plates which can be used are 13 × 21 cm., or half that size. With the arrangement of the source of light, illuminating lens, and Microscope described, impressions may, it is said, be taken of Bacteria × 1000 with an ordinary petroleum lamp and an exposure of a few minutes. With direct sunlight an exposure of a few seconds is enough even with the highest powers.

Stein's "Large Photomicroscope."‡—Dr. S. T. Stein's instrument (fig. 57) consists of a "parallactic" tripod, to which the camera B is attached by a ball-and-socket joint C. The triple tube D has a ring *f* connected with E, which has a slot by which it can be moved up and down on a pin in one of the legs of the tripod. The optical part is at F, consisting of an objective *e*, coarse-adjustment *a*, fine-adjustment *b*, and

Fig. 57.



condenser *d*. An arm at *c* carries a reflector or lamp. The apparatus can be extended so as to give a length of 1½ metres from A to *d*.

Photomicrographs of Diatoms.—MM. A. Truan and O. Witt have just issued a work beautifully illustrated by photographs taken from nature of the fossil diatoms from Jeremie, Hayti. Full details of the processes employed are given in the introduction.

The peculiarity of their method consists in first photographing the

* Stein's 'Das Licht im Dienste Wiss. Forschung,' 2nd ed. 1885, pp. 177–8 (1 fig.).

object with a magnification of not more than 100 diameters, and afterwards reproducing it magnified five times so as to obtain a photograph magnified 500 diameters proper for photo-printing. Fine details are thus brought out, invisible to the naked eye in the smaller photograph.

Crystal Palace Photographic Exhibition.

[Special Certificate in Class F. (General Appliances and Plant) "awarded to James Swift & Son for Apparatus and Microscopes arranged for Photo-micrography."]

Journ. and Trans. Phot. Soc. Gr. Britain, XII. (1888) p. 80.

Jeserich, P.—**Die Mikrophotographie auf Bromsilbergelatine bei natürlichem und künstlichem Lichte unter ganz besonderer Berücksichtigung des Kalklichtes.** (Photomicrography by the bromo-silver gelatin process with natural and artificial light, with special reference to the limelight.)

xiv. and 246 pp. (4 photomicrographs and 60 figs.), 8vo, Berlin, 1888.

Knösel's Photomicrographs.

[Note on some photomicrographs of animals and plants, taken by the oxy-hydrogen light.]

Zeitschr. f. Naturwiss., LX. (1887) p. 481.

(5) Microscopical Optics and Manipulation.

Advantages of a Knowledge of the Theory of the Microscope.—Dr. W. H. Dallinger writing * on the English translation of Nägeli and Schwendener's 'The Microscope in Theory and Practice,' says that it "opens to English readers an entirely new page in microscopical literature. It leads the way in supplying a want which every thorough microscopist has realized for the last twenty years. In a complete form this treatise has been accessible to the German reader for at least ten years. The absence of it, or an equivalent, in the English language has been a most serious drawback to the advancement of the highest optical work in English Microscopes. In optical manipulation, the English optician at his best proves not only equal to any in the world, but in the highest class of work, has shown lately that he takes a foremost place. But with no attempt on the part of English mathematicians and microscopists to become masters and expounders of the theory of the Microscope and of microscopic vision, the practical optician can make no real advance. English "stands," and those made in America on English models, are of exquisite construction, and are quite equal to our present necessities; but for all the great advances and improvements that have been made in *English* object-glasses during the last fifteen years, we are, for all practical purposes, primarily indebted to Germany. And this is readily explained by the fact that the German specialists have made a systematic and persistent study of the theory of the Microscope.

"It is not forgotten that it was to the suggestion of Mr. J. W. Stephenson that we are indebted for the invaluable improvements that belong to the homogeneous system of lenses.† But, without doubt, it was on account of the insight which a study of the theory of microscopic vision brought with it, that Mr. Stephenson perceived at once the advantages of great numerical aperture, and the new way to obtain it. Moreover, it is certain that Prof. Abbe was approaching this very method of employing lenses, though from another point, and not in so direct a way. It would have been shortly reached by him, there can be but little question; but when it was reached, what did a constant, enthusiastic, and laborious study of the theory of the Microscope carry

* Nature, xxxvii. (1887) pp. 171–2.

† See this Journal, 1878, p. 51.

with it? A perception, that with glass of greater range of refractive and dispersive indices than any we possessed, we might not only secure great numerical apertures, but secure them devoid of all colour; that we could not only annul the primary, but also the secondary and tertiary spectra. It need not surprise us then, that in a country where such splendid theoretical and mathematical work had been done by experts on the principles of microscopic lenses and the laws of their construction and use, even the Government should be convinced that the time to aid the optical expert had come; that theory had demonstrated the practical possibility of a great improvement in the construction of lenses. The sum of 6000*l.* was granted by the German Government to Abbe and his collaborateurs, and with, as we have reason to believe, an equivalent outlay on Abbe's own part, the new glass was prepared; and the new apochromatic lenses with their systems of compensating eye-pieces devised.

"It is in no spirit of boast, but rather in a spirit of humiliation and regret, that we say that we have examined many of these apochromatic objectives of all the powers made in Germany, and we have examined all the principal ones that have, since the new glass has reached London, been made there; and we are bound to say that the English work, based on the principles laid down by Abbe, is so fine as to make the regret immeasurably keener that English microscopical literature has been for all these years a blank for practical purposes, on the theory and principles of optical construction, and on the theory of microscopical observation and interpretation. Such a paper as that of Prof. G. G. Stokes, P.R.S., on the question of a theoretical limit to the apertures of microscopic objectives * from its very loneliness only gives emphasis and point to our contention. Those who have any doubt of the full force of what we are here contending for, have only to compare a dry 1/6-in. objective, say of twenty-five years ago, made by the best makers in London, with a well-chosen water-immersion of ten years ago; and both these with a recent homogeneous glass of the same power with a numerical aperture of 1·5. Or still better, a dry 1/50-in. objective, of the same date and the same makers, of numerical aperture 0·98, with a water-immersion lens of the same power of say ten years ago, having an aperture of 1·04, and a recent homogeneous 1/50 in., with a numerical aperture of 1·38. Still more strikingly, let the same observations be made with a dry 1/12 in. objective of twenty years ago, with a numerical aperture of 0·99, and a homogeneous lens of the same power, with numerical aperture 1·5; and finally, both these with an apochromatic objective of the same power by the same London makers, and an aperture of 1·40. We venture to say, to histologist, bacteriologist, diatomist, and all other serious workers with the Microscope, that there can be no proper comparison of the results; or, rather, the comparison is odious indeed for the oldest, and even the elder lenses.

"But, as we have stated, it is to Germany we are indebted for the knowledge out of which, alone, these improvements could have arisen. In spite of the length and abundance of English treatises on the Microscope, it has never been part of the scope of the respective authors to do other than make the scantiest reference to the principles of the Microscope; and nothing is found that will elucidate the theory of the

* See this Journal, 1878, p. 139.

construction of objectives, and eye-pieces, and the possible and real relations of each to the other. There is nothing to be found indeed in our language (except in the invaluable translations published in the successive Journals of the Royal Microscopical Society) which discusses the phenomena of diffraction, of polarization, of the principles of the true interpretation of microscopical images, and the theory of work with the Microscope. English workers with high powers have discovered painfully where their lenses during many years were at fault; they could show our opticians what they wanted; but it has been only as the result of the laborious mastery of the theory of lens-construction by German investigators, with Abbe at their head, that the English worker has been able to get his wants, in object-glasses and eye-pieces, supplied.

"But like all advances in insight and analytical power, these very improvements, so welcome and so helpful to searchers in many important branches of science, only open up the horizon of the unknown more fully; and the very knowledge we get, through the inestimable improvements, only reveals new difficulties; and again creates optical wants. It is then, with pleasure indeed that we hail this excellent translation of Nägeli's work on the theory and practice of the Microscope."

Fasoldt's Test-plates.—A good deal of amusement has been felt in the Old World at the vagaries of part of the New over these plates. As Old World microscopists are aware, it is one of the plainest and best established scientific truths that there is a limit to the number of lines to the inch that can be made visible to the human eye with our existing optical appliances, and to believe that more have been seen relegates the believer to the ranks of those who believe in perpetual motion, the creation of force, squaring the circle, and other self-demonstrated fallacies.

Our American brethren are not one whit behind us in their appreciation of scientific principles, and it was therefore puzzling to read from time to time positive statements that many people had seen 200,000 lines to the inch—the limit, even with the maximum aperture of 1·52, being 158,845. We put out of account the statements of the ruler of the lines, as he may be forgiven a not unnatural tendency to see lines that he feels certain his acknowledged mechanical skill has really put on the slide.

We gather that the explanation of these discrepancies is that the persons who are "ready to make affidavits" that they saw the lines are people who have had no practice in such observations, and it is well known how much the power of recognizing such minute magnitudes is dependent upon long habit and experience. It will be seen from the second report printed below that Dr. R. H. Ward, the well-known microscopist, has investigated the matter—under the superintendence of Mr. Fasoldt and his son—and that the results are in accordance with theory. The 110,000 band was seen with perfect ease, and the 120,000 clearly, though with difficulty, "while in higher bands no trace or suspicion of lines was perceived." Mr. Fasoldt himself "did not seem to recognize the lines nearly as far up in the series as this," while his son, who was the manipulator, could see nothing beyond 130,000. Dr. Ward further shows that the people who allege they have seen the higher bands admit that they "furnish only passing glimpses and cannot be kept in focus and examined at leisure or shown to other observers."

We have prefaced Dr. Ward's report by that of a Mr. P. H. Dudley,

which is a good specimen of the kind of evidence seriously put forward as sufficient to upset fundamental laws of light. It will be seen that Mr. Dudley was unable to resolve the 160,000, 170,000, and 180,000 band, but that "the 190,000 band came out sharp and clear. This was all he could do at that time!"

(1) *Dudley's Report on the Examination of the Fasoldt Test-plates.**—Mr. P. H. Dudley reports his examination (on an invitation from Mr. Fasoldt) of test-plates of his ruling, "as shown by his new vertical illuminator, lamp, and specially constructed Microscope." It was, he says, "an interesting and instructive evening." The stand was one constructed by Mr. Fasoldt, substituting a screw movement to the body instead of the ordinary rack and pinion. The vertical illuminator had, like Beck's, a thin glass for a reflector, but the method of mounting, construction of the diaphragms, and means to control the light, were "entirely different." The mechanical stage was constructed for the purpose of making fine measurements, and comparing micrometers. The eye-piece carried a micrometer, which had three delicate steel prongs in lieu of cobwebs, or lines on glass. Each prong was adjustable, extending partway across the field. One was in the upper part, and two in the lower part of the field. The advantages of the prongs are many, one being that but part of the line is covered. The lamp had a single wick, 2 in. wide. In trimming, the wick was curved from edge to edge; the centre being fully 1/8 in. higher than the edges. The chimney was specially formed of a metallic frame, carrying parallel plate-glass sides; those opposite the width of the frame about 3 by 4 in., and those opposite the edges 3 by 2 in. On the top of the frame was put a metallic tube, about $1\frac{1}{4}$ in. diameter, and 14 in. high, to produce the draught. The flame was large, and burned very white and steady. The lamp was placed from two to four feet from the Microscope, the edge of the flame being turned towards the illuminator, a small condenser, of 2 in. focus, being placed before the illuminator, so as to throw an image of the flame obliquely across the band of lines. The entire field was not equally illuminated, as better results are obtained by having different portions of different degrees of brightness.

Photomicrograph No. 1 shown by Mr. Dudley was of a test-plate having nineteen bands—said to have bands ranging from 5000 lines per inch, to the eighteenth, which has 120,000 lines per inch. The nineteenth band only has 50,000 lines per inch of the same depth of cutting as the eighteenth band. These bands all having been resolved, new plates were ruled, having finer bands.

Photomicrograph No. 2 was of a test-plate with bands in the metric measures. In one important respect the system of ruling on this plate was modified. Each band, for a short portion of its length, was only ruled with one-half of the number of lines in the rest of the band.

Photomicrograph No. 3 was of a test-plate having twenty-three bands; the highest having, it is said, 200,000 lines per inch. The ruling was very delicate, and the lines quite shallow, as must be the case. "Mr. Fasoldt says twelve persons have seen the lines in the last band, under his method of illumination, and with a Bausch and Lomb 1/12 in. objective, N.A. 1·35."

The first evening Mr. Dudley looked at the test-plates he saw the

* Journ. New York Micr. Soc., iv. (1888) pp. 81–4.

lines in the band of 130,000, clear and well-defined, after the instrument was focused. Unaided he was unable to go beyond the 90,000 band. This trial was made after a railroad trip of ten week-days and five nights. The vision was not as acute, and the touch of the fingers was not as sensitive as usual. In about a week afterwards, at a second trial, he "saw all of the lines to the 160,000 band, which he was unable to resolve." The 170,000 and 180,000 bands he "did not resolve, but the 190,000 band came out sharp and clear. This was all he could do at that time. The delicacy of focusing is probably as difficult as the discerning of the lines."

Photomicrograph No. 4 was of a quadruple ruling, the central bands being 80,000 per inch. When both sets of lines are illuminated, the spectra produced are gorgeous. "Mr. Fasoldt states that rulings which do not produce spectra are not resolvable, and he discards such rulings, as the lines are ruined."

"These rulings are of very great interest to the microscopist, as a measure of what can be done by different methods of illumination. After many trials by transmitted light, the band of 90,000 lines per inch was the most I could resolve. Mr. Fasoldt says the 110,000 band is the highest one he knows to have been resolved by the same 1/12 objective by transmitted light. It would be very interesting to know what kind of rulings Prof. Abbe used in determining the theoretical resolving power of an objective, as well as the method of illumination."

(2) *Dr. Ward's Report on the Examination of a Fasoldt Test-plate.*—Dr. R. H. Ward's report was embodied in remarks made at the Pittsburg meeting of the American Society of Microscopists. The following is furnished to us by the author:—

The plate consists of twenty-three bands ruled on a cover-glass, beginning at 5000 lines to the inch, and increasing by 5000 each time to 30,000, and thence by 10,000 each time to or toward 200,000. The lines are ruled alternately longer and shorter, so that the 40,000 band becomes at each end a 20,000 band with interlying lines, and the "200,000" band should be seen, if resolved at all, as a 100,000 band similarly interlined. The extraordinary mechanical skill of the maker and his success in ruling the lower bands attach real interest to the plate, and to his methods of studying it, in respect of the possibilities of fine ruling and of extreme resolution; an interest which is enhanced rather than diminished by the maker's easy faith in the character and visibility of the highest bands and his inability to apprehend the mechanical uncertainties and scientific absurdities involved in this belief. If he has done even a small portion of what he thinks, he has far surpassed all other experimenters, as far as yet proved, and has earned and will receive the credit that he claims.

Upon learning of the appointment of a committee to consider the subject, Mr. Fasoldt tendered a request that he might be allowed to be present when the plate was examined, and kindly offered the use of his apparatus, and also of his own services, "to show the lines" to the Committee at any time. Believing it to be of scientific as well as historic interest and importance to know exactly what he saw and how he saw it, I replied that while it would be impracticable for the Committee as a whole to make the proposed arrangement, as a member of the Committee I would gladly accept his offer to show the lines, and that the lines desired to be seen were those of the higher

band, from "120,000" upward. No objection was made to this form of acceptance.

At an appointed time, one afternoon, the Microscope was placed in a wooden cabinet which nearly excluded daylight, and light from a kerosene lamp, with a large flat wick, placed edgewise at a distance of about two feet, was admitted through an opening in a cabinet on a level with the nose-piece of the Microscope. The stand was a large and heavy one, made by Mr. Fasoldt himself, with about ten inches of tube-length, including the objective, and furnished with a Bausch and Lomb 1/12-inch hom.-imm. objective claiming 1·40 N.A., and a 1-inch "periscopic" ocular by the same makers. The illuminating rays were brought to a focus at the side of the nose-piece, and about one-fourth of an inch from it, by means of a "watchmaker's glass" of about two inches focus, mounted as a bull's-eye condenser, the best effect being gained with an achromatic one said to have been made for the purpose. The divergent pencil was then admitted to the tube, and reflected downward through the objective by means of a cover-glass internal illuminator claimed and patented by Mr. Fasoldt as his own. The peculiarity of this illuminator (aside from the oddity of its large size and square shape, the substitution of Fasoldt's spring nose-piece for the ordinary Society-screw to carry the objective, and an adjustment for withdrawing at will the cover-glass reflector from the optical axis), consists of an ingenious combination of shutters at the side, by means of which light is admitted only through a long narrow slit that is adjustable in both width and position. With this arrangement a variety of bright- or dark-field effects were obtained by slight changes in the position of the lamp and the adjustment of the slit. When the image of the illuminating flame was formed by the objective just at the edge of the field of view and slightly out of the plane of the object, a transparent effect was produced over a considerable portion of the field, presumably by internal reflection at the bottom of the dry-mounted cover-glass, on the lower surface of which the lines were ruled, and in the bright portion of the field the lines of the lower-middle bands were very easily and distinctly seen.

Starting from any of the coarser bands, where there could be no question about the lines, the plate was moved across the field by means of the steady mechanical stage, and the lines of successive bands appeared with distinctness, but increasing firmness, up to the band claiming 110,000 to the inch, which was seen with perfect ease, and the alleged 120,000 which was seen clearly and repeatedly, though with difficulty, while in higher bands no trace or suspicion of lines was perceived. The same limit was reached in several separate trials by the writer, whose eyes, however, by reason of long over-use, should set no limit against the reasonable claims of others presuming to go further. Mr. Fasoldt himself did not seem to recognize the lines nearly as far up in the series as this; but his son, Ernest C., who was depended upon for most of the manipulation, was positive that he saw the lines in the "130,000" band, and none beyond that. Any importance attached to his judgment at this interesting point must be received in connection with the fact that on another occasion he was satisfied that he resolved a "200,000" band. No attempt to measure the spacing of the lines was made at that time, and none is ready to report now.

Mr. Fasoldt's faith in the integrity and visibility of the still higher bands, which faith, it is scarcely necessary to say, is not known to be

shared by any scientific man, seems to depend wholly upon his belief in the infallibility of his carefully concealed method of ruling them, and upon his impression that he has seen the lines as high as "150,000," and upon the equally firm impression of a few other persons that they have seen all up to and including the "200,000." These persons, however, admit that the higher bands furnish only passing glimpses, and cannot be kept in focus and examined at leisure or shown to other observers, as can be done with more or less ease up to "120,000." Is it possible that, after looking long and intently at the coarse and really visible lines, the retinal impressions may remain and be recognized by the observer while subsequently gazing at the higher bands?

On another occasion, when it was claimed that all the bands of a duplicate plate were resolved, and that the illumination was exceptionally good and the resolution exceptionally easy, the writer, and two friends with younger eyes who accompanied him, recognized the lines of the 110,000 band very easily and distinctly, but failed to go further.

"It would be evidently improper to undertake to anticipate the action of the Committee as a whole, by saying exactly what should be considered sufficient evidence to establish the reality of certain of the lines and the fact of their resolution; but it will be noticed that the projecting alternate lines must greatly aid in the task of counting a measured portion of a band either with a micrometer or by aid of photography. It can scarcely be long impossible to make a satisfactory count of the band claiming to be spaced at 120,000 if it is correctly ruled, since the lines really to be counted are only at 60,000. And if, which is not improbable, though not yet formally demonstrated, this band should prove to be successfully ruled and to be resolvable by existing lenses, a fact that has been plausibly claimed but never yet really proved of any band of equal fineness, then the study of the next two bands would be one of the most interesting problems in the practical optics of the present day. At the same time, it seems not improbable that photography may not only give us an easy count of lines visible, but extremely difficult to count otherwise, but may yet show the details of bands that are permanently beyond the reach of direct microscopic vision."

With regard to Dr. Ward's last remark, we should remind our readers that, as we have already shown,* photography increases resolution in the inverse ratio of 53 to 40, the limit being raised from 158,845 to 193,037 lines to the inch.

Daylight or Lamplight for Microscopical Observation.†—Dr. W. H. Dallinger, referring to the fact that Nägeli and Schwendener give the preference to daylight over lamplight, believing that it exerts less strain upon the eye, says he suspects that the majority of English observers, especially at continuous work, and with high powers, will be inclined to reverse this judgment. Extremely white and intense light can be obtained from good modern lamps, and, unlike daylight, it is unvarying, devoid of caprice, and easy of manipulation. But this is a matter, perhaps, in some sense subjective, and not of vital moment.

Curious Interference Phenomena with Amphipleura pellucida.—Mr. E. M. Nelson writes:—"I have recently observed some remarkable interference phenomena in connection with photomicrographic glass

* See this Journal, 1885, p. 968.

† Nature, xxxvii. (1887) p. 173.

positives of *Amphipleura pellucida* × 730, the transverse striæ on which count 126 to the inch. The wooden case in which the positive is placed carries a Zeiss achromatic lens (No. 127) × 6, focused on the photograph.

The interference phenomena are as follows:—When the photograph is viewed through the lens, the illumination being of some extent, such as diffused daylight from a white cloud or wall, opalescent globe, &c., the transverse striæ appear as in fig. 58; but when the source of light is of smaller dimensions, such as a common Microscope lamp with a half-inch wick, the striæ are seen as in fig. 59.

Fig. 58.

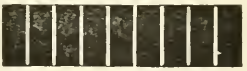


Fig. 59.

This change of appearance cannot be accounted for by the non-admission of the pairs of diffraction spectra of either the 1st, 2nd, or 3rd order, because the angular divergence of the 1st diffraction spectrum from the dioptric beam is about as many minutes of arc as the lens has degrees of aperture.

Any moderate difference in the relative size of the striæ and interspaces would not alter the case, for Prof. P. G. Tait states that 'the ratio of the breadths of the bar and interstice has but little effect on the result unless it be either very large or very small.' Neither does it matter if the glass side or the film side is next the lens.

Now we come to a very curious point, viz. that other glass positives, printed from the same negative, do not possess the unique peculiarity which this one has. It is true that, by alteration of focus or other manipulation, the above and other diffracted images may be made; but I am aware of no object but this one that possesses the peculiarities above described. The negative from which this positive was printed does not exhibit the phenomena in such a striking manner, and then only by an alteration of focus.

I have another negative × 1200, which will show the effect, but the lens, which has a focus of $1\frac{1}{4}$ in., requires to be altered either 1 inch within or without its focus before it will show it."

Spectra of Pleurosigma angulatum.—This subject is a veritable *pons asinorum* to Mr. E. M. Nelson, who in a further note repeats the mistake on which we commented in this Journal, 1886, pp. 692–5, and which we then described as the most typical instance known to us of a critic being hoist with his own petard.

To understand Mr. Nelson's new note * it is necessary to recall the original one.

Mr. Nelson there † expressed his astonishment on two points. The first was that "the R. M. S." should be so foolish as not to see that Dr. Eichhorn's views on this subject "stultified Prof. Abbe's magnificent diffraction theory."

We pointed out that it was from Prof. Abbe that Dr. Eichhorn's paper was received, and that the problem solved was set by the Professor himself! It was therefore obvious that there was some little mistake somewhere in Mr. Nelson's views.

The second point was that Mr. Nelson declared (giving what he evidently considered irrefragable reasons for his assertion) that the mark-

* Engl. Mech., xlvii. (1888) p. 32. † Ibid., xliii. (1886) p. 337.

ings in question could only be seen by *enlarging* the dioptric beam, and cutting out the six spectra.

Here, again, there was evidently something wrong in Mr. Nelson's ideas, as Mr. Stephenson used only a very *narrow* beam, and none of the six spectra were cut out.

In his new paper Mr. Nelson, never having revised his original premisses, falls into the old blunder over again. Referring to plate III. of the present volume of this Journal, he inquires "what has become of Dr. Eichhorn's fantastic diagram?" and "supposes that the officers of the R. M. S., since writing their strictures on my paper, have changed their minds, and have adopted Dippel's picture, which is similar to mine."

We are afraid that we shall only be adding to Mr. Nelson's present bewilderment when we point out that the fig. which he considers as "similar to his," was laid before the Society many years back, and that it emanated from the same authority as that of Dr. Eichhorn. Here again, therefore, there must necessarily be something a little defective in Mr. Nelson's ideas on the subject!

In our original comments we ventured to give a pretty broad hint as to where Mr. Nelson had gone wrong, but he does not seem to have yet found it out. The superficial way in which he approaches the matter may be judged of by the fact that he treats as a "dictum of the R.M.S." a statement in Prof. Abbe's original paper in Max Schultze's 'Archiv,' translated and published by the Bristol Naturalists Society! We are sure if he would only sit down with a serious determination to master the subject he would have no difficulty in finding where he has gone wrong, and having found it would then laugh as heartily as other microscopists do now at the absurdities into which he has allowed himself to be led.

Poli, A.—Sul modo di valutare ed indicare razionalmente gl' ingrandimenti del Microscopio e delle imagini microscopiche. (On the mode of determining and indicating correctly the amplification of the Microscope and microscopical images.) Extr. from *Spallanzani*, 1887, 11 pp.

„ „ Sulla misura dell' ingrandimento dei disegni degli oggetti microscopici. (On the measure of the amplification of the images of microscopic objects.) *Atti Congress. Naz. Bot. Crittog. Parma*, 1887, *Proc. Verb.*, pp. 109–13.

(6) Miscellaneous.

American Postal Microscopical Club.
[Satirical directions issued by the Club to meet new U.S. postal regulations.] *Queen's Micr. Bulletin*, IV. (1887) p. 45. Cf. *Microscope*, VIII. (1888) p. 22.

Baltimore Microscopical Society. *Microscope*, VII. (1887) pp. 359–62.

Brooklyn Microscopical Society. *Journ. New York Micr. Soc.*, IV. (1888) pp. 96–7.

Central New York Microscopical Club. *Microscope*, VII. (1887) p. 364.

Crisp, F.—**Ancient Microscopes.**
[Friday evening lecture at Royal Institution on February 3rd, 1888.] *Daily News*, Feb. 4, 1888; *Scientific Enquirer*, III. (1888) pp. 44–6; *Morning Post*, 1888, Feb. 4; *Scientific News*, I. (1888) p. 162.

Essex County Microscopical Society of New Jersey. *Journ. New York Micr. Soc.*, IV. (1888) p. 97.

Local Microscopical Societies. *Microscope*, VIII. (1888) pp. 18–20.

Louisville Microscopical Club. *Microscope*, VII. (1887) p. 364.

Mayall, J., Jun.—**Recent Improvements of the Microscope: a visit to Jena.** *19th Ann. Rep. Liverpool Micr. Soc.*, 1888, pp. 8–11.

Medical Microscopical Society of Brooklyn. *Journ. New York Micr. Soc.*, IV. (1888) p. 97.

Microscopical Club of the Buffalo Society of Natural Sciences.
Microscope, VII. (1887) p. 364.

Microscopical Society of Pittsburg. *Microscope*, VII. (1887) pp. 362–3.

NELSON, E. M.—**Nobert's Bands.**
[Lines to inch in 10, 13, 15, 19, and 20 band plates.]
Engl. Mech., XLVI. (1888) p. 460.

Ohio State Microscopical Society. *Microscope*, VII. (1887) p. 363.

[OSBORN, H. L.—**Microscopical Societies should combine for work.**]
Amer. Mon. Micr. Journ., IX. (1888) pp. 35–6.

ROYSTON-PIGOTT, G. W.—**Microscopical Advances.** XXXI., XXXII., XXXIII., XXXIV.
[Butterfly dust—Latticed and beaded Ribs—Researches in High-power Definition—Interferences, Disappearances, and Reappearances.]
Engl. Mech., XLVI. (1888) pp. 449 (6 figs.), 497 (2 figs.), 591 (5 figs.); XLVII. (1888) p. 93 (2 figs.).

St. Louis Club of Microscopists. *Microscope*, VII. (1887) p. 363.

SMITH, L. H.—**Memoir of D. S. Kellicott, Pres. Amer. Soc. Micr.**
Microscope, VIII. (1888) pp. 8–10 (portrait).

VEREKER, J. G. P.—**Presidential Address to the Postal Microscopical Society.**
Journ. of Micr., I. (1888) pp. 1–8.

VORCE, C. M.—**Making Lantern Slides.**
[Correction of his previous paper—see this Journal, 1885, p. 866—and full details of amended process.]
Amer. Mon. Micr. Journ., VIII. (1887) pp. 172–4.

Wenham, Mr.
["Retired.—In a communication to the 'English Mechanic' of a late date Mr. Wenham, whose name is known to every microscopist the world over, announces that he has retired from microscopy; that he has given it up and has not looked through an instrument for several months, and has no expectation of ever doing so again. Mr. Wenham offers no explanation of his determination, but however painful it may be to the thousands who have learned to look upon him as one of the immortals in microscopy, from the tone of his letter we are convinced of his sincerity, and accept his dictum as final."]
St. Louis Med. and Surg. Journ., LIV. (1888) pp. 29–30.

WOOD, J. G.—**The Boy's Modern Playmate. A Book of Games, Sports, and Diversions.**
[Contains a chapter on "the Microscope," pp. 690–701, 14 figs.]
New revised ed., x. and 883 pp. and figs., 8vo, London, n.d.

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Collecting, Growing, and Examining Fresh-water Sponges.†—In a contribution to a synopsis of the American forms of fresh-water sponges, Mr. E. Potts has some remarks on their collection and examination.

In *collecting* the author has found great advantage in the use of the "scraper-net" in relatively deep water, and in connection with perpendicular timbers, &c. This consists of a small net with one part of its edge shaped into a scraper like a garden hoe; it is attached to a long pole. At depths of two feet or less, great facility of action is gained by wearing high rubber boots, and wading after the specimens, to pick from the bottom stones, sticks or pieces of waterlogged timber, under which they may be concealed. Where the water is deeper, of course a

* 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.

† Proc. Acad. Nat. Sci. Philad., 1887, pp. 158–84. Cf. also H. Mills in Microscope, vii. (1887) pp. 291–7.

boat must be used, to approach the floating, submerged, or dependent sponge-bearing substances. A large, strong knife or paper-hanger's scraper will be found convenient for hand work at short range. A case containing trays an inch or so in depth is suitable for carrying the smaller specimens; the larger will of course require vessels of greater size. On reaching home it is well to select some specimens of characteristic shapes, and containing gemmules, for storage in dilute alcohol, making use of wide-mouthed bottles to avoid crushing them. The rest may be spread upon boards in sheltered situations, in the shade (for the sun bleaches them rapidly) and left to dry; turning them every few hours to prevent decomposition. If time is limited or the specimens are large, artificial heat may be necessary; but whatever process is used, the drying must be *thorough*, or mould will soon cover the sponges with a mycelium which may be beautiful enough in itself, but is far from agreeable or sightly as a feature of the sponge. Whether they are to be dried or preserved in alcohol, they should be dealt with promptly, and on no account left to lie long in the water after being gathered. Preserve from dust in covered boxes.

Unless the sponges are large, it is difficult to detach them without mutilation from the rough surfaces of stones. It is therefore preferable to gather, when possible, those growing upon wood, which may be scraped or chipped without injury to them. It is essential to secure the very lowest portions, as it is there the gemmules often abide.

The proper season for collecting fresh-water sponges, in waters of the temperate zone, depends upon the purpose of the collector. If it is his desire to gather cabinet specimens merely, for the identification of old, or the determination of novel species, it is hardly worth while to begin before July. As with the flowering of plants, the maturity of different species of sponges is attained at various dates between midsummer and late in November. The essential point is that the gemmules and their armature shall be fully perfected; and when that condition is attained in any specimen, there is no reason for further delay.

The author would, however, "recommend to intending students a far higher object for their ambition—that is, the study of the physiology and life-history of sponges, as members of a sub-kingdom whose position has been greatly questioned, and whose character, derivation, and subsequent evolution are very important and perplexing topics." He would have such workers search for and examine them at all seasons of the year (even in midwinter, when he has never failed, in suitable situations, to find some in a growing condition), keeping memoranda as to each species separately, noting the date of their germination or earliest appearance, the location, elevation, and temperature, rapidity of growth at different seasons, time and manner of formation of gemmules, stability or decadence during the winter, modes of distribution and progression, whether always down stream or by other more adventitious methods, what becomes of the gemmules upon reaching salt water, and the thousand and one problems that go to make up the life-history of any animal form, and that in this instance have been very little studied. He is particularly anxious that some competent person should undertake their study in the briny, brackish, and the fresh-water lakes pertaining to what is known as the "Great Basin of the West," with a special view to ascertain the conditions under which they form "protected gemmules"

in such localities. By this means light may possibly be thrown upon the problem of their possible derivation from the marine sponges.

Great pleasure and profit may be attained in the same direction by *germinating the statoblasts* or gemmules under artificial conditions, and studying the development of the young sponges by the aid of as high powers of the Microscope as the ingenuity of each student may bring to bear upon the subject. He further recommends Mr. Carter's directions * for germinating statoblasts, which he considers will be found valuable.

"To obtain the young *Spongillæ* it is only necessary to get a portion of an old living specimen bearing statoblasts, and, having taken out a few (six to twelve) of the latter, to roll them gently between the folds of a towel to free them from all extra material as much as possible, place them in a watch-glass so as not to touch each other, with a little water, in a saucer or small dish filled with shot to keep the saucer upright and, covering them with a glass shade, transfer the whole to a window-bench opposite to the light. In a few days the young *Spongilla* may be observed (from its white colour) issuing from the statoblast and glueing the latter as well as itself to the watch-glass, when it will be ready for transfer to the field of the Microscope for examination, care being taken that it is never uncovered by the water, which may be replenished as often as necessary; but of course the object-glass (when 1/4 in. with high ocular is used for viewing the minute structure) must admit of being dipped into the water without suffusion of the lens."

His own first experience in the propagation of fresh-water sponges may prove instructive in various ways. Late in the autumn of the year 1879, in a pond within the Centennial Grounds, Philadelphia, he found for the first time a living sponge. It was a vigorous, branching specimen of *Spongilla lacustris*, charged with gemmules in all parts of its structure. A fragment firmly attached to a stone was taken home and placed in a gallon "specie-jar" with water, in the hope, begotten of inexperience, that it would continue to grow, exhibit its inflowing and exhalent currents, &c. On the contrary, almost necessarily, it died, and in a few days the water became insupportably foul. It was changed and another trial made, which resulted as before. This time the jar was thoroughly cleansed; the stone with the attached sponge was taken out and held long under the flowing hydrant before it was replaced in the jar, which was now left in an outer shed and, very naturally, forgotten. Weeks passed and winter came on, and one severe night the water in the jar was frozen solid and the vessel fractured. He supposed that the low temperature to which it had been subjected would prove fatal to the germs, but, as the specimen was a fine one, it seemed well to save it, even in its skeletonized condition. So when its icy envelope had been melted off, the sponge was again thoroughly washed until all the sarcode was removed, when in a fresh jar, it again became a "parlour specimen."

The author does not clearly remember when signs of germination were first observed. It was probably in January, as during that month artificial conditions very frequently bring about the hatching of such animal germs as those of the polyzoa, &c. He detected first a filmy, greyish-white growth, that seemed associated with the detached gemmules which lay in a groove around the bottom of the jar. A grey, feature-

* Ann. and Mag. Nat. Hist., 1882, p. 365.

less growth at first, then spicules were seen, in slightly fasciculated lines, attached to the glass and reaching upward, then spreading out fan-like and branching. These were, of course, covered with sarcode, nearly transparent at first, and through the filmy surface pores and osteoles could be detected with a pocket lens. The latter were surmounted by the so-called "chimneys" or cone-shaped extensions of the dermal film; and through the apertures at their summits effete particles could almost constantly be seen, puffed out, as if thrown from a volcano, and then blown off by the wind.

These products of single gemmules did not, as time passed on, greatly increase in size—possibly, because of a deficient nutriment in the unchanged water of the jar—but, crawling upward along the glass to an average height of an inch or less, left the naked spicules in place behind them as so many ladders or stepping-stones of their dead selves by which they had reached to higher things. Near the summit, one or more new gemmules would sometimes be formed, after which the mother mass entirely disappeared.

So much for the amount of growth from single gemmules. Where, however, they were thickly sown, or germinated *in situ* upon the stone, so that the contents of several could mingle and flow together, the resultant sponge was very much larger. The mass, if it may be so called, covered, at its best, nearly one-third the surface of the jar; while those gemmules remaining upon the stone and amongst the spicules of the old sponge continued to germinate, to form abundant sarcode and spicules, and, at least in one place, to throw out a long unsupported branch or finger-like process that ultimately reached a length of two or three inches.

Of course it was impossible to bring the higher powers of a compound Microscope to bear upon a sponge growing under such circumstances. A strong Coddington lens was the best that could be applied to this work; but a very fair share of success was obtained by the device of scattering small squares of mica among the growing gemmules, which, when covered by the young sponge, could be moved to the stage of the instrument, covered with water in a compressorium and examined comparatively at leisure. It was a perpetual cause of astonishment to see so large a production of silicious spicules from a single gallon of water, in which the chemist would probably have failed to find any such constituent. It is worthy of consideration however, whether such silica as composed the older spicules may not, at least when under the influence of the growth force of the younger sponges, be to some extent soluble.

For the determination of species the author gives a few general directions, which however he thinks will be soon modified to suit the taste or ingenuity of the worker. It is assumed that the investigator has already noted the general appearance of the sponge in hand; its colour, size, compactness, whether simply encrusting, or cushion-like, sending out finger-like processes, &c. These indications may help an experienced collector to a guess; but there are very few species that even such a one could name, with any confidence, before he had made and examined microscopical preparations of the same.

A stand, supporting a dozen or more test-tubes, say 3/4 in. in diameter by 1¼ in. in depth; a dropping-bottle containing nitric acid, and the usual material and apparatus for mounting in balsam are all the appliances

needed. As the processes to be described are certain to disturb the normal relations of the several classes of spicules to each other, it is well before the dried specimen has been much handled, to separate some clean portions of the outer or dermal film; lay them upon a slide and mount in balsam without further preparation. An examination of this may determine the presence and decide the character of the dermal spicules, if there are any pertaining to the species in hand. This precaution is necessary in view of the displacement of parts just mentioned, and also on account of the indiscriminating habit of the sponge-currents during life, which almost necessarily charge the tissues with various foreign particles, including vagrant spicules of its own and neighbouring species. In practice, the rightful presence of dermal spicules in any species is often so doubtful, that it can only be settled by an examination of young sponges, grown under observation from isolated statoblasts, whose identity has been satisfactorily determined.

Next, separate from the sponge some minute fragments containing skeleton spicules, the dermal and interstitial tissues, and a dozen or more gemmules. Place several of the last-named with a few adherent skeleton spicules upon the centre of a fresh slide; bring to the boiling-point in one of the test-tubes five or six drops of nitric acid, and by the aid of a dropping-tube apply a single drop of the hot acid to the gemmules upon the slide. While the acid is partially destroying their cellular or granular crust, pour the remaining fragments into the acid left in the test-tube and boil violently until all the tissues are destroyed and the spicules left as a sediment upon the bottom of the tube. Fill up the tube with water and stand it aside to settle, which may take an hour or more. The few minutes that have elapsed will probably have been as much as the gemmules upon the slide will bear; they must not be left so long as to destroy the chitinous coat, nor is it well, though a common practice, to *boil them upon the slide*, for this often smears and disfigures it with frothy matter. Remove most of the acid by trickling drop after drop of water over the slide while held in a slightly inclined position. Wipe off all the water that can be reached and apply repeated drops of strong alcohol to take up the remainder. When this is so far accomplished that the gemmules will absorb benzole freely and receive their covering of benzole and chloroform balsam without *clouding*, apply the balsam and a cover-glass. This process of removing moisture by the use of alcohol, rather than by drying over a lamp, is to be preferred, although it requires more care and time, because the gemmules are less likely to be distorted in shape and the cells of the crust to become filled with air if they are kept always under fluid. Yet if the mounted gemmules, when examined, appear black, showing an accidental intrusion of air, much of this can be removed by carefully heating the slide over a lamp.

If this mount has been successful, the gemmules are now so transparent that their surrounding spicules can be readily seen and the genus determined; but a better view of the detached spicules is necessary, and may be obtained by mounting some of the contents of the test-tube. If the lately suspended spicules have now settled, carefully pour off all the water except one or two drops, though if there has been much acid used it may be better to wash them a second time. Shake up and place a sufficient quantity upon one or more slides, being careful not to leave the contained spicules in too dense a mass. It is best to allow the water

to evaporate from these slowly, as, if hurried over a lamp, each spicule is often margined with minute globules that it is impossible afterwards to remove. However, when the slide is apparently quite dry, it may be safely exposed a moment to the heat to make sure of it, and then covered with balsam and glass as usual.

The author adds:—"The investigator has now before him all the elements necessary for solving his *specific* problem, according to the formulæ which follow:—The normal sponge, the dermal film, the transparent gemmule, and a display of the detached spicules. Neither would alone answer, but the series will settle all points, excepting in the case of the genus *Carterius*. When this is suspected, the gemmules should first be examined *dry*; and, in preparations for mounting, great care should be taken to avoid the destruction of the tendrils (cirri), by the prolonged use of strong acids. Expert microscopists will improve their gemmule mounts by dividing some of them with a thin knife, endeavouring to make the section through the foraminal aperture; this, in the case of species having long birotulates, such as *Myenia crateriformis*, is of the utmost importance.

"'Seniors' in microscopy will please pardon the minutiæ of the processes just given, as they were necessary to make them available for the freshmen. All are reminded that the above directions as to collection and examination refer to mature sponges only. It is seldom safe, or even possible, to *name* one in which no gemmules can be found. If a course of study is undertaken, involving the histology and physiology of fresh-water sponges, many peculiarities will of course be observed that have not been alluded to here. One of them concerns the development of the spicules, and, if not understood, will pretty certainly mislead the beginner into the supposition that he is examining a novel species. Both the skeleton and the dermal spicules of *young sponges* are frequently marked with bulbous enlargements at the middle, and often half-way between the middle and each end of the spicule. These seem to indicate an immature condition, as they disappear when the spicules are fully formed."

Potato Cultivations.*—Dr. J. Eisenberg, instead of using solid pieces of potato, employs a mash. The potatoes are first well cooked by steaming, and then pounded in a mortar. The mashed potato is then pressed down into small glass pans about 5 cm. in diameter. The pans are provided with a lid in which there is a groove, so that the cover may fit accurately. The pans are then sterilized for three successive days, for half an hour a day, in a steam sterilizer. When required for use, the cover is lifted up and the surface inoculated. To make the pan air-tight, it is only necessary to turn it down on the cover, and run some melted paraffin round the angle between the lid and the pan. If there should be any condensation water on the lid this can be got rid of by passing the pan through the flame of a Bunser's burner two or three times.

Sterilization of Potato, Apples, and Water for cultivation purposes.†—Dr. H. Plaut first sterilizes three or four test-tubes (3 cm. broad and 20 cm. long) which have been plugged with cotton wool in the usual way. Potatoes are then peeled with a clean knife, while apples

* Centralbl. f. Bakteriol. u. Parasitenk., iii. (1888) pp. 216-7 (1 fig.).
† Ibid., pp. 100-1, 126-8 (1 fig.).

are merely washed clean. Cubes of apple or potato, sufficiently large so as not to interfere with one another in the tubes, are then cut up. About eight of these cubes are able to be put in each tube, and the latter having been plugged with cotton wool, are placed in a steam sterilizer for half an hour. When cool, transfer to a well-closed jar, upon the bottom of which some water must be poured from time to time. Here they may be kept for quite a month. Thus, after sterilization, is obtained from four tubes material sufficient for 32 Koch's jars. Each cube is removed to a separate test-tube or jar by impaling it on the bent end of a piece of platinum wire previously thoroughly heated. Some practice is needful for this, as the cubes are apt to slip away. The cover of the jar may be held up by an assistant, or more simply the whole manipulation may be affected as described by the author in Zürn's 'Parasiten,' 2nd edition, ii. p. 165. The apple-cubes, which the author uses for cultivating all kinds of Saccharomyces, become soft as jelly after sterilization, and are only held together by the peel. Hence manipulation of them is somewhat troublesome, but if any irregularity of surface occur, this may be removed by smoothing it down with a previously heated spatula.

To obtain and keep a quantity of water that shall be free from fungi, the author takes an ordinary flask; this is three-parts filled with water, plugged with cotton wool, and sterilized. The rubber tube and the glass stoppers are then fitted in and plugged round with cotton wool. The apparatus is then placed in a steam sterilizer for half an hour. When cool, the one end is fitted with a rubber spray bellows, and the other supplied with a pinchcock. When to be used it is necessary to squeeze the bellows twice before opening the pinchcock, and to close the latter before the stream of water has ceased.

ARLOING—**Modification apportée à un analyseur bactériologique.** (Modification in a bacteriological analyser.) *CR. Soc. Biol.*, 1887, p. 722.

DAL POZZO, D.—**Das Eiweiss der Kiebitzeier als Nährboden für Mikroorganismen.** (The albumen of the plover's egg as a culture medium for micro-organisms.) *Med. Jahrb.* (*Wien*), 1887, pp. 523–9.

FISCHL, R.—(*a*) **Ein neues Verfahren zur Herstellung mikroskopischer Präparate aus Reagenzglasculturen**; (*b*) **Die Anfertigung von wirksamen mit Mikroorganismen imprägnirten Fäden.** ((*a*) A new process for making microscopic preparations from test-tube cultures; (*b*) the preparation of threads effectively impregnated with micro-organisms.) *Fortschr. d. Medicin*, 1887, pp. 663–6.

ROUX, E.—**De la Culture sur Pomme de terre.** (On potato cultivation.) *Ann. Instit. Pasteur*, 1888, pp. 28–30.

(2) Preparing Objects.

Demonstrating the Reticulated Protoplasm in the Interstitial Cells of the Ovary.*—M. N. Löwenthal remarks that it is not rare to meet in sections of ovary of dog, cat, or rabbit, with interstitial cells, the body of which appears to be subdivided by a protoplasmic network more or less restricted to small areas of round, oblong, or polygonal shape. This special conformation of the interstitial cells is particularly frequent and easy to demonstrate in the cat. It is due to the fact that the cell is infiltrated with globules which stain black, not only with osmic acid, but with chrom-aceto-osmic acid. The globules are particularly large in the cat; much smaller in the rabbit. They are

* Arch Sci. Phys. et Nat., xviii. (1887) pp. 558–9.

disposed with much regularity all round the nucleus. As they increase in size they almost touch, and in consequence the protoplasm proper is reduced to a delicate framework.

The procedure for showing the structural peculiarities of the interstitial cells consists in fixing the pieces in the chrom-aceto-osmic acid mixture, and staining the sections after Flemming's method with safranin. After dehydration the sections are placed in oil of turpentine. By this means the globules blackened by the osmic acid are for the most part dissolved; in those that remain the intensity of colour is much diminished. Sometimes the cell assumes a more or less deep lilac tint.

Methods of investigating Structure of Nerve-tissues.*—Mr. F. Nansen, in his studies on the structure of nervous tissues, made use of fresh isolated tissues, as well as of those that had been macerated or cut into sections. The first were examined in the blood of the animal from which they were taken, either as large pieces or after being teased with glass-needles, the use of which the author strongly recommends. For macerations use was made of B. Haller's fluid composed of 5 parts acetic acid, 5 parts glycerin, and 20 parts distilled water; pieces were treated with this for from one to twenty-four hours, then teased in 50 per cent. glycerin, or washed and stained with ammonia-carmine or picro-carmine. Delafield's solution is specially recommended. For some purposes it was better to macerate in dilute alcohol, when weak solutions (17–20 per cent.) were found good. Sometimes, however, this process has to be continued for weeks; when finished, the tissues were stained in ammonia-carmine diluted with an equal quantity of macerating fluid for twenty-four hours, and teased in glycerin of 50 per cent.

The author usually stains before teasing or isolating, because he thinks it much more practical, and when one is careful not to employ too strong solutions, and to dissolve or dilute the staining colours in the macerating fluid, the facility of isolation is not seriously disturbed. Though one of the oldest methods, that of maceration in potassium bichromate is one of the best, and must never be omitted when it is wished to examine the most delicate structure with good results.

The most important thing in researches on the histology of the nervous elements is to get good sections from well fixed and stained preparations. The author strongly recommends Flemming's mixture as made of 15 parts of 1 per cent. chromic acid, 4 parts of 2 per cent. osmic acid, and 1 part (or less) of acetic acid. Pieces as small as possible must be treated in not too small quantities of the fluid for from 12–24 hours, or even longer. After washing they should be directly inclosed (not imbedded) in paraffin, and may then be easily cut under alcohol or water. Mr. Nansen has succeeded in getting sections only 0·005 mm. thick.

A method which was found very useful with Mollusca was the following:—The pieces for examination, cut as small as possible, were treated with 1 per cent. osmic acid for 48 hours, then washed in running water and cut at once by hand, or with the microtome (or they may be first hardened in alcohol and then cut). The sections were stained in Delafield's hæmatoxylin (diluted), and the colour destroyed in water containing a little acetic acid; the sections were examined in glycerin

* Bergens Museum Aarsberetning for 1886 (1887) pp. 73–80.

or Canada balsam. By this method the fibrillar substance got a distinct blackish staining.

Mr. Nansen concludes with describing a method the importance of which "for our future knowledge of the nervous system can scarcely be overestimated, as it affords really quite marvellous preparations, and far surpasses every method hitherto known." By modifications of the black chromo-silver method of Prof. Golgi the author has obtained excellent preparations. As employed for *Myxine glutinosa* the following method is adopted:—The nerve-cord is cut out of the living animal, and divided into pieces one or two centimetres long; these are laid in a solution of potassium-bichromate (2–2·5 per cent.) for about an hour, when the solution is changed and made a little stronger. In this the pieces are left for about twenty-four hours, after which they are put into a fresh solution consisting of 4 parts of 3 per cent. solution of potassium-bichromate and 1 part of 1 per cent. osmic acid, in which they remain for about three days. When the pieces are ready, they are directly treated with silver nitrate; they are first washed in a weak solution (0·5 per cent.), and then placed in 1 per cent. solutions. After one day the staining is generally complete. Sections need not be very thin; if the staining is good the ganglion-cells will be seen with all their processes, and nerve-tubes with their ramifications will appear quite dark or black on a transparent field.

Specimens intended to be preserved should be washed well in alcohol of 90 to 96 per cent.; when sufficiently washed they should be placed in absolute alcohol. After some hours of this the sections are placed in pure turpentine, which must be changed several times; and they are then placed on the slide in dammar-resin dissolved in turpentine. If it is desired to keep the preparation a long time, it must not be protected by a cover-glass; the dammar is at once dried in a warm bath or incubator, when the turpentine is very rapidly evaporated and the dammar becomes quite hard and smooth. The addition of a cover-glass prevents, of course, the evaporation of the turpentine and other volatile oils.

Prof. Golgi mounts the sections, in dammar, on cover-glasses, and the cover-glasses are again mounted on wooden slides, in the middle of which square apertures are cut to suit the glasses. This excellent method not only admits of the use of oil-immersion lenses, but allows the sections to be examined from both sides, which is often of great importance when the sections are thick. Silver-stained preparations should, of course, be kept in the dark when not being used.

New Method for Investigation of Blood.*—Dr. D. Biondi describes a new method for the microscopical examination of the blood. He notes the disadvantages of the methods hitherto practised. Being desirous to study the blood more intimately, by means of sections, he experimented with all sorts of imbedding mixtures without success. Eventually, he fixed the elements by placing drops of fresh blood in 5 c.cm. of 2 per cent. osmic acid solution, and this achieved the first step. The imbedding was successfully effected, after many attempts, in agar-agar, so much used by Koch and other bacteriologists. The mixture of blood and osmic acid is placed in dissolved agar at a temperature of 35°–37°. The fluid is allowed to harden in the usual moulds, is sliced into little portions, placed for some days in 85° alcohol, and cut in pith. The

* Arch. f. Mikr. Anat., xxxi. (1887) pp. 103–12.

agar method may also be combined with the usual paraffin process. He gives further details as to staining, clearing, and the like, but the point of importance is the successful results of this agar imbedding for the purpose of minute morphological study of fine elements like blood-corpuscles.

Methods of studying typical Bird's Feather.*—Mr. R. S. Wray came to the results which he has reached with regard to the structure of a typical pennaceous feather, while preparing a model for the Natural History Museum. A feather was soaked in turpentine and bits of the vane were cut out and mounted in Canada balsam to show the upper and lower surfaces. Separate barbs were mounted, the barbules on some being teased out with needles, and on others the barbules were cut off by placing a sharp razor on the sides of the barb and pressing gently on the slide, when sufficiently perfect barbules of each kind were obtained for examination. Portions of the vane were carefully imbedded in paraffin, and sections mounted by the creosote-shellac method, so that the parts were obtained in their relative, natural, and undisturbed positions. In addition to transverse and horizontal, sections parallel to the distal barbules were made. A gutta-percha model illustrating the points elucidated by Mr. Wray, is to be seen in the "index-museum" of the Natural History Museum, and is worthy of the attention of microscopists.

Mounting Tape-worms.†—Mr. W. S. Jackman states that a joint or segment of tape-worm mounted in the following manner will show the ovaries and eggs very clearly.

Procure good-sized specimens with well-filled ovaries. Remove the alcohol in which they have been hardened, wash and immerse in glycerin for a few days until clear and pulpy in appearance. Place between two strips of glass and squeeze until the specimen is quite thin. Clamp with a stiff spring and allow it to remain thus for several hours—a day is not too long; sufficient glycerin will adhere to the glass to keep it moist. Next place it in the stain, a few minutes will usually be long enough; pass it then through the fixing solution and place in oil of cloves, allow it to remain here until the tissue around the eggs assumes a transparent glassy appearance, then remove to a thin balsam solution and mount. Turpentine should not be used for clearing, as it makes the specimens opaque. "Hard finish" answers as well as balsam, is pleasanter to handle, and easier to prepare. It should be thinned with benzol and then filtered.

Reeves's Method.‡—Mr. R. N. Reynolds states that by following Dr. J. E. Reeves's method of preparing, cutting, and mounting pathological specimens he has now great success. The sections are 1/4000 in. thick, but only about half or one-third come from under the flattener in a condition to mount. Instead of balsam he uses Berry Bros'. oil finish. Sections 1/2000 in. thick came out straight enough for mounting. The chief difficulty in the method arises from not using sufficiently hard paraffin. The author found that the hardest refined paraffin of the Standard Oil Company, Cleveland, supplied the want, but in very cold weather a softer variety could be used. If the

* Ibis, 1887, pp. 422–3.

† The Microscope, viii. (1888) pp. 5–6.

‡ Ibid., p. 31.

specimens remain cloudy after liberal use of absolute alcohol, this is due to insufficient immersion in the turpentine bath.

Mode of rendering visible the closing Membrane of Bordered Pits.*—Herr A. Zimmermann recommends for this object staining with hæmatoxylin (in Böhmer's solution), and clearing with oil of cloves and Canada balsam. If slightly tinged, the "torus" alone then takes up the pigment strongly, while all the other membranes are almost entirely colourless. By this method the torus is rendered visible even in relatively thick sections and with low magnification.

Mounting small Organisms—Disaggregation of Rocks.†—Sig. D. Pantanelli who recently suggested a method for mounting small organisms found in the residues from finely divided rocks, by using a mixture of collodion and oil of cloves, has, on account of the impurities in the latter, and the difficulty of making elegant preparations, now substituted for it salicylic ether ($C^9H^{10}O^3$), which, on being evaporated at a temperature of 60°, leaves the collodion unaltered, while at ordinary temperatures it keeps viscid sufficiently long for making the preparation.

Tempère advised that rocks refractory to acids should be disaggregated by boiling them in a concentrated solution of sulphate of soda, the act of crystallization completely breaks up the rock; when used for diatoms this method succeeds very well with porous rocks, and serves excellently for separating out the foraminifera from argillaceous or calcareous rocks, which are not reduced by repeated immersion in water. Having experimented with porous, calcareous, and compact argillaceous rocks, the author has succeeded in separating out, without damage, the most delicate foraminifera, and still more easily radiolaria and diatoms. Whenever siliceous organisms are sought for, the acid process should be adopted, and whenever this fails to break up the rock, the solution of sulphate of soda should be tried.

KÜHNE, H.—**Ueber ein kombinirtes Universalverfahren, Spaltpilze im thierischen Gewebe nachzuweisen.** (On a combined universal process for demonstrating bacteria in animal tissues.) *Dermatol. Studien* (Unna), 1887, pp. 9–14.

MANTON, W. P.—**Rudiments of Practical Embryology, being working notes with simple methods for beginners.** *Microscope*, VIII. (1888) pp. 15–8.

(3) Cutting, including Imbedding.

Application of Paraffin Imbedding in Botany.‡—Dr. J. W. Moll enthusiastically recommends paraffin imbedding for botanical preparations. The reasons given why this method has not hitherto been more generally adopted are that tissues preserved in alcohol are unsuitable, and that it has usually been tried with full-grown parts, for which it is not so well adapted.

The procedure is as follows:—Take, say, fresh tips of some primary or secondary root 1–2 cm. long, and fix in watery 1 per cent. solution of chromic acid, or a saturated solution of picric acid, or, best of all, a modified Flemming's mixture (chromic acid 1 per cent., osmic acid 0·02 per cent., acetic acid 0·1 per cent.).

Herein the root-tips remain for twenty-four hours, and then the acids

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 216–7.
† Atti Soc. Tosc. Sci. Nat., vi. (1887) Proc. Verb., pp. 12–13.
‡ Bot. Gazette, xiii. (1888) pp. 5–14.

are to be thoroughly washed out with running water. The water is then replaced by alcohol, which must be added gradually in increasing strengths of 20, 40, 60, 80, 95 per cent., to prevent it swelling. The alcohol is next replaced by a solvent of paraffin, turpentine being the best. This is performed gradually, first with equal parts of alcohol and turpentine, then with pure turpentine; then transfer to a cold saturated solution of paraffin in turpentine; then to equal parts of turpentine and paraffin kept at a heat of 30°–40° C. After an hour the temperature is raised to 50°–55° C., and the roots finally placed in pure melted paraffin renewed once or twice. In about six hours the roots will be thoroughly permeated, and then they are placed in rectangular moulds suitable for being held in a microtome clamp. The inner surface of the moulds should be wetted with turpentine before the melted paraffin is poured in, and as soon as the molten mass is cooled so far that a film is formed on its surface, cold water should be at once poured over it, as sudden setting of paraffin prevents the formation of cavities. After the sections are made they are glued to the slide with indiarubber solution, albumen, or collodion; the two last are to be preferred. If albumen, equal parts of white of egg and albumen are mixed together, some drops of carbolic acid added, and the whole filtered. If collodion, then a mixture of equal parts of collodion and oil of cloves is made. In either case the slide is painted with the adhesive, the section pressed thereon, and the slide is then heated in the oven for fifteen minutes at 50° C. While still warm the slide is transferred to turpentine, which dissolves the paraffin, and the turpentine removed by means of alcohol.

The specimens may be stained before imbedding or as sections on the slide. If the former, then Grenacher's alum-carmine when the specimens have reached the 60 per cent. alcohol stage; if the latter, then alum-carmine, hæmatoxylin or the anilins, the last being specially suitable for demonstrating karyokinesis.

The sections may be mounted in glycerin or balsam, but the latter is preferable.

New Imbedding Material.*—Prof. E. Pfitzer describes a new mode of imbedding, which he has found very useful in the examination of minute and very soft or thin parts of plants, such as the flowers of orchids in early stages of their development. The principal objects were to obtain an imbedding material which should combine solubility in water with a great degree of transparency. These properties are presented by glycerin soap.

Prof. Pfitzer heats in a water-bath of a temperature between 60° and 70° C. a mixture of equal volumes of glycerin and 90 per cent. alcohol, with as many minute yellow transparent pieces of glycerin soap as will dissolve in it. This is best done in a cylindrical vessel stopped with cotton wool, from which but little alcohol evaporates. The yellow perfectly transparent or only slightly turbid fluid is poured either into a flat dish or into a paper cup made by wrapping strips of paper round a cork and fastening with a pin, the paper having been first saturated with strong alcohol. While the mixture is hardening, the object must be placed by a needle in a position suitable for making sections. With larger objects it is convenient to insure perfect saturation by laying them in a cold saturated solution of soap before transferring into the

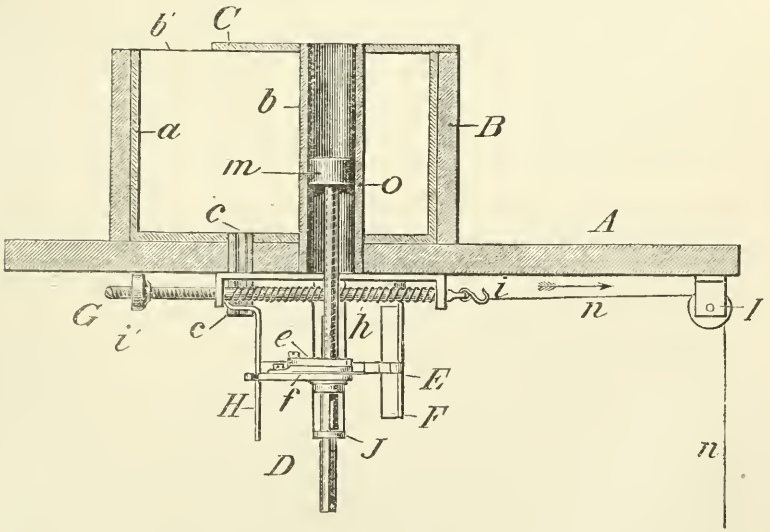
* Ber. Deutsch. Bot. Gesell. (Gen.-Versamml. Heft) v. (1887) pp. lxv.–viii.

hot mixture. The imbedding substance can be preserved cold in corked vessels for an indefinite time, and will melt at a temperature of about 40° C.

By this means perfectly clear transparent imbeddings may be obtained, which can be cut with the greatest ease after hardening in the cold, and can be preserved unchanged in a vessel over fused calcium chloride, which renders them somewhat harder and therefore better. Very minute objects may be imbedded still more quickly by placing drops of the material on a cork, laying the object on them, and adding another drop of the material. Small quantities of the solution of soap harden completely in a quarter of an hour. For harder parts of plants the process is not very convenient, the material being not sufficiently solid; paraffin or celloidin are better. For making the sections Thoma's slit-microtome was used.

Dale's Microtome.—Mr. H. F. Dale has patented the microtome shown in figs. 60 and 61, the primary object he had in view being "to provide an instrument which, while it may be made at comparatively

Fig. 60.



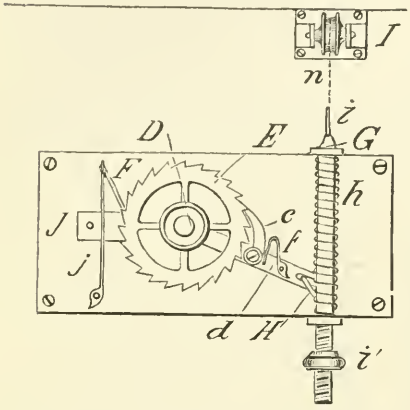
small cost, shall be effective and durable to the highest degree possible, and which particularly distinguishes itself also owing to the facility with, and advantageous manner in which it is operated."

The device comprises a base-plate A, upon the surface of which is fixed a rectangular box B, having a freezing chamber *a* perforated at the bottom with two holes, into the larger of which is secured a tube *b*, which contains the object. The smaller perforation is provided with a short length of tube *c*, which serves to drain off the liquefied refrigerant. On the top of the box B is a face plate C, partially covering the box, the open portion b^1 allowing of the introduction of the refrigerant.

The mechanism for raising the object comprises a spindle D, to the centre of which is fixed a rachet-wheel E, into the teeth of which a

pawl *e* takes, carried upon an arm *d*, the pawl being pressed against the rachet-wheel by a small bent spring *f*. The arm *d*, which works loosely upon the spindle D, is kept in its proper position by means of a washer; the extremity of the arm is forked, into which takes a bent wire H, fixed to a rod G, working horizontally in bearings. Within the bearings the rod is surrounded by a spiral spring *h*. To one end of the rod, beyond the bearing, is a small hook *i*, to allow of the attachment of a cord, which, passing over the small pulley I, is secured to a suitable treadle beneath the table. The other end of the rod has a screw-thread with a thumbscrew i^1 for regulating and limiting the horizontal motion or "play" of the rod.

Fig. 61.



To the base plate A is fixed a second pawl F, of such length as to act upon the rachet-wheel E at whatever height the latter may be, the pawl being gently pressed against the rachet-wheel by the spring *j*. The upper part of the vertical spindle D has a fine screw-thread, which works in a metal disc screwed to the base plate. The other extremity of the spindle is plain, and moves freely in a bearing formed in a rigid bracket J, which serves to keep the spindle perfectly central relatively to the tube *b*. The spindle terminates at its upper extremity in a conical point *o*, upon the apex of which is a plug *m*, which moves freely up and down in unison with the vertical motion of the spindle.

The mode of working the apparatus is as follows:—Having adjusted the thumbscrew i^1, the treadle is depressed, and by means of the cord *n* attached to the rod G, the latter is drawn forward in the direction of the arrow, a distance limited by the position of the thumbscrew i^1, and in this forward motion carries with it, by means of the wire H, the arm *d*; whereupon the pawl *e* takes into the rachet-wheel E and rotates the latter a distance corresponding to one, two, or more teeth, thus raising the plug *m* and object to such a height as to allow of a section being taken in accordance with the thickness desired. The whole of the mechanism, it will be seen, is actuated by the depression of the treadle, thus leaving both hands free to manipulate the knife, as also to vary the position of the object.

The author, in his specification,* further says:—"It is well known that in preparing objects for microscopic examination, it is almost impossible, by the methods at present generally adopted, to obtain very thin sections or slices of substances of a brittle or non-elastic nature. This difficulty is, to some extent, due to the inability to utilise both hands for manipulating the razor or section knife before referred to, but with the improved apparatus above described, inasmuch as the

* 1887, No. 9900.

mechanism is actuated by the foot, both hands are available to give to the cutting knife those exact movements so essentially necessary to the successful production of extremely fine, thin, delicate films; therefore the brittle substances having been treated in any of the usual ways to impart tenacity and partial elasticity thereto, the knife is made to approach and cut into the substance of the object, either direct, diagonally, or in any other desired manner, without fear of one part of the film or slice being of greater thickness than another, a most important consideration with respect to opaque or semi-opaque substances. Another important feature in the device arranged as above described, is the rigidity with which the object to be operated upon is maintained in position during the process of cutting or slicing the same, as the means for imparting motion being situated at a distance from the mechanism, and the latter inclosed if desired in a protective case or box, the risk of movement, or shifting of the substance from which a film is to be cut, is rendered impossible."

(4) Staining and Injecting.

Staining Cultivation Media and its results on micro-organisms.*—Dr. G. D'Abundo's object in staining cultivation media with various dyes was to attempt to ascertain if any new biological characteristics could be imparted to the micro-organisms cultivated thereon, and, if possible, to stain the spores. The media were distilled water, peptonized broth, gelatin, agar, and potato; the dyes were methylen-blue, fuchsin, and methylen-violet. Sterilization was performed in the usual way. The results were as follows:—

Distilled water and methylen-blue; typhoid bacillus grow feebly, but were stained, the water being unaffected. Similar results were obtained with fuchsin, methyl-violet, and Bismarck brown. Peptonized broth coloured as above becomes decolorized, but the bacilli are unaffected. If the test-tube be shaken the colour returns. Stained with fuchsin the broth gave similar results; but with methyl-violet the bacillus grows slowly, but is stained. Pneumonia coccus gave similar results; that is, it was stained with methylen-violet, but not with other dyes. Anthrax seems to have stained in the blue-violet and red anilin if the medium were deeply stained. On gelatin stained with methylen-blue typhoid bacillus developed a colour, and this was demonstrated microscopically. Bismarck brown and methyl-violet gave similar results, but fuchsin failed. Pneumonia coccus only developed a faint colour when the medium was highly charged with pigment. On agar the typhoid bacillus is coloured with methylen-blue and methyl-violet, but not with fuchsin. On potato, coloured with methylen-blue, typhoid bacillus developed a hue much deeper than the cultivation medium; but there was no result with fuchsin.

Nitrate of Silver Method.†—Sig. C. Martinotti proposes the following improvements on the method of staining with nitrate of silver:—(1) increase the volume of the silver solution in proportion to that of the object to be stained; (2) increase the duration of immersion (15–30 days); (3) maintain the objects at a temperature of about 25 degrees for ganglionic cells, or if for neuroglia cells alone at 35–40 degrees;

* Atti Soc. Tosc. Sci. Nat., vi. (1887) Proc. Verb., pp. 15–9.
† Arch. Ital. Biol., ix. (1887) pp. 24–5.

(4) add 50 per cent. glycerin to the silver solution for very delicate results; to avoid surface precipitation cover the objects when removed from Müller's fluid with a sheath of paper brouillard previously prepared with distilled water. By following these methods Martinotti obtained most satisfactory results.

Freeborn, G. C.—**Notices of New Methods. I.**
[1. Staining of elastic fibres (Lustgarten, Herxheimer, and Martinotti). 2. Substitutes for hæmatoxylin (Paneth and Francotte). 3. Mounting (Weigert).]
Amer. Mon. Micr. Journ., IX. (1888) pp. 26–7.

Wilkinson, W. H.—**Colour-Reaction: its use to the Microscopist and to the Biologist.** *Midl. Naturalist*, XI. (1888) pp. 1–4 (1 pl.).

Ziemacki, J.—**Zur Entfettung mikroskopischer Präparate von Eiter, Blut, Sputum u. s. w. vor der Tinction in wässe rigen Färbelösungen bei Untersuchung auf Mikroorganismen.** (On the removal of fat from microscopical preparations of pus, blood, sputum, &c., before using aqueous staining solutions in examinations for micro-organisms.) *St. Petersburger Med. Wochenschr.*, 1885, p. 130.

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

Indexing Microscopical Slides.*—Dr. R. H. Ward describes his system of indexing slides as developed in his "Slide-Catalogue."

"The alphabetical index is, of course, a large and essential portion of the system. Its pages are specially ruled for convenience in entering titles and numbers, and they have a capacity for several references to each slide, the volume for 2000 slides having room for about 10,000 references. Thus a leaf preparation may not unlikely be referred to under both popular and scientific names of the plant, and also under several such titles as, 'Leaf of ——,' 'Spiral vessels in ——,' 'Stomates of ——,' 'Raphides in ——,' &c. But as many simple slides require only two or three entries, the more complex ones will have room for eight or ten. The index is lettered alphabetically, the number of pages assigned to each letter depending upon the frequency with which that letter occurs at the beginning of English words. Subdivision is accomplished according to the vowel system of arrangement, whose advantages are familiar to all readers, and which may, by means of a few obvious expedients, be made applicable to slide-catalogues of various sizes. Thus the pages devoted to any letter, as *S*, are divided into six portions, and lettered *Sa*, *Se*, *Si*, *So*, *Su*, *Sy*; the first portion being for words beginning with *S*, and having *a* for their first vowel, and so on for the rest. Further subdivision depends so largely upon individual wants as to be best left optional with the user. But having given a page to the *Sa* words, for instance, it is hardly possible that any thoughtful person could throw all these together at random. Probably nearly every one would enter things pertaining to animals at the top of the page, vegetables in the middle, and minerals at the bottom, or *vice versâ*. A specialist in any department would give the lion's share of the page to his particular province, subdivided to suit himself; and the vegetable kingdom, being in the middle, could be carried up or down, where experience shows that room could best be spared. After such entries as starch, pollen, hair, &c., several lines would be left blank for similar items, so that ultimately these items would appear in blocks that would be instantly recognized on glancing at the page. In larger collections, where *Sa* included many

* The Microscope, vii. (1887) pp. 355–8.

pages, a certain number of these whole pages would be assigned to animal, vegetable, and mineral objects respectively. In this case a botanist, for instance, would probably reserve more pages for plants than for all the rest, and at first he might devote a column, or even a whole page, to such a group as starches, and a like portion of *Se* to seeds, one

Sa.—Animal.	No.
Saw-fish, tooth sec.	233
Scaly epithelium	272
Scale insect	2440-3, 2364
Scales (see Wings)	
„ Mosquito	273
„ Lepisma	2066
„ Podura	2797, 2090
„ Cabbage Butterfly	2106
„ Tinea	2699
„ Sole, and *in situ*	665-6
„ Trout	1596
„ Flounder, and *in situ*	1597-8
„ Gold-fish	1599
„ Eel	1863
„ Sturgeon, sec.	2096
„ Dog Shark	2098
Starfish (young)	2005
„ Madreporic body	2006
„ Pedicellaria	2007
„ Spine, secs.	2527-9, 2030-7
Sarcina	1495
Sarcoptes	1925-6
Scalp, secs.	2025-6
„ Negro	2131
Statoblasts of Cristatella	2508
Sarcoma, Giant-cell	573
„ Spindle-cell	1496
„ Cystic	1731
„ Osteo-	1792
„ Round-cell	2804
„ Melanotic	2987, 2820
Snails, "Palates"	1073-8

Vegetable.	No.
Scales (see Hairs)	
„ of Fern	207
"Star Polishing Powder"	2526
Starch, Corn	886
„ Potato, and *in situ*	887-8
„ Canna, pure and commercial	955-6
„ Wheat	980
„ Rice, pure and adulterated	1125-6
„ Arrowroot, and *in situ*	1699
Sanguinaria, sec.	710
"Star Fungus"	730
Salicine	1536, 855
Santonine	1029
Stamens (see Flowers)	
„ Lobelia	1367
„ Salvia	1368
„ Tradescantia	1710
„ Vaccinium	1839
„ Deutzia	1982
„ (Petaloid)	2880, 2173
„ Willow (to ovaries)	2740-4
Scalariform Vessels	2930, 2885
"Santa Monica" deposit	2891

Mineral.	
Satin Spar	589
Sand, Oolitic	987
„ Auriferous	2820
„ Sonorous	2907
Stalactite	2821, 1983
Slag from Iron Furnace	2256
„ Copper Furnace	2741

column of the seed page being given to whole seeds, and another to sections, &c. Subsequently, if too much space proved to have been reserved anywhere, the lower portion of the vacant parts would be filled with other things. By such expedients a rough but most useful working classification of the pages and their contents can be maintained until the book is nearly full. The accompanying sample page of *Sa* entries of

familiar objects, though much more crowded, and, therefore, less satisfactory than in actual use, shows how such a plan is carried out, and with what facility any object may be found in a collection of three or four thousand slides.

Obviously the catch-word by which an entry will be found is its first word, by which it was located and sought for: and the other most characteristic word, which distinguishes the item from others of its kind, and which may or may not be the only other word, may be underlined for easy recognition. The author uses pencils of different colours for this purpose, in the serial list as well as in the index—red for animal, green for vegetable, and blue for mineral specimens—and thus gains a perspicuity whose value is evident. By a little extra care in labelling the slides the same distinction of colour may be extended to the labels, using red, green, and blue tinted papers, or white paper with printed borders of those colours, as a means for rapidly recognizing and distributing the slides themselves whenever they have become mixed in use.

Though not admitting the absolutely alphabetical sequence attained by cards, this system is in some respects even more practical than that for small collections, say up to three or four thousand slides. It is easier to see and compare numerous items when collated upon a page than when stacked away in cards. Thus fifty or sixty entries of hairs or of crystals can be reviewed and compared, and a half-dozen selected for some purpose, much better by glancing over a page than by leafing over that number of separate cards; while the graphic effect of the page is of perceptible use in keeping one's mind constantly familiar with the extent and character of his collection. The cards are theoretically better, and in very large collections practically better, for finding any specified slide that one knows he wants; but are not better, nor even as good, for assisting him to decide what he wants among many."

Coplin—**Brief Directions for Using the Microscopical Mounting Outfit (Jefferson design).** *Queen's Micr. Bulletin*, IV. (1887) pp. 45–6.

Latham, V. A.—**The Microscope and How to Use It.**
[XIII. Cements and useful recipes.] *Journ. of Micr.*, I. (1888) pp. 39–46.

(6) Miscellaneous.

Colouring matter of blood as a means for distinguishing between the gas exchange of plants in light and darkness.*—Dr. T. W. Engelmann, while experimenting as to the secretion of oxygen by purple bacteria, made use of hæmoglobin for showing the variations in the amount of oxygen developed under the influence of light by certain plants. For this purpose he placed a filament of *Spirogyra*, rich in chlorophyll, about 0·1 mm. thick and 1 cm. long, under a cover-glass, and immersed in a drop of defibrinated bullock's blood which had assumed the venous colour by transmitting a stream of hydrogen or carbonic acid through it. When the preparation was placed in diffused light, the immediate vicinity of the green filament for a distance of 1/2 to 1 or 2 mm. became bright red in ten to fifteen minutes. In direct sunlight the action was produced in a fraction of a minute. The boundary between the dark venous and the bright arterial colour was so sharp that under the Microscope it could be determined to less than 0·1 mm. In the dark the

* Arch. f. d. Gesammt. Physiol. (Pflüger), xlii. (1888) pp. 186–8.

venous colour returned in about the same time. By intense illumination of a single cell or part of a cell a bright-red area formed only about the illuminated spot.

The development of oxygen in the light and its absorption in the dark can be followed with a spectral ocular, or, better still, with the microspectral photometer. It is then seen that on illuminating the cell (gaslight or an electric incandescent suffices) in place of the dark absorption-bands of oxygenless hæmoglobin, the two dark bands of oxyhæmoglobin appear. The change becomes apparent in ten to twenty seconds, and first occurs at the surface of the cells, from which it spreads outwards. Per contra, in the dark the hæmoglobin-band returns.

The next step was to ascertain if the unequal effects of the different rays of the spectrum upon the development of oxygen could be rendered visible to the naked eye. For this purpose a filament of spirogyra was placed in venous blood under a cover-glass, and illuminated with a spectrum of about 1 cm. long from a Sugg's burner of 50 candle-power. In about fifteen minutes the boundary between the arterial and venous colour was seen in the extreme visible red, and it attained its maximum, about 1 mm., near C. Although, owing to the cloudiness of the weather, the experiments with sunlight were few, they were sufficient to show that the strongly refracting rays were more powerful than those of the gas spectrum. The maximum lay in the middle of the visible red, not in the orange or yellow. The action in the green between D and E was less strong than in the blue-green or blue. Even in the violet a slight action was perceptible. In conclusion, the author remarks that he does not doubt that plants with red, yellow, or brown chlorophyll will give characteristic "hæmatospectrograms" of the development of oxygen.

Microchemical Tests for Callus.*—Mr. F. W. Oliver gives the following microchemical tests for the callus which he finds in the trumpet-hyphæ and true sieve-tubes of *Macrocystis* and *Nereocystis*;† but they apply also to the callus in the sieve-tubes of Phanerogams.

(1) *Russow's callus reagent* (a mixture of equal parts of chlorzinc-iodine and iodine in potassic iodide) stains callus a deep brown; a very delicate test; (2) *Coralline-soda* (prepared by adding rosolic acid to a strong aqueous solution of sodium carbonate) gives a brilliant rose-pink; (3) *Bismarck brown* dissolved in water reveals a very decided stratification; (4) *Hoffmann's blue* (dissolved in 50 per cent. of alcohol) stains the callus-plates a brilliant blue; (5) *chlorzinc-iodine* does not, as a rule, stain the plates, but they swell up and show stratification; (6) *methylene-blue* gives negative results; (7) *hæmatoxylin*, with dilute solutions, the callus-plates stain deeply; (8) *hydric sulphate* causes the plates to swell up, showing a very beautiful stratification, and finally they are completely dissolved; (9) *potash* causes them to swell up, but does not actually dissolve them.

BEAUREGARD, H., and V. GALIPPE.—**Guide pratique pour les travaux de Micrographie, comprenant la Technique et les applications du Microscope à l'Histologie végétale et animale, à la Bactériologie, à la Clinique, à l'Hygiène et à la Médecine légale.** (Practical Guide to Microscopy, including technique and the application of the Microscope to vegetable and animal Histology, to Bacteriology, to Clinics, to Hygiene, and to Medical Jurisprudence.)
2nd ed., vii. and 901 pp., 586 figs., 8vo, Paris, 1888.

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* Ann. of Bot. i. (1887) pp. 109-11.

† See *ante*, p. 265.

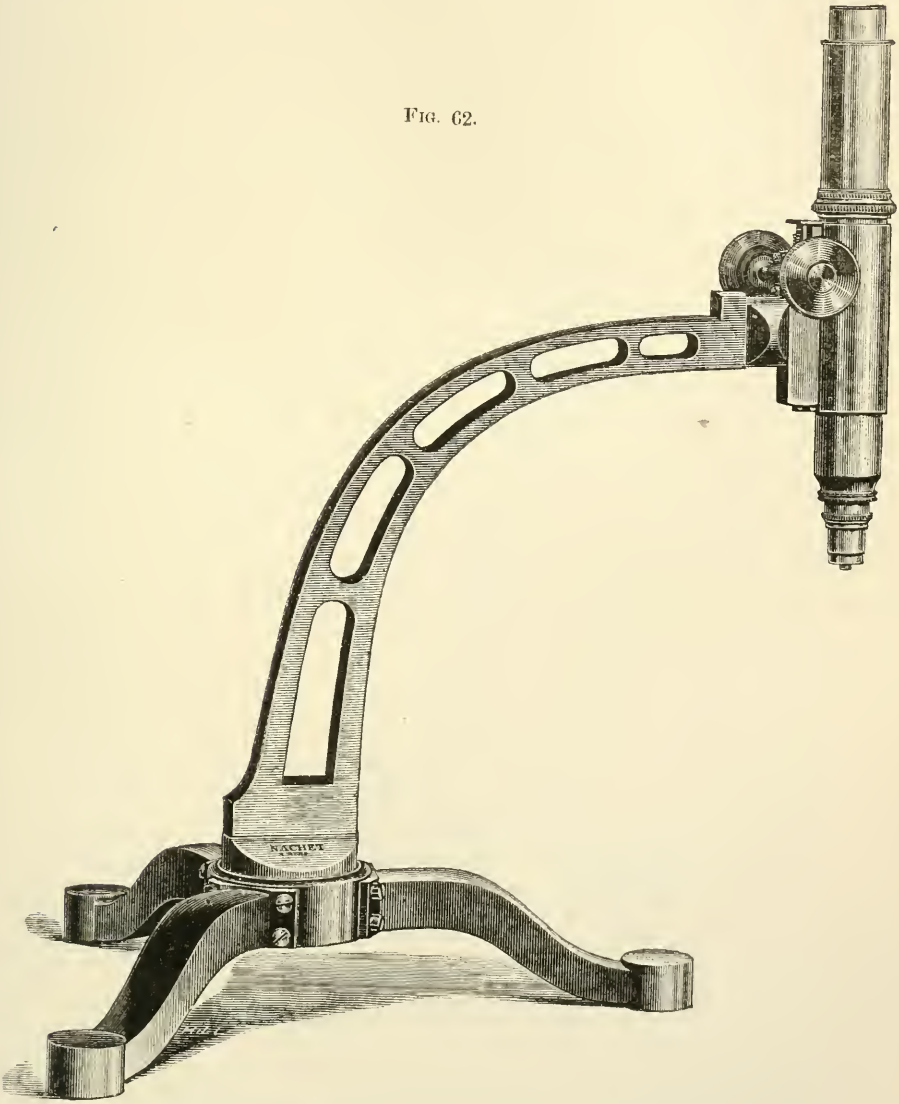
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Nachet's Crane-arm Microscope.—This form of Microscope (fig. 62) was designed by M. A. Nachet on the suggestion of Prof. Lacaze-

FIG. 62.



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

Duthiers to meet the case of microscopic examination being required of the surfaces of large objects of various kinds, especially animals.

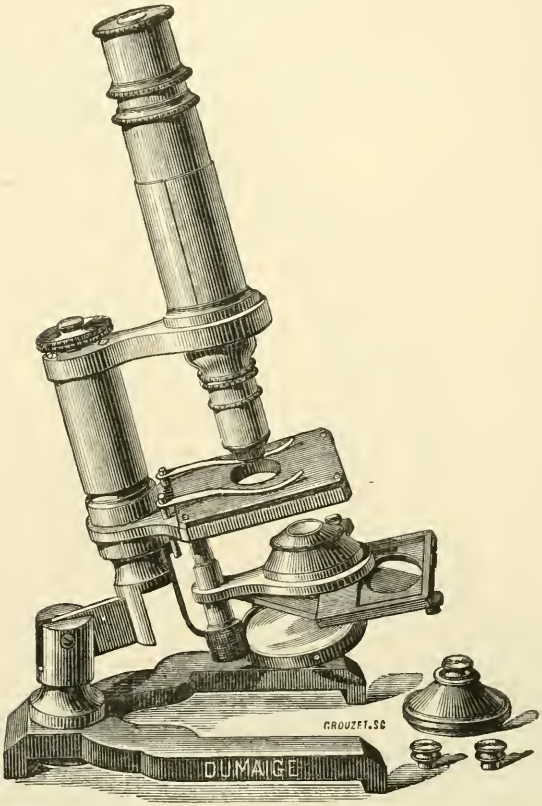
On a tripod with broadly spreading feet is fixed, so as to rotate on the centre of the tripod, a curved standard 20 inches long, pierced in five places to reduce the weight. At the top of the standard is the slide support for the body-tube, which is raised and lowered by rack and pinion. The slide itself also rotates laterally on the end of the standard so that the body-tube can be set at an angle.

Dumaige's Travelling Microscope.* — This Microscope of M. Dumaige (fig. 63) anticipates one of the features of Mr. Giles's "Army Medical Microscope," in that the stage and foot are in one piece.

The following is a translation of the description :—

"The instruments which the makers offer for sale under the name of travelling Microscopes, if they have the advantage of being small in size,

Fig. 63.



have on the other hand, in most cases at least, the grave inconvenience of being deficient in the stability necessary for delicate observations.

* Comptes Rendus Soc. de Biol. (Paris), 1887, p. 103. (Séance of 19th Feb.)

M. Dumaige has devised an instrument which while packing into a small compass, has all the conditions of perfect stability and all the improvements which are applied to large laboratory Microscopes.

When set up the instrument is an inclining Microscope of ordinary dimensions. It can be divided into two parts; the first comprising the stem and the tube; the second the stage and the foot.

The standard is fixed on the stage by a screw of special construction having four threads. This mode of construction assuring very great stability, it has been possible to make the standard very short. Owing to the arrangement of the screw it is sufficient to turn the standard half round to fix it in the stage perfectly securely.

The lower part of the Microscope can be reduced to minimum dimensions by [rotating the stage and short pillar 180° and then inverting the stage on the hinge by which it is connected with the pillar] and placing it between the feet of the base.

Thus divided and folded the Microscope occupies only a small space, and can be placed in a case of reduced dimensions" (6 in. × 6 in.).

A special condenser is added, differing, however, from the Abbe form only in its mechanical part, which is arranged so as to take up only a very small space.

Nelson's Mechanical Stage.—In bringing before the March meeting a new mechanical stage, Mr. E. M. Nelson said he "desired to point out that, in designing a Microscope, one had to guard against falling into one of two errors—over-complexity on the one hand, and over-simplicity on the other. It must be remembered that over-simplicity is an error just as great as over-complexity; it is to be feared that in consequence of so much notice having been given to over-complexity (and surely it was wanted), the other error of over-simplicity has been neglected. It is almost an abuse of terms to call the heavy-footed, non-inclining, Continental abomination, with its spring-clip stage, small aperture, and with a sliding-tube coarse-adjustment, by the now exalted name of Microscope. As to stages, it would be hard to invent a worse form than that usually found in Continental stands, consisting of a small flat stage, one small hole, and spring clips."

Mr. Nelson then described his new stage as follows:—

"The stage, which is of my horseshoe form, has two narrow vertical slots cut in it, one on either side of the opening. The usual rack-and-pinion which is placed underneath the stage, moves blocks sliding in the vertical slots. These blocks come flush with the stage, and have a screw in them, the head of which, projecting above the stage and pressing against the lower edge of the slide, pushes it up. The position of the Microscope is assumed to be an inclined one, then on turning back the pinion the slide drops. In fine, the slide is kept against the screw-heads by gravity, the Microscope being inclined.

As the blocks only come up through the slots flush with the stage, the screw-heads alone projecting, a plain stage may be obtained at any time by removing the screws. Or, if preferred, a bar may be fixed by the screws to the blocks, which will make a mechanical sliding bar.

This last is the form I have adopted in my own Microscope. In addition to the vertical, a horizontal movement may be fitted in the same way by slotting the stage and moving a block by a screw underneath. Such a fitting has been put to the Microscope before you. It is obvious that by such a method one can push the slide across the stage; but there

is no means but that of the finger to bring it back again. Of course, by keeping the slide pressed against the stud one can regulate the motion backwards by means of the screw. If a horizontal backward motion is required, there are two—and only two—alternatives before you: either you must clip the slide, or you must place the slide in a moving plate. If, on the one hand, the slide is clipped, you fall into the errors mentioned above; and if, on the other, you adopt the moving plate, you must, if it is to stand a crucial test, copy the Powell model. Now, as the scope of the new stage is to improve the student's Microscope at a small extra cost, it stands to reason that the second alternative is out of the question.

The advantages I claim for the new movement are as follows:—

(1) The vertical and horizontal movements are independent of one another, so you can have a vertical movement fitted to your Microscope without the horizontal, or *vice versâ*.

(2) By removing the screws in the blocks which are the only things above the stage, the stage is left perfectly plain, just as if there was no mechanical movement at all.

(3) By merely slotting the sliding-bar, to enable it to pass over the screw-heads, the sliding-bar and the mechanical movement can be used independently of one another.

(4) By screwing a bar to the blocks you have a perfect mechanical vertical movement. This, I think, in practice, will be found the most useful.

(5) By graduating the heads of the pinions, and by marking the stage for each complete revolution, a finder and a rough micrometer sufficiently accurate for low and medium powers is made.

(6) It is inexpensive.

(7) And perhaps the most important. The moving pinions being fastened to a fixed stage, and the blocks sliding in grooves in the stage, renders the movement peculiarly steady."

When exhibited it was pointed out * that as both hands are required to work the stage—one for the milled head and the other to keep the slide pressed against the screws—the great advantage of a mechanical stage, in being able to focus at the same time that the slide is moved, was lost.†

Fine-adjustment by tilting the Stage.—In describing Queen and Co.'s "New Laboratory Microscope, Acme No. 5," in which the upper stage-plate is lifted at one end by a screw, the writer says ‡ that this "plan of constructing the fine-adjustment has the following invaluable features, which especially fit it for class work in the laboratory.

First (and principally). Perfection of action: The upper plate, carrying the object, must respond instantly to the movement of the screw —upward by positive action, downward by the spring of the plate; and without any lateral or side motion; these, of course, are the essential features of a good fine-adjustment.

Second (and important). This perfect action will continue as at first; as there are no joints to wear loose or become strained, there can be developed no lost motion nor lateral motion by wear or rough handling, all being made practically in one solid piece.

* *Ante*, p. 334. † Cf. Engl. Mech., xlvii. (1888) p. 117.

‡ Queen's Micr. Bulletin, iv. (1887) p. 44 (1 pl.).

Third. It is inexpensive in construction. An objection is sometimes made that one side of the stage-plate is moved, while the other is not, thus elevating one side more than the other. We only ask those to whom this may appear an objection, to make a practical and careful test. They will find that this objection is utterly invalid in practice, as the range of the motion required is very slight."

On the other hand it must be pointed out that this system of fine-adjustment is hardly tolerable for any but rough-and-ready elementary work, as the continual tilting of the stage-plate supporting the object renders the employment of substage apparatus very inconvenient, not to say practically impossible.

Amici adopted this mechanism in one of his models we have met with, one of which is shown in fig. 64, where the stage consists of a plate bent on itself, the upper half being pressed upwards by a screw, returning by its own "spring" when the screw is withdrawn. The more common form is that shown in figs. 65 and 66, where the stage does not consist of one plate bent on itself, but of two joined by a short bar at one end. A peculiar modification of this plan is shown in fig. 67, where the thick stage has a thin plate separated from its upper surface, which is raised at one end by a screw, as in the other cases. Fig. 68 shows another modification, adopted by Seibert, of Wetzlar, the stage being suspended between two pivots at one end and tilted by a screw at the other end, acting against the pressure of a spiral-spring.

Amici also adopted the system of suspending the stage (fig. 69) on pivots on either side of the pillar, an angle-piece being connected at the back forming a bent lever, by which the stage was tilted by a screw acting against a spring. Nobert modified this latter system, even with his largest Microscopes to which he applied his stage-micrometer, by suspending the stage on pivots on either side of the pillar, and attaching the angle-piece beneath the stage so as to be acted upon by a screw passing through the pillar; the downward motion of the stage acted by gravity only as in the small French Microscope shown in fig. 70, which instrument has in addition a peculiar crank-arm attached near the edge of the milled head, which raises and lowers the body-tube instead of the usual rack and pinion. This plan has been adopted in many of the commoner types of Microscopes issued in recent years in Germany, in some cases (as in the Microscope by Schieck, of Berlin, shown in fig. 71) the downward motion of the stage is controlled by a spiral-spring pressing on the front of the angle-piece.

Trécourt and Oberhäuser (fig. 72) avoided the tilting of the stage by making the upper plate move up or down in a horizontal position by means of a screw and socket at one end and a guide-pin at the other end. Charles Chevalier and others in France adopted this mechanism, with more or less modification; and in England, Pritchard, Carpenter and Westley, and others also employed the system. Fig. 73 shows the application of a rack and pinion with a guide-pin giving parallel motion to the upper stage-plate. This focusing by the stage was subsequently elaborated by the late Hugh Powell, for which he was awarded a silver medal by the Society of Arts in 1841, and which consisted in making the upper part of the stage, carrying the "Turrill" mechanism, to move upwards or downwards in the strictly horizontal position by a system of screws acting upon levers and wedges. Andrew Ross appears to have adopted this system also in some of his early constructions.

Fig. 64.

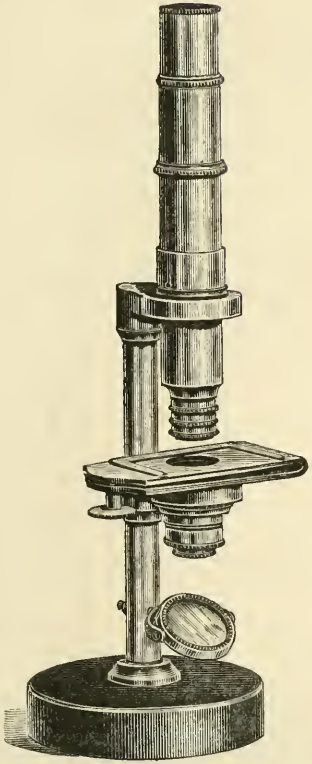


Fig. 65.

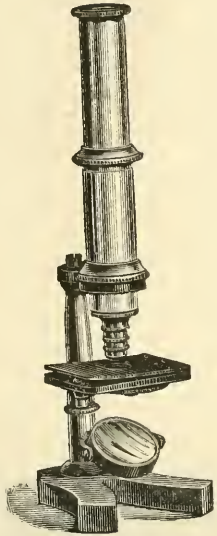


Fig. 66.

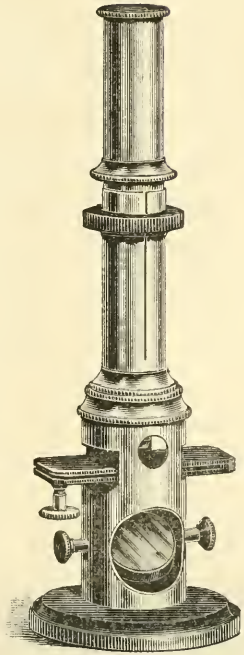


Fig. 67.

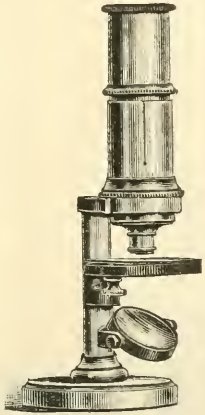
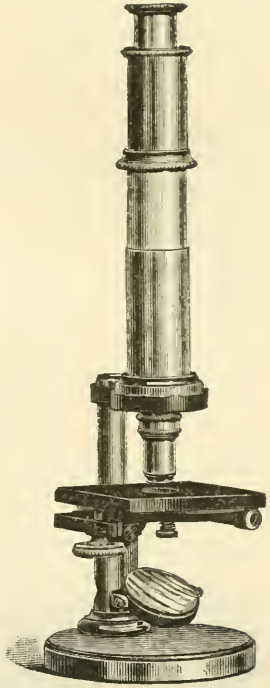


Fig. 68.



Microscopes with Stage Fine-adjustment.

Fig. 69. Fig. 70. Fig. 71. Fig. 72. Fig. 73.

MICROSCOPES WITH STAGE FINE-ADJUSTMENT.

It appears to us regrettable that so many opticians should struggle to issue "students'" Microscopes, the chief aim of which appears to be a low cost of production regardless of the modern requirements in such instruments. Our own experience is that with a stand well equipped with substage appliances for controlling the illumination, every good objective may be made to yield images at least 50 per cent. better than are possible without such appliances. A "student" should obviously commence his training in microscopy by learning to use his optical battery in the most effective manner, which practically necessitates his being provided with a stand altogether superior in construction to those usually supplied as "students'" Microscopes.

Since the above was written the writer of the article on which we were commenting replied * to a similar criticism as follows:—

"Another eminent professor, for whose opinion we have great respect, in reply to our argument in favour of the Acme No. 5, urging the inexpensive construction combined with thorough efficiency, of the fine-adjustment, presents the well-known theoretical objection to this form, and (while willing to admit that he might not be able to tell, by looking through the Microscope, which side of the stage was most elevated) says that in his experience expense is not an objection if the Microscopes are likely to be effective and durable in use in the laboratory. He considers it desirable to pay more and get instruments free from theoretical objection. He speaks of his experience in Germany with German laboratory Microscopes; how each year they required to be sent to the maker for repair. Right here is a strong argument in favour of the construction of the fine-adjustment adopted in the Acme No. 5. In instruments of the usual German type the operation of the 'slip-tube' brings a great strain on the slide of the fine-adjustment; in the Microscope above referred to the two adjustments are entirely separate, and there is no strain on the fine-adjustment from the use of the other; in fact, there is no slide or joint whatever that can wear loose. The slip-tube adjustment is carried upon a solid arm, to which it is firmly dovetailed and screwed fast. We are willing to admit that another form of fine-adjustment may be preferable for the expert engaged in work which requires the use of substage condenser, highest powers, &c.; but for the ordinary work of the histological laboratory we believe that it will prove eminently adapted. In the language of modern science, its structure being suited to the conditions of its 'environment,' it will survive, being of the 'fittest.'"

"**American Microscopes—A Complaint.**"—A great sensation has been caused in the United States by the publication † of the following article by Prof. C. S. Minot, condemnatory of American Microscopes. The author's criticism is much too sweeping and indiscriminate.

"Every autumn when the colleges and medical schools of the country begin their Academic years, there are many students who come to their instructors seeking advice in regard to the purchase of Microscopes. Often they appear already furnished with an instrument of which they are anxious to learn that the lenses are particularly good.

"As it has been my duty for several years to conduct a large class in practical histology, I have had frequent applications for advice about Microscopes, and have seen and examined a great many different

* Queen's Micr. Bulletin, v. (1888) p. 2. † Science, x. (1887) pp. 275–6.

stands, and the lenses of many manufacturers. I have had, therefore, opportunities to test the practical convenience and advantages of the many sorts of Microscopes which the students have brought along with them. The result of this experience is the conviction that it is undesirable to recommend a student to purchase any Microscope whatsoever of American manufacture, and to always counsel him to obtain, if possible, one of the German or French instruments.

"In order to make my judgment more clear, I may add that I know of no American Microscope which I should like to purchase at any price, for my own use in histological or embryological work.

"I venture to express this adverse opinion in regard to American Microscopes in the hope of inducing some of our opticians to manufacture a stand for a Microscope suitable for the use of students of histology and biology. It appears to me that the simple model now almost universally adopted in Europe is far superior to everything offered us in rivalry to them by our own dealers.

"To justify myself, I should like to give, first, the reasons for my disapproval of the American forms; and, second, the reasons for my preference of German forms. The fundamental error in Microscopes of American manufacture is that they are for the most part constructed with a view of, I might almost say, entrapping inexperienced purchasers. The zeal of the maker is turned too much to decorative lacquering and nickel-plating; he adds to his stand as great a variety of mechanical contrivances and adjustments as the price of the stand will permit, and many of these contrivances are not really commendable for their utility. In the majority of cases the stands are made to tilt, which, for one that uses the Microscope for real work, is an almost useless luxury, because he who really works in histology necessarily examines fresh specimens in fluids, or at least constantly has on the stage of his Microscope preparations in various stages of unreadiness, and not mounted in a permanent form. All this implies the constant use of fluids, and, if the stage of the Microscope is inclined, the use of liquids is impracticable. Any one, therefore, who uses his Microscope for the ordinary purposes of a student or an investigator, or in connection with clinical or pathological work, very soon falls out of the habit of tilting his Microscope. Hence it is, that, while making a Microscope to tilt renders it considerably more expensive, it adds nothing essential to the convenience of the stand for laboratory work. This same fact, that most of the work must be done with the tube of the Microscope vertical, renders it indispensable that the Microscope should not be too high; so that we must put down the ten-inch tube as a bad feature for a student's Microscope. A rack and pinion is undoubtedly advantageous; it renders the use of the Microscope more convenient, and increases its durability by diminishing the strain upon the stand during the coarse adjustment of the focus. When this adjustment is effected by shoving the tube with the hand, the Microscope wears out sooner than with the rack-and-pinion movement; yet even the rack and pinion, which are so generally put on our American Microscopes, are not indispensable, and the greater part of the histological and embryological investigations of the past twenty years have been made without the employment of this convenience.

"The stage of the American Microscope is very faulty. The large movable glass plate with a hole through it is a toy fit only for an amateur or fancy collector; it interferes with the use of fluids, and with

the freedom of movement of the slide over the field of the Microscope—the two things which are most indispensable in practice. A good stage should be large and flat, with nothing upon it except a pair of spring clips and a hole for a diaphragm. The diaphragms are often a matter of particularly fanciful construction. Thus the iris diaphragm is often introduced to allure the inexperienced, but it is not a good form except in conjunction with an achromatic condenser. There are other details of construction which are equally open to unfavourable criticism, but it is unnecessary to go into their discussion.

"Unfortunately, while we see so much pains expended upon the brasswork of the Microscope, we see a neglect of the optical members of the instrument; so that the Microscope as a whole is converted into a showy piece of apparatus, and the eye-pieces and objectives are generally, though not always, of a decidedly inferior character; when they are really good, the lenses are very expensive.

"If, now, our manufacturers would reverse the distribution of their painstaking, and make a simple stand of small size and compact model with first-class lenses, they would furnish something which could be recommended to students and others by conscientious advisers.

"Turning now to the consideration of Continental Microscopes, so universally used in Europe, and now happily gaining supremacy in this country, we see at once that they conform to the practical requirements which are disdained in the making of most American Microscopes.

"They are built with a firm base. The stage is easily reached by the fingers when the hand is resting upon the table. It carries no superfluous appurtenances, but is large and flat. The eye-piece is of such a height, that when the instrument is vertical it is easy to look into it. Concerning the lenses, it must be said that most of the European manufacturers are very conscientious in regard to those which they furnish. There are, of course, some makers who put upon the market objectives of inferior quality, and which are sold as such, and therefore at a correspondingly low price. This is of course legitimate, as there is a demand for cheap Microscopes.

"The price of these desirable Microscopes is very much less than that of undesirable American ones. According to our system of protection, the physicians, scientific men, and students are taxed enormously if they buy a foreign instrument. Put into plain English, this means that we are heavily fined if we secure what we require in the way of Microscopes, while a small number of manufacturers, whose money-making is of very little significance to the public, receive a bonus for furnishing an inferior article at a high price. Thus what is really important is sacrificed for what is unimportant. Many valuable members of the nation are sacrificed by being obliged to pay for the advantage of a small number of men who have never shown themselves willing to supply to those by whose sacrifices they benefit, the kind of instrument wanted.

"Can anything be more unjust? and are not we, who are engaged in university careers, in the practice of medicine, or any other useful occupation requiring the employment of Microscopes, justified in complaining of the condition of affairs, which is little short of a national calamity? Is it unreasonable to ask the manufacturers of Microscopes in this country to furnish us instruments of the kind we really need, as some sort of acknowledgment of the money they extract from us whether we will or not?

"In expressing myself so decisively and emphatically upon the subject of American Microscopes, I have not considered it necessary to give a detailed discussion of the relative merits and demerits of the different makes, because what I have expressed is the opinion, in these matters, of all the competent judges with whom I have talked on the subject.

"I know positively that many of the best scientific men of America are ready to join me in saying, as I said at the beginning, that there is no American Microscope which we should like to buy at any price for our own use."

In reply to some comments * to which his article gave rise, Dr. Minot wrote as follows †:—

"The object of my letter in 'Science' was to direct attention to a special need which I believe to exist in this country. This need is one which has arisen in consequence of the introduction of the Microscope as an aid to the educational courses of American colleges and medical schools. There the requirement is that the Microscope shall be as inexpensive as possible. Now, a Microscope must fulfil one indispensable requirement, it must be optically good. If the lenses are inferior, the value of the instrument is excessively diminished.

"Pretty much all the other qualities of the Microscope may vary without affecting anything but the convenience of the Microscope. It is therefore evident that it is solely in regard to the stand that the economy must be effected. I hold, therefore, that the ideal student's Microscope must have the simplest construction possible, and that nothing should be added to it which can be left out, and still leave the instrument sufficiently convenient for actual use. The hinged joint for tilting, the rack and pinion, and the iris diaphragm all increase the expense of the Microscope, and yet do not add anything indispensable.

"In Germany Microscopes are very little used by amateurs, but are extensively used by scientific investigators and students; accordingly, we find the stands which are made in that country adapted to the demand. A similar demand has arisen in this country, and will probably grow, and I should suppose that it would be for the interest of American manufacturers to meet this demand rather than to leave the market to European makers without competition."

Buffalo Microscopical Club.

[Protest against Prof. Minot's article on American Microscopes, *supra*, p. 482.]

The Microscope, VIII. (1888) pp. 55–6.

Henrici, J. F.—**Recently-discovered Microscopes of historic interest.**

[Describes and figures two Microscopes—(1) cf. *post;* (2) a Culpeper, "the exact counterpart in every particular of one figured in plate iv. of Adams's 'Essays on the Microscope' (1787)," with the addition of a rack and pinion for focusing.]

The Microscope, VIII. (1888) pp. 97–9 (2 figs.).

Scott, G. P.—**[Exhibition of a Microscope.]**

["This Microscope possesses many ingenious appliances connected with the body, the stage, and the substage of this instrument. Especially noticeable among these are the contrivances by which, with a quarter revolution, the polarizer, the selenite, and the analyser of the polarizing apparatus can instantly be brought into use or turned to one side, so as to avoid all interference with the examination of an object by ordinary light."]

Journ. N. York Micr. Soc., IV. (1888) p. 120.

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* Cf. inter alia Queen's Micr. Bull., iv. (1887) pp. 41–3; also v. (1888) p. 4.

† Queen's Micr. Bull., v. (1888) p. 8.

(2) Eye-pieces and Objectives.

The Jena Optical Glass.*—Mr. J. Swift states that the difficulties in the practical use of this glass has been great, "for nearly the whole of the new glass purchased by him was found to be worthless, so rapid was the deterioration of most of the samples; and some systems of lenses made of them became pitted on the surfaces within a week after the manufacture. He found about three stable samples in the whole of a very large batch." Figs. 74 and 75 represent in the actual dimensions the eye-piece and objective of a Microscope made entirely of the new materials. In fig. 74, A, B, and C are of the new crown glass, and D of the new flint. In the objective, fig. 75, A is the aperture above the compound lens B C; B is of hard crown, C of flint, D crown,

Fig. 74.

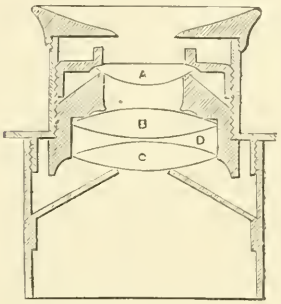
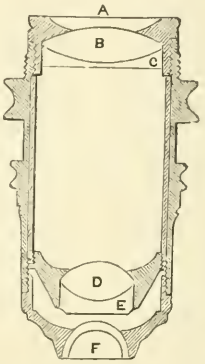


Fig. 75.



E flint, and F a plano-convex crown element of deep curvature, cemented to the meniscus flint element above it. Although it is difficult work to make an objective entirely of the new glass in its stable forms, Messrs. Swift use the glass now in all their Microscopes to some extent for objectives varying from the 1/12 in. immersion to the 3 in.; the benefit, they state, is that the 2 in. objective which formerly had an angular aperture of 15°, with the new glass has an angular aperture of 22°, and strange to say, instead of being dearer it is cheaper, because with the good samples of the new glass the manufacturing optician is more sure of his results. As regards the eye-piece, fig. 74, Mr. Swift says:—"It would be very difficult to use the ordinary Huyghenian eye-piece of the same power, as the loss of light would be so great that the detail the objective would be capable of picking up would not be seen, or the eye would have to be nearly in contact with the eye-piece, to enable the object to be seen, but with the eye-piece shown the focal distance is so increased that it can be used with as much ease as one of the ordinary construction with a magnification of only ten diameters."

Bausch, E.—**Society Screw.**

[Condemns the ambiguity of the instructions of the original committee, and urges that something should be done to get a better standard.]

The Microscope, VIII. (1888) p. 127.

* The Engineer, 1888, March 2, pp. 182–3 (2 figs.).

L., A. S.—**Inquiry as to the best proportion of Eye-piece to Objective.**
Engl. Mech., XLVII. (1888) pp. 169-70.

Objectives, English and Continental.

[Inquiry "how to compare the English and Continental nomenclature of objectives."

Reply by "T. F. S." that such a list as desired "would be impossible, from the simple fact that the magnifying powers of the objectives as supplied by the makers do not agree with their own catalogues." He then proceeds as follows:—

"Within certain limits, however, the focal distance of the objective is not of the slightest importance, the numerical aperture being the only measure of its capacity to show fine detail. Thus if a 1/4 in. and a 1/8 in. objective have the same N.A., and an object is shown under the first with an eye-piece magnifying eight, and under the latter with an eye-piece magnifying four times, there will be no difference between the images whatever, neither in brightness nor in the amount of detail shown, provided both glasses are equally corrected. The measuring the capacity of an objective by its focus is an old superstition handed down from the time when the angle had to be limited from a want of skill in making the necessary corrections for chromatic and spherical aberration, and like most superstitions, has lingered for a long time after the cause, which made it a real faith, has disappeared. I can only, then, counsel 'A Constant Reader' to throw aside all notions of measuring the capacity of a glass by its focal length, and in its place to study the 'Aperture Table' given in the 'Journal' of the Royal Microscopical Society, where he will find the resolving power for any given aperture, and can then compare catalogues for himself."

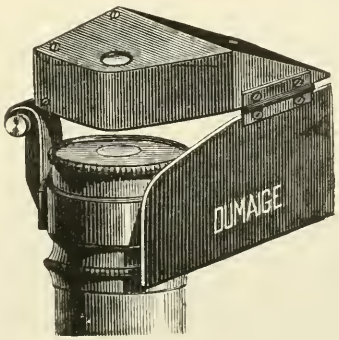
It cannot, however, be quite so broadly laid down that the "focal distance of an objective is not of the slightest importance." Even when resolution is alone considered there is a proper relation between aperture and power which renders a knowledge of the latter important.]

Engl. Mech., XLVII. (1888) pp. 125 and 146.

(3) Illuminating and other Apparatus.

Dumaige's Camera Lucida.—The peculiarity of M. Dumaige's camera lucida is that the prism and reflecting mirror are in a box, which can be closed when the camera is not in use. When in use the cover of the box hangs down at the side of the eye-piece, as shown in fig. 76. The optical arrangement consists of a small prism over the eye-piece, covering half

Fig. 76.



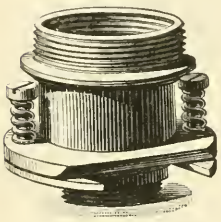
the eye-lens, with a mirror about 1 in. square which receives the image of the paper and pencil and reflects them to the prism, whence they are reflected to the observer's eye, which views simultaneously the image from the object through the uncovered half of the eye-lens. The

prism is mounted on a short pin on an adjustable slide at the side of the box.

Eye-shades.—These "shades," intended to be placed in front of the unused eye in microscopical observations, have hitherto been blackened, but it is suggested * that it would be preferable if they were white.

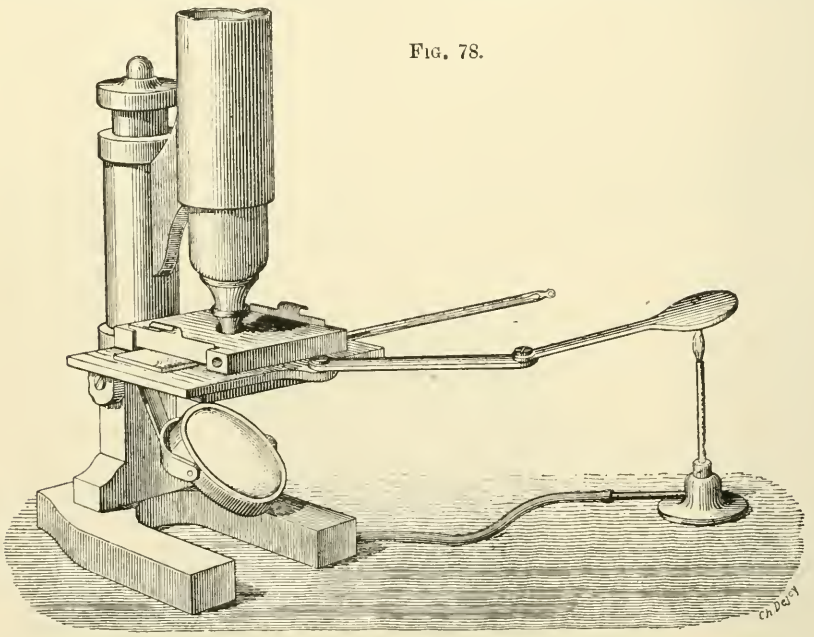
Dumaige's Nose-piece for Changing Objectives.—This device (fig. 77) of M. Dumaige somewhat resembles that of the Geneva Physical Instrument Co., described in this Journal, 1884, p. 284. It differs from that, however, in the use not of two hinged plates kept together by a set screw acting on a spiral spring, but of two spiral springs, as shown in the figure, which press the lower horseshoe plate against the adapter. The objective is provided with a sloping flanged collar, which is slipped between the lower plate and the adapter, and is held fast by the action of the springs. In order to further secure it there is an annular countersunk piece in the adapter into which the collar fits.

Fig. 77.



Malassez's Hot Stage.†—M. L. Malassez has devised a hot stage which is both simple and handy. It consists (fig. 78) of a metal

Fig. 78.



plate, covered over so as to form a box, into which the preparation is slipped. From the front of the plate projects a flat double arm, also of

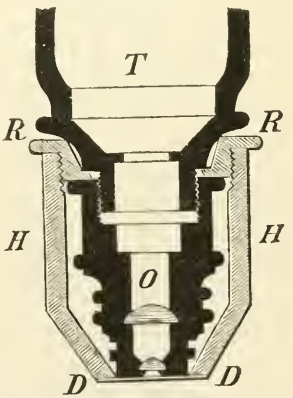
* Queen's Micr. Bull., v. (1888) p. 5.

† Arch. de Physiol., viii. (1886) pp. 271–3 (1 fig.).

metal. The end of the arm is expanded in order to be more readily heated. The sides of the hot chamber or box are of unequal thickness, the side farthest from the arm being the thicker, in order that the temperature of the side from which the arm projects and that of the opposite side may be about equal. This is shown by putting little pieces of paraffin on the top of the box, for they melt at almost the same time. A thermometer is placed within the chamber to mark the temperature, and this may be made to rise more or less quickly, according as the expanded end of the arm is more or less heated, and thus the temperature be kept fairly equable. If, however, a constant temperature be necessary, the author advises the use of M. Vignal's hot stage. The one described, however, is much more simple, and quite suitable for most purposes. The instrument may also be used for cooling down preparations by using methyl chloride on the expansion at the end of the arm.

Hällstén's "Compressorium."*—Dr. K. Hällstén apologetically calls his apparatus a compressorium for want of a better name, for its main use is intended to safeguard the face of the objective from the deposit of vapour while examining the circulation of the blood, e. g. in the chick. It may, however, be used as a compressorium for flattening out or exerting equal pressure upon the parts of a specimen.

Fig. 79.



The apparatus (fig. 79) consists of a cylindrical brass tube H, which surrounds the objective and carries the cover-glass D so that watery vapour is prevented from reaching the objective or face of the lens. R is a ring into which the upper end of the brass tube is screwed. This ring is screwed in between the body-tube T and the objective O. The cover-glass DD is fixed to the lower end of the compressorium tube by an alcoholic shellac solution. When in use the tube can be screwed down so that the cover-glass penetrates within the examining fluid and comes in contact with the blastoderm, and observation is unhindered by the presence of vapour.

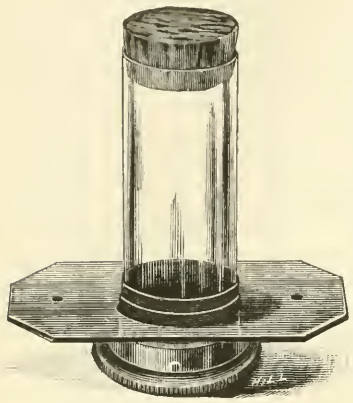
When the apparatus acts as a compressorium, the action is effected by merely screwing or pushing the tube down upon the object.

Hardy's Growing Slide.—Mr. J. D. Hardy writes:—"The absolutely necessary qualities of a growing slide are that there should be a perfectly free current, that the water supply should be pure or devoid of any extraneous matter, and that the object should be observable at any time. To carry out these desiderata I use apparatus shown in fig. 80 consisting of the old 'animalcule box' of $1\frac{1}{4}$ in. in diameter. At the upper part of the raised cylinder a small vertical slit is made half-way down. On the opposite side a hole is drilled in the bottom of the groove which runs round the central glass disc. A hole is drilled in the side of the cap about half-way down, so that when the cap is pressed close down the

* Zeitschr. f. Biol., xxii. (1886) pp. 404–7 (1 fig.).

hole is below the bottom of the slit. The compressor is now inverted, and a bottle or tube, made to fit watertight, and having a small hole in the side at the bottom, is inserted in the well. The hole in the bottle and that in the bottom of the groove are plugged with cotton-wool, either loosely or tight, according as the flow of water is desired. The water flows through the hole in the bottle, and then through that in the bottom of the groove, and so between the glass covers containing the object, passing out through the slit and the hole in the cap. The flow can be so regulated that it may take either a day or an hour to empty the bottle, which will contain about one fluid ounce. The cotton-wool plugs completely stop any foreign substance passing. When observation is required, the bottle being removed, the water will remain in the life-box, or it may be at once rendered watertight by turning the hole in the cap away from the slit."

Fig. 80.



Schieck's Microscope Lamps.—Herr J. W. Schieck has devised the lamps shown in figs. 81–4.

Fig. 81.

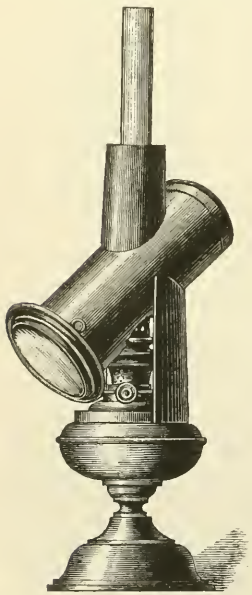
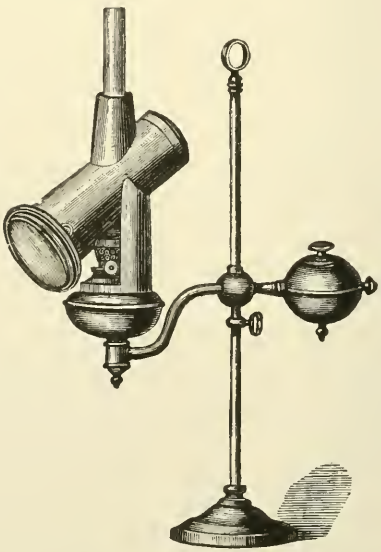


Fig. 82.



The peculiarity of the two former (which differ only in their mounting) is the metal shade and reflector, which is shaped as shown in the figs.

with a condensing lens in the lower end. The two latter have a hinged shade which can be placed in different positions in front of the lens according to the illumination required.

Fig. 83.

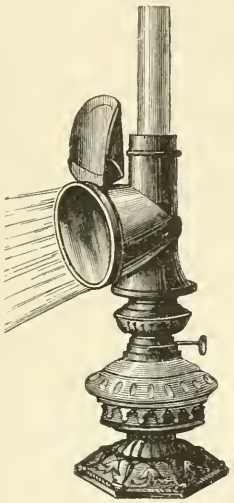
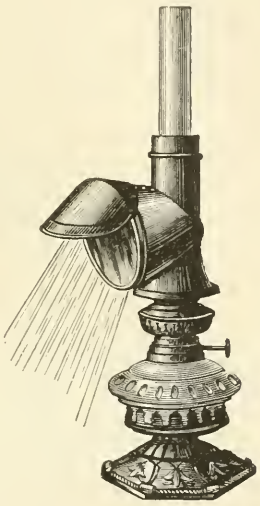


Fig. 84.



Gerlach's Embryoscope.* — The embryoscope, devised by Dr. L. Gerlach, supplies a great and long-felt desideratum in experimental embryology. It is a mechanism for closing hermetically a circular opening, made with a trepan, in the shell of the hen's egg; and it serves the purpose of a window, through which the living embryo may be directly observed, and its development followed from day to day.

The instrument consists of two parts:—(1) A mounting-ring to be firmly cemented to the egg-shell. (2) A key-piece with glass front, which screws into the ring and closes it air-tight.

Fig. 85 represents the embryoscope in perspective, and fig. 86 in section. The metallic mounting-ring is $1\frac{1}{4}$ mm. thick, and has a lumen 2 cm. in diameter. The lower edge *Ar* is bevelled and saddle-shaped so as to fit the equatorial surface of the egg, while the upper edge is flat. From the outer surface of the ring two square-cornered bars Z project in opposite directions. On its inner surface, a little above the lower edge, is a diaphragm *Md* with an opening 13 mm. in diameter. Resting upon this diaphragm, and corresponding with it in size and shape, is a second diaphragm of thin wax-cloth *Wd*, which serves as a packing-washer for the key-piece.

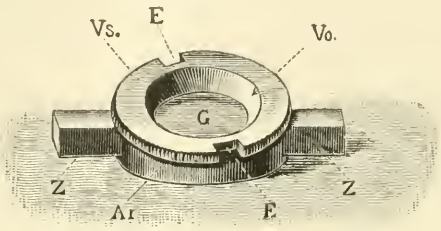
The key-piece of the embryoscope consists of a low metallic cylinder, closed by a disc of glass G, which represents the window that is to cover the artificial opening in the shell. The upper part of the cylinder expands peripherally to form a rim with a milled edge *Vs*. This rim has two notches E opposite each other, into which fit the arms of a small wrench, by the aid of which the key-piece can be tightly screwed down.

* Anat. Anzeig., ii. (1887) p. 583 (2 figs.).

There is also a short, narrow vertical canal *Vo* or vent, the lower end of which must open in the middle of the key-piece ring.

The accessory apparatus required in the use of the embryoscope consist of (1) a trepan; (2) a guide-ring for the same; (3) a metallic fork; and (4) the key or wrench before mentioned.

Fig. 85.



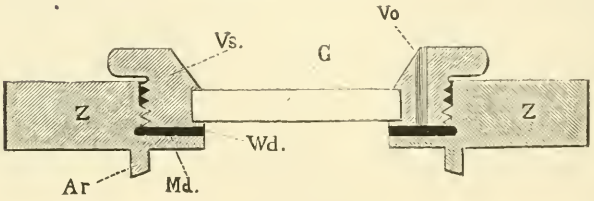


Fig. 86.

The trepan is a thin metallic cylinder, 2 to $2\frac{1}{2}$ cm. long, the lower end of which is toothed, while the upper part is fluted and serves as the handle. The diameter of the trepan is a trifle smaller than that of the opening of the diaphragm. The object of this is to leave a very narrow zone of shell, covered with shellac, inside the inner edge of the diaphragm.

The guide-ring for the trepan has the same construction as the key-piece, except that it has no glass disc. It serves to steady as well as guide the trepan during the process of cutting.

The fork has two notches at the ends of its prongs fitted to receive the two bars of the mounting-ring. When adjusted to the bars, the fork serves as a means of holding the embryoscope securely while screwing or unscrewing the key-piece.

The wrench, the use of which has already been explained, is similar in construction to the wrench used for mathematical instruments.

The mounting-ring is fastened to the egg by means of a cement consisting of two parts of wax and three parts of colophonium. The cement is hard and brittle at the ordinary room-temperature, but becomes soft and kneadable when held in the hand for a few moments. After warming the mounting-ring over a gas or a spirit-lamp, a roll of the softened cement is pressed into the space which must be completely filled between the lower face of the diaphragm and the lower edge of the ring. As soon as the ring becomes sufficiently cool, it is pressed firmly to the equatorial surface of the egg, and the excess of the still soft cement, which is thus forced outward and inward beneath the ring,

should be removed before it becomes brittle by the aid of a small, sharp-pointed blade. In order to avoid injuring the blastoderm, which might occur if the hot ring were fastened to the shell directly over it, it is best to fix the ring to the side rather than the top of the egg.

After the ring has been securely fixed and the superfluous cement removed, the exposed edges of the remaining cement seen beneath the lower edge of the ring and the inner edge of the diaphragm, must be covered with a coat of an alcoholic solution of yellow shellac. This may be applied with a small brush, care being taken to cover the cement completely, and as little of the egg-shell as possible.

After the shellac has dried, a process which is completed in twelve to fourteen hours in the open air and in six hours in the incubator, the shell may be trepanned.

Antiseptic precautions are required in opening the egg. An oblong porcelain trough or glass dish is first filled with a 3 per cent. solution of carbolic acid, and in this are placed the instruments to be used in the operation: a glass rod, a medium-sized brush, small shears, forceps, the trepan, and the guide-ring. Before using, these instruments are dried with carbolized cotton, and after using, returned to the dish of carbolic acid.

After washing the hands in dilute sublimate, or carbolic acid, a perfectly fresh egg is painted with the 3 per cent. solution of carbolic acid, and then dried with carbolized cotton. The small end of the egg-shell is then cut out with the shears, and the thick white poured with the aid of the glass rod into a clean dish, leaving the yolk and the thinner white in the shell. The white is to be used in screwing in the key-piece, and must therefore always be prepared beforehand.

After these preparations, the egg to which the mounting-ring has been cemented is disinfected in the manner above described, and placed in an egg-carrier with the ring uppermost. The inside of the ring is then brushed with carbolic acid, which is shaken out after one or two minutes, and replaced by a 1/2 per cent. solution of common salt, which is also allowed to remain from one to two minutes, and then completely removed by means of carbolized cotton. The guide-ring is now screwed in, and the egg trepanned from the side in order to avoid injuring the blastoderm. The egg is next placed with its opening upward, and the guide-ring removed. When the trepan is withdrawn, the excised piece of shell often comes with it, and sometimes the underlying shell-membrane. If this is not the case, the two pieces must be removed separately by the aid of the pincers. Care must, of course, be taken not to injure the blastoderm and the *zona pellucida*.

The thin white, which was left with the yolk in the shell, is allowed to flow over the glass rod upon the exposed blastoderm until the ring is filled, care being taken to avoid air-bubbles. The wax-cloth diaphragm is next taken from the dish of carbolic acid, dried in blotting-paper, drawn through the thick white, and inserted in the ring in close contact with the metallic diaphragm, and then the key-piece, previously washed with carbolic acid, and dried with carbolized cotton, is slowly screwed down. The superfluous white is thus slowly forced out through the vent *Vo*, until the key-piece reaches the diaphragm and closes the vent. Finally, when the strength of the hand is no longer sufficient, the egg with its embryoscope is placed in the metallic fork, and the wrench applied, until with this means it is no longer possible to turn the key-piece farther.

The process of trepanning and inserting the key-piece is somewhat more complicated in the case of eggs that have already been incubated, as the egg and the fluids employed must be kept warm. A water-bath is required, consisting of a low tin box, filled with water, and provided with covered apartments for the reception of the egg, the thin white, the carbolic acid, and the salt solution, which are in this way maintained at a proper temperature. In other respects, the mode of procedure is exactly the same as given above.

The key-piece may be removed as often as desired, provided the above precautions are taken each time in inserting it. If the key-piece is unscrewed by means of the fork and wrench, it must, of course, be washed in the warm carbolic acid, and the vent cleared by the introduction of a wire. The egg must be placed in the incubator with the embryoscope on one side. If it is placed upward the respiration of the embryo is hindered. The embryoscope can be turned up at any moment, and kept upright for five minutes at a time without injury to the embryo. With a little practice the whole process of arming an egg with the embryoscope may be completed in from six to eight minutes.

The embryoscope is well adapted for purposes of class-demonstration, for investigating the growth of the various parts of the embryo, and the physiological processes during embryonic life, as the action of the heart, movements of the body, &c. It is indispensable to the study of the effects of external agents upon the embryos of warm-blooded animals, and must be of great service where it is required to determine the precise stage of development before removing the embryo from the egg. It has been found useful in studying the formation of double embryos. Fenestrated eggs have been successfully incubated up to the thirteenth day, and it is probable that, under favourable conditions, the embryos of such eggs would reach maturity.

On the fifth day it is still easy to bring the embryos under the window. On the sixth and seventh days it is more difficult. At this period the change in the position of the embryo, which requires from five to ten minutes, should take place in the incubator.

After the eighth day the embryo cannot be brought under the window. If it be necessary to determine whether such an egg or an older one still lives, we have only to leave the egg for several hours in the incubator with the window directed upwards a little, after which, by strong reflected light, one may readily see the blood circulating through the channels of the vascular area.*

CURTIS, J. S.—**The Quantitative Determination of Silver by means of the Microscope.**

[Describes a "micrometer measuring apparatus," consisting of a Microscope with a vertical and two horizontal cross hairs and a mechanical stage.]

6th *Ann. Rep. U.S. Geol. Survey*, 1885, pp. 323–52 (1 pl. and 2 figs.).

MALASSEZ, L.—**Sur quelques nouveaux Appareils. II. Hémochromomètre perfectionné.** (On some new apparatus. II. Improved hæmochromometer.)

Arch. de Physiol., VIII. (1886) pp. 261–8 (2 figs.).

NEY, O.—**Magnesiumlampen.** (Magnesium lamps.)

[The magnesium ribbon is unrolled from a wheel at the back of the apparatus, and there is a patent adjustment for the burner which removes the ash by means of a clockwork motion with brushes, rollers, revolving discs, or some such mechanism. Three kinds are figured, one representing the lamp in the form in which it can be used directly with suitable lenses or mirrors for

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* Cf. Dr. C. O. Whitman in Amer. Natural., xxii. (1888) pp. 186–90 (2 figs.).

general purposes of illumination. A second, in which it is shown as applied for projecting microscopic objects, &c.; it is claimed that as an illuminator for this purpose it is far superior to petroleum lamps as being free from smell and from excessive heat, and at the same time more brilliant. The third is a special form for photographic illumination.]

Central-Ztg. f. Optik u. Mech., IX. (1888) p. 82 (3 figs.).

PULFRICH, C.—**Ein neues Refractometer, besonders zum Gebrauch für Chemiker eingerichtet.** (A new refractometer, specially intended for the use of chemists.)

Zeitschr. f. Instrumentenk., VIII. (1888) pp. 47–53 (2 figs.).

SEIFERT.—**Ueber das Auer'sche Gasglühlicht.** (On the Auer incandescent gas burner.)

[Recommendation of the Auer von Welsbach light (known in England as the *Welsbach*) for microscopical observations, examination of the nose, ear, &c.]

SB. Physik.-Med. Gesell. Würzburg, 1887, pp. 11–3.

(4) Photomicrography.

CROSS, C. F., E. J. BEVAN, C. M. KING, E. JOYNSON, and G. WATT.—**Report on Indian Fibres and Fibrous Substances exhibited at the Colonial and Indian Exhibition, 1886.**

[Contains a description of the photomicrographic apparatus and the method of working, pp. 13–6, 1 fig.]

viii. and 71 pp., 5 pls. of photomicr., 8vo, London, 1887.

[MANTON, W. P., and others.]—**Photomicrography.**

[Urging that the "helpful devices and methods" of workers should be "written up and published for the general good, and not held secret for individual benefit."]

The Microscope, VIII. (1888) p. 89.

NELSON, E. M.—**On the Formation of Diatom Structure.**

[In exhibiting some photomicrographic positives of diatoms, Mr. Nelson said, "I believe we are on the verge of a new departure in the field of microscopical work, viz. illustration by means of lantern pictures from photomicrographic positives."]

Journ. Quek. Micr. Club, III. (1888) pp. 201–2 (1 pl. of photomicr.).

(5) Microscopical Optics and Manipulation.

Learning to see with the Microscope.*—Mr. E. B. Poulton, in a review of the new edition of Huxley and Martin's 'Course of Elementary Instruction in Practical Biology,' writes on this subject as follows:—

"The most striking thing in the revised form of 'Practical Biology' is the reversal of the old arrangement, so that the student is now led to begin with a vertebrate type, and from this to work his way down to the lowest forms of life, and from these again upwards to a type of the flowering plants. There is little doubt that such a change will be met by conflicting criticisms. I believe, however, that the majority of those who have had the widest experience of biological teaching, and especially those who have instructed students in the first use of the Microscope, will heartily agree with Prof. Huxley's defence of the alteration in the preface to the revised edition.

"The process by which the student first learns to see with the Microscope is almost like the education of a new sense-organ suddenly conferred upon a mature organism. We know that under such circumstances it would be a very long time before the impressions conveyed by the new organ could be harmonized with the well-known experiences resulting from the stimulation of other organs. Accustomed to judge of the shapes of objects by their appearance in three dimensions, the student is suddenly provided with a field of vision in which shapes have

* Nature, xxxvii. (1888) pp. 505–6.

to be nearly always inferred from the appearance of solid three-dimensioned objects when seen under conditions which prevent them from being examined in more than two dimensions at any one time. For it is a long time before the student can accustom himself, by focusing at successive depths, and by making the most of the limited third dimensions of depth which the high powers of the Microscope provide, to judge accurately of the forms of objects. And the novel conditions under which a student sees with a Microscope effectually prevent him from making the best of the impressions he receives. Thus, if the section of a solid object presented the appearance of a circle 1 inch in diameter, and if two other sections at right angles to each other and to the first section presented the appearance of a rectangular figure 3 feet by 1 inch, nearly every one would readily infer that the shape was that of a cylinder 3 feet long by 1 inch in diameter. But precisely similar data when presented in the field of the Microscope, do not readily lead the student to any definite conclusions as to the forms of objects, and in reality a long course of discipline is necessary in order to make him form any clear conception of the actual shape of the object at which he is looking.

"I therefore think that it is expedient to begin the course of biological teaching with organisms which only require the use of a Microscope for the investigation of part of their structure, and thus to gradually work downwards to the minutest organisms, in which the whole investigation depends upon high microscopic powers. Thus the gradual training in the use of the Microscope will proceed parallel with its gradually increasing necessity."

Cover-correction.—Herr C. Reichert considers* that the "importance of 'cover-correction' by means of a screw collar is not so great as it once was, because, in the first place, it is now possible to readily obtain cover-glasses of a definite thickness, and, in the next place, because all good Microscopes are now provided with a draw-tube. In all high-class instruments, the draw-tube forms an important part, and is less intended to increase the magnification than to correct for the difference in the thickness of the cover-glasses. By means of varying the length of the tube, we are able to produce an effect upon the image similar to that which is the result of making the back lenses approach or recede from the front lenses of the objective. The effect due to varying the tube-length is noticeable in an objective such as No. 5, which has a focal length of about 1/16 in., and is more marked as the power of the objective increases. For example, if an objective having a focal distance of about 1/10 in. be corrected for a cover-glass 0·17 mm. thick, when the tube is half drawn out, it may, by shortening the tube, be made suitable for cover-glasses having a thickness of 0·25 mm. to 0·30 mm.; and if the tube be fully drawn out, the objective will then be suitable for cover-glasses from 0·14 to 0·12 mm.

"Those commencing microscopical studies should make themselves familiar with the influence exerted by the varying length of the tube, and this may conveniently be done by studying a delicate test-object, such as *Pleurosigma angulatum*, when the tube is extended or shortened in the manner already described."

* Reichert, C., 'Directions for using the Microscope,' translated by A. Frazer. 8vo, Edinburgh, 1887, 12 pp. (2 figs.).

On this point we will observe that the student will find his range of experience much increased by varying the position of the mirror so as to make the illumination more or less oblique. The differences between the positions of the draw-tube required to obtain the more perfect definition will thus be much more plainly appreciable by the untrained eye, and he will thus learn to discriminate at a glance when he is obtaining the best images his objectives will produce.

Further, this method of practice should also be adopted in conjunction with the correction-collar of the objective, which should be turned slowly from end to end of its range in one direction, and then in the other whilst following the varying focus by the other hand on the fine-adjustment. The eye and the hand will thus be trained to the *skilful* employment of the Microscope, a matter which has been far too much neglected hitherto.

It is a subject of common observation by opticians that the great majority of Microscopists have no practical training in the use of a correction-adjustment in improving the quality of the image under varying conditions of the illumination and with different thicknesses of cover-glass. Through neglect of such points the student drifts into regarding the correction-adjustment as useless; hence, he too frequently contents himself with mediocre definition, when his Microscope is capable of superior work if only properly handled.

Adjusting an Objective for the Thickness of the Cover-glass.—In a description of their "National" Microscope, Messrs. R. and J. Beck give directions for adjusting an objective, which are conveniently arranged

FIG. 87.

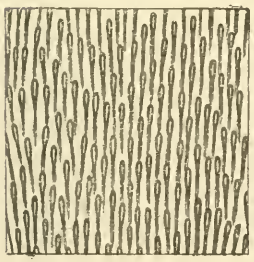


FIG. 88.

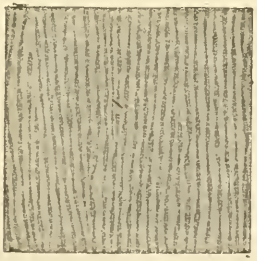


FIG. 89.

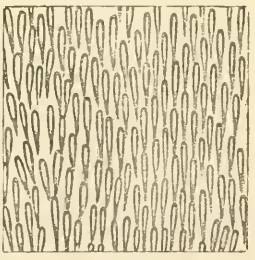


FIG. 90.

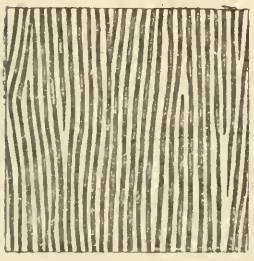


FIG. 91.

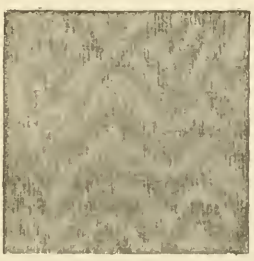
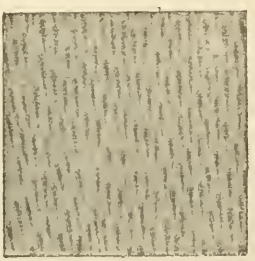


FIG. 92.



for the use of the student microscopist, and with these they give the following figures showing the appearance of a Podura scale when (fig. 87)

the adjustment of the object-glass is correct; the effect (fig. 88) produced on each side of the exact focus; and the way (fig. 89) in which the markings individually divide when all the adjustments are correct, and when the focus is altered the least possible amount only each way.

Figs. 90 and 91 show the two appearances on one and the other side of the best focus when the adjustment is incorrect; fig. 92 showing the appearance of the same at its best focus.

Villi on the Scales of Butterflies and Moths.—Dr. G. W. Royston-Pigott considers * that the resolution of these difficult objects is a capital introduction to the study of the minute structure of disease germs, and he can consequently strongly commend it to the attention of microscopists who have neglected this department of natural history.

Many of the villi in butterfly and moth scales are pawn-shaped, possessing a base and a spherical summit. This form was the first one discovered, with exceeding difficulty, on the scales of the Red Admiral butterfly. The scales of *Amathusia Horsfeldii* gave clearer indications, but their extreme delicacy permits of no pressure being applied, as it flattens and distorts them. After seven years' prosecution of the research he was rewarded with finding an entirely new vein, which has proved very rich in material, in moths of the *Zygœna* tribe. Occasionally they are seen to lie flat upon the basic membrane, and to be connected by cross ramifications, interlacing in an extraordinary manner. At other times the bases of the villi are ciliated, forming reticulations, resembling ancient hieroglyphics or archaic writing. Their thickness varies from 1/60,000 to 1/120,000 in., and their length is sometimes prodigious.

The villi principally observed at present take the following forms:—i. Beaded villi; ii. Embossed villi; iii. Pillar villi; iv. Ciliated villi; v. Connected villi; vi. Banana or Bunched villi; vii. Spinous villi; and viii. Tall villi.

Out of about 400 preparations (dry mounts) of scales obtained from all parts of the world, the author selects a few which with good object-glasses give, he considers, some startling results. Only a brief abstract is, however, given of the appearances.

Mr. T. F. Smith considers † that some of the appearances described in the paper are due to the villi being seen out of focus. In his view they are in between the two membranes of which the scales are composed, their use being to keep the two surfaces of the scale apart, and they are longer or shorter according to whether the surfaces are more or less rounded. He had seen some of the appearances, but only by taking too deep a focus. "As for the beading, he had never seen it, and he was strongly inclined to the belief that it arose from Dr. Pigott's methods being in some way at fault. He believed from what he had read that Dr. Pigott worked with a very small aperture, and if any one wanted to produce false appearances they could not go a better way to work; by using the lowest aperture of the condenser the same effects could be produced. With regard to Dr. Pigott's test rings, he knew that appearance perfectly well; but it was again a false effect due to the results of using too small an aperture."

Mr. Smith also shows ‡ that "some very respectable beads" may be

* Journ. Quek. Micr. Club, iii. (1888) pp. 205–7.

† Ibid., pp. 234–5.

‡ Ibid., p. 204.

developed by using the smallest aperture of the condenser, but that they instantly vanish when the light is restored.

There can be very little doubt that Mr. Smith is right in his criticism, and that it is Dr. Pigott's defective methods of manipulation that have led him astray in this matter.

New Appearances in Podura Scale.*—Mr. T. F. Smith calls attention to what he considers to be a new appearance of the *Podura* scale not yet recorded. In place of the optician's appearance of the scale, with the exclamation marks, blue or red, according to the corrections of the glass, and with a light streak in the middle, more or less extended as the aperture is larger or smaller, the usual markings had vanished, and in their stead "the whole scale was studded with very slender spines with round heads, and the pointed ends stuck into the scale like a lot of pins stuck loosely and anyhow into a paper, and instead of being blue or red were a pure white." At first he thought there were two sides to the scale, and that this was the wrong one, but he found that the scale was tight against the cover, and that all the scales so placed had the same appearance.

Since then he has examined many scales on several slides, and is "now strongly of opinion that the note of exclamation markings are spurious, and that the light streak is the true appearance, which has hitherto been seen with the darker outline on each from taking too deep a focus. It is a well-known fact that an oil-immersion objective works only with its full aperture when an object mounted dry is well on the cover, and this in itself should be sufficient evidence that the appearance the object presents, under these circumstances, is the truer one. Then, again, the pin-like looking spines are not more than half the diameter of the exclamation marks, and the image is always at its smallest when in focus; never larger." Another fact which guides the author in his estimation of the structure is the observation of a hair with small projecting spines. "Here was structure of which there could be no doubt, and the same point of the correction-collar that gave the sharpest image of this hair gave also the sharpest image of the spines on the scale. Still another proof. To bring the note of exclamation marks out well requires a deal of management of the light, and they are best seen with the smallest apertures of the condenser; but no amount of light will obliterate the new ones or prevent them from standing out sharply from the general blaze."

"New Glass just made in Sweden."—We have received from a considerable number of correspondents cuttings from various newspapers describing this "new glass." As will be seen it is a revival of the paragraphs to which we called attention in the last volume of this Journal, pp. 155 and 321. What is the cause of this recrudescence we do not at all know, but it has apparently been disseminated all over England, as our cuttings come from London papers, local country papers, religious papers, &c.

The paragraphs are the most outrageous piece of rubbish ever published, and while of course editors can't be expected to know everything, they might surely get to know enough to avoid putting in such asinine statements as these.

"Perhaps the most wonderful thing that has been discovered of late

* Journ. Quek. Micr. Club, iii. (1888) pp. 203–4.

" is the new glass which hast just been made in Sweden. The revolution " which this new refractor is destined to make is almost inconceivable, if " it is true, as is positively alleged, that, while the highest power of an " old-fashioned microscopic lens reveals only the one four-hundred- " thousandth part of an inch, this new glass will enable us to distinguish " one two-hundred-and-four-million-seven-hundred-thousandth part of an " inch." *

" A new kind of glass, which is to revolutionize scientific investiga- " tion, has been invented in Sweden. Ordinary glass is composed of six " ingredients, but this compound contains no less than fourteen, chief " among the new substances employed being phosphorus and boron. For " microscopic purposes the power claimed for this Swedish glass is almost " incredible. One 400,000th of an inch can be distinguished by the " strongest lens at present, but the new glass will, it is said, reveal the " 204,700,000th part of an inch. If the Swedish invention at all ap- " proaches what is promised for it, its importance can hardly be exagger- " ated, but the very moderate performance of the so-called 'unbreakable " glass' invented a few years ago, may warn us to be somewhat sceptical " in regard to new wonders in the way of glass." †

Curiosities of the Senses.

["According to a memoir communicated to the Biological Society of Paris by M. Mathias Duval, and reported in the *Siècle*, it is not advantageous when looking through a telescope with one eye to close the other, but rather the contrary. We have not succeeded in verifying this observation with the Microscope."]

Scientif. News, I. (1888) p. 372.

Cz[apski, S.]—**Bemerkungen über Prof. Abbe's Abhandlung: Die Vergrösserung einer Linse oder eines Linsensystems.** (Remarks on Prof. Abbe's paper: The magnifying power of a lens or a lens-system.)

[Criticism of the papers of Prof. Abbe and Prof. Giltay in this Journal, 1884, p. 348, and 1885, p. 960.

" For practical microscopists to adopt Abbe's definition for ordinary use seems to me not only purposeless, but at no time desirable. On the other hand, for scientific purposes in theoretical discussions relating to the magnifying power of an optical apparatus, the stricter definition of Abbe will be of value; and even in Giltay's point of view, the number which represents the magnifying power is subjective, and applies only to an eye which sees an object best at the distance of 25 cm., but is different for another length of vision. The arbitrary character of the measure which Giltay raises as an objection to Abbe cannot be supported as an argument against his definition, for it is common to all magnitudes expressed in so-called absolute units.]

Zeitschr. f. Instrumentenk., VIII. (1888) pp. 104–5.

D., M. T.—**Microscopical Drawings.**

[Device for drawing with the Microscope:—" Take a small portion of the silvering from the back of a mirror, about 1/16 in. in diameter (there must be a thick coating of paint on the back of the amalgam to support it, or it will not break off). This small reflector is to be mounted with cement on the edge of a piece of watch-spring at the proper angle. The spring is bent round and fixed to a brass tube fitting over the eye-piece, so that the reflector stands about 1/4 in. from the eye-lens and central with it. On looking into it the object on the stage of the Microscope is seen, and appears to be projected on to the paper spread below. I believe that steel mirrors are used for the same purpose; but the amalgam has a very good surface, costs nothing, and can be renewed in a very short time. It is better than the 'neutral glass plate.'"]

Engl. Mech., XLVII. (1888) p. 170.

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* Essex local paper. † Christian World, 1888, April 19.

HODGKINSON, A.—**On the Diffraction of Microscopic Objects in Relation to the Resolving Power of Objectives.**
Proc. Manch. Lit. and Phil. Soc., XXV. (1886) pp. 263–7 (5 figs.) and pp. 223 and 271–2.

JAMES, F. L.—**Nobert's Bands.**
St. Louis Med. and Surg. Journ., LIV. (1888) pp. 166–7.

L., A. S.—**Powers of Eye-pieces.**
["Table of the powers of the eye-pieces of different makers as deduced from the total magnification with the 1 in. objective."]
Engl. Mech., XLVII. (1888) p. 146.

QUEEN, J. W.—**Apparent and Actual Size of Field, Magnifying Power, &c.**
Queen's Micr. Bulletin, V. (1888) pp. 1–2.

" " **General Hints on the use and care of the Microscope.**
The Microscope, VIII. (1888) pp. 4–5.

ROYSTON-PIGOTT, G. W.—**Microscopical Advances. XXXV., XXXVI.**
[Researches in High Power Definition. Interference lines, circles, and dots. Attenuated lines, circles and dots.]
Engl. Mech., XLVII. (1888) pp. 137 (2 figs.), 226–7 (2 figs.).

WIENER, O.—**[Measuring Thin Films.]**
["In an exhaustive paper upon methods of measuring thin films, Otto Wiener makes certain measurements of the thickness of a film of silver which can just be perceived by the eye, and arrives at the conclusion that 0·2 millionths of a millimetre is an upper limit of the diameter of a silver molecule."]
The Microscope, VIII. (1888) p. 93, from *Scientific American*.

ZECH, P.—**Elementare Behandlung von Linsensystemen.** (Elementary treatment of lens-systems.) 8vo, Tübingen, 1887.

(6) Miscellaneous.

Heather's 'Mathematical Instruments.'—It is really a disgrace to all concerned—publishers and editor—that this book with a title-page of 1888,* should have been published.

It is inconceivable that any intelligent grown-up person should not have known that the extracts we print below are an anachronism in this year 1888 or even in the year 1848. Imagine, for instance, describing any Microscope of this date as having the "amplifying lens" of the old makers.

"The compound or achromatic Microscope consists of four lenses and a diaphragm, placed in the following order: the object-lens, the diaphragm, the amplifying lens, so-called because it amplifies or enlarges the field of view, the field-lens, and the eye-lens. The relations between the focal lengths and intervals of the lenses, and the distance of the diaphragm from the object-lenses are determined so that the combination may be achromatic, aplanatic, and free from spherical confusion. The field-lens and eye-lens form what is called the eye-piece, and the object-lens and amplifying-lens form, or tend to form, an enlarged image of the object in the focus of the eye-piece, which image is viewed through the eye-piece" (p. 79).

The following paragraph is also deserving of note:—

"The best Microscopes are constructed with compound object-lenses, which are both achromatic and aplanatic, and by this means the aperture, and consequently the quantity of light, is much increased. Good compound lenses possessing the required properties have been formed of a concave lens of flint glass placed between two convex lenses, one of crown glass and the other of Dutch plate" (p. 79).

* Heather, J. F., 'A Treatise on Mathematical Instruments, their construction, adjustment, testing, and use concisely explained.' 14th ed., revised, with additions by A. T. Walmisley. 8vo, London, 1888.

The above is followed by a whole page on "the Reflecting Microscope," no such a Microscope having been made certainly since 1840.

Micromillimetre.*—Prof. A. W. Rücker observing that the word micromillimetre is used as equivalent to the *thousandth* of a millimetre, and being told that it is now commonly employed by biologists, and especially by botanists, with that meaning, protests against such a use of the word.

As he thinks it would be very unfortunate if the same word were habitually used in different senses by students of different branches of science, he points out that, according to the definitions of the C.G.S. system, a micromillimetre is the *millionth* of a millimetre.

In the well-known report of the Committee of the British Association for the "Selection and Nomenclature of Dynamical and Electrical Units," it is laid down that the prefixes *mega* and *micro* are to be employed "for multiplication and division by a million." This ruling has been generally accepted not only by scientific men, but also by those engaged in commerce. Megohm and microfarad are terms which are used in contracts, and are universally understood to mean a million ohms and a millionth of a farad respectively. It will be hopeless, he thinks, to try to introduce scientific systems of measurement into the affairs of daily life if scientific men themselves disregard the rules on which those systems are framed.

It would also, in his view, be particularly confusing if the micromillimetre were wrongly used by microscopists. In its proper sense it is the most convenient unit in which to express molecular magnitudes. It has been employed for that purpose by Sir William Thomson and others in England, and also by physicists abroad. If the micromillimetre of the microscopist is 1000 times too large, all sorts of mistakes will be rife as to the relative dimensions of molecules and of the smallest objects visible with the Microscope.

The proper name for the thousandth of a millimetre (μ) is, in his view, the *micromètre*, and though the similarity of this word to *micromèter* is no doubt a drawback, it is not likely that confusion could often arise between them. He therefore begs respectfully to suggest that botanists should bring their nomenclature of units of length into conformity with the definitions of the C.G.S. system. Otherwise there will be a permanent confusion between the micrometre (μ) and the micromillimetre ($\mu\mu$).

On the other hand, Mr. H. J. Chaney suggests† "that even the denomination 'micromètre' may be hardly acceptable to scientific workers. The denomination for the measure of the one-thousandth of a millimetre (μ), or 0·000001 metre, is 'micron,' and not 'micromètre.'

"For the 'micron' we have the authority of the 'Comité International des Poids et Mesures.' One shudders at the thought of the confusion likely to arise when computers are required to deal with both micromètre-units and micromèter-divisions.

"The Comité International have also recommended the use of the following metric denominations for minute measurements:—

Denomination.	Symbol.	Equivalent.
Micron	μ	0·001 millimetre.
Microgramme ..	γ	0·001 milligramme.
Millilitre	ml.	0·001 litre.
Microlitre	λ	0·000001 litre."

* Nature, xxxvii. (1888) pp. 388–9. † Ibid., p. 438.

Mr. A. D'Abbadie also writes* to say that "here" (presumably Paris), *micron* is currently used to express the 1/1000 mm.; while Mr. R. B. Hayward proposes† a new nomenclature which would convert the micro-millimetre into a "hexametret."

The Council of the Society having considered the question raised by Prof. Rücker, decided, as announced at the April Meeting, that the term micron should in future be used in this Journal and in the official proceedings of the Society, in place of micro-millimetre. It was felt that the term micrometre from its similarity to micrometer (especially in French) was unsuitable.

American Society of Microscopists.—Columbus, Ohio, Meeting, 1888.
The Microscope, VIII. (1888) pp. 117–8.

Bond, G. M. (Editor).—**Standards of Length and their practical application.** A résumé covering the methods employed for the production of standard gauges to insure uniformity and interchangeability in every department of manufactures, including the reports of Prof. W. A. Rogers; the Committee on Standards and Gauges, American Society of Mechanical Engineers; the Committee of the Master Car-Builders' Association; and including also the Report of the Special Committee appointed by the Franklin Institute, April 1864.
[Describes and figures the Rogers-Bond Universal Comparator.]
iv. and 180 pp. and 31 figs., 8vo, Hartford, Conn., U.S.A., 1887.

Calcutta Microscopical Society. *The Microscope*, VIII. (1888) pp. 89–90.

Dallinger, W. H.—**Least and simplest forms of Life.**
[Three lectures at the Royal Institution.]
Scientif. News, I. (1888) pp. 282, 306, 378.

East London Microscopical Society.
[Report of meeting.] *Engl. Mech.*, XLVII. (1888) p. 142.

Michael, A. D.—**Parasitism.**
[Presidential Address to Quekett Microscopical Club.]
Journ. Quek. Micr. Club, III. (1888) pp. 208–24.

M'Intire, S. J.—**The Quekett Microscopical Club.**
[Report on soirée of 9th March.] *Sci.-Gossip*, 1888, p. 92.

Postal Microscopical Society.
[Suggestion for the formation of "circles" for "work either of a general or a specific character."]
Journ. of Micr., I. (1888) pp. 118–20.

Quimby, B. F.—**[Widening the Scope of Microscopical Societies.]**
The Microscope, VIII. (1888) pp. 125–6.

Schröder, H.—**Aufforderung der Gründung eines Instituts, um die grossen Entdeckungen der neuesten Zeit in der Astronomie, Astrophysik, Optik und Mikroskopie Allen zugänglich zu machen.** (Suggestion for the establishment of an Institute to make accessible to all the great discoveries of recent times in Astronomy, Astronomical Physics, Optics, and Microscopy.)
Central-Ztg. f. Optik u. Mech., IX. (1888) pp. 85–9 (5 figs.).

β. Technique.‡

(1) Collecting Objects, including Culture Processes.

Alkaline Egg-albumen as a Medium for Bacteria Cultivation.§ — Dr. J. Tarchanoff and Dr. Kolessnikoff find that if hens' eggs with their shells be placed in 5 to 10 per cent. solution of hydrate of potash for

* Nature, xxxvii. (1888) p. 438. † Ibid., pp. 437–8.

‡ 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.

§ Russkaja Medicina, No. 11, 1887, p. 191. Cf. Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 405–6.

from four to fourteen days, the albumen undergoes a change of consistence. By the fourth day it is fluid and transparent; from the fifth to the fourteenth it is transparent but firm, gelatinous and yellowish. Both modifications can be produced in a steam sterilizer either alone or in combination with gelatin (3 to 10 per cent. half-fluid) or agar agar (1 per cent. firm). For testing the utility of this medium for cultivation purposes the author's three combinations of alkali albuminate were (1) Bouillon albuminate: Albumen of eggs having lain four days in 10 per cent. KHO solution, and water added to make a 10 per cent. solution which was steam sterilized in the usual way for three days, and then put in test-tubes or Pasteur's "Matras" and again sterilized. (2) Syrup alkali albuminate: Albumen having been four days in KHO was diluted one-half with water, placed in test-tubes, and sterilized in the usual way. (3) Firm albuminate (*a*) Sterilized: Half-fluid albumen of four days' standing was poured in test-tubes and steam sterilized at 105° for some minutes to one hour on one or three days. It resulted that albumen after fifteen minutes' sterilization became opalescent-whitish, but was always transparent. On repeated or protracted sterilization it hardened and became of a yellowish-orange colour. (*b*) Unsterilized: Hard transparent hen's egg albumen of fourteen days' standing in 10 per cent. KHO was cut up into thin plates and treated like potato cultivations. On these three media various bacteria were sown. *Bacillus anthracis* grew very well on the bouillon albuminate; on No. 2 and 3 it was slower in starting. The cultivations were all pathogenic. *Spirochæte choleræ asiaticæ* and Prior-Finkler grew just as well as on their ordinary media. Although the latter fluidified No. 2 and No. 3 albuminates, the colonies were not characteristic. *Bacillus tuberculosis* and *Mallei* grew well, as did also *Bacillus subtilis*, *prodigiosus*, *Micrococcus ruber* Flügge, *Sarcina flava*, and orange. The authors lay stress on the simplicity of the production, the transparency and the cultural utility of this new medium for the most different kinds of bacteria. They anticipate that it will eventually supplant the ordinary gelatin, agar, and serum media.

Fatty Matters in Cultivation Media.*—Sig. L. Manfredi reports his experiments with cultivation media containing fatty matters.

The results were that whenever the fatty constituent (as in broths) reached one-third of the total amount, the bacillus of anthrax failed to thrive, and that when it passed that proportion, the cultivation became exceedingly feeble, totally ceasing before two-thirds was reached. This is given as a matter of precaution to those who experiment with fatty broths, &c. It has, however, a value beyond this, viz. that with the decreasing vitality of the specific microbes, their virus is attenuated, and that, consequently, by using a certain amount of fatty matter in the pure cultures, the virus may be correspondingly attenuated.

Collecting Microscopic Algæ.

["Take waxed paper (from cakes of soap, &c.), and punch holes slightly smaller than the largest covers; then wrap the paper about the slides in such a way as to bring the holes in the middle on each slide. On suspending the slides good mounts can be obtained. Surround it with a ring, place on another slip or cover-glass, and it is ready for observation."]

Scientif. Enquirer, II. (1888) p. 68.

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* St. Louis Med. and Surg. Journ., liv. (1888) p. 97, from Giorn. Internat.

EYRE, J.—**Pond Dredging and Collecting.**

[For more delicate work or for use in ponds, &c., comparatively free from weeds, a large-sized test-tube might be substituted for the bottle, and should be fastened to a short thin length of bamboo as follows:—"Take a 6 in. length of caoutchouc tubing, and make a cross cut three-quarters through, at about an inch from one end; then another at right angles to the first along the other 5 inches; the result is a short piece of tube with a 5 in. slip of gutta-percha. The tube is slipped over the end of the rod, and the free end of the flap is pushed between the rod and the tubing, the test-tube placed in the loop so formed, and the strip drawn tight and fastened off."]

Sci.-Gossip, 1888, p. 69.

ROUSSELET, C.—**Pond Dredging and Collecting.**

["Hints on collecting Infusoria, Rotifera, and Polyzoa, the result of my experience in this interesting pursuit."]

Sci.-Gossip, 1888, pp. 54-5.

(2) Preparing Objects.

Demonstrating Nuclein and Plastin.*—Dr. E. Zacharias in discussing the properties and mode of origin of nuclein and plastin, remarks that both substances are undissolved when the cells are treated with artificial gastric juice. Under the action of gastric juice, or of 0·2–0·3 per cent. hydrochloric acid, parts containing nuclein present a sharply defined appearance, while bodies which contain plastin but no nuclein swell up and grow pale. Nuclein swells up in 10 per cent. salt solution, in solution of soda and in dilute caustic potash. Plastin, on the contrary, does not swell up in 10 per cent. salt solution, and is only soluble with difficulty in alkalies. Both are soluble in concentrated hydrochloric acid, but in a mixture of 4 vols. HCl to 3 vols. H_2O the nuclein only disappears. When fresh, bodies containing nuclein swell up in distilled water. Long preservation in spirit is detrimental to these reactions. Nuclein takes up pigments with avidity, but this property is in no way confined to parts containing nuclein. All the cell protoplasm becomes stained by the prolonged action of pigment. It cannot therefore be concluded that nuclein is present because the nucleus becomes stained, but if it do not, it may be inferred that it is absent or present in small quantity.

Substances with the foregoing properties have hitherto only been demonstrated in the cell-nuclei; plastin, on the other hand, is a constituent of the whole cell-plasma. The existence of nuclein in bottom yeast, in Phycochromaceæ, milk, and yolk-corpuscles of animal ova appears to clash with the former statement. In the two last cases the substance in question differs in its reactions from nuclein. The author found it both in germinating and in bottom yeast. By extracting germinating yeast with ether alcohol, then soaking in water, and staining with Grenacher's hæmatoxylin, the cell-nuclei are rendered evident. The action of the digestion-fluid failed to demonstrate the nucleus; but in bottom yeast the nucleus was found to contain nuclein. Bottom yeast extracted with alcohol ether, digested, and then placed in a 0·3 per cent. salt solution for 24 hours, showed in the bright swollen-up plasma residue corpuscles of irregular shape, and with the characteristic brightness of nuclein. By adding pure strong hydrochloric acid the corpuscles lose the brightness, the plasma becomes clearer, and then disappears along with the corpuscles. A 10 per cent. salt solution acting on digested material which has been extracted with alcohol-ether causes the corpuscles to swell up while the rest of the plasma remains well defined

* Bot. Ztg., xlv. (1887) pp. 282–8, 297–304, 313–9, 329–37, 345–56, 361–72, 377–88 (1 pl.).

and unswollen. In Phycochromaceæ the nucleus was demonstrated in *Tolypothrix*, *Ægagropila*, and *Oscillaria* sp.; it was best shown by digesting the fresh filament, then extracting with ether-alcohol and examining in a 0·3 per cent. salt solution. The author also treats of the resting and active condition of the nucleus, and the cells taking part in reproduction.

Preparation of Nerve-cells and Peripheral Ganglia.*—Anna Kotlarewsky employed in her researches on the spinal ganglia, and on the Gasserian ganglion four different hardening methods. (1) Hardening in acids: 3 per cent. nitric acid; half per cent. chromic acid; 1 per cent. osmic acid; 1 per cent. picric acid, and Flemming's mixture. The preparations were imbedded in celloidin, or paraffin. Next to freshly examined cells, the picric acid was found to produce the best effect. Flemming's mixture had an unfavourable action on the shape of the cells. In all the preparations hardened in acids, the outline of the cells was sharp; the cell-body took stains well, but the nucleus only slightly, though the nucleoli were well coloured. (2) Hardening in acid salts (Müller's solution). (3) Hardening in neutral media (neutral acetate of lead and spirit): Cells in the preparations treated with 10 per cent. solution of acetate of lead showed excellent fixation; hardening in spirit was less favourable. (4) Hardening in alkaline media: Basic acetate of lead and ammoniacal chloride of silver (1 per cent.) were used. Both solutions penetrated only slowly, so that the superficial layers could be used. The depth to which the hardening medium had penetrated was determined by treating the sections with hydric sulphide or bichromate of potash.

The hardened objects were variously stained. (1) With metals: Osmic acid used for preparations hardened in Müller's fluid effected no remarkable differentiation of the nervous elements. After-treatment with ammoniacal silver solution (reduction being effected in an incubator) gave a better result. In this way good pictures were obtained in 24 hours; the preparations, however, did not keep. (2) With nuclear stains: these affected the bodies of the nerve-cells more than the nuclei, the corpuscles in the latter behaving in a way similar to the cell-body. Gentian-violet and hæmatoxylin stained the granula of the body of the cell; carmine in neutral solution did not. Merkel's staining method gave favourable results for differentiating the chromophilous and chromophobous cells. (3) Dyes were used which do not stain the nucleus; eosin, fuchsin, nigrosin. Of these, nigrosin produced in the lead preparations interesting pictures, the dye having stained the protoplasm, a reticulated appearance was imparted to the cell-body. In the lead preparations, eosin stained the nucleus pretty dark, and the cell-body of the nerve-cells diffusely. Methylen-blue was examined by dissolving it in 0·7 per cent. salt solution, and injecting it into the spinal lymph-sac or abdominal cavity of a frog. Some time after the injection the ganglia were removed as quickly as possible, and examined in salt solution or glycerin. The cells were stained in about one or two hours.

Methæmoglobin Crystals.†—According to Dr. W. D. Halliburton the following is an easy way to obtain these crystals:—

Defibrinate a few cubic centimetres of the blood of a rat, guinea-pig,

* MT. Naturf. Gesell. Bern, 1887, pp. 3-23.

† St. Louis Med. and Surg. Journ., liv. (1888) p. 96.

or squirrel, and add to it a few drops of amyl nitrite and shake violently for a minute or two, or until the nitrite assumes a chocolate colour. A drop of this is withdrawn with a pipette, and placed on a slide, the cover-glass being applied immediately. In a few moments the methæmoglobin crystals will begin to form. By sealing the edge of the cover-glass, the crystals will remain unchanged a very long time.

Preparation of Brains and other Organs.*—Prof. M. Flesch prepares brains for permanent preservation in the dry condition in the following simple manner:—

After having been hardened in spirit, the preparations are first placed in a mixture of equal parts of glycerin, alcohol, and water, and afterwards into pure glycerin. To both fluids sublimate is added in the proportion of 1 to 3000. Bone and cartilage may, without previous hardening, be placed in the first solution and then changed to the second. The time of the treatment depends on the size of the object. A human brain should lie about four weeks in spirit (if placed upon cotton-wool 10–12 cm. thick, it is not necessary to change the spirit, nor to turn the brain so often), then for three weeks in each of the two solutions. The rest of the treatment consists in removing the superfluous glycerin by placing the specimens to drain upon a layer of blotting-paper supported on cotton-wool, and they are finally put up in a similar way and covered over with a glass-topped cardboard case. The cost of the method is small, since both solutions can be used repeatedly.

Preparing Radulæ of small species of Gastropoda.†—Mr. C. E. Beecher kills the organisms by boiling or immersion in alcohol, and then extracts the animals from their shells by drawing them out with a mounted needle or hook, and, in the larger species the head is cut off and the remainder of the animal rejected. In the minute species the shell may be removed with hydrochloric acid. Either process may be employed upon shells which contain the dried remains of the animals.

The specimens are then placed in a small porcelain crucible containing water in a sand-bath over a Bunsen burner. After boiling a short while, a small piece of caustic potash is added and the boiling continued until the tissues have become disintegrated. The boiling is then stopped to prevent the thin membrane upon which the lingual teeth are situated from being attacked. After removal from the burner, water is added, and the undissolved material allowed to precipitate. The fluid is then removed by means of a pipette, or by decantation, and fresh water added, and this last procedure repeated until the potash and light flocculent material are eliminated. The residue is then washed in a flat-bottomed dish or large watch-crystal, and the radulæ removed on needles to a vessel containing a small amount of water. In case the radulæ are very small, the material is transferred drop by drop with a pipette, and examined under a 1-inch objective; the Microscope should be furnished with an erector. The radulæ are thus easily detected and removed.

A drop of strong chromic acid is added to the specimens, and in from one to two minutes the teeth on the radulæ are stained a light yellow or amber colour. After washing out the chromic acid, the specimens are dehydrated in the usual way, and after removing the alcohol with a

* MT. Naturforsch. Gesell. Bern, 1887, pp. xiii.-xiv.
† Journ. New York Micr. Soc., iv. (1888) pp. 7-11.

pipette, absorbent paper, and partial evaporation, oil of cloves is added, and the specimen mounted in balsam. The lingual membranes will be found more or less coiled, and usually attached to the jaws. It is desirable to have the membrane flattened out, with the dentiferous side uppermost, and dissociated from the jaws. Some species have a large strong jaw, which, if left with the lingual membrane, will raise the cover so far above the denticles as to prevent the use of high powers. It is therefore necessary to unfold the radula and remove the jaw. Having provided a clean glass slide on the turntable, the specimen is taken from the clove oil and centered on the slide. The radula is then easily unrolled with needles under a Microscope provided with an erector, and the jaw removed. Replaced on the turntable, a thin cover-glass is imposed and centered. This should be done before the balsam is added, as it prevents the specimen from again becoming coiled or displaced. A drop of balsam in benzol is put adjacent to the edge of the cover, and the slide held an instant over a gas-burner or spirit-lamp, which will cause the balsam to flow under the cover. A spring clip is then put on to fix the cover down. The slide is next removed to an oven and left until the balsam has hardened, so that the portion outside the cover can be scraped off. The slide is then cleaned by washing in strong spirit, and dried with soft tissue paper. The cover-glasses should be of known thickness. Many radulæ require a 1/10 in. objective. The convexity of the object, combined with the thickness of the cover, necessitates the use of very thin glass. For the Rissoiidæ the author usually employs glass of 0·004 in. thickness.

Some good preparations were obtained by using nitrate of silver instead of chromic acid as a staining reagent, but the specimens require boiling in the silver solution, and this additional step further complicates the process and makes it less possible to retain small specimens. Besides, too much action of the silver renders the objects opaque.

Preparation of Cypridinæ.*—Dr. A. Garbini examined fresh teased-out tissue in sea water. Maceration was effected in a small quantity of one-third spirit. The best fixative was found to be a watery solution of sublimate. In this the animals were left for 5 to 7 minutes, and then transferred to distilled water, and afterwards to 75 per cent. alcohol, with a trace of tincture of iodine, and finally to pure 75 per cent. alcohol. Good results were obtained from Mayer's fluid (Kleinenberg's mixture with sulphuric acid), but the epithelium of the digestive tract was less well fixed. The preparations were imbedded in paraffin by Giesbrecht's method.

Preparing Ova of Ascaris megalocephala.†—Prof. E. van Beneden, in his further researches on the ova of *Ascaris megalocephala*, treated the fresh ova with glacial acetic acid or with an equal mixture of crystallizable acetic acid and absolute alcohol. After twenty minutes, when fixing had taken place, the acid was replaced by a third part of glycerin in water, and by aqueous solution of malachite-green, or of vesuvin, or of both together. The staining soon takes place, and if it be allowed to go too far can be readily washed out. If glycerin be rapidly substituted after five or ten minutes, the ova although stained will go on segmenting, and even form normal embryos.

* Bull. Soc. Entomol. Ital., xix. (1887) pp. 35–51 (5 pls.).

† Bull. Acad. R. Sci. Belg., xiv. (1887) pp. 215–24 (2 pls.). *Supra*, p. 423.

Mode of Investigating Echinorhynchi.*—Dr. R. Koehler finds that the tissues of *Echinorhynchi* can be well fixed by the employment of a sublimate solution acidified to saturation by acetic acid (Roulle's liquid). This reagent has the advantage over osmic acid of not producing after-coloration, and as animals generally die in it without contraction it is additionally useful. The fixation of the internal organs is complete ten minutes or a quarter of an hour after immersion. He did not find any difficulty, such as was experienced by Saeftigen, in staining the tissues, though the coloration is a little slower than usual. Any want of success is due to trying staining *en masse*, for the cuticle is difficult to penetrate; there is no difficulty with sections. Kleinenberg's hæmatoxylin is to be recommended. Anilin dyes, such as coccéinin and "rouge de Bordeaux R," give very fine stains, and the latter was found good for all kinds of tissues, and in very weak solutions, applied for some hours, gave good colorations to pieces of *Echinorhynchus heruca*. With *E. gigas* coloration *en masse* is easy if the cuticle be removed, as can easily be done.

Preparing the Nervous System of Opheliaceæ.†—Dr. W. Kükenthal places the Annelida to be examined in a mixture of chloral hydrate and sea water (1 : 1000), or adds a little spirit to the sea water. The animals are thus benumbed without contraction or laceration, and afterwards killed in 70 per cent. spirit or sublimate. Lang's mixture hot or cold, 1 per cent. chromic acid, osmic acid, picrosulphuric acid, Müller's fluid, iodine alcohol, and Merkel's fluid were used for the same purpose.

The author's method for producing nerve-preparations is as follows :— (1) The fresh animals were cut up along their back, placed in a basin, and covered over with 10 per cent. nitric acid, which was allowed to act for ten or twelve days. They were then well washed with distilled water, and then immersed for fifteen minutes in a 1 per cent. solution of gold chloride, to which one drop of hydrochloric acid was added. They were again washed in distilled water and placed in 5 per cent. formic acid for twenty-four hours. Then frequent washing with distilled water, removal of the intestinal tract and of the muscles by means of a fine brush and a stream of water. Then spirit, turpentine, Canada balsam. (2) The animals were slowly killed in sea water plus a little Merkel's solution, spread out in a basin, and covered over with pure Merkel's fluid. After twenty-four hours they were washed and transferred to weak spirit, stained with Grenacher's borax-carmine, then decolorised with hydrochloric acid alcohol, and after absolute alcohol and turpentine, mounted in Canada balsam. (3) (According to the author very suitable for material long in spirit). The animals were cut up and spread out in a basin and immersed in 1 per cent. osmic acid for twelve to eighteen hours. They were then washed, stained with hæmatoxylin, and mounted in Canada balsam. The simplest and best method for cutting is as follows:—The animals hardened in 70 per cent. spirit are stained with Grenacher's borax-carmine, then treated successively with acidulated acohol, absolute alcohol, chloroform, and finally imbedded in paraffin. The sections are stuck on with collodium-clove oil, followed by turpentine oil, to which a few drops of picric acid are added. Then methyl-green, turpentine oil, pure turpentine, Canada balsam. The nuclei are red, the plasma and intercellular substance green, the nervous

* Journ. de l'Anat. et de Physiol., xxiii. (1887) pp. 614-5.
† Jenaisch. Zeitschr. f. Naturwiss., xx. (1887) pp. 511-80 (3 pls.).

tissue yellow and well defined. Animals preserved in spirit may be placed for twelve to eighteen hours in 1 per cent. osmic acid, and after being well washed stained with hæmatoxylin.

Preparation of Echinodermata.*—Dr. O. Hamann preserves the organs of Echinodermata in Flemming's chromo-osmium acetic acid. For preserving and decalcifying small animals chromic acid was used; animals preserved in strong spirit were afterwards decalcified by immersion in a 0·3 per cent. solution. After having been washed for twelve hours they were stained with hæmatoxylin. For examining the anal blood-lacunæ, the sea urchin is well hardened in spirit, the anal parts are decalcified in 1 : 400 chromic acid, and stained with a neutral carmine solution. Decalcification in hydrochloric acid or in chromo-nitric acid is less satisfactory, as the tissues are more affected. The pedicellaria can be cut without being decalcified, and after being carefully washed, stained with carmine or logwood.

For examining the glandular organ, the so-called heart, treatment with the anilin dyes (safranin, methyl-green, anilin-green) was found to be advantageous. Excellent preparations of organs of *Sphærechinus granularis*, hardened in a 1/2 per cent. chromic acid, were obtained by staining the sections with Schiefferdecker's anilin-green, absolute alcohol, bergamot oil or xylol, paraffin, xylol, xylol-balsam. The author prefers xylol to turpentine, chloroform, and oil of cloves.

Methods of Fixing and Preserving Animal Tissues.†—The present systems of fixation may be resolved, says Dr. N. Kultschizky, into three :—(1) The chromic acid salts of potassium and ammonia and mixtures of those with other salts (Müller's and Erlicki's fluids) fix histological objects well, but this method, according to Prof. Flemming, is not suitable for examining the process of karyokinesis. Prof. Virchow has, however, recently stated that the deficiencies of chromic acid salts may be obviated if they be dissolved in spirit in the dark. (2) The second group of fixatives consists of chromic acid, osmic acid, picric acid, acetic acid, &c., and includes the mixtures of Flemming, Kleinenberg, Fol, and others. This group, particularly the Flemming's mixture, is especially valuable for demonstrating the division of the nucleus. Chromic acid, it must be remembered, almost always produces an insoluble precipitate of albumen, and consequently is deceptive, from calling into existence a tissue-like structure and for forming insoluble and impermeable combinations, as, for example, in objects with a muscular tissue. (3) The best fixative of all is alcohol, but, as it has a great attraction for the watery element of albumen, it produces considerable alteration in the form of objects.

Hence, as none of the three foregoing methods are perfect, the author has found it advisable to pursue the following course, which includes the least defective points of all three.

The fixative is prepared by mixing excess of finely powdered bichromate of potash and sulphate of copper in weak spirit (50°), and allowing them to stand in complete darkness for twenty-four hours. A greenish-yellow fluid is hereby obtained, and this, before being used, is acidulated with acetic acid (five or six drops to 100 ccm.).

The object to be fixed is placed in the fluid prepared as above for twelve

* Jenaisch. Zeitschr. f. Naturwiss., xxi. (1887) pp. 87–266 (13 pls. and 2 figs.).
† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 345–9.

to twenty-four hours, according to its size and the degree of hardness required. The whole transaction must be carried out in the dark, otherwise the salts will be precipitated. The objects are then placed in strong spirit for twelve to twenty-four hours, after which they may be sectioned in any of the usual ways. With regard to the preservation of material the author rejects alcohol and chromic acid and its salts on account of the changes induced by these reagents, and advises ether, xylol, toluol, or any substance which does not act upon albuminous matter.

Isolating Lower Algæ.* — The isolation of some Chytridiaceæ, Saprolegniæ, and monads from different waters is easily effected by catching them with the aid of pollen-grains, fern-spores, or fungi spores which are disseminated in the water and then allowing them to developo until they fructify. For this purpose, says Dr. W. Zopf, the pollen-grains of Coniferæ are very suitable. By this method *Lagenidium pygmæum*, *Rhizophidium pollinis*, and *Olpidium luxurians* can be isolated with almost unfailing certainty. Under favourable circumstances algæ with sporangia can often be obtained in 15 to 30 hours after depositing the pollen-grains.

CURTIS, C.—**The Tapeworm: methods of preparation.**
[Reports finding in Trans. Linn. Soc., II. 1794, a paper by A. Carlisle, which presents the same methods and elucidates the same fact regarding the valves" as the paper of J. M. Stedman, *ante*, p. 148.]
The Microscope, VIII. (1888) pp. 102–4.

Entomologists, Young, Microscopic Work for.
["A few simple directions to the beginner who wants to know how to mount the hard parts of common insects."]
Scientif. News, I. (1888) p. 316.

LATHAM, V. A.—**To prepare the Head of a Flea. Mounting Tongues of Flies.**
Scientif. Enquirer, III. (1888) pp. 10 and 13.

" " **Preparing Sections of Buds.**
["Take a small piece of a twig—say, linden—having a bud at its upper end; fix well in section-cutter, wet with alcohol, cut with a sharp knife into thin slices, keep flooding the knife with strong alcohol to keep the sections floating, and to keep them from falling apart. Do not let a drop of water touch the section, or it will cause it to fall to pieces. Now place in alcohol faintly coloured with iodine-green; let them remain for several hours until the colour disappears from the alcohol. Again put them into alcohol, this time coloured a little more deeply with eosin in place of green. Let them remain there till they are all pink. Then wash in two alcohols of 95 per cent., drop into clove oil for a few moments only, and mount in Canada balsam. They are thus very instructive."]
Scientif. Enquirer, III. (1888) p. 69.

SCHWERDOFF.—**Untersuchungsmethode frühzeitiger Studien der Entwickelung von Säugetiereiern.** (Method of investigation for the earlier stages of the development of mammalian ova.)
Arbeit. Versamml. Russ. Aerzte Moskau, I. (1887) 1/2 p. (Russian).

VAN GIESON, J.—**A résumé of recent Technical Methods for the Nervous System.**
Journ. Nerv. and Met. Diseases, XIV. (1887) p. 310.

(3) Cutting, including Imbedding.

Imbedding Plant Tissues.—We referred at p. 680 of the last volume to Dr. S. Schönland's method of imbedding delicate plant tissues in paraffin, so that unshrunken serial sections may be cut by the ribbon method. The author then described the results which can be attained as almost incredible. In serial sections of leaves one can not infrequently

* Abh. Naturf. Gesellsch. Halle, xvii. (1887) 31 pp. (2 pls.).

obtain four to six sections through the same stoma, and it is easy to get several sections through the apical cell of a fern root when the imbedding is properly done.

Dr. Schönland now writes * that since the publication of his former article he has had the opportunity of gaining more experience in the use of the method, leading him to modify it slightly. In the first place he now uses absolute alcohol where he formerly only used the strong methylated spirit of commerce. Further, he now leaves specimens to be imbedded for 24 hours in pure oil of cloves (after they have sunk), 24 hours in pure turpentine, 24 hours in turpentine saturated with paraffin, and 24 hours in melted paraffin. Although much more time is thus required, the results are more reliable, and he can now imbed by his method without previous staining in borax-carmine, and thus considerable time and trouble are saved.

He adds that sections fixed to the slide with collodion stain very well with Bismarck brown, and can then easily be photographed. Bismarck brown † stains all cell-walls. If Kleinenberg's hæmatoxylin is used in addition, the cellulose walls turn blue, while all other walls retain their yellow colour, and thus a nice double stain is effected. If sections of young tissues are treated in this way, the process of lignification in vessels can be easily traced; and if the hæmatoxylin is allowed to act a sufficient time on the sections, the structure of the protoplasm will be brought out.

Celloidin-paraffin Methods of Imbedding.‡—Prof. J. A. Ryder calls attention to Kultschizky's method for imbedding in celloidin and paraffin, which method was noticed in this Journal, 1887, p. 845. He finds that it works admirably with specimens of injected spleen. The sections can be cut with a dry knife on any paraffin microtome. With the author's automatic microtome it is easy to cut sections 1/2000 in. in thickness with the greatest ease, since a ribbon forms more easily than even in the case of ordinary paraffin imbedding. The section-stretcher may be dispensed with entirely, so that for consecutive or embryological work the method is highly to be recommended. The author has modified the original method by substituting chloroform for origanum oil, as the latter is objectionable because it is disagreeable in odour, inflammable, darkens in a short time, and causes the object to shrink slightly. Beyond the substitution of chloroform for origanum oil there is no alteration in the details of the process.

In order to fasten the block containing the object in the holder, a heated wire is used, and to make the sections form a ribbon nicely, the hard paraffin used for the final imbedding may be mixed with soft paraffin or paraffin gum, melting at 45° C. This method enables thinner sections to be cut than with the usual wet celloidin process.

The sections may be mounted direct from the chloroform, but the operator must not allow the chloroform to evaporate before the section is covered with balsam. Another method of clearing the section is that proposed by Weigert, who uses a mixture of equal parts of xylol and

* Bot. Gazette, xiii. (1888) p. 61.

† The solution of Bismarck brown is prepared by saturating 1 part of absolute alcohol with Bismarck brown and adding 2 parts of distilled water. A solution in 70 per cent. alcohol, as often used by zoologists, does not stain lignified cell-walls very readily, and the solution in water hitherto used by botanists is said not to keep very well.

‡ Queen's Micr. Bulletin, iv. (1887) pp. 43–4.

pure carbolic acid. This liquid may be applied to sections on the slide by means of a camel's hair pencil, and will clear other sections instantly without in the least attacking the celloidin.

Pharmacognostic Microtome and Technique.*—Dr. E. Vinassa has recently made several improvements in the microtome adopted for pharmacological work and described in this Journal, 1886, p. 887.

In the first place the general construction has been so altered that it

Fig. 93.

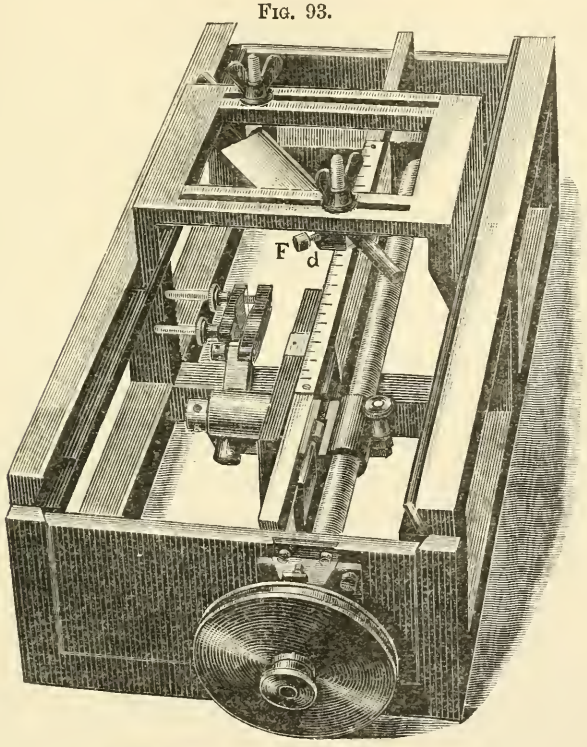


Fig. 94.

is now much broader, and therefore allows more play for the manipulation of the knife and object-carriers. The object-clamp has also been rendered firmer by a new device. This consists of a plate moved up and down by a long screw, and adjusted so that it supports the object-carrier while it in nowise impedes the play of the carrier about its various axes.

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 295–303 (3 figs.).

A further inconvenience, namely the too complicated arrangement for altering the horizontal position of the carrier, has been obviated.

The knife-handle now, instead of being flat, is made round so that it can be fixed in any position quite easily by means of the screw F (fig. 93). The handle passes through an iron block *d*, and is tightened up by means of the winged screws. The exact shape of the knife fitted with a handle for sharpening is shown in fig. 94. For cutting hard objects such as dense wood and bark, the author advises the knife to be ground like a plane.

After alluding to the advantage of using Jung's section-stretcher in connection with his microtome, the author passes on to the treatment of vegetable preparations. In a former communication the author advised the imbedding of roots, barks, and wood in glycerin jelly. But as the vacuum apparatus necessary for this procedure is not always available, he now occasionally resorts to the older methods of softening the preparations in spirit, glycerin, and water, and this is specially adapted to hard close-grained objects. Woods are always placed in glycerin and water, and can then be cut with an unwetted knife without tearing. If afterwards the sections are placed in glycerin to which some caustic soda has been added they are easily unrolled.

With regard to fruit and seeds of a hard consistence and structure, such as *Strychnos potatorum*, *S. nux vomica*, *Coffea arabica*, and the kernel of *Phœnix dactylifera*, preparations easy to be cut can be obtained in two or three days by softening the objects in dilute caustic soda or potash. But as any further microchemical examination is useless owing to the destruction of the alkaloids by the caustic alkalies it is preferable to soften the seeds by means of steam. This is done in a wide funnel into which a piece of wire gauze is placed as a sort of filter, and upon this the seeds. The funnel should be lined with filter paper to carry off the condensation water, and the funnel supported on a tripod in a water-bath. In 30 to 60 minutes the objects will be found sufficiently softened to cut quite regular sections from.

Some objects, such as almonds and cocoa-beans, crumble away under the action of the knife, and therefore require to be imbedded as they cannot be fixed directly in the jaws of the object-carrier. Glycerin gelatin is unsuitable for this purpose as the mass does not offer sufficient resistance, and although paraffin is usually unsuitable owing to its complicated manipulation it gives fair results by the following procedure. The seeds should be slightly warmed in order to drive off as much moisture as possible, and quickly immersed in paraffin only heated a few degrees above its setting point. They are then left to cool until a thick coating has developed upon them. In this way the paraffin will be found to have filled up all the chinks and crannies in the seeds, and not only offer sufficient resistance to the knife, but will also invest the sections with a sheath sufficiently strong to prevent their crumbling away. The paraffin is then dissolved out with benzin, ether, or chloroform, and the preparations mounted in glycerin jelly or in Canada balsam according to the special idiosyncrasies of the seeds.

Small seeds and fruits, such as those of the Solanaceæ and Umbelliferæ, should be imbedded in a paraffin of a high melting-point. Glycerin jelly, to which a little sublimate is added, is recommended for mounting permanently. Air-bubbles are easily got rid off by slightly warming the slide and then pressing on the cover-glass with a lead roller, 3 cm

long and 1 cm. in diameter. In a few hours the expressed jelly may be scraped off with a knife, the last traces being removed with lukewarm water. The slide is then cleared up with spirit and ringed round with some cement. Glycerin jelly not only possesses the clarifying property of glycerin, but all the other advantages of this medium.

HAENSELL, P.—La Méthode de l'inclusion du Globe Oculaire dans la paraffine et dans la celloidine. (Method of imbedding the eye in paraffin and celloidin.) *Bull. Clin. Nat. Ophthalm. Hôp. Quinze-Vingt*, IV. (1886) p. 154.

REYNOLDS, R. N.—A new Planisher. *The Microscope*, VIII. (1888) pp. 104–5 (4 figs.).

(4) Staining and Injecting.

Staining Living Preparations.*—Prof. M. Flesch is of opinion that living objects do not become stained by the ordinary methods, or do so in a way quite different from hardened preparations. Cyanin, for example, produces in the tissue-elements of the living organism different forms from those in which the same dye has been employed after fixation. What has stained in the dead preparation can never be similarly affected while alive. The parts which become stained show in many cases a great chemical activity, a lively power of reduction towards certain chemical compounds. One series of stains is only successful after previous treatment of the object with easily reducible metallic combinations. By control experiments it is seen that the staining extends just as far as the metallic precipitate. The original constituents of the tissues are not stained, but chemical products which result from the treatment with hardening agents. These might be metal albuminates or decomposition products arising from the chemical processes at the death of the living tissue, induced by the reduction processes. The result of a stain can only be judged from the chemical processes arising during fixation.

Staining Nerve-endings with Methylen-blue.†—Dr. C. Arnstein states that in frogs injected with methylen-blue the motor nerve-endings, Courvoisier's fibres, and the cells of the sympathetic are stained. In the freshly cut-out retina there is usually no stain, but this appears after the air has acted upon it. As a fixative, besides the iodine previously given, picrocarmine or picrate of ammonia may be used. The choice of the substance depends on whether a nuclear or diffuse stain is desired. Fixation by the last two methods is more lasting than when effected with iodine, though with the latter the nerves are deeply stained. Mammals and birds die too quickly after the injection of the methylen-blue for the method to be practically available, yet these animals, after they have been killed with chloroform, can be successfully injected through the heart or some large vessel. The pigment is used in a concentrated form, and the injection is suspended directly the resistance becomes marked. The organs first stained blue quickly become pale, and no nerve-staining is seen at first, but this occurs directly there is access of air to the preparation. The gradually occurring colour may be followed under the Microscope, and when it has attained its maximum some drops of a fixative medium may be added. In this way very perfect nerve-endings from the cornea, iris, and retina of mammals and birds have been

* MT. Naturforsch. Gesell. Bern, 1887, pp. xiv.–xv.

† Anat. Anzeig., ii. (1887) pp. 551–4.

obtained. Staining may also be effected on the slide if a nerve-end apparatus be spread out and a dilute solution of methyl-blue be added. Staining the retina of fish, birds, and mammals is more successful by this method than by injection. In other parts this method gave less favourable results.

Demonstrating Karyokinetic Figures.*—Dr. G. Martinotti and Dr. L. Resegotti proceed as follows to demonstrate karyokinetic figures.

The tissues are fixed with absolute alcohol. The sections are stained by leaving them five minutes in an aqueous solution of safranin and the stain is differentiated by transfering them to a spirit and water solution of chromic acid. This solution is prepared by mixing one part (by volume) of a watery solution of chromic acid (1:1000) with nine parts of absolute alcohol. In this very dilute solution the sections are left for a half or one minute, agitated therein, and then dehydrated in absolute alcohol, cleared up in bergamot oil, and mounted in dammar. In this way the chromatin filaments and the true nucleoli are stained a lively red, the protoplasm and the intercellular substance remain uncoloured, the resting nuclei are faintly stained a pale red.

The spirit and water solution of chromic acid should be prepared fresh every time. In some cases it is useful to employ a slightly stronger solution, that is, to mix two volumes of the watery solution of chromic acid (1:1000) with eight parts of absolute alcohol. At other times it is advantageous to dilute the watery solution of safranin with an equal volume of distilled water, and to leave the sections therein for five minutes, then keep them in the chromic acid solution until they have assumed a uniform rose tint.

The authors in conclusion remark that safranin seems to have a special affinity for the chromatin of the nucleus, that they have been unable to convince themselves that anilin oil is detrimental to nuclei in motion, and that oil of cloves, as previously noted by Bizzozero, extracts the anilin dyes more quickly from nuclei in repose than from those in mitosis.

Staining Membranes in Living Siphoneæ.†—Dr. F. Noll finds that in *Caulerpa prolifera*, some kinds of *Bryopsis* and *Derbesia*, and some Florideæ, the membranes become thickened by deposition of new layers. If the original membrane be stained without damaging the plant, it is seen that on further growth new unstained lamellæ are deposited upon the stained parts. The author coloured the membrane with Berlin or Turnbull's blue in the following way:—One part of sea water was diluted with two parts of sweet water, and in the mixture so much ferrocyanide of potash was dissolved as to give it the specific gravity of sea water. A second fluid consisted of two parts sea water and one part sweet water, and some drops of chloride of iron. This solution must be made fresh before each time of using. If Turnbull's blue were used the solutions were ferrocyanide of potash and lactate of iron. The deposition of Berlin blue was effected by removing the plants from sea water to the cyanide solution (1–3 seconds); they were then washed in sea water, and immersed for 1/2–2 seconds in the iron solution. The plants were next again removed for a moment to the ferrocyanide solution, and afterwards washed in much sea water. Care was always taken that the cyanide should be in excess in order that the iron chloride should never come in contact with the plasma as iron chloride. By

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 326–9.

† Bot. Ztg., xlv. (1887) pp. 473–82.

repeating the process a beautiful blue of any desired tone was easily imparted to the membrane. If the plant had not been damaged by the above treatment, the bluish colour disappeared in a few hours, the Berlin blue was decomposed, and the iron remained. By putting the plant in a solution of ferrocyanide of potash acidulated with hydrochloric acid, the blue could be restored to its original situation.

Roux's Colour-test for the detection of Gonococcus.*—Dr. E. C. Wendt's researches on gonococcus were merely intended to find a diagnostic criterion for gonorrhœa. He therefore examined other secretions as well, e.g. balanitis, otorrhœa, conjunctivitis, &c. Gonococci were found in all cases of gonorrhœa, but in other cases, even in the normal urethra, there were found diplococci indistinguishable from the gonorrhœa cocci. The criterion insisted on by Bumm, namely the intracellular arrangement of the gonococci about the nucleus, is found by the author to be not always correct, since it is not the case where blenorrhœa is passing away. The only certain characteristic, according to the author, is that from Roux's test, which depends on the fact that the gonorrhœa bacteria are able to retain anilin to a slight extent.

Acid Logwood Stain.†—An excellent acid logwood stain can, it is stated, be made as follows :—One part of a saturated solution of calcium chloride in proof spirit (alcohol of 50°) is added to eight parts of a similar solution of alum. Extract of logwood (the common commercial) is added to the mixture and agitated until it no longer dissolves freely. Let the container stand in a cool, quiet place for a few days, decant the clear liquid (which makes an excellent stain just as it is), and to every 100 parts add 80 parts of a 1 per cent. aqueous solution of acetic acid. Let stand for a day or two, and filter off into a glass-stoppered vial.

Alcoholic Alum-Carmine Stain.‡—Dr. W. C. Borden gives the following formula for producing a perfectly clear purplish-red fluid, superior to any aqueous alum-carmine stain in clearness and brilliancy of colouring. It will keep indefinitely, but a slight precipitate sometimes forms which should be filtered out. This does not indicate any decomposition of the stain, nor does it alter its staining character in any respect. Cochineal (whole insects), 1 dr.; saturated solution of alum, 4 oz.; 95 per cent. alcohol, 4 oz. Pulverize the cochineal in a mortar, add the saturated solution of alum, and boil for fifteen minutes, adding distilled water occasionally during the boiling to make up for the water lost by evaporation. Cool and pour without filtering into a ten-ounce or larger bottle. Add the alcohol and let stand, with occasional shaking, for forty-eight hours. Filter and preserve in a close-stoppered bottle.

The following stain made with carmine and without heat will give a fluid nearly identical with the first, except that no precipitate occurs, however long it be kept. Carmine, 30 gr.; alum, 4 dr.; distilled water, 4 oz.; 95 per cent. alcohol, 4 oz. Grind the carmine and alum together in a mortar, gradually adding the water. Add the spirit and pour without filtering into a ten-ounce bottle, cork tightly, and let stand for a week, shaking occasionally. Filter, and preserve in a close-stoppered bottle.

For staining in bulk, pieces of tissue may be transferred directly from strong spirit to either fluid, and may remain from two days to two weeks.

* Med. News, i. (1887) pp. 455–7.
† St. Louis Med. and Surg. Journ., liv. (1888) p. 165.
‡ The Microscope, viii. (1888) pp. 83–5.

Tissues hardened in alcohol or in corrosive sublimate and spirit stain more rapidly than those hardened in Müller's fluid or chromic acid. In any case in which a fluid other than alcohol has been used for hardening, the reagent must be entirely removed by immersion in spirit. The length of time required for staining can only be learnt by experience, but over-staining need not be feared. When the paraffin or celloidin methods are used, the best way is to immerse the slide, to which the section is stuck on in a wide-mouthed vessel filled with stain. Both stains give excellent results in photomicrography by lamplight, owing to the sharp nuclear definition and slight staining of the other tissue elements.

Preparing Picrocarmine.*—The following, according to the 'Magazine of Pharmacy,' is an improved method of preparing picrocarmine for microscopical purposes:—

About half a gramme of carmine is dissolved in 100 ccm. of water containing 5 ccm. of a 1 per cent. solution of soda. The liquid is then boiled, filtered, and made up again to 100 ccm. by addition of distilled water. In order to neutralize the solution, it is mixed with an equal volume of water, and a 1 per cent. solution of picric acid is then added. This at first causes a turbidity to appear, but it subsequently disappears. If not, it indicates that the point of neutralization has been overstepped.

Staining with Rosanilin Nitrate in watery Glycerin Solution.†—Dr. W. Flemming states that Böttcher has for a long time stained preparations previously treated with Müller's fluid and alcohol with rosanilin nitrate in a watery glycerin solution; then passed through alcohol, cleared up in creosote, and mounted in dammar or balsam.

New Injecting Mass.‡—Dr. M. N. Miller has devised the following injecting mass:—

First procure some thin, clear, colourless French gelatin in sheets about 3 in. by 8 in., with crossed markings. To 1 oz. of gelatin add 10 oz. of water. Allow the gelatin to swell for one hour, and then place the vessel containing the whole in a kettle of boiling water, and allow it to remain until the gelatin melts thoroughly. Strain through previously moistened flannel into, preferably, a flask. While yet warm and fluid, pour about half of the gelatin into another glass vessel. Dissolve in the one half two grains of dry common salt, and in the other half ten grains of nitrate of silver. Should the gelatin become stiffened by cooling, it must be warmed and so kept fluid. When all is dissolved, mix the two gelatin solutions and shake briskly for from three to five minutes. Add 10 grains of citric acid and keep the gelatin warm until the former dissolves. This is the injecting mass, and is ready for use. If filtered first through paper the solution will be clearer, but this is not absolutely essential.

The colour of the injection mass in the mounted section is a beautiful purple, and perfectly translucent. The differentiation between arterioles, venules, and capillaries is perfect, and the larger the vessel, the darker the colour of the mass. The citric acid must be put in last, and metal vessels must not be used, as the silver salt would act upon them. The mass is not spoilt if partly darkened before use.

* Scientif. News, i. (1888) p. 319.
† Arch. f. Mikr. Anat., xxx. (1887).
‡ Amer. Mon. Micr. Journ., ix. (1888) pp. 50–1.

FREEBORN, G. C.—**Notices of New Methods. II.**
[Celloidin-paraffin imbedding and carmine staining (Kultschizky). New staining medium (Plattner.)]
Amer. Mon. Micr. Journ., IX. (1888) pp. 52–3.

HVASS, T.—**Om nyare färgningsmethoder vid histologiska studier af nervväfnad.** (On new staining methods in the histological study of nerve-tissue.)
Hygeia, XLIX. (1887) p. 50.

LENNOX.—**Beobachtungen über die Histologie der Netzhaut mittels der Weigert-schen Färbungsmethode.** (Observations on the histology of the retina by means of the Weigert staining method.) *Graefe's Arch. f. Ophthalm.*, XXXII. (1887).

LINDNER, P.—**Gefärbte Hefenpräparate.** (Stained yeast preparations.)
Wochenschr. f. Brauerei, 1887, p. 773.

SOUZA, A. DE.—**De la pyridine en histologie.** (On pyridine in histology.)
C.R. Soc. Biol., IV. (1887) No. 35.

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

Medium of High Refractive Index.—Mr. Arthur E. Meates, who has been for more than two years past experimenting upon Prof. Hamilton L. Smith's,* and other media of high refractive indices, considers the following to be his most successful result:—

Put into a 4-in. test-tube 71½ grains of bromine, add 28¾ grains of sulphur, and warm gently until combined; then add 67 grains of *freshly sublimed* arsenic by very small portions at a time, otherwise the violent action which takes place between the bromine and arsenic will cause the mixture to boil over. After about 20 grains have been added this violent action ceases, and then the rest of the arsenic can be put in at once. When the whole of the arsenic is added, boil gently until it is completely dissolved, which will take about fifteen or twenty minutes. While boiling care must be taken that the vapours of bromide of arsenic (which can be seen mounting up the tube) do not escape. If properly made, thin films of the medium, when cold, will be of a pale-yellow colour. Its refractive index is high, considerably above that of phosphorus. It melts at about 200° Fahr.

For mounting, the medium should be warmed till it is quite liquid, a small portion taken out on a glass dipping-rod, dropped on a warm slide, and, while soft, the cover with the diatoms pressed upon it. When cold, the superfluous medium may be scraped away and the mount ringed with copal or any other varnish that does not contain alcohol. Hitherto, it has shown no signs of deliquescence or crystallization, although put to most severe tests.

The medium is practically *orpiment* dissolved in bromide of arsenic; but this solution cannot be effected satisfactorily, except by combining the substances while in a nascent condition. It can, however, also be made by dissolving the proper proportions of sulphur and arsenic in a certain amount of bromide of arsenic. It differs from Prof. Smith's medium, which is stated to be "realgar, the transparent sulphide of arsenic, dissolved in bromide of arsenic by aid of heat";* realgar being As_2S_2, and orpiment As_2S_3.

Wax Cells.†—Dr. Taylor in describing his method of making wax cells, says that much complaint has been made about these cells on account of their becoming "foggy." This may occur if cells are

* See this Journal, 1885, p. 1099.

† Report of Proceedings at Washington Microscopical Society. Cf. Engl. Mech., xlvii. (1888) p. 29.

made from sheet wax, as in its preparation it is passed between rollers which are continually wet, and much moisture is absorbed. The best way of making wax cells is to melt common beeswax over a spirit-lamp; add to it 5 per cent. of resin; after the whole is melted, slightly lower the temperature, but not so much as to solidify the mass in any degree. Slides can then be placed on the turntable and cells ringed in a moment. A cell can be made and varnished in ten minutes. The wax rings may be covered with a mixture of glycerin and solution of gum-arabic, and the cover-glass then be put on and pressed down. The solution becomes hard very soon, and the cover-glass is firmly cemented.

Shellac Cement.*—Mr. W. N. Seaman gives the following directions for making a strong and lasting cement for attaching metal to glass.

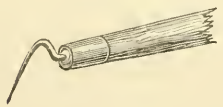
Take 50 grm. of *unbleached* shellac, add to it 50 ccm. of commercial alcohol, and then cover the mixture with an equal quantity of kerosene oil, shake the mixture frequently for the first two or three days, and then set it away for a month, or until it separates into four layers as follows beginning at the top:—(1) Kerosene. (2) A layer of woolly-looking stuff. (3) Clear shellac. (4) Sediment. By means of a pipette or any other convenient way, draw off the shellac, and to each 50 parts of it add one part of boiled linseed oil.

WARD, R. H.—**Instantaneous Mounting in Farrants' Gum and Glycerin Medium.**
[Useful directions for mounting in this medium, which is too much neglected now-a-days. As the author says, "too much can scarcely be said in its favour for facility of use."]
13*th Ann. Rep. Amer. Post. Micr. Club*, 1888, pp. 13–14.

(6) Miscellaneous.

James's Teasing-Needle.†—Fig. 95 shows the form of a teasing needle which Dr. F. L. James has used for some time past in lieu of the old straight and curved needles, over which it possesses (it is claimed) many and manifest advantages. It may be held in the hand exactly as a pen-holder, and when two are used the curved portion may be laid flat on the material, thus holding it in place while it is teased out by the aid of the other. The points may be made of heavy straight needles, the temper of which is drawn by holding for a moment in the lamp. A better material, however, is old umbrella wires drawn and filed down. The fig. gives about the proper curvature.

FIG. 95.



Medico-legal Identification of Blood-stains.‡—M. Ferry describes a method for the identification of blood-stains. While differing in an important particular from that of Ranvier, the method is not entirely new. It is as follows:—

If the stain be upon woven fabric the fibres are to be teased out and put into a test-tube and covered with a solution of sodium chloride 1:1000. After standing a while the fluid will become a brownish red. Examined by the spectroscope, if the stains were made by blood the hæmoglobin lines will appear. The examination for blood-corpuscles may now proceed. For this purpose, to each ccm. of the saline solution add one minim of a saturated solution of chloral hydrate, and if blood

* Amer. Mon. Micr. Journ., ix. (1888) pp. 53–4.
† St. Louis Med. and Surg. Journ., liv. (1888) pp. 167–8 (1 fig.).
‡ Ibid., pp. 165–6.

be present a rose-red precipitate will be formed. Allow it to settle, and remove with a pipette a drop of the precipitate, and place on a cover-glass. Hold this for a moment over the flame of a spirit-lamp, and with a bit of absorbent paper take up the clear liquid which forms. A drop of fuchsin or magenta is now added and allowed to remain a few minutes, or long enough to stain the pellicle on the cover-glass. Wash in water and clear with acetic acid. If blood-corpuscles be present they will appear stained a bright red.

Dr. F. L. James makes some suggestions as to carrying out the process. It very frequently happens that the authorities (or sometimes the attorneys for the defendant) will not allow a fabric to be cut or mutilated, for reasons which are obvious. In two such cases in which he carried out the examination, he proceeded as follows:—The saline solution (1:1000) was placed in a small glass saucer or watch-glass, and the cloth (a handkerchief in one instance, a linen cuff in the other) was folded across one of the spots. The surface was rubbed together some moments, and then carefully turned over so that the abraded surfaces rested face downward in the saucer, touching the fluid. Holding it firmly on the edges of the little vessel, a paper-knife was rubbed several times over the spot from the back. The brownish-red or iron-rust colour rapidly imparted itself to the fluid, and after letting the glass stand for a few hours a drop removed from the bottom disclosed the blood-corpuscles under the Microscope. In cases where a very small piece of the stained material may be removed, the picking to pieces should be done in a watch-glass, and the saline solution poured over it.

Microscopical Examination of Paper.*—Herr J. Wiesner publishes the results of a microscopical examination of the paper in the El-Faijûm collection, made by the Arabs in the eighth and ninth centuries. He finds that it was not made, as has been usually supposed, from "raw" or unmanufactured cotton, but from linen rags, an invention which has usually been ascribed to the fourteenth century. The chief constituent of the paper is linen, among which are traces of cotton, hemp, and of several animal fibres. Well-preserved yarn-threads are of frequent occurrence. The invention of linen-paper is, therefore, neither Italian nor German, but Eastern. The paper was invariably "clayed," the substance used being always starch-paste, and not in the rough state, but prepared starch, apparently from wheat. In the tenth and eleventh centuries buckwheat-starch was employed. The materials used for writing were apparently iron tannate, Indian ink, and carbon.

The author further examined more than 500 Eastern and European papers, ranging from the ninth to the fifteenth century, not one of which was made from "raw" cotton; the greater number were made of linen, and "clayed" with starch-paste; the use of glue or resin for this purpose begins with the fourteenth century.

Illustrations to Microscopical Publications.†—The editors of 'The Microscope' write on this subject as follows:—

"In looking over the various text-books and other publications dealing with microscopical subjects, one cannot fail to be impressed with the clear fine-cut appearance of the usual illustrations. To one not familiar with the subject, a study of many of these illustrations should lead him to the conclusion that microscopy, so far as observation goes,

* Wiesner, J., 'Die Mikroskopische Unters. d. Papieres, 1887, 82 pp., and 15 figs. See Bot. Centralbl., xxxiii. (1888) p. 340.

† The Microscope, viii. (1888) p. 60-1.

is not a difficult thing to master. And this, indeed, has been the case in our experience with students who have come to us for instruction in histology. The first rude awakening often comes to the beginner when he takes his text-book cut as a guide to lead him through the intricacy of his first mount. Everything looks so differently from what he expected, and even the instructor, in attempting to point out the features so clearly displayed in the cut, will for some time meet with but feeble success. It may be urged that the difficulty is that the eye requires a special training to enable it to convey a correct impression under conditions to which it is not at all accustomed. This is very true; but is it the only reason for such complete (and not uncommon) failures to see anything at all? It seems to us that one cause of failure is to be looked for in the illustrations, and the reason is, generally, that they are too diagrammatic. We think that the better class of illustrations in question are very helpful to the advanced worker, not because they are true pictures—for they are not—but that he has learned to take something for granted, and to make just the proper allowances to enable him oftentimes to know exactly what the artist intended. No specimen, however well prepared, can show such clear differentiation of its component parts as the illustration which represents it. The latter has caught the general features, exaggerated them, and bothered not at all with the spirit of its subject. The aim, moreover, has been apparently to picture the specimen not as it looks, but as it is. For the benefit of the beginner this should be reversed; he must first learn to see the specimen as it looks, and then be taught to know it as it is.

The difficulties at the root of the matter seem to be (1) the fact that the delineations are not confined to that which is seen at a single focus, but are deduced from a knowledge gained by a study of several focuses, and (2) the process employed.

(1) It is this which makes complete tubules in a section where there are few, if any, and which fills up the indistinct spaces with ideal representations of that which, though not seen, is known to be there.

(2) The process usually employed makes use of distinct lines, something seldom seen in a specimen. A skilful artist could probably etch a tolerably correct picture, and he would do so by carefully toning down his lines to the proper degree.

Photography and many new processes are coming into use, some of which, it is hoped, will prove more satisfactory. And yet we think that much better work could be done with the method now in vogue (drawing with the use of a camera lucida and photo-engraving the result) if the artist confined himself to drawing that only which he sees at one focus, and conserving that blending of parts which, though sometimes amounting to indistinctness, has at least the merit of being natural."

Leeuwenhoek's Discovery of Micro-organisms.*—Herr J. F. Schill points out that 1674 and not 1675 should be taken as the date of Leeuwenhoek's discovery of organisms. Attention is directed to a letter dated Sept. 7th, 1674, which appears in the 'Philosophical Transactions' of Nov. 23rd, 1674, and which seems to confirm his contention.

Collected Papers of T. R. Lewis.†—The 'In Memoriam' volume which contains the collected papers of the late Dr. T. R. Lewis should be

* Zool. Anzeig., x. (1887) pp. 685-6.

† Published by the Lewis Memorial Committee. 4to, London, 1888, 732 pp., 43 pls., and numerous woodcuts.

brought to the notice of microscopists, for it contains a number of valuable papers which have hitherto been very difficult of access, owing to their having been published in official Indian reports, or in Indian medical journals; we may cite the 'Report on Bladder-worms,' 'The Microscopic Organisms found in the blood of Man and Animals, and their relation to disease,' the memorandum on the Comma-bacillus, and other reports on the agent or agents which produce cholera.

Cole's Microscopical Preparations.—We are naturally opposed in principle to *free* advertisements, but Mr. A. C. Cole has done such a large amount of valuable work in the extensive series of microscopical preparations that he has from time to time placed at the disposal of microscopists, that we cannot but call attention to the fact that though he has been obliged to discontinue the publication of his descriptions of preparations he still continues to issue the preparations themselves in the same condition of excellence as before. Any support given to Mr. Cole will be well directed in the interest of microscopy.

Enock's Insect Slides.—While Mr. F. Enock works in a more limited sphere than Mr. Cole his slides are, as is well known, quite unique of their kind as models of mounting, and Mr. Enock deserves a large measure of appreciation at the hands of microscopists. Mr. Enock supplies with his slides a description with figures illustrating the chief points, which, as we have before noticed in these pages, largely increases their value.

ADAN, H. P.—**Le Monde Invisible dévoilé. Révelations du Microscope.** (The Invisible World revealed. Revelations of the Microscope.)
New ed., 506 pp. and 24 pls., 8vo, Bruxelles, 1888.

BRIGGS, D. H.—**Beautiful Micro-polariscope Objects.**
[Salicin and hippuric acid.] *Journ. N. York Micr. Soc.*, IV. (1888) pp. 115–7.

BROWN, F. W.—**A Course in Animal Histology. I.** (*concld.*). **Instruments and Reagents. II. Cells and Intercellular Substances.**
The Microscope, VIII. (1888) pp. 57–8, 113–6 (4 figs.).

HOBBS, W. H.—**On the use of the Microscope in Petrography.**
Amer. Mon. Micr. Journ., IX. (1888) pp. 70–4.

JAMES, F. L.—**[Physicians and the Microscope.]**
["If physicians would only try the experiment for a few times of consulting the Microscope in their doubtful cases of urinary disorders, we feel assured that they would never again attempt to treat these disorders without a competent microscopical examination. We feel further assured that when one becomes acquainted with the value of the Microscope in this particular direction, he would be impelled to apply the same instrument and methods to the diagnosis of other troubles. He who fails to do so deliberately throws away the most powerful aid to diagnosis yet discovered."]
St. Louis Med. and Surg. Journ., LIV. (1888) p. 96.

LATHAM, V. A.—**The Microscope and how to use it. XIV.**
[Practical Notes on Histology. Special Methods for examination of the Spinal Cord, Brain, &c.]
Journ. of Micr., I. (1888) pp. 102–6.

,, ,, **A few good Objects for the Microscope.**
[Sections of laburnum wood, deal, and rhubarb; scales of the sulphur and cabbage butterflies; goldfinch's and lark's feathers; elder pith; and palates of molluscs.]
Scientif. Enquirer, III. (1888) p. 7.

MANTON, W. P.—**Rudiments of Practical Embryology. II. Material.**
The Microscope, VIII. (1888) pp. 58–60 (1 fig.), 110–3 (2 figs.).

MILLER, M. N.—**Practical Microscopy: A Course of Normal Histology for Students and Practitioners of Medicine.** xv. and 217 pp., 8vo, New York, 1887.

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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and a Vice-President and Treasurer of the Linnean Society of London;

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FELLOWS OF THE SOCIETY.

FOR THE YEAR

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Part 2.

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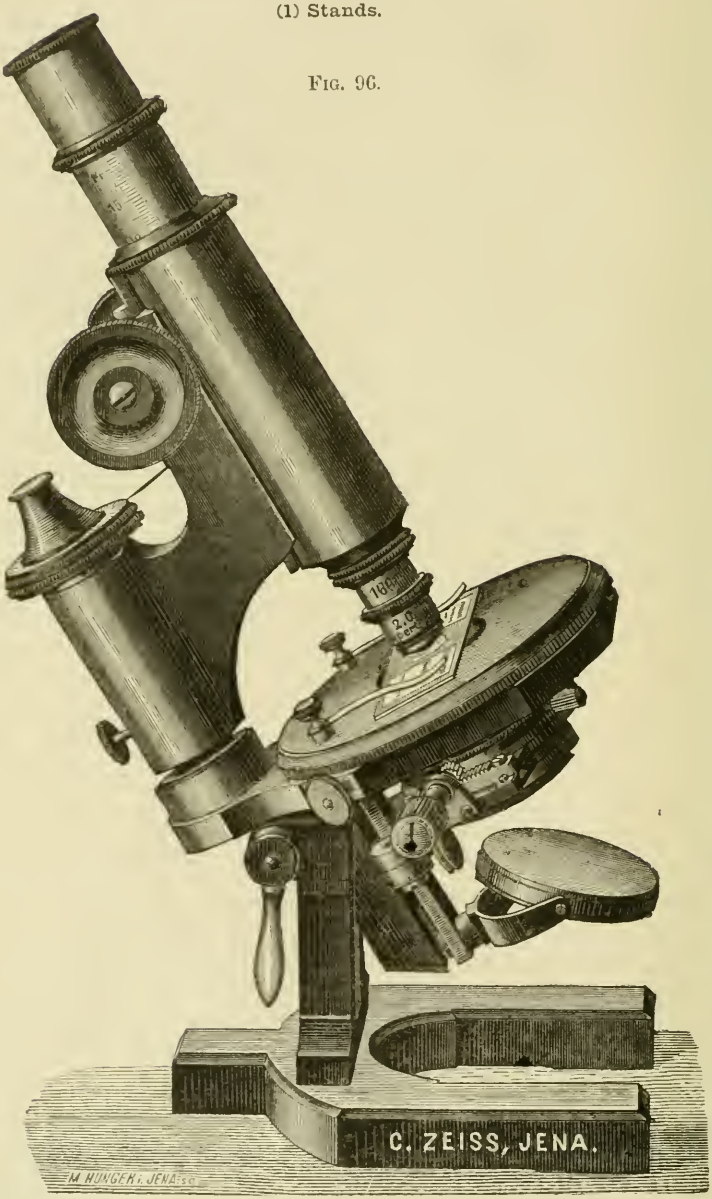
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Fig. 96.



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

Zeiss's IIa. Microscope.—Dr. C. Zeiss's new stand II*a*. (fig. 96), resembles his No. II. in general form and dimensions, but differs from it in having the fine-adjustment described in this Journal, 1887, p. 150. The upper part is not made to rotate about the optic axis as in No. II., but there is instead a disc of vulcanite which rotates on the stage; this is centered by means of two screws working against springs, one of which is shown in the figure immediately below the right-hand clip. The play of the centering screws is said to be sufficient to answer the purpose of a mechanical stage with high powers. The stage is large enough for cultivation plates. The Microscope inclines and can be clamped in any position.

The Abbe illuminator is provided with an Iris-diaphragm. The optical system (1·40 N.A.) is fixed in a brass holder which fits into a corresponding sliding socket, so that it may be withdrawn without difficulty from below, and replaced by a cylinder diaphragm or any other appliance similarly fitted (photographic condenser, illuminator for monochromatic light, microspectral-objective, spectral-polarizer, &c.).

The height of the stage above the base of the stand is reduced as far as possible for two reasons: (1) in order that the hands of the observer while manipulating the object may rest easily upon the stage, which is not the case with the stands of larger dimensions; (2) because a low stand is more convenient for most observers, and makes the instrument more portable.

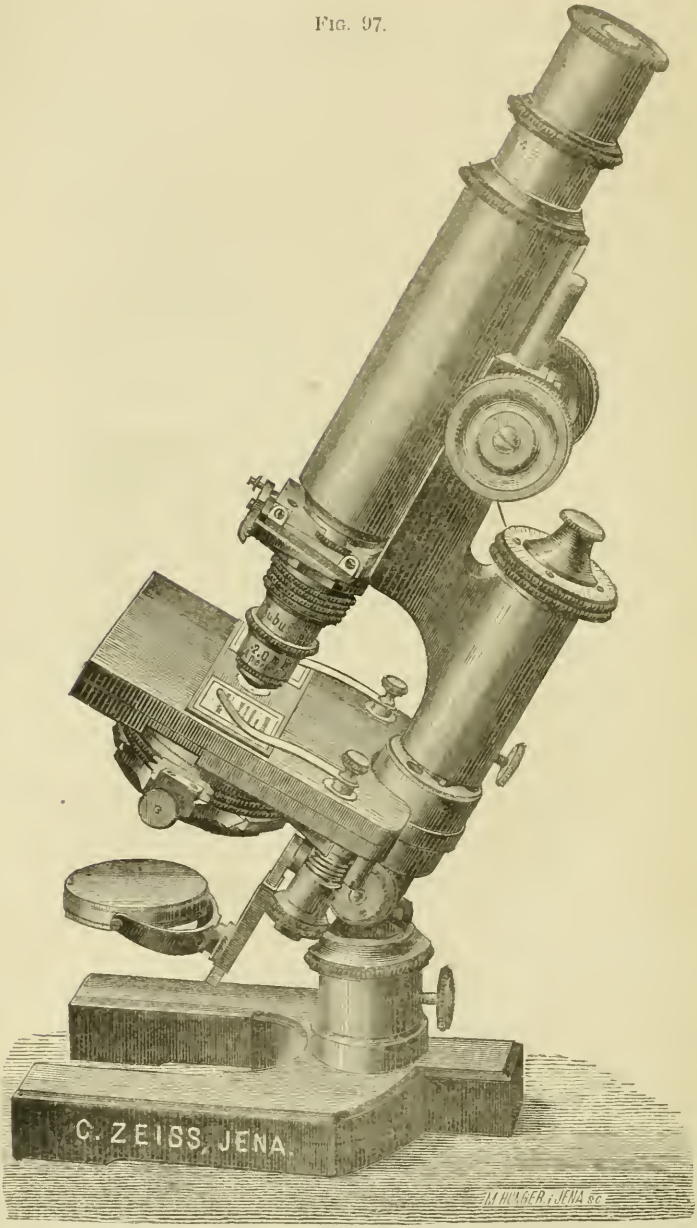
Babuchin's Microscope.—This stand (fig. 97), is made by Dr. Zeiss, after the design of the Moscow histologist Prof. A. Babuchin.

The Abbe illuminator has almost the form adopted by M. Nachet; the optical system, fixed in a holder, can be inserted from above into the carrier, which can be screwed downwards and swung out to the left. By these means the lenses are most easily interchanged with those of different aperture, or with a cylinder diaphragm, or polarizer. Below the condenser is a slot made to rotate about the optic axis in which the iris-diaphragm with rack and pinion is inserted; for oblique illumination it can be adjusted excentrically. The illuminator is moved in the optic axis, not, as is generally the case, by rack and pinion, but by a screw fitted to the left under side of the stage, which gives a slower and more exact motion. When the screw has been turned until the illuminator has reached the lowest point, a further turn swings it out to the left.

A specially large mirror is fixed to a sliding carrier by which it may be raised or lowered, or, when the condenser is swung to one side, fixed in any oblique position. The stage, which is not made to rotate or move, is large enough for cultivation plates.

The upper part of the stand is attached by a hinge-joint to a short pillar, which slides in a tube on the base, so that it can be drawn out and clamped. This renders it possible to lower the stage as much as is required for convenient manipulation or portability, or to increase the height of the stage and stand if this is required for application to a photographic camera, or to admit a larger substage, &c. The height of the stand can be varied between 200 and 230 mm., and that of the stage from 105 to 135 mm. It has the adapter for changing objectives which was described in this Journal, 1887, p. 646, and the fine-adjustment described p. 150.

Fig. 97.



Babuchin's Microscope.

Galileo's Microscopes.—In the "Museo di Fisica," at Florence, are two small Microscopes made wholly of brass, which Professor Meucci (Curator of the Museum) informs us are considered to have been constructed by Galileo (*ante* 1642), they having been handed down from the days of the "Accademia del Cimento," always bearing the traditional association of Galileo's name, and forming part of the collection of instruments belonging to that Academy at the date of its dissolution (1667). By the courtesy of Professor Meucci we were enabled recently to photograph the instruments, whence our figs. 98 and 99 are reproduced.

The two Microscopes are of essentially the same design, differing only in the shape of the scroll tripod supports, and in the fact that one is provided with a cap over the eye-lens.

As the lenses are wanting in both instruments, we are not able to determine whether the eye-lens was of the convex (Keplerian) or the concave (generally known as the Galilean) form. For focusing there

Fig. 98.

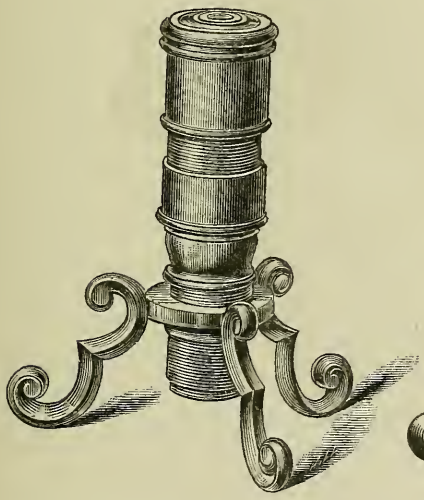
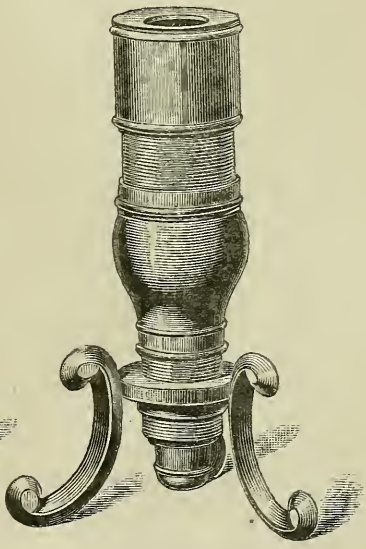


Fig. 99.



are two screw adjustments, one for distancing the whole optical-body from the object, and the other for regulating the distance of the eye-lens from the objective, as in the Campani Microscopes we recently figured.* The absence of any kind of stage would imply that the examination of opaque objects was principally intended.

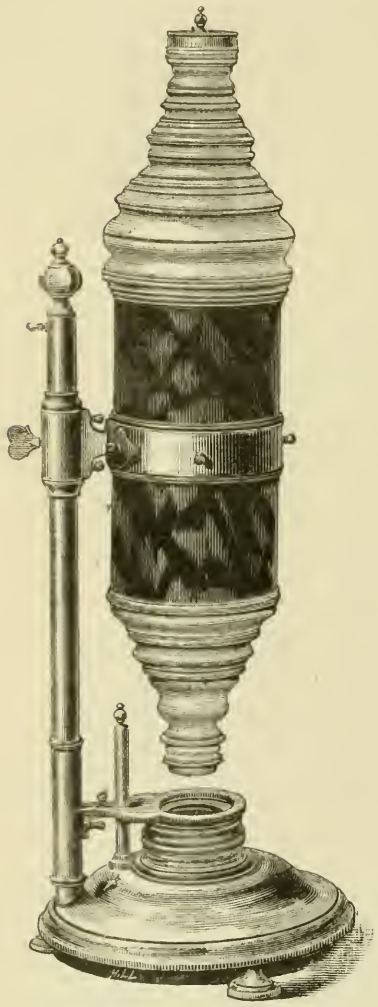
Apart from the late Professor Harting's conjecture regarding the possible origin of the so-called "Janssen" Microscope,† and on the supposition that these instruments were really made by Galileo, they must be regarded as the earliest Compound Microscopes in existence.

* See this Journal, 1886, p. 643, and 1887, p. 109.
† See this Journal, 1883, pp. 708–9.

One of the Microscopes was exhibited at the Loan Collection of Scientific Instruments in London in 1876.

Joblot's Microscope.—In the same Museum referred to in the preceding note we also found the Microscope shown in fig. 100, which is constructed of ivory, tortoiseshell, and brass. It bears no name, and no record of its origin is contained in the Museum. From the ornate character and general resemblance to a Microscope figured by Joblot * we think it probable that he was the maker.

Fig. 100.



For the coarse-adjustment the socket slides on the pillar; the fine-adjustment is by means of a screw passing down the pillar to the stage-socket, and is actuated by the shaped knob on the top.

Hensoldt's Reading Microscopes.† — Herr M. Hensoldt has published an elaborate article "On Reading Microscopes in general, and on screw Microscopes, and the scale Microscopes of the author in particular."

The great advantage of Microscopes over verniers in reading divided circles and scales, consists in the greater magnifying power of the Microscope as compared with the lens of the vernier, as well as in obviating parallax, and the possible excentricity of the latter. While the lens only possesses a magnifying power of 8–10 (and those of greater power cannot well be employed), the Microscope can easily be used with a power of 40–60, which means a 5–7-fold increase of efficiency. For if the interval between two divisions is increased 5–7-fold by optical means, the intermediate positions or subdivisions can be estimated with greater certainty in the same proportion. With screw Microscopes in which the subdivisions are measured by the turns of the screw, the hundredth or sixtieth part of such a division is determined with greater certainty in proportion as the magnitude of

* 'Descriptions et usages de plusieurs nouveaux Microscopes, tant simples que composez,' &c., par L. Joblot, Paris, 1718, fol., pl. 14.

† Central-Ztg. f. Opt. u. Mech., viii. (1887) pp. 242–6 (3 figs.).

the hundredth or a sixtieth of a turn can be recognized with greater accuracy; otherwise the reading of the drum is merely illusory. If the magnifying power of the Microscope is small, and the pitch of the screw very shallow, the hundredth parts which are read are only approximately true, and different results will be obtained from repeated observations, because the small size of the hundredths in the image cannot be clearly distinguished. With stronger magnifying power a screw of greater pitch can be used, and the hundredth parts can be more clearly determined. With scale Microscopes of high power, the micrometer divisions are more widely separated, and their tenths or half-tenths can be estimated with proportionally greater accuracy. The latter also possess, besides great simplicity, the advantage of rapid reading. While, with the vernier and lens, it is necessary to search a length of divisions for the coincident lines; and with the screw Microscope, the distance of the cross wire from the nearest division must be measured by rotating and reading the screw-head; with the scale Microscope, a single glance is enough to show how many minutes, tenths, &c., are to be added to the nearest division.

Considering the accuracy attainable with scale Microscopes, and the inconvenience attaching to screw Microscopes with their high power and consequent loss of light, the latter must be regarded as inferior to the former, unless means are devised for improving their optical character to the same extent.

In the author's opinion screw Microscopes are generally made too long (and too heavy), in which there is no advantage, for, (1) the instrument becomes large and inconvenient, and (2) the efficiency is not increased, but diminished. In Microscopes used for scientific observations where the greatest efficiency and strongest magnifying power are necessary, it has long been known that the best results are obtained from powerful objectives combined with weak eye-pieces. Their short focal length necessitates close approximation to the object, involving increased aperture and greater intensity of light. Since, here as with telescopes, increase of light means increased efficiency, this is of particular importance in the present case where the object is opaque and cannot be satisfactorily illuminated. But as with the telescope, so here in greater degree, it is impossible to retain the same relation between focal length and apertures for all focal lengths. Short focal lengths involve much greater apertures than long; both with a single objective lens and with a compound system. Thus the most powerful dry systems of 2·8 and 1·85 mm. equivalent focal lengths can have an aperture of 116°; while with 4·3 mm. focal length, the latter falls to 74°, with 7 mm. to 50°, with 11 mm. to 40°, with 18 mm. to 24°, and with 27 mm. to 20°.

Half the aperture corresponds to one-quarter of the intensity of light; the latter varies as the square of the former. From this it follows that reading Microscopes with objectives of short focal length have the advantage. Since they give brighter images, they can have stronger magnifying power, and therefore greater efficiency, while at the same time they are shorter and more convenient.

To gain space for illumination, the objectives should consist of a single aplanatic lens. The following table gives the most convenient relation between aperture and focal length for such lenses.

The aperture is slightly diminished by the fact that the object is never strictly at the focus as is assumed in the table.

Focal Length.		Linear Aperture.	Angular Aperture.
lines.	mm.	mm.	degrees.
3	6·8	3·1	26·0
4	9·0	3·6	22·6
5	11·3	4·1	20·6
6	13·5	4·5	18·9
7	15·8	4·75	17·0
8	18·0	5·0	15·8
10	22·5	5·6	14·1
12	27·0	6·2	13·0
15	34·0	6·6	11·1
18	40·5	7·0	9·9
24	54·0	7·5	7·9

The intensity of light, taking that of the 3-line objective as = 1, is for the objectives of 6, 12, 18, 24 lines focal length, 0·53, 0·25, 0·144, 0·091 respectively.

With screw Microscopes, objectives of less than 8–15 lines focal length have rarely been employed, in spite of the advantages which they would realize. It is advisable with the strongest objectives, and even if possible with the others, to use orthoscopic eye-pieces which give greater definition of image near the borders of the field.

To test the relative advantages of short and long focal length in the objective, a comparison was made between a Microscope of the author's construction, and a theodolite Microscope, with an objective of 30 mm. focal length, 6·7 mm. free aperture, and (as it stood 38·6 mm. from the scale) 10° angular aperture. The magnifying power was 40 (objective 3·5 and eye-piece 11·3). The total length from the scale to the end of the eye-piece was 20·5 cm. The other Microscope had a length of 95 mm. from the scale to the end of the eye-piece, magnifying power = 50 (objective 3·6, eye-piece 14), focal length of objective = 5 lines, angular aperture = 20°. It was found that with the smaller Microscope the intensity of light was three times as great as with the larger.

There are cases in which for special reasons long Microscopes are desirable or necessary, as with dividing machines where the heat of the body is to be avoided, or where it is necessary to read from a distance. The angular aperture may here be increased by using an objective composed of two weaker lenses of greater diameter so as to gain light; or the tube may be lengthened by a terrestrial eye-piece (with erect image) without weakening the objective; or the light may be increased by setting the Microscope at an angle to the plane of the scale. This last contrivance, which is so convenient with vernier lenses, can only be applied to Microscopes to a limited extent. The inclined position serves to reflect light from the silvered scale into the lens or Microscope; so that the divisions appear as sharply defined black lines upon a bright white ground. In the normal position of the Microscope, when it is perpendicular to the scale, the angles of incidence and reflection must both be 90°, i.e. the light must come vertically downwards; this is effected by the illuminator. If the Microscope is inclined backwards the field is brighter, but the divisions are not visible in their whole length, but only in a small part. In practice, however, a backward inclination of 10° may be attained; the light incident between 80° and 90° is then reflected from the scale directly into the Microscope and

gives a much brighter field, while the above-mentioned objection, which in no way diminishes the accuracy of the measurements, has also a certain advantage; for since powerful Microscopes are very sensitive in respect of exact focusing, the plane of the scale must be accurately perpendicular to the axis of the Microscope, or the image will not remain clear during a complete rotation; whereas with the inclined position one part is always in focus.

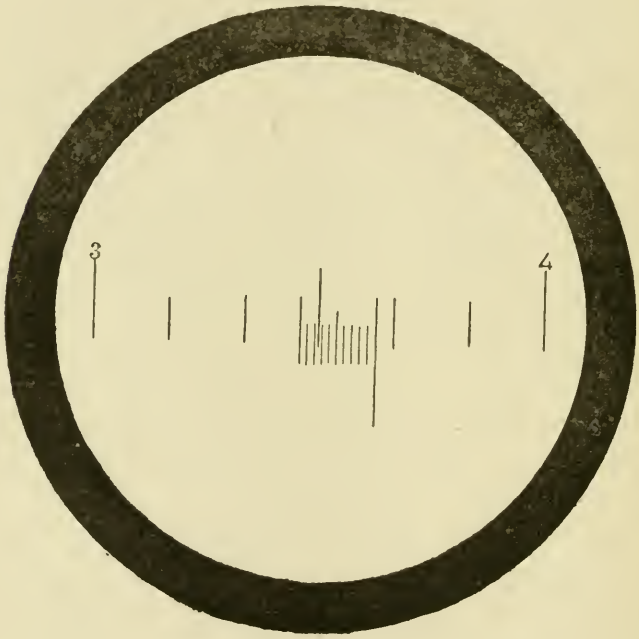
Describing the special advantages of his own arrangement of the Microscope which has now been largely used since 1879, the author says: "The great advantage is simplicity; the few divisions of the micrometer are easily taken in by the eye, so that no other method of measurement is so rapid. Further subdivisions or transverse lines are unnecessary and troublesome, and do not increase the accuracy. A portion of the scale of the instrument is separated by the Microscope into 100 parts; one-tenth of these are read by the direct divisions of the micrometer, and the tenths of the latter by estimation. The reading is not conducted in any other way except for special purposes.

If, for example, a circle is divided by one-sixth of a degree, or at intervals of ten minutes, and the micrometer contains ten equal intervals which occupy exactly one division of the circle, each such interval corresponds to one minute. If the latter can by estimation be subdivided into tenths (by practice even into half-tenths) the unit of reading is six (or three) seconds. Fig. 101 shows the sixth division of a degree on the circle near the ten divisions of the micrometer. The divisions of the circle are numbered from degree to degree with 0 to 9, either by the pantograph or with figures made as small as possible and as near as possible to the lines so that at least one number shall be visible in the Microscope whose field covers more than one degree. It is not then necessary to use a special index or a lens to read the angle; for the principal numbers at each 10 degrees may be made large and placed outside the silver strip where they can be easily seen with the naked eye. If the circle is not covered the illuminator will at once show whether the reading is between 10 and 20 or 30 and 40, &c., and the single degrees are given by the divisions in the Microscope. If the circle is covered it will be necessary to have, in addition to the two small apertures for the Microscopes, a larger one inclosing about 15 degrees, at a point 90° from them, and having in the middle of its glass a black line by which the approximate angle is read off. Supposing that this line shows the reading to be between 30° and 40°, and that the micrometer stands as shown in the figure, the reading will be 33° 37′·3 or 33° 37′ 18″.

In the inverting Microscope the division on the circle always runs towards the long or zero mark of the micrometer, i. e. from left to right when the numbers of the horizontal circle run from right to left. The divisions of the micrometer are reckoned from zero point in the opposite direction, from right to left. With vertical circles where the numbers go from left to right, because the circle turns with the telescope, everything is reversed; in the right-hand Microscope alone the graduations are reckoned from right to left or downwards, and the micrometer divisions upwards; in the left-hand Microscope the graduations are read upwards and the micrometer downwards. For small instruments it is convenient to have the scale divided at intervals of 20 minutes; a micrometer division is then equivalent to 2 minutes; in this case it is

not necessary to take the mean of the two Microscope readings since their sum will give the mean directly. A glance into the Microscopes is sufficient to give the mean of the readings and scarcely occupies a quarter of the time necessary for vernier readings. The scale graduations, which cannot be made so fine upon metal as the micrometer graduations upon glass, and which are magnified three to five times by the objective, appear much broader than the latter. With ordinary instruments which are finely divided a line on the scale covers at least

Fig. 101.



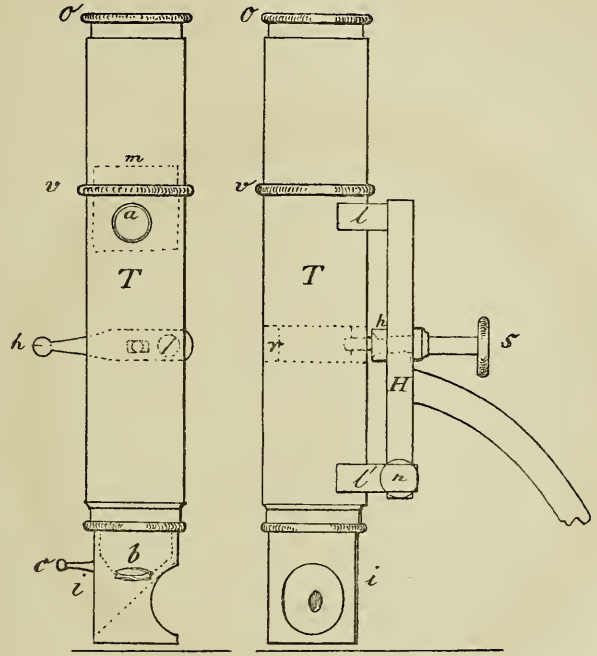
30 seconds to one minute, and from this fact would result a source of error if means were not found to obviate it. Instead of using the whole breadth of the mark the attention is confined to the same edge of it, namely that which is on the right-hand side towards the long mark. It is still better if the graduations terminate at one end in a point, such as is generally produced by the graving tool; but the pointed end should always be that at which the divisions are level, and not towards the prolongations of the whole degrees and half degrees. The tenths, &c., can then be very accurately estimated if the micrometer divisions project beyond the pointed ends (fig. 101)."

The divisions should be short (not more than 1/2 mm. in length), and as fine as possible; the exact coincidence of ten divisions in the micrometer with one division of the scale is secured as nearly as possible by preliminary calculations and then made absolute by a slight movement of the objective-tube.

With powerful Microscopes it is desirable to have some simple and

steady means of focusing; on this point the author says: "In place of the ordinary ring with clamp enclosing the Microscope tube, I apply above and below two segments *l l'* (fig. 102) which accurately fit the tube, most closely however at the edges, so that they are not quite in contact in the middle. The upper one, next to the eye-piece O and micrometer,

FIG. 102.



is only fixed to the holder H by a screw so that it can be turned slightly. The other, which is broader at its lower end, has a square pin, which passes through the holder, and is also secured by a screw; it can be slightly moved sideways by two milled head screws *n* to bring the reading accurately to 180°. Into the two bearings *l l'* the Microscope-tube T is placed and is held in position by a screw *s* which passes into the Microscope-tube; for this purpose a thick ring *r*, having a screw thread for *s*, is let into the tube. *s* is not to be turned so far as to fix the Microscope. Between T and H, and attached to the latter, is a small lever *h* turning on a screw; through this *s* passes and can be slightly raised or lowered by touching the end of the lever after slightly loosening *s*, which is finally screwed up tight. In this way I obtain a satisfactory fine-adjustment by simple means."

To clean the micrometer, if necessary, the upper part of the Microscope unscrews. The connecting-piece *v* contains the micrometer *m* which is to be adjusted parallel to the scale. This would generally be done by rotating the tube in the rings which hold it, but with the above fine-adjustment the tube cannot turn, and it is necessary to elongate *v* so that it passes down inside T and fits accurately in the lower part of the

tube and can be rotated with it. *m* is fixed in position by the screw *a*. The eye-piece is movable, to suit different eyes. The illuminator *i* is screwed to the holder of the objective *b*, and is turned towards the light by a small handle *c*. The scale should be covered with thin glass brought as near to it as possible in order that the illuminator may not be further from the scale than is necessary.

The author claims that his method of reading has also the advantage that errors in the dividing are at once detected by the failure of coincidence between the micrometer divisions and those of the scale, and he concludes with the results of some observations with a theodolite of 13·5 cm. diameter divided to one-third of a degree, which showed the mean error in an angular measurement to be ± 3″, and the maximum error ± 5″.

LEACH, W.—**The Lantern Microscope.**
[Cf. this Journal, 1887, pp. 1019–21.]
Trans. and Ann. Rep. Manchester Micr. Soc., 1887, pp. 52–7 (1 fig.).

QUINN, E. P.—**The Advantages and Deficiencies of the Lantern Microscope.**
Trans. and Ann. Rep. Manchester Micr. Soc., 1887, pp. 26–7.

(2) Eye-pieces and Objectives.

Hartnack's new Objective.—We transcribe the following paragraph verbatim:*—

"A new objective, after calculations of Dr. Schröder, has been produced by Professor Hartnack, in Potsdam, whose microscopic objectives enjoy a well-deserved reputation, and which is destined to fill out the place between the photographic aplanat and the microscopic system. The weak microscopic systems, which are ordinarily applied, if more extended microscopic objects, histological preparations, polished stones, and metals are to be photographed, have besides their proportionate light-weakness and their chemical focus, a very moderate expansion of the evenly illuminated available picture field, comprising hardly more than 6 to 8 degrees. The small aplanats, which are used for the same purpose, require very strong diaphragms and give a picture field with little plane. The new objective, which is furnished without diaphragms, comprises an extremely large picture angle of almost 26°, and covers to the edge of the field with almost equal sharpness and without the least trace of chemical focus. The instrument, which I have tested, has an equivalent focal distance of about 50 mm., and forms a sharp object of nearly 4 sq. cm. The light power is quite extraordinary; for enlargements 10 to 15 times by ordinary 15-candle gaslight the exposure was 3 to 8 seconds upon bromide of silver gelatin. The instruments, whose general introduction is only to be desired, can also be executed in other sizes, as for instance from 4 to 6 inches equivalent focal distance."

PENNY, W. G.—**Eye-pieces—Physical Aberration and Distortion.**
Engl. Mech., XLVII. (1888) p. 215 (1 fig.).

(3) Illuminating and other Apparatus.

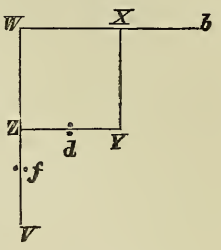
Hilgendorf's Auxanograph.†—This instrument, devised by Dr. F. Hilgendorf, is a micropantograph designed to produce outline sketches (orthogonal projections) of small objects down to less than 1 mm. on an increased scale of from 2 to 10.

The four arms W *b*, W V, Z Y, X Y (fig. 103), are supported on long

* Dr. H. W. Vogel in 'Anthony's Photographic Bulletin,' 1888, p. 230.
† Zeitschr. f. Instrumentenk., vii. (1887) pp. 290–1 (1 fig.).

vertical axes at W, X, Z, Y, above a drawing board; at *f* is a rod, held by drawing pins, which serves as the fixed point about which the whole instrument turns in drawing; the paper is placed under the pencil at *b*; the object is at *d* under a lens which is carried by a diopter in ZY, and which has a cross engraved upon its upper surface. The pencil at *b* is moved by the hand in such a way as always to keep the centre of the cross upon the outline of the object as it appears to the eye above *d*. The scale of the drawing may be varied by sliding the rod *f* and the lens *d* along their bars; the points *f d b* are to be always in the same straight line. Between V and Z are slots corresponding to an amplification of 2, 5/2, 3, 4, 6, 8, and 10 respectively, and the lens is adjusted by means of a scale along Z Y having its zero point at Z. The board being set horizontal by a level, and the upper opening of the tube being adjustable, the line joining the two openings may be made vertical by a plummet, so that the line of vision is always perpendicular to the plane of the drawing. The lens is made horizontal by means of a pendulum movement about the screw which fixes the lens-holder to the tube. The lens may also be adjusted by means of a horizontal mirror placed below it, the engraved cross being made to coincide with its image seen in the mirror. When higher powers are used the object is to be raised by a support to the correct focal distance. When a large object is being drawn, the long axis at Y may be replaced by a short one; and in this case the bar X Y may be prolonged beyond Y, and fitted with a long axis at its end.

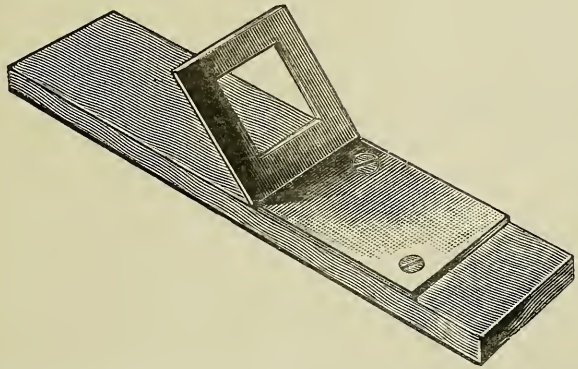
Fig. 103.



The instrument is designed "rather with a view to practical convenience than to realize with mathematical accuracy the exact reproduction of an object."

Slide for observing Soap-bubble Films.* — A simple means for showing soap-films by the Microscope, may, Mr. F. T. Chapman points

Fig. 104.



out, consist of a thin strip of wood (3 in. by 1 in.), or other material, with a metal plate secured to it. The plate should have one end

* Read before the Washington Microscopical Society. Cf. Amer. Mon. Micr Journ., ix. (1888) pp. 81–2 (1 fig.).

bent upward from the strip at an angle of 45°, and have a square hole through it. The film increases in brilliancy as it grows thin. The light should be thrown on the film from above, so that the beam will be reflected up the tube of the instrument. The proper angle can readily be found by trial.

The following are some directions for making suitable soap-bubbles:—

(1) Shave Marseilles (Castille) soap and dry thoroughly in the sun or on a stove. (2) Put the dried shavings in a bottle with alcohol of exactly 80 per cent. strength (specific gravity 0·865), sufficient to form a saturated solution at 60° Fahr., the solution then marking 74° on the centesimal alcoholometer, with a density of 0·880. The solution must be made cold, as warm alcohol would dissolve too much soap, and the solution would solidify when cool.

(3) Make a mixture of glycerin and water, so as to mark 17·1° Baumé, or have a density of 1·35 at 68° Fahr. This solution can be made of equal parts of the most concentrated glycerin and water, and it is well to heat the solution in a water-bath.

(4) To make the final solution, take 100 parts, by volume, of the glycerin solution (3) to 25 parts of the soap solution (2), mix and boil to expel alcohol. When cool, pour into a graduate and add water to equal 100 volumes. Then filter several times to remove oleate of lime. Common glycerin is apt to make the solution turbid on account of the presence of gypsum and lime. A funnel with a plug of cotton makes the best filter, as the flow can be regulated by the tightness of the cotton in the funnel. Soap-bubbles, not more than 4 in. in diameter, and supported on a tripod under a bell-glass, are said to last for an hour. The preparation is suitable for Plateau's experiments with thin films, soap-bubbles, &c.

Plateau's soap-bubble solution is prepared as follows:—

Dissolve one part of Marseilles soap in 40 parts of water (rain or distilled), which may be warmed. When cool, filter through very porous filter paper and add Price's glycerin in the proportion of 11 parts of glycerin to 15 parts of the soap solution. Shake thoroughly, and allow the solution to stand for seven days where the temperature will not fall below 67° Fahr. Then cool to 37° Fahr. and filter, keeping a bottle of ice in the funnel. The first parts filtered should be refiltered, using very porous filter paper. Halbrook's brown oil silk soap, or his Gallipoli soap, and Sheering and Glatz's glycerin work very well. Long standing and decantation from sediment may take the place of the second filtration. After all the trouble, the mixture may not give very good results.

An excellent soap-bubble solution may be formed by a compound of oleate of soda and pure glycerin. Bubbles 2 feet in diameter may be blown, and bubbles have been kept under glass for 48 hours.

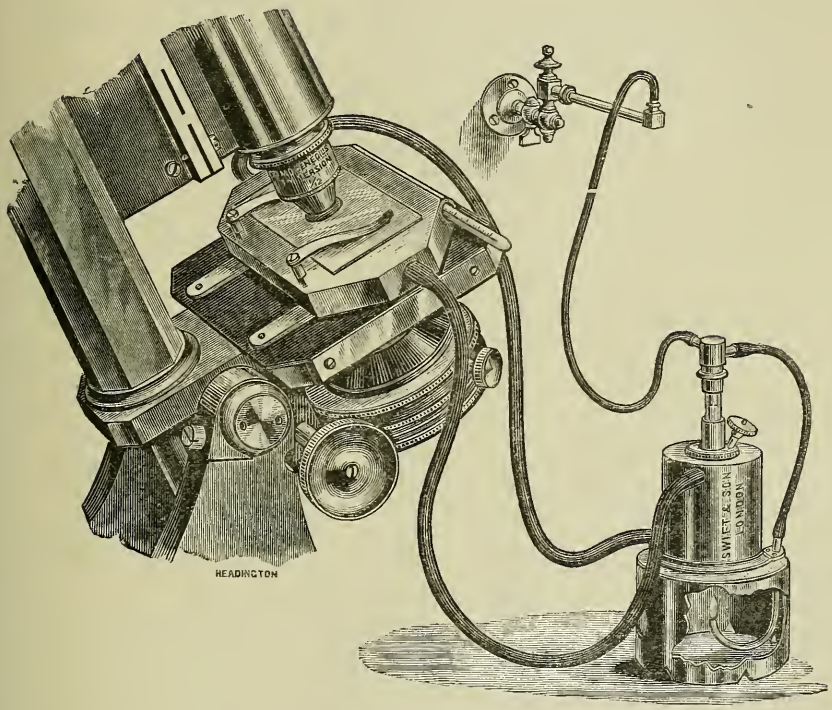
A good and easily prepared solution may be made by shaving 4 oz. of Marseilles, or better, of pure oil soap, and placing it in a quart of distilled or rain-water. Shake until a saturated solution is formed, and let it settle for a few hours. The solution should then be clear. If otherwise, pour off the water, and add fresh water to the same soap and try again. To the clear solution add about one-half the quantity of glycerin that is absolutely pure. The presence of the least quantity of acid in the glycerin is fatal to good results and therefore it is recom-

mended that for any soap-bubble solution the ingredients be the best and purest obtainable, and that chemically pure glycerin be used.

Schäfer's Hot-water Circulation Stage and Swift's Regulator.—Prof. E. A. Schäfer's hot stage (fig. 105), consists simply of a metal box with a pipe at each end; hot water entering by the lower end, and flowing away at the upper.

Messrs. Swift and Son use as a regulator for maintaining an even temperature what is practically the same apparatus as was described in

Fig. 105.



this Journal, 1887, p. 316, a pipe for the gas leading into a tube with mercury, whence it flows by another pipe to the gas-jet beneath the water reservoir, the milled head screw regulating the height of the mercury in the tube in the first instance.

Bertrand's Refractometer.*—In order to measure the index of refraction of pyroxene, amphibole, &c., which is $> 1{\cdot}69$ with this apparatus,† M. E. Bertrand has made the hemispherical lens of flint glass ($n = 1{\cdot}962$), and proposes as moistening fluid methylen iodide ($n = 1{\cdot}75$), the refractive index of which might possibly be increased by dissolving other substances in it.

* Bull. Soc. Franç. Min., x. (1887) pp. 140–1.
† See this Journal, 1887, p. 469.

Seaman.—**Exhibition of Lamp and Vertical Illuminator.**

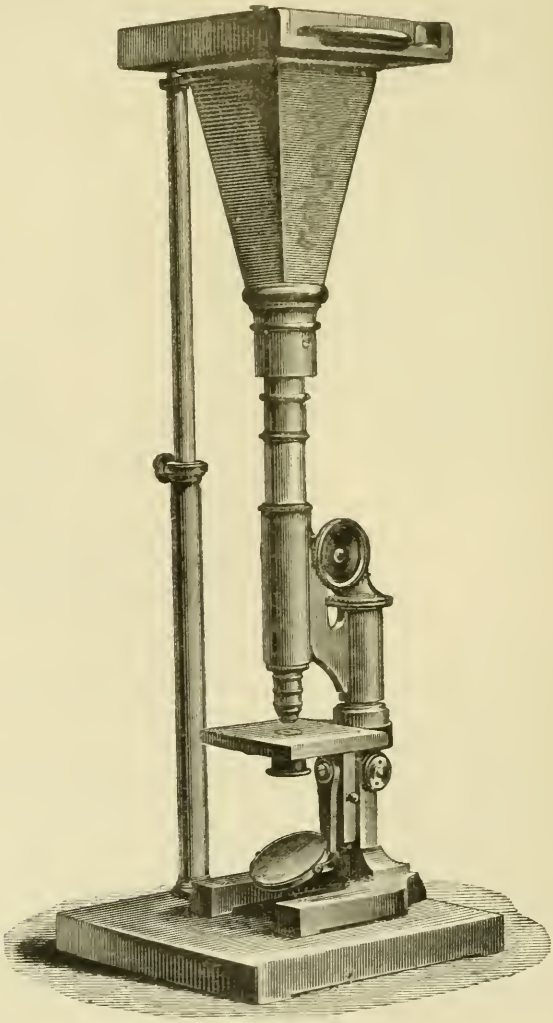
[He said, "You may remember that some time ago I showed a vertical illuminator made by Mr. Chas. Fasoldt of Albany. I have here a slide of his rulings, which contains 19 bands, from 5000 to 120,000 to the inch, which is no doubt a very excellent specimen of this kind of work, similar to the celebrated Nobert plates. I have no hesitation in saying that on an object of this kind, with an immersion-lens, the definition obtained by this illuminator is superior to anything I have ever seen, and that by its means the human vision may be pushed to its utmost limit."]

Amer. Mon. Micr. Journ., IX. (1888) p. 97.

(4) Photomicrography.

Leitz's small Photomicrographic Apparatus.—This, fig. 106, is an adaptation of several somewhat similar forms which have been already

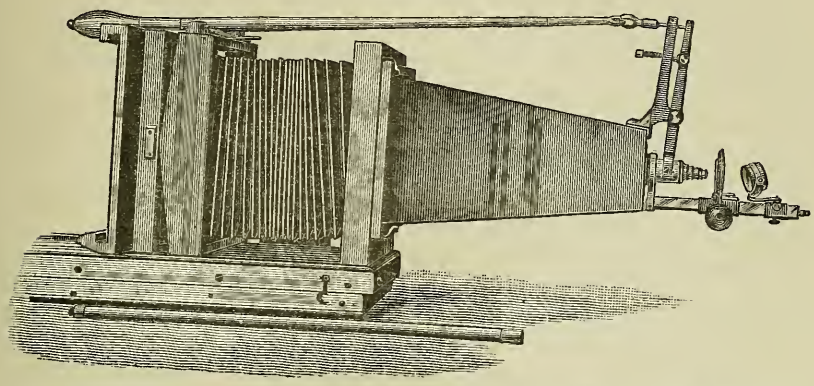
Fig. 106.



described. Its speciality consists in attaching the camera to a rod which is extensible in a socket (with a clamp screw), by which means the camera can be made to fit any Microscope, whatever its height.

Plössl's Focusing Arrangement.—Messrs. S. Plössl apply to their photomicrographic camera the fine-adjustment shown in fig. 107.

Fig. 107.



This is practically a very large form of the Jackson fine-adjustment, the lever which raises and depresses the movable nose-piece being actuated by a large rod with a "Hooke's joint," the handle of which is at the end of the camera.

It appears to us (without having practically tested the point), that the enormous leverage of the focusing rod must add greatly to the difficulty of focusing.

Instantaneous Photomicrography.* — Sig. S. Capranica comes to the following conclusions as the results of his experiments on instantaneous photomicrography:—

(1) Rapid photography 1/20 of a second, or very rapid 1/200 of a second, can be obtained with the photographic Microscope if very high powers and immersion lenses be used.

(2) By means of a special shutter and a particular arrangement, any number of successive negatives of the movements of an object can be obtained just as, macroscopically, the flight of birds, and the rapid movements of other animals (Marey, Maybridge, &c.), have been.

(3) By the method of successive positions, the author has succeeded in reproducing upon the same sheet the different planes of any preparation, obtaining thus a photograph unique in its entirety.

The author particularly calls the attention of microscopists to the results noticed in (2), as they are entirely new and susceptible of numerous and important applications in the study of the Infusoria and of all living micro-organisms.

Kitt, T.—**Ueber Mikrophotographien.** (On Photomicrographs.) *Oesterr. Monatschr. f. Thierheilk.*, 1888, No. 6, 18 pp.

Müller, N. J. C.—**Atlas der Holzstructur dargestellt in Mikrophotographien.** (Atlas of wood structure represented in photomicrographs.) 21 pls. and 60 figs., 4to, Halle, 1888.

* Journ. de Microgr., xii. (1888) p. 227.

Simmons, W. J.—**Magnification in Photomicrographs.** *Sci.-Gossip*, 1888, p. 162.

Walmsley, W. H.—**Photomicrography and the making of Lantern Slides.** *Anthony's Phot. Bulletin*, XIX. (1888) pp. 231–3.

(5) Microscopical Optics and Manipulation.

Blackburn, W.—**Diffraction Spectra.**
Trans. and Ann. Rep. Manchester Micr. Soc., 1887, pp. 58–60.

Crisp, F.—**Micromillimetre.**
[Announcement of the decision of the Council and Fellows, *ante*, p. 503.]
Nature, XXXVIII. (1888) p. 221.

Nelson, E. M.—
[Nomenclature of eye-pieces and objectives—Relation of aperture to power, &c.; also letters by T. F. S., F. D'Agen, and A. S. Z.]
Engl. Mech., XLVII. (1888) pp. 190–1, 216.

Royston-Pigott, G. W.—**Microscopical Advances. XXXVII., XXXVIII.**
[Researches in high-power definition—Attenuated lines, circles and dots.]
Engl. Mech., XLVII. (1888) pp. 293 (2 figs.), 447 (1 fig.).

Rücker, A. W.—**Micro-millimetre.**
[Reply to Mr. Crisp's letter, *supra*.] *Nature*, XXXVIII. (1888) p. 244.

Salomons, D.—**Note on Depth of Focus.**
Journ. and Trans. Phot. Soc. Gr. Britain, XII. (1888) pp. 160–5.

(6) Miscellaneous.

American Microscopes.*—Mr. C. F. Cox in his inaugural address as President of the New York Microscopical Society, said that it was "not long since some professed advocates of the popularization of science went through the form of reading us microscopists out of the general body of scientists, on the ground that we were not entitled to fellowship or encouragement because we were only 'amateurs' (that is say, lovers of science), were 'hangers on to the regular scientific army,' were 'universal gatherers,' and were 'undertaking to divide the sciences according to the tools used;' and we were spoken of contemptuously as 'delighting in a formidable and extensive deal of brass stand.' To most of these charges it was hardly necessary to put in any formal defence, for it was obvious that the animus of the attack upon us was the old-fashioned delusion that there is some kind of merit in doing scientific work with poor appliances. But another phase of this general notion has recently manifested itself in a vigorous onslaught upon American Microscopes, for which, with evident appropriateness, the vehicle selected has been the journal which three years ago promulgated the now celebrated bull of excommunication. According to the latest champion of scientific orthodoxy, who declares that he has 'seen and examined a great many different stands, and the lenses of many manufacturers,' 'it is undesirable to recommend a student to purchase any Microscope whatsoever of American manufacture,' but it *is* desirable 'to always counsel him to obtain, if possible, one of the German or French instruments,' which, as nearly as I can make out, conform to the common model of twenty-five or thirty years ago. The general objection to American stands seems to be that they furnish more mechanism than the particular worker who wrote the complaint happens to require for his particular work. He makes a more specific charge, however, that they have a joint in the body by means of which they *may* be tipped out of a vertical position, when the makers ought to have

* Journ. New York Micr. Soc., iv. (1888) pp. 106–15.

known that he and his pupils never *care* to tip their Microscopes; and another specification is made of the fact that the length of the tube has not been determined solely with reference to the height of the table or the chair which this rather exacting critic commonly employs; at least this is the inference I draw from his demand that tubes should never be made longer than suits *his* convenience.

Now, I presume you find it as difficult as I do to understand why all supposed faults are laid at the doors of American manufacturers; for surely all bad Microscopes are not American, even if all American Microscopes are bad. But the unreasonable and sweeping denunciation in which this somewhat self-opinionated iconoclast indulges is only another illustration of the familiar phenomenon of blotting out all the rest of the world by holding a comparatively small object close to one's eye; for here is an acknowledged expert in histology, who is so completely absorbed in his speciality as to be entirely oblivious to, or regardless of, the instrumental needs of all other branches of microscopy. In common with others who have lately made public display of their ignorance of the vastness and variety of microscopical research, he would actually prescribe 'for one that uses the Microscope for real work' a single simple pattern which, as you may imagine, would be pretty strictly limited to the requirements of his own restricted field of investigation. Instruments which perhaps meet the demands of different classes of observers are 'constructed with a view of entrapping inexperienced purchasers.'

Unfortunately, this sort of narrow opposition to the inevitable elaboration of scientific implements is not a thing which decreases with the general increase of knowledge. It has accompanied every step in the development of the Microscope and its accessories, and I suppose it will go right on in the future; for I can hardly imagine a time when some specialist will not think it praiseworthy to contemn 'the latest improvements,' and take personal pride in pointing to the results of his own labours accomplished by the use of only the simplest mechanical aids.

Within a short time we have heard learned sermons preached upon the superiority of specimens prepared without the employment of circular cover-glasses, and, of course, without the assistance of the turntable. It was admitted that they were not very attractive to the naked eye; but then there was 'no nonsense' about them, they were intended '*for use!*' So, too, we have witnessed a later contest over the microtome. What earnest homilies we have listened to upon the superlative excellence of the German method of free-hand section-cutting, and how positively we have been assured that all mechanical section-cutters were only delusions and snares. I have to admit that some of the later developments of this accessory are rather formidable-looking engines which seem capable almost of cutting timber for commercial purposes; but I notice that the gentleman who denounces all American Microscopes as being too complicated, is himself the inventor of one of those elaborate slicing machines. Yet the automatic microtome plainly has come to stay, so have the mechanical stage, the swinging substage, and many other contrivances over which we have seen battle waged.

Shall we ever forget the terrific struggle with which the homogeneous-immersion lens was obliged to win its way to a footing in the microscopical world? Men of no small importance blocked the road, not

with drawn swords, but with drawn diagrams which most certainly proved, if they proved anything, that an angle of more than 180° was an optical impossibility, and that, no matter what people might *think* they saw, they at all events could not see round a corner; for, as old John Trumbull wrote,—

> "Optics sharp it needs, I ween,
> To see what is not to be seen."

But now how perverse and prejudiced all that opposition seems, and how simple and reasonable the new system of numerical aperture is seen to be!

Before our time the fight was fought over the binocular body, the achromatic objective, and even the compound principle itself."

The author then quotes from Hill's 'Essays in Natural History and Philosophy' (1752), a passage in which the general superiority of the simple over the compound Microscope is insisted upon, and refers to an "amusing case of circumstantial mendacity, or of clever fiction," quoted from Father Noel D'Argonne* in that curious work attributed to Dr. John Campbell, entitled 'Hermippus Redivivus, or the Sage's Triumph over Old Age and the Grave,' in which is mentioned a Microscope which not only showed the atoms of Epicurus and the subtile matter of Des Cartes, but the secret of personal sympathy and antipathy which was shown to depend on the similarity or contrariety of the perspired vapours. A recent writer† has also described "an original arrangement of lenses," by which he has "hit upon the awful discovery of the departing soul with its astral covering!"

These matters were introduced by the author into the subject with which he was dealing, because he "cannot see anything better in under-rating the value of our mechanical appliances than in over-estimating the capabilities of our lenses."

Death of Mr. Webb.—We regret to have to record the death of Mr. Webb, the well-known engraver of the Lord's Prayer in characters so minute that the whole Bible could (in the case of one slide in our possession) be written fifty-nine times in a square inch. In this and similar feats Mr. Webb was without a rival, and his name may fitly be linked with that of Nobert as one of the great masters of the art of minute engraving with a diamond on glass.

American Postal Microscopical Club.
[Comments on 13th Ann. Report.] *The Microscope*, VIII. (1888) p. 149.

Bidwell, W. D.—**The Microscope in Medicine.**
Amer. Mon. Micr. Journ., IX. (1888) pp. 108-9.

Bowman, F. H.—**Does Science aid Faith? II.**
[Contains illustrations drawn from the Microscope.]
Christian World Pulpit, 1888, May 30th, pp. 348-50.

Couvreur, E.—**Le Microscope et ses Applications à l'étude des Végétaux et des Animaux.** (The Microscope and its applications to the study of plants and animals.) 350 pp. and 112 figs., 8vo, Paris, 1888.

Examinations in Microscopy.
["The examination in microscopy passed by the graduating class of the St. Louis College of Pharmacy, and published in the 'National Druggist,' is

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* 'Mélange d'histoire et de litérature, par M. de Vigneul-Marville,' Paris, 1700.
† 'The Hidden Way across the Threshold,' by J. C. Street, Boston.

a model of its kind. We are certain of 51 Ph.G.'s who know something of the use of the Microscope."]

The Microscope, VIII. (1888) p. 156.

Italian Microscopical Society.

[Just formed; articles and papers are to be published in Latin, French, English, and German. Secretary, Sigr. J. Platania, 14, Via S. Giuseppe, Acireale, Sicily.]

Sci.-Gossip, 1888, p. 139.

Munchausen still alive.

[While the following is too outrageous rubbish for the pages of the Summary, it ought not to go quite unrecorded. "A weekly and much-read paper has the following bit of veracity: *The Human Blood.*—'Professor Bronson (an American) states, that if a drop of human blood be subjected to examination by the hydrogen Microscope, and magnified some 20,000,000 of times, all the species of animals now existing on the earth, or that have existed during the different stages of creation for thousands of years past will be then discovered. In the blood of a healthy person all the animalcula are quiet and peaceable; but in the blood of a diseased person they are furious, raging, and preying upon each other. That man contains within himself all the principles of the universe; also, that, if a dead cat be thrown into a pool of stagnant water, and allowed to dissolve there, a drop of water taken from any part of the pool, will show as above, every species of animal of the cat kind that has ever existed on the earth, raging and destroying one another, the bodies of all the lower animals being thus made animalcula similar to themselves, and the body of man being compounded of all that is below in the scale of creation.'"]

Sci.-Gossip, 1888, p. 142.

QUINN, E. P.—**The use of the Microscope in the examination of Rock Sections by Polarized Light.**

Trans. and Ann. Rep. Manchester Micr Soc., 1887, pp. 60–1.

Zentmayer, J., Obituary of. *Queen's Micr. Bulletin*, V. (1888) p. 9.

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Preparation of Nutritive Media.†—Dr. E. Jacobi prepares agar, gelatin and *Fucus* as nutritive media as follows:—The test-tubes, flasks, &c., are first cleaned and stopped with cotton-wool, and then heated for 2½ hours in a Papin's digester over a gas-burner. The cotton-wool must nowhere touch the sides of the digester. The temperature inside reaches to about 150°.

(1) In making agar-agar, the ordinary agar is cut into small pieces, and (*a*) either 1½ litre of cold meat infusion with 15 gr. (1 per cent.) peptone, 7·5 gr. (0·5 per cent.) NaCl, and 15–22·5 gr. (1–1½ per cent.) agar, or (*b*) 1½ litre of water, 7·5 (0·5 per cent.) Kemmerich's meat-peptone, 15 gr. (1 per cent.) peptone, and 15–22·5 gr. agar, are boiled in a metal saucepan over the open fire until the agar is perfectly dissolved, which happens in about 3/4 hour. The water lost by evaporation is replaced and the solution rendered slightly alkaline by means of carbonate or phosphate of soda. The fluid is then poured into flasks and steamed until the albuminous matters have separated out; if neutralized with sodium phosphate this happens in about 2 hours; if with carbonate of soda, the time is longer. Filtration is effected in a few minutes. A tube holding about 1½ litre, about 70 cm. long and 6 cm. in diameter, is

* 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.

† Centralbl. f. Bakteriol. u. Parasitenk., iii. (1888) pp. 538–40.

closed at its lower end by a layer of cotton-wool 5 cm. thick; the fluid is then poured in and the upper end closed with a caoutchouc plug, in which is an opening for a glass tube. To the glass tube is connected a rubber bellows which, when worked, compresses the air inside the tube, so that the agar soon runs out quite clear, and is then sterilized in the usual manner.

(2) For preparing gelatin, 1½ litre of water, 22·5 gr. (1½ per cent.) Kemmerich's meat-peptone, and 45 gr. (3 per cent.) peptone, are boiled for some minutes in a metal pan over the open fire and then cooled down to 50°–60° C. In this mass are dissolved 225 gr. (15 per cent.) gelatin, and the solution neutralized with carbonate of soda. The whole mass is then shaken with the white of an egg and steamed for 1/2 hour; the albumen and other substances are precipitated, and then filtration is done in the way described above. The water-clear gelatin is then distributed into flasks and sterilized in the usual manner.

(3) For preparing a fucus mass, the same directions as were given for agar must be followed, except that 2½ per cent. *Fucus crispus* is used. Before neutralization it must be strained through a cloth, as *Fucus crispus* is not so perfectly soluble as agar.

Preparing Agar-agar.*—Dr. E. Freudenreich prepares agar, and at the same time shortens the process in the following manner:—1 per cent. of agar is added to meat infusion, and the mixture boiled on the open fire until the agar is quite dissolved. The solution is then neutralized and afterwards reboiled until the albuminous matters are precipitated. So much of the solution as will be required to fill a flask or test-tube is then poured into a funnel with paper filter and placed in a steam sterilizer, and the temperature raised to about 110°, and in about one hour the glass vessel will have received its proper quantity of clear agar. Of course, several flasks, &c., may be got ready at the same time. When complete the vessels are plugged with cotton-wool, and in this way one sterilization is saved.

Milk-peptone-gelatin for cultivating Pathogenic Micro-organisms.†—Mdlle. M. Raskin prepares milk-peptone-gelatin by warming 1000 ccm. of new milk to 60°–70° C., and then adding 60–70 gr. of solid gelatin. When the gelatin is dissolved the solution is boiled until complete coagulation of the casein has taken place. It is then strained through a linen cloth into a wide glass vessel, in order that the fat may ascend to the surface without difficulty, and when it has settled the fat is skimmed off. When freed from the fat the mixture is heated and 1 per cent. peptone added, and then soda to neutralization. The addition of NaCl increases the nutritive value of the quite clear transparent gelatin.

The preparation of milk-peptone-agar is somewhat more complicated. To 1000 ccm. of milk are added 50 ccm. gelatin and five to seven pieces of agar cut up small. After standing for fourteen hours at the ordinary room temperature, the mixture is boiled for three hours until the casein is coagulated; the rest of the procedure is as in the foregoing preparation.

In preparing milk-casein-gelatin and milk-casein-agar, 150 ccm. of

* Centralbl. f. Bakteriol. u. Parasitenk., iii. (1888) pp. 797–8.

† Petersburger Med. Wochenschrift, 1887, pp. 20–43. Cf. Centralbl. f. Bacteriol. u. Parasitenk., iii. (1888) pp. 568–9.

pure 8 per cent. casein solution, quite free from fat, are mixed with 350 ccm. of a filtered mixture of whey and 12 per cent. gelatin or 1·75 per cent. agar. The whole mass is then heated to 60° C. and transferred to test-tubes.

To prepare milk-albumen-gelatin and milk-albumen-agar the peptone is replaced by a saturated solution of sodium albuminate.

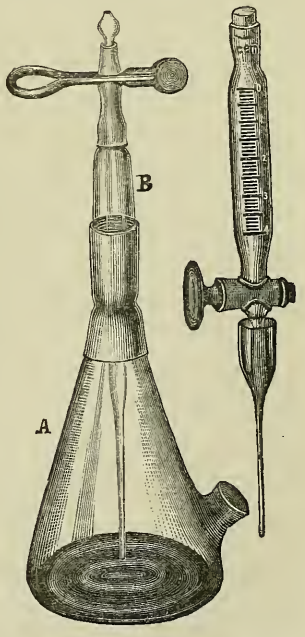
With the foregoing media cultivation experiments were made with *Bacillus mallei*, *B. Typh. abdom.*, comma bacillus, *B. tussis convuls.*

The authoress states that glanders-bacillus developes luxuriantly on the milk-peptone media at 37°–38° C. On the second day after inoculation a thick dull-white crust forms on the agar surface. In three to four days the colour is amber to orange, the deeper layers being brownish-red. The authoress is disposed to regard these milk media as being very favourable to the growth of certain microbes which on others do not betray any special characteristics.

Vessel for the Culture of Low Organisms.*—Herr N. W. Diakonow has constructed an apparatus, of which the following is a description, for the culture of low organisms, the special object being to prevent the intrusion of bacteria and other foreign bodies.

The apparatus (fig. 108) consists of a vessel composed of two parts, a bulb A provided with two necks, and a burette B, connected with one another by a caoutchouc tube in such a way that the burette moves easily from side to side. To the lower end of the burette, which must be supplied with a glass tube of equal diameter with the upper portion of the neck of the bulb, is fused a short and narrow glass tube running out into a capillary prolongation. The upper part of the burette is again connected with a narrow glass tube by means of a caoutchouc tube shut off by a stop-cock, the glass tube being widened at its upper end for the reception of a wad. The size of the entire apparatus may be adapted to the requirements of the experiments; for fungi cultivated on a nutrient solution only 10–15 ccm. in quantity, the height need not exceed 15–17 cm.; the bulb then having a capacity of about 70–80 and the burette of about 3–5 ccm. It is especially needful that the apparatus should be so constructed that, after the sterilizing of the nutrient solution, no foreign organisms can enter it.

Fig. 108.



In using the apparatus, the burette and the solution to be introduced into it must first of all be sterilized. For this purpose the whole burette with its capillary prolongation is dipped into boiling water, which is sucked up to the upper bulb containing the wad; this process is repeated several times. The

* Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 52–4 (1 fig.).

burette is then immediately immersed in the hot solution, filled with it, and placed in connection with the bulb A; and the nutrient solution in A is then further sterilized by long boiling. After the sterilized nutrient solution has become cold, it is neutralized from the burette until the red colour has almost entirely disappeared; and the germs are then introduced into A through the lower neck. The exchange of gases between the interior of the apparatus and the external air can take place only through this neck, which is stopped by a wad. In experiments where quantitative estimation is required, the burette B may be replaced by another, represented at the right of fig. 108.

Puteren, M. D. v.—**Ueber Bereitung fester Nahrungsgemische für Mikroben aus der Milch.** (On the preparation of solid nutrient media for microbes from milk.) *Wratsch*, 1888, pp. 281–4 (Russian).

(2) Preparing Objects.

Preservation of Parts and Organs of Animals.*—Dr. A. Mischtold praises highly Giacomini's method of preserving organs, both normal and pathological. The parts retain their normal size and appearance and remain perfectly supple, so that they can be placed in any position.

With time the volume diminishes about 1/20, but the weight is increased by 150–200 grm. in consequence of the impregnation. The procedure is as follows:—The organ, for example a whole brain, is first of all injected through an artery with a saturated filtered solution of chloride of zinc, and then placed in a solution of this until the brain has sunk down to the bottom of the vessel.

During this time (about eight days) it is advisable to strip off the membranes, otherwise rusty patches appear along the course of the vessels. The brain is then placed in strong spirit for ten or twelve days, or until it has sunk to the bottom. The spirit must be changed two or three times. It is next placed in pure glycerin, to which 1 per cent. of carbolic acid is added, until it again sinks to the bottom. The preparation should be turned over several times, and when saturated with glycerin should be exposed to the air for several days upon a layer of cotton-wool to dry. It is finally coated over with a thin layer of a solution of gummi elasticum or guttapercha in benzin. For preparations other than brains an 8 per cent. zinc chloride solution is advised, and for still smaller ones a solution half as strong.

Two new Methods for preparing Nerve-cells.†—(1) Instantaneous preparation.—Prof. L. v. Thanhoffer takes a small piece from the grey substance and presses it between two cover-glasses, so that when drawn apart there adheres to both a thin layer of nervous matter. The cover-glass is then heated in the flame of a spirit-lamp or of a gas-jet until the nervous layer has assumed a blackish-brown colour, and a distinct smell of burning is perceptible. The preparation is then mounted in xylol-dammar. The nerve-cells and the nuclei of the neuroglia-cells, as well as the blood-vessels and their nuclei, are very clearly seen in such preparations.

(2) Double cover-glass preparation.—To produce permanent and

* Morskoi Sbornik, Supplement, 1886, pp. 207–9. Cf. Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 375–6

† Zeitschr f. Wiss. Mikr., iv. (1887) pp. 167–9.

stained preparations of nerve-tissue, the author squeezes a piece of grey substance about the size of a hemp-seed between two cover-glasses. The double cover is then placed for 15 days in picrocarmine, four days in absolute alcohol, and then for two days in oil of cloves and xylol apiece, and lastly fixed up with xylol dammar, which is poured over the cover-glasses. After the dammar varnish is dried the surface of the cover-glass is cleansed of the resin.

New Method for the Microscopical Study of the Blood.*—The methods hitherto employed in preparing the blood for microscopical examination have aimed either at the production of fresh or of dry preparations. Preparations of the first class are not permanent, and those of the second class never exhibit the morphological elements intact. Dr. D. Biondi has worked out a method which combines the advantages, and is free from the defects, of previous methods. The problem was to find the means of perfect fixation, preservation, imbedding, and mounting —in other words, a method by which the blood could be treated as a solid tissue. The method is equally useful in the study of other organic fluids, and has been successfully employed in tracing the changes that take place in the maturation of the spermatozoa. It may doubtless be used to advantage in the study of Infusoria, as suggested by Biondi.

The point of chief interest in Biondi's method is the use of agar as an imbedding material. Agar is a vegetable gelatin obtained from *Gracilaria lichenoides* and *Gigartina speciosa*, and has already been successfully employed for some time by Koch in bacteriological investigations. Among the different sorts of agar, the columnar form (Säulen-Agar) is considered the best. A perfectly transparent solution is required, in the preparation of which great care must be taken. This may be accomplished in the following manner:—Place two parts of agar in 100 parts of distilled water, leaving it to soften for twenty-four hours at the ordinary room temperature; then heat to boiling on the sand-bath until the agar is all dissolved. The evaporation of the water may be checked by closing the flask with a cork provided with a long glass tube. Add carbonate of sodium to the point of weak alkaline reaction, and boil for an hour in a steam apparatus. Pour the solution into long slender test-tubes, and leave from 12–24 hours at a temperature of 50° to 60° C. The solution separates into two layers, the upper of which is quite clear, and this layer alone can be used for imbedding purposes. But clarification must be carried still farther before it is fit for use. The clear portion of the solution is next to be heated to about 40°, white of egg added, the mixture shaken up several times in the course of ten minutes, boiled for an hour in the steam apparatus, and then filtered. The reaction should then be tested, and, if necessary, carbonate of sodium added until the solution is neutralized. Exact neutralization is necessary, in view of the staining fluid to be employed.

It is important that the mass should be kept sterile up to the moment of using, as otherwise a large number of micro-organisms may develope in it and render it worthless for the finer uses. It is advisable, therefore, to keep the mass in test-tubes, limiting the quantity placed in each to the probable requirements of a single imbedding operation. For a single preparation of the blood five cmm. of the mass is sufficient. The

* Arch. f. Mikr. Anat., xxxi. (1887) p. 103. Cf. Amer. Natural., xxii. (1888) pp. 379–81.

test-tubes should be cleansed with hydrochloric acid and then washed with distilled water. After receiving the agar solution, the tubes are closed with cotton, and then sterilized in the steam apparatus for half an hour daily on three successive days.

As the preparation of the agar mass is somewhat complicated, much time and trouble may be saved by turning this work over to some apothecary.

The best medium of fixation for the elements of blood is a 2 per cent. solution of osmic acid. If a drop of blood from the frog be examined in this medium under the Microscope, it will be seen that both the red and the white corpuscles are perfectly preserved in form and structure. The red corpuscles become a little paler than in the living condition, and are slightly browned. The corpuscles of mammalian blood are isolated and seen to greater advantage than in any other medium of fixation. As it is important that the acid should be perfectly clear and free from all impurities, it is well to filter before using.

Method of Procedure.—(1) By the aid of a clean pipette, take a little blood from the heart of a frog, and allow two drops to fall into five ccm. of osmic acid (2 per cent.). Shake a little—the sooner the better—in order to separate the elements and scatter them through the whole body of the acid. After standing a while, the blood-corpuscles will be found at the bottom of the tube, the deeper layer being formed mainly of red corpuscles, which sink first by virtue of their greater specific gravity. Exposure, 1–24 hours.

(2) The process of fixation completed, four to five drops of the mixture of blood and osmic acid are allowed to fall from a pipette into the melted agar, which is kept fluid at a temperature of 35°–37° C. By rotating the test-tube the blood-corpuscles are distributed through the agar, and then the whole is poured into a paper box, as in the ordinary paraffin method of imbedding. Within a few minutes the mass stiffens and may be removed from the box to 85 per cent. alcohol for hardening. In three to six days the mass is hard enough for sectioning, and may be inclosed in elder-pith and cut with the microtome.

If finer sections are required than can be obtained in this way, the agar block may be imbedded in paraffin in the following manner:—The block is to be transferred from the 85 per cent. alcohol to bergamot oil (24 hours), then direct to soft paraffin kept at a temperature of 45° C. After one to two hours, the imbedding process may be completed in the usual way. As the agar is saturated with paraffin, very fine sections may be obtained; and these may be freed from paraffin with the usual solvents, and then stained.

(3) Sections thus prepared may be safely treated with nearly all staining media. Methyl-green, methyl-blue, fuchsin, safranin, &c., give the most reliable results. The agar itself is stained only by the most intense anilin dyes (e. g. gentian-violet), but in such cases it loses its colour quickly in alcohol, or in any other decolorizing fluid.

(4) Sections may be clarified, preparatory to mounting, in balsam or dammar, in clove oil, origanum oil, bergamot oil, creosote, &c. Xylol alone should not be used as it causes the sections to curl.

Preparation and Staining of the Spinal Cord.*—Prof. L. Ranvier, who has been making observations on the transformation of nerves with

* Journ. de Microgr., xii. (1888) pp. 142-4.

Schwann's sheath to nerves without the sheath at the point of union of the anterior and posterior roots with the spinal cord, examined transverse sections of the cord in the following manner:—The dorsal region of a calf was chosen because the direction of the roots are more perpendicular to the axis of the cord than in other parts. Segments 1 to 1½ cm., with the corresponding roots, were placed in a solution of bichromate of ammonia, renewed two or three times during the course of a year. It requires quite a year to harden cord in bichromate of ammonia, but the process may be hastened by using successively bichromate of ammonia and chromic acid, according to Deiter's method. Sections were then made with an ordinary microtome perpendicular to the axis of the cord, and afterwards deeply stained with picrocarminate of ammonia. The sections having remained in 0·1 per cent. picrocarminate of ammonia are too deeply stained, and the colour must be removed with formic acid. This acid is of the usual strength and dissolves part of the carmine, leaving the sections a rose colour.

The decolorizing action is extremely valuable, inasmuch as it is very slow, and acts unequally on certain elements which retain carmine more than others. The formula for the formic acid solution is equal parts of ordinary formic acid and alcohol at 36°. In twenty-four hours the sections are sufficiently decolorized; they are then placed in absolute alcohol, cleared up in oil of cloves, and mounted in balsam or dammar.

All the nuclei of the neuroglia are admirably distinct, but the fibres are usually quite decolorized. The axis-cylinders are rose, and not red, but less decolorized than the neuroglia fibres. The neuroglia nuclei are able to withstand a prolonged action of the formic acid and spirit mixture, and their greater abundance in the grey matter than in the white matter of the cord is strikingly shown. The neuroglia nuclei may also be stained with purpurin or with Boehm's hæmatoxylin, which, from lapse of time, has become brownish. As this stains all the elements, everything but the neuroglia nuclei must be decolorized by means of acetic acid diluted with an equal volume of water or of spirit. A better result can be obtained from a logwood solution made from the deposit from Boehm's hæmatoxylin. This deposit is washed with distilled water and dissolved in a 1 per cent. aqueous solution of alum by the aid of heat, and then filtered. This solution only stains the neuroglia, the axis-cylinders and nerve-cells remaining quite uncoloured.

Demonstrating the Canalicular Prolongations of Bone-corpuscles.* —Sig. G. Chiarugi in attempting to solve the problem of the existence of protoplasmic prolongations of bone-cells in the primitive canaliculi, answers the question partly on theoretical grounds, for thereby the formation of the canaliculi is explained, and partly on practical, since they have already been demonstrated in the tooth. The author employed the following method.

Small pieces of fresh bone were decalcified in picro-nitric acid diluted with two parts of distilled water. These were then transferred to spirit, at first dilute, but afterwards gradually concentrated. The sections were stained for some minutes in a one per cent. watery solution of eosin, and then treated with a 3–4 per thousand solution of hydrate of potash until the colour was no longer altered. In this way the

* Bollet. Soc. tra i Cult. Sci. Med. Siena, 1886, Fasc. viii. and ix. Cf. Zeitschr. f. Wiss. Mikr., iv. (1887) p. 490.

ground substance was unstained, while the cell elements and their prolongations remained of a bright red hue. This staining was fixed by immersing the sections for some hours in a one per cent. solution of alum. They were then examined, and mounted in the alum solution, which must be sterilized. The prolongations of adjacent cells were found to anastomose.

Preparing Mammalian Ovaries.*—From his investigation on the ovaries of mammalia Prof. G. Paladino finds that these organs are the seat of a continuous movement of destruction and renovation, and further, that in the formation of the ovules, the regeneration of the parenchyma, the development of the follicles, and in the production of the corpora lutea, karyokinesis occurs freely.

For hardening the ovaries the author used a 2–4 per cent. bichromate of potash solution, Müller's fluid, 1/2 to 1 per cent. osmic acid, saturated aqueous solution of sublimate, 2 per cent. chromic acid, and also Flemming's chrom-osmium acetic acid. The staining seems to have been effected entirely with picro-carminate of ammonia, of which two solutions were used, a 1 and 2 per cent. The pieces were placed in these solutions for a short time only, and then transferred to very dilute solution of picric acid. The pieces were always completely freed from the hardening fluids, and rendered neutral as the neutral reaction is indispensable for properly staining the nucleus.

Preparing and Staining Annelida.†—M. É. Jourdan found that 90° alcohol and picric acid gave very bad results in examination of Annelida; the tissues being crumpled and their elements unrecognizable. From bichromate of ammonia in 2 per cent. solution, sublimate in 5 per cent., or a saturated solution and Laug's fluid, beautiful preparations were obtained. One per cent. solution of osmic acid was found to give excellent results for examining antennæ and other delicate organs. After fixation in the above-mentioned fluids, the preparations were hardened in spirit. The objects were stained with carmine solution, principally with Grenacher's alum-carmine, and were imbedded in celloidin or in paraffin. The sections, which were stuck on by Schällibaum's method, were, for studying gland-cells, stained with hæmatoxylin eosin and with Hoffmann's green.

Preparing Polygordius.‡—Dr. J. Fraipont hardens the entire animal in 1 per cent osmic acid, washes with water, stains with ammoniacal picrocarmine, and after treating with alcohol and turpentine oil mounts in balsam.

Macerated specimens are prepared in 40 per cent. spirit for 36 to 48 hours, or still better in chromic acid 1/10000 for 24 hours. Besides employing the usual methods for macerated specimens, the author found it also advisable to squeeze half macerated parts between cover-glass and slide, by which the separated parts and their relation to one another were recognizable. Living animals treated with 1 per cent. gold chloride and citric acid, and afterwards teased out, is not a very easy method, but sometimes gives very instructive pictures. The macerated parts can be

* 'Ulteriore ricerche sulla distruzione e rinnovamento continuo del parenchyma ovarico nei mammiferi: nuove contribuzioni alla morfologia e fisiologia dell'ovaja.' 8vo, Naples, 1887, 230 pp. (9 pls.). Cf. Journ. de Microgr., xii. (1888) pp. 223–6.

† Ann. Sci. Nat. (Zool.), ii. (1887) pp. 239–304 (5 pls.).

‡ Fauna u. Flora d. Golfes von Neapel, xiv. (1887) 125 pp. (16 pls. and 1 fig.).

stained with borax-carmine, haematoxylin or ammoniacal picrocarmine, and mounted in glycerin or balsam. In order to kill the animals without contraction, so that they may be suitable for sectioning, the author recommends benumbing them by pouring spirit into sea water and then hardening, or to pour a hot and strong solution of sublimate over them. Hot sublimate, however, alters the tissues somewhat, especially the epidermis, but even by the first mentioned method the epidermis, and also the central nervous system, are not quite satisfactory. For hardening, the author used strong spirit, osmic acid, picro-sulphuric acid, chromic acid, cold sublimate, and then treated the animals with the foregoing fluids or with acetic acid, absolute alcohol, 1 per cent. gold chloride, and a mixture of 1 per cent. osmic acid and of chromic acid 2/1000 For staining, picrocarmine and borax-carmine gave the best results. The former colours badly after chromic acid or sublimate, but after being allowed to act for 24 hours, the hue may be increased by the aid of borax-carmine. Hæmatoxylin and the anilins were tried on the chromic acid specimens.

Zacharias' Method of Preparing the Eggs of Ascaris megalocephala.*—Dr. O. Zacharias has discovered an acid mixture which overcomes the resistance of the egg membrane and fixes the egg completely within 25 to 30 minutes. The mixture consist of—alcohol 90 to 100 per cent., 80 ccm.; glacial acetic acid, 20 ccm.; osmic acid 1 per cent, 20 to 30 drops. A little glycerin or chloroform increases the clarifying power of the mixture. Van Beneden employed a stronger mixture, consisting of absolute alcohol and acetic acid in equal parts, without the addition of osmic acid.

(1) *Ascaris* females obtained from the living horse by means of arsenic pills, are placed between two sheets of cotton which have been slightly moistened in a 3 per cent. salt solution, then covered with a bell-glass and exposed one to three hours to an incubation temperature of 25° C. This procedure brings the polar globules to development in the younger eggs, and forces the cleavage in the older eggs.

(2) After an hour's incubation it is well to preserve a part of the material at disposal. The genital sacs are laid bare by a longitudinal slit in the body-wall opposite the sexual aperture; the vagina is then cut free from the body, the alimentary tract lying between the two sacs is carefully removed, and the ovarian portions of the sacs are cut off, leaving the uterine portions with their contents for preservation. The anterior ends of the uteri contain eggs in all stages of maturation and fecundation; the posterior ends contain eggs already beginning to cleave. The killing and hardening process should vary considerably for these different stages.

(3) It is advisable, therefore, to cut each uterus into thirds, and to expose the anterior third to the action of the acid mixture only 5 to 7 minutes, and the posterior third at least 25 minutes. After fixation the anterior and middle thirds are transferred to 30 per cent. alcohol, and after a few hours to 50 per cent. alcohol, in which they may be kept for a long time. Eggs in process of cleavage—found in the posterior third—should be removed to absolute alcohol the moment they begin to show a light brown staining. After two or three hours they are to be transferred to 70 per cent. alcohol for preservation. If the acid mixture be

* Anat. Anzeig., iii. (1888) p. 24. Cf. Amer. Naturalist, xxii. (1888) pp. 277-9.

heated to about 24° C., the posterior third of the uterus will require an exposure of only 10 to 15 minutes.

(4) Schneider's acid carmine is an excellent staining agent. It is prepared as follows:—Glacial acetic acid is diluted with distilled water to about 50 per cent., then as much pulverized carmine is added to the boiling acid as will dissolve. After filtering until the fluid becomes clear, a little rectified wood-vinegar is added (one drop A. pyrolignosum to 10 ccm. of the carmine solution) for the purpose of strengthening the clarifying power of the mixture. The younger stages may be left in the dye 3 to 4 hours, the older stages 8 to 10.

Beautiful views of the karyokinetic figures are thus obtained, but they are not permanent; after 3 or 4 hours they begin to lose in distinctness. Grenacher's alcohol carmine gives more durable preparations. Eggs thus stained may be improved by treatment with methyl-green (2 per cent.) to which have been added a few drops of glycerin. The spindle-fibres of the first and second amphiasters may be most successfully stained with "Modebraun" in very dilute aqueous solution. Preparations are mounted in two-thirds glycerin.

Boveri's Method of Preparing the Eggs of Ascaris megalocephala.*—The following is Prof. T. Boveri's method:—

(1) The egg-sacs are plunged for a few seconds in boiling absolute alcohol which contains 1 per cent. glacial acetic acid. The eggs are thus killed instantly, and at the same time the egg-membrane is rendered penetrable to the reagents. The alcohol is allowed to cool gradually, and after a few hours the eggs are transferred to pure alcohol, coloured, and examined in glycerin or clove oil. This method shows the achromatic spindles and the chromatic equatorial plates, but not a trace of protoplasmic asters.

(2) The following mixture was used cold, with excellent results. A saturated solution of picric acid is diluted with twice its volume of water, and then 1 per cent. glacial acetic acid is added. The egg-sacs are left at least twenty-four hours in this mixture, then washed in 70 per cent. alcohol, stained in Grenacher's alcoholic borax-carmine (24 hours), transferred to 70 per cent. alcohol plus 1 per cent. hydrochloric acid (24 hours), and finally placed in pure alcohol.

For examination, glycerin is preferred to clove oil. If the egg-sacs are removed from alcohol to a mixture of glycerin (1 part) and absolute alcohol (3 parts), and then allowed to stand until the alcohol has evaporated, the eggs do not shrink. It will be found, however, that the eggs are not all equally well preserved with the cold mixture, owing probably to individual differences in the constitution of the membranes, some being more, others less permeable to the fixing reagent.

Isolating Foraminifera.†—Herr C. C. Keller states that Foraminifera can be obtained from marl in a very short time and in a very clean condition in the following manner. The marl is first reduced by means of highly concentrated Glauber's salts. When the pulverization has proceeded sufficiently, the sulphate of soda is washed out and the residue poured into a glass vessel in which there is a little water. The vessel is then filled up with carbonic acid water, and then placed in some warm spot or is warmed in a water-bath, its contents being carefully stirred up

* Jenaisch. Zeitschr. f. Naturwiss., xxi. (1887) p. 432. Cf. Amer. Naturalist, xxii. (1888) pp. 381–2.

† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 474–5.

from time to time with a glass rod. The carbonic acid then bubbles up and escapes, and at the same time numerous Foraminifera collect on the surface. The explanation of this is simple. Small bubbles of the gas, owing to the heat, are developed and become entangled in the shells of the Foraminifera, and the latter are raised to the surface. The Foraminifera may then be skimmed off with the sieve used for diatoms.

Permanent preparations are made by placing the Foraminifera thus obtained in absolute alcohol in order to expel the air. They are then cleared up in oil of cloves or xylol, and mounted in Canada balsam.

Preparing Sphærozoa.*—For examining living Sphærozoa, Dr. K. Brandt recommends the use of a polarizing apparatus and also staining the organisms while alive. He points out that while 0·1 per cent. osmic acid fixes well, its value is discounted by the great blackening it causes, especially of the pseudopodia. The author notes also that all Sphærozoa are not equally susceptible to the action of the same reagent. (1) For *Collozoum inerme*, *C. pelagicum*, *C. fulvum*, *Sphærozoum punctatum*, *S. acuferum*, and *S. neapolitanum*, the most advantageous is a tincture of iodine (1 part 70 per cent. spirit; 1 part sea water; and so much tincture of iodine as will impart a distinctly yellow colour to the mixture). The tube in which the animals are killed is very gently shaken, and after 15-30 minutes its contents are washed with water to remove the sea salt, and then the colonies are removed to spirit of 30, 50, and 70 per cent. successively. (2) *Myxosphæra cærulea*, *Collosphæra Huxleyi*, and *Aerosphæra spinosa* are well fixed in 0·5 to 1·0 per cent. chromic acid. After having been well washed they are transferred to 30, 50, and 70 per cent. spirits. By the iodine tincture the jelly of the species last mentioned is either dissolved or completely altered in form, while those mentioned under number (1) with the exception of *S. acuferum*, lose their jelly by the action of chromic acid, or at least their shape is damaged. (3) Strong solutions of picric acid (and picro-sulphuric acid too) behave like weak solutions of chromic acid. The species given under (2) retain some connection, but in the others the jelly is dissolved. (4) Hydrofluoric acid fixes the plasma well. (5) A 5 to 15 per cent. solution of sublimate in sea water retains the shape of *C. pelagicum*, *S. punctatum*, *S. neapolitanum* well (after acting 15–30 minutes they are well washed in sea water, then in sweet water; afterwards alcohols 30, 50, 70 per cent.). The most useful stain was found to be a watery solution of hæmatoxylin, but for *Collosphæra Huxleyi* Grenacher's alcohol carmine. Besides these were used dahlia, the other carmine solutions of Grenacher, and Mayer's alcoholic cochineal solution.

Preparation and Mounting of Ferns.†—Mr. J. D. King remarks that the selection of the fern is all-important. It should be of robust growth and free from dirt. If not fully ripe the spores will be shrunken, if over ripe, absent. Have ready wide-mouthed bottles, to hold about an ounce, and filled with a mixture of equal parts of spirit and water. In this place the selected pinnæ.

If the pinnæ are to be kept for some time, add one-fourth part spirit, put only one kind in a bottle, avoid shaking the bottles, and handle the material with forceps without touching the sori.

For bleaching, the following mixture is successful :—Dry chloride of

* Fauna u. Flora d. Golfes v. Neapel, xiii. (1885) 276 pp. (8 pls.).

† The Microscope, viii. (1888) pp. 78–81.

lime, 2 oz.; common soda, 3 oz.; water, 2 pints. Mix the chloride of lime with half the water, and the soda with the other half, then mix the two solutions and let settle in a well-corked bottle; pour off the clear liquid for use, and keep in stoppered bottles.

Pour the spirit and water from the fern and replace it with the bleaching fluid, and put in a strong light if you wish to hasten the process. Look at them often, and when there is no longer any appearance of chlorophyll in the sporangia or in the leaf, the bleaching has gone far enough. It is not always safe to wait for a stout mid-vein to become perfectly clear, for a very little over-bleaching may injure or ruin the fern. In some cases, however, it may be necessary to change the bleaching fluid two or three times.

When the bleaching is completed, remove to a liberal supply of soft water and change frequently until no trace of chlorine remains, for if the chlorine be not quite removed the staining will be a failure. Then harden the material in alcohol.

For staining epidermal structure the author advises alum-carmine and methyl-green in the proportion of one drop of methyl-green to ten drops of alum-carmine. The time required is variable. The spores and cases stain green and the leaf red; sometimes the larger veins also take on the green. If stained too long the red will supplant the green. Transfer to at least two ounces of water and soak for three or more hours to remove the alum.

For thick-leaved ferns, and for showing the fibro-vascular system and sporangia, the following procedure will be found more satisfactory: To forty drops of borax-carmine add one drop of methyl-green. The time required is longer than with alum-carmine. Then soak in water as before. A saturated solution of ammonia acetate used as a mordant will heighten the colour a trifle.

The best medium for mounting is glycerin jelly made after Kaiser's formula, with additional gelatin to give it hardness. First transfer to a mixture of equal parts of glycerin and alcohol. Then heat the glycerin jelly in a water-bath, keeping hot while using to prevent air-bubbles. With a glass rod place a few drops on the slide with or without a cell; a cell makes a better finish. Place the ferns in the glycerin jelly, add a few drops, and pour off to get rid of the alcohol and glycerin, replace what is poured off and examine with a dissecting Microscope for air-bubbles, which must be removed before the cover is applied. Breathe on the cover and apply a drop or two of hot glycerin jelly, then breathe on the slide and impose the cover.

Another way is to let the glycerin jelly harden on the slide with the fern on it and afterwards apply some hot jelly to the surface before putting on the cover. Wood sections may be stained and mounted in the foregoing manner.

Application of Lactic Acid to the Examination of Algæ.*—Herr G. Lagerheim recommends the use of lactic acid for restoring the turgidity to dry algæ. The acid is used in a concentrated semi-fluid form. The dry alga is first softened in water, and then placed in small pieces in a few drops of the acid on a glass slide, and heated until small bubbles make their appearance in the acid. The alga must be prevented from becoming too fluid and flowing away by heaping up with a knife. After

* Hedwigia, xxvii. (1888) pp. 58-9.

being heated for a sufficiently long time, the cover-glass is placed on, and the alga, which was previously dry and shrunk, is now found to have swollen up to its natural form. The cell-contents are at least partially dissolved or clarified if the preparation has been boiled sufficiently long, a point of great importance, especially in the examination of desmids.

Tempère's Preparations of Diatoms.*—M. J. Tempère is preparing series of all the known genera of diatoms. Each series will comprise twenty-five preparations, and each preparation will contain one to three species or varieties. The first series has recently appeared.

FREEBORN, G. C.—**Notices of new Methods.** III., IV.
[Sublimate as a hardening medium for the brain (Diomidoff). New methods of preparing nerve-cells (Thanhoffer). Neutral anilin staining fluid (Babes). Safranin solution with anilin oil (Babes).
Amer. Mon. Micr. Journ., IX. (1888) pp. 84, 111–2.

LUGGER, O.—**A new Method of Preserving transparent Aquatic Insects for the Microscope.** *Proc. Entom. Soc. Washington*, I. (1888) pp. 101–2.

MANTON, W. P.—**Rudiments of Practical Embryology.** III.
[Preparation of the Embryo. Hardening.]
The Microscope, VIII. (1888) pp. 144–5.

PELLETAN, J.—**Les Diatomées, histoire naturelle, préparation, classification et description des principales espèces, avec une introduction à l'étude des diatomées par M. J. Deby et un chapitre sur la classification des diatomées par M. Paul Petit.** (The Diatomaceæ, natural history, preparation, classification and description of the principal species, with an introduction on the study of the Diatomaceæ by M. J. Deby, and a chapter on classification by M. Paul Petit.)
[Contains chapters on collecting, preparing and mounting.]
vol. i., 350 pp., 5 pls. and 250 figs., 8vo, Paris, 1888.

(3) Cutting, including Imbedding.

Collodion for Imbedding in Embryology.†—In a note appended to a paper on "Collodion in the Technique of Embryology," Prof. M. Duval states that celloidin has no advantage over collodion; with thick collodion the same hard and resisting mass is produced, and this is always quite transparent, which is not the case with celloidin.

The method given for imbedding in collodion is as follows:—When the piece is removed from spirit after having been hardened, it is placed for some short time in a mixture of alcohol and ether (1 spirit, 10 ether). It is then placed in a solution of pure collodion for 10 minutes to 24 hours, according to size, after which it is immersed in a solution of collodion of a syrupy or pasty consistence, according to the degree of hardness required for the imbedding mass. On removal the mass is exposed to the air for not more than a minute, and it is then plunged into alcohol of 36°; the vessel containing the spirit is left open. In 6 to 10 hours the collodion is sufficiently solidified, and transparent as glass. The mass is then stuck on a piece of elder-pith with collodion, and fixed then in any position for cutting sections, which are made with a wet knife. Under certain circumstances, as, for example, when it is desired to obtain sections of batrachian ova, which are extremely friable, it is necessary to smear the surface of every section with collodion, in order to prevent the sections breaking up or evacuating their contents. The collodion for this purpose is made very thin, and a few minutes after it

* Journ. de Microgr., xii. (1888) pp. 226–7.
† Ibid., pp. 197–204.

is laid on the surface of the section is washed with spirit. In practice this does not involve any waste of time. These collodion sections may be mounted in glycerin or in balsam, in which latter case the author proceeds in two ways. First, when he deals with sections of the blastoderm with an embryo up to the sixth day; secondly, when the embryo is larger and exceeds six days.

(1) The embryos are hardened, stained, and kept in some provisional medium. When required for sections they are passed through 36° spirit, absolute alcohol, the mixture of spirit and ether, very thin collodion, and lastly the thick collodion. A piece of elder-pith cut straight is washed with ether and then immersed in the thick collodion wherein is the blastodermic disc. The latter is then placed on the pith in the desired position and then carefully withdrawn, and after being allowed to dry in the air for a minute or two is immersed in absolute alcohol for at least 24 hours. The sections are then made, with or without brushing the surface each time with collodion, and are swept into water, from which they are easily placed upon the slide in the proper order. The sections are then dehydrated completely, and this done, the cover-glass is imposed. Clarifying is then effected by running benzine under the cover-glass, and when this is complete the section is mounted in balsam dissolved in benzine. The benzine and the benzine-balsam are run under the cover-glass, and their entrance facilitated by drawing out the fluid at the opposite side with filter-paper. The benzine used is that known as benzine Collas.

(2) If the embryo be too large to be stained *en masse*, the section is stained on the slide; moreover, the largeness of the embryo necessitates special care in the imbedding. They must be inclosed in a block of collodion, and the hardening of a block requires that the evaporation of the ether should be slow. This is effected by placing the cup in which the embryo lies imbedded in thick collodion in a saucer containing 36° spirit, and covering the two vessels with a bell-jar. In 12–36 hours the consistence of the mass is examined, and if the embryo appear above the level, more thick collodion is added and the process continued until the desired consistence is attained. The mass is then dug out and cut into a block, which is stuck on elder-pith with collodion. The sections must be stained on the slide, and this is done by coating the sections with glycerin coloured with the staining solution (picro-carmine, Grenacher, alum-carmine, &c.). Owing to the glycerin, there is no fear that the section will dry: an aqueous solution may be used for staining, but in this case the slide must be placed in a moist chamber. In 24 hours the sections are well stained with carmine. The sections are mounted in balsam, but, owing to their size, the benzin and balsam cannot be run under the cover. The sections are first dehydrated with 36° alcohol, the slide is then placed on a warm brick and washed with absolute alcohol, then with benzin, and finally the balsam is dropped or brushed on, and this followed by putting on the cover-glass.

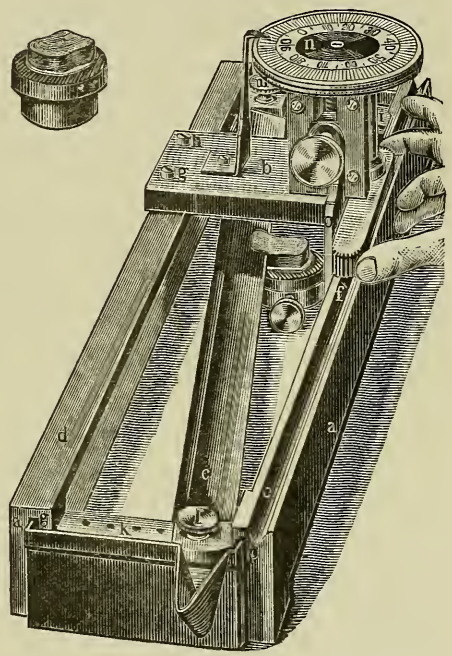
Schwabe's Sliding Microtome.*—Schwabe's microtome consists of three separate parts; an oblong support *a* (fig. 109) which also serves for the slide-way, the piece *b* which carries the object, and the knife *c*.

The slide-way *e* is grooved, and *d* flat; in both cases ivory pegs are used to prevent friction, these are shown at *f*, *g*, and *h*. The stability

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 463–4 (1 fig.).

of the carrier is insured by its weight and by its working along the triangular grooved slide-way *e*. In the cross pieces *i k* are several holes, these are for the purpose of altering the angle of the knife *c*, which is fixed by means of the screws *l* and *m*. The angle which the knife makes with the slide-ways depends on the size or diameter of the preparation, and must always be so selected that the edge of the knife can be used as far as possible throughout its extent.

Fig. 109.



The upper part *b* carries the micrometer screw *n* which moves the object-carrier *o* up and down. This screw has a turn of 1 mm., and as the head is divided into 100 parts the carrier can be raised 0·01 mm. The lower part of the microtome can either be constructed as a pan, or the instrument be placed in one, so that it can be made to work under fluid, and is therefore very useful for the preparation of nervous tissue. In the later constructions the object-clamp is made independent of the micrometer screw for its coarse-adjustment.

Fig. 110.

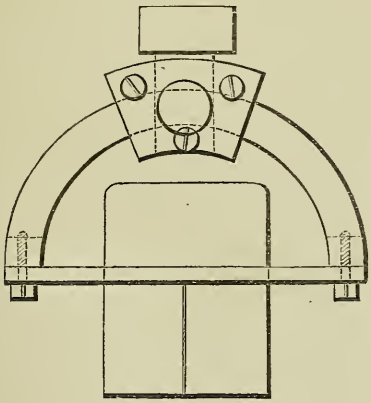
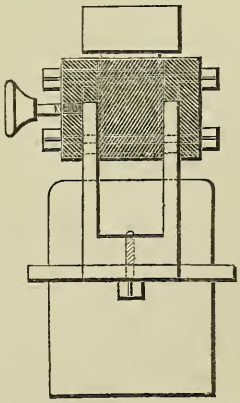


Fig. 111.



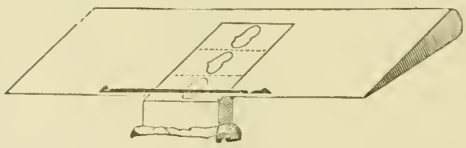
Accessory to the Cambridge Rocking Microtome.*—Dr. H. Zwaardemaker has in conjunction with his amanuensis L. Hasselaer

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 465-6 (2 figs.).

adapted to this microtome an adjunct which is intended to obviate the defect in this instrument of not being able to alter the position of the object in an easy way. Instead of the tube in which the object is fixed with paraffin, the author devised the apparatus shown in figs. 110 and 111. This consists of a copper tube which fits over the main piece, and carries two parallel semicircular rings. Along these half rings runs a steel block, which by means of a binding-screw can be fixed at any point of their circuit. The block carries the small movable cylinder which takes the place of the English contrivance. In use the semicircular rings are placed horizontally, and by combination of the movement along the rings with that of the cylinder about its own axis, the preparation is moved in all directions. But on account of the construction of the microtome, this movement is cramped, and only a turn of 60° instead of 90° is possible. This amount, however, suffices for most cases.

Inexpensive Section-smoother.*—Fig. 112 shows a device for preventing the curling of paraffin sections, which Mr. H. C. Bumpus considers is extremely simple and easily made. After cutting off the head and point of an ordinary brass pin, fix it parallel to the edge of

Fig. 112.



the knife by pressing its ends into two small pellets of beeswax. The proper elevation is easily determined by testing on the waste paraffin before the object is reached. The pin can only be used with the transverse knife. With the knife set obliquely, a piece of drawn wire will serve the same purpose.

Preparing Long Series of Sections with Celloidin.†—The procedure which Dr. J. Apáthy advocates very warmly consists in dehydrating the surface of the celloidin block immediately previous to and during the act of sectioning and removing the section to a strip of paper kept moist with bergamot oil. The method in detail is as follows :—

After fixation by any method, and hardening in spirit, the preparation is passed into absolute alcohol, and when imbedded in celloidin kept in 80 per cent. alcohol.

Staining is done *in toto* by the hæmatoxylin and chromic acid method. The strength of the chromic acid salt (mono- or bichromate of potash) is 1/2 to 1 per cent., and this, frequently renewed, is allowed to act for not more than one hour. The hæmatoxylin solution is 1/2 per cent., and allowed to act for ten minutes to one hour, according to size of object. The object is then washed, and next transferred to spirit, first 70 per cent., then absolute. The imbedding then follows, and when cutting, in the right hand are held a camel's-hair brush and a needle, while this hand also works the microtome. In the left is held a strip of tracing paper, which is at the same time flexible and stiff. The paper strip is about as broad as the slide and thrice as long as the cover-glass. The

* Amer. Naturalist, xxii. (1888) p. 382 (1 fig.).

† MT. Zool. Station Neapel, vii. (1887) pp. 742–8.

free end of the paper strip, which is well saturated with bergamot oil, is allowed to dip into a capsule of this oil. The surface of the celloidin block is then brushed over with absolute alcohol, the section made and transferred to the oil, from which it is picked up by the needle and arranged on the paper strip. When the required number of sections have been duly placed in position on the strip of paper, the latter is drained. The paper is then laid, the section side downwards, on a carefully dried slide, and then dried with blotting-paper. The paper strip is then carefully removed by rolling it off from one end or corner. If a section should stick to the paper the surface may be moistened with the oil again, and the strip pressed down again, and if this fail it must be taken with a brush and placed in its proper position. When all the sections are properly arranged, the surface is smoothed down and all the oil removed with smooth blotting-paper. The balsam is then applied, and the cover-glass imposed.

The sections, in order to prevent decoloration, should not be allowed to get too near the edge of the cover-glass. In imbedding long objects as certain worms, the process may be hastened by imbedding first the whole object and then cutting it into pieces and arranging these in their proper order in a second imbedding, so that one action of the knife produces ten to twenty sections serially arranged.

Proper Thickness of Microscopical Sections.*—Nowadays, says the Editor of the 'Microscope,' it seems to be the aim of many possessors of good microtomes to cut their sections as thin as possible, e. g. from 1/2000 to 1/4000 of an inch in thickness. The origin of this fashion of cutting over-thin sections is difficult to determine, for such sections are, in the majority of cases, quite useless for any purpose of study, and the time involved in their preparation is as good as wasted. It is probably due to a desire to exhibit one's skill without regard for utility—something like that which induces one to write 10,000 words on a post-card, simply because some one else has succeeded in writing 9000.

Friedländer in his excellent little 'Manual of Microscopical Technology,' raises the following objections to sections of extreme thinness:—"(1) They are manipulated with difficulty and considerable time is often lost in spreading them on the slide. (2) The various elements contained in the meshes of these sections are very apt to fall out, and as these are generally of extreme importance, the object of the examination may be defeated. (3) Structures which are sparingly distributed throughout an organ, as, for example, animal and vegetable parasites, are naturally more apt to be discovered in thick sections. (4) In thick sections definite stereometric conceptions of the structure of an object are frequently obtained, inasmuch as several superimposed strata are scanned directly, *in situ et in continuo*, while with extremely thin sections plane images alone appear." For sections of fresh organs he recommends a thickness of from 1/500–1/250 in.; for hardened preparations from 1/2500 to about 1/850 in. The rule should be, then, not to make sections as thin as possible, but rather to have them of a thickness that will include as many layers as can be clearly studied.

Preparing Sections from Test-tube Cultivations.†—Prof. A. Neisser first warms the test-tube containing the cultivation, so that the gelatin

* The Microscope, viii. (1888) pp. 147–8.

† Centralbl. f. Bacteriol. u. Parasitenk., iii. (1888) pp. 506–10.

cast slips easily out of the tube. According to its size and thickness it is placed for 1–4–8 days in 1 per cent. bichromate of potash solution, which must stand in the light so as to produce a modification of gelatin insoluble in water. The gelatin is then carefully washed and hardened in 70° and 96° spirit. When the desired consistence has been attained the gelatin cast is cut up longitudinally or transversely into pieces, and these are stuck with gum on cork, and then placed in absolute alcohol for twenty-four hours. Before making sections it is advisable to remove the external layer of gelatin, as it is too hard, and interferes with manipulation. Drying, staining, decolorizing, and clearing up are to be carried out on the cover-glass.

For staining the author used—

(1) Löffler's alkaline methylen-blue solution, but did not employ the 1/2 per cent. acetic acid, and decolorized with the spirit. This usually gave good results.

(2) Watery methyl-violet solution (b B extra, Stuttgart Fabrik, Catal. 528) was not so useful, as although the bacteria were well stained, they easily lost their colour.

(3) Gentian-violet in watery solution was a failure, as it had some solvent action on the gelatin.

(4, 5) Bismarck brown and Babes's anilin safranin stained well, but the decoloration of the gelatin was slow and rarely perfect.

(6) Gram's and Weigert's method gave excellent results. The former requires oil of cloves for decolorizing, as spirit alone is insufficient. The decolorized sections should always be cleared up with bergamot oil.

(7) Double staining with anilin methyl-violet, Bismarck brown, or anilin fuchsin-methylen blue did not produce favourable results.

When decolorizing it is advisable to wash in water before using the spirit; clearing up should be performed in bergamot oil, and the specimen mounted in thickened balsam.

Though this method has the advantage of allowing spore-formation to be observed under high powers, of showing the way in which the individuals are disposed, and even of disclosing impurities otherwise unsuspected, it is not available for micro-organisms which fluidify gelatin.

Agar cultivations were manipulated by stripping off small lumps of the cultures and plunging them into agar liquefied at 40°, so that they became imbedded when the agar set. The agar was removed from the tube and hardened just as in the gelatin cultivations, but as it was not susceptible of being sectioned, the pieces were saturated with bergamot oil, then plunged into a mixture of paraffin and bergamot oil, and lastly left in pure paraffin for twelve to twenty-four hours in an incubator. When cooled very fine sections can be made, and the process is then reversed to rid them of the paraffin, and they are then treated like the gelatin sections. The staining is not so satisfactory as with the gelatin method, but the photographic results are very good. A mixture of agar and gelatin was also used by the author for certain organisms which require a firm medium. This method does not offer any other advantage, as the microscopical appearances are deceptive and hardening an impossibility.

Campbell, D. H.—**Paraffin-Einbettungs-Methode für pflanzliche Objecte.** (Paraffin imbedding method for vegetable objects.)

Naturwiss. Wochenschr., II. (1888) p. 61.

Romiti, G.—**Presentazione di un Microtomo.** (Exhibition of a microtome.)

Atti Soc. Tosc. Sci. Nat. Pisa, V. (1888) pp. 250–1.

(4) Staining and Injecting.

Double-staining of Nucleated Blood-corpuscles.*—Dr. W. M. Gray gives the following directions:--Spread a thin layer of blood on a clean slide, and dry; immerse the slide in a beaker of alum-carmine (Grenacher's formula) for five minutes; wash in clean water, and immerse in a beaker of a weak solution of sulphindigotate of soda or potash (the solution should be of a dark-blue colour, not black-blue as in a strong solution). After the slide has acquired a purplish hue, wash in water and dry. After drying, warm slightly and mount in balsam. The nuclei will be a beautiful red, and the protoplasm a greenish blue.

Staining Nerve-endings with Gold Chloride.†—In his new researches on motor nerve endings, Dr. W. Kühne gives the following as the best methods for manipulating gold chloride:—

(1) Lowit's method, sometimes to be followed by strong formic acid, is especially useful, as thin muscles need not be dissociated.

(2) First, 1/2 per cent. formic acid, gold chloride 1 per cent., then equal parts of a mixture of glycerin and water, to which 1/4 to 1/5 volume formic acid has been added. Specially useful for muscle of warm-blooded animals.

(3) Same as (2), but without preliminary acidulation. For cold-blooded animals.

(4) Golgi's method. 1/2 per cent. arsenious acid, 1/2 per cent. gold chloride of potash, then 1 per cent. arsenious acid, and reduction in sunlight. Useful for all objects.

(5) Modification of 4, consists of laying the strips of muscle in a mixture of 1/2 per cent. arsenious acid, 1/4 per cent. gold chloride of potassium, and 0·1 per cent. osmic acid, then 1 per cent. arsenious acid, and reduction in sunlight. Best suited for reptiles.

With regard to the rest of the preparation, the author says that the finer dissociation should be effected at the most favourable stage of the hardening, therefore always in the gold solution. Secondly, many small bits of muscle (ten to twenty from 1–2 mm. broad) should be placed in 2–5 ccm. of the fluid, which should be allowed to act for different lengths of time, then in the gold solution from four to thirty minutes; from the reduction fluid they are to be removed, say hour by hour, and transferred to unacidulated dilute glycerin. In Golgi's method the separate portions were transferred to fresh arsenious acid in the dark when staining began. In this way various degrees in the effects can be obtained. With the exception of Golgi's all the methods are usually found to overstain, and this has therefore to be removed. The effect of acid on nerve-endings is always disadvantageous; it is, therefore, a great advantage to produce gold preparations without previous acidulation, and the acidulation stage should always be shortened as much as possible.

Preservation of preparations in dilute glycerin acidulated with formic acid is not very favourable for details. Golgi's method, therefore, has a great advantage in not employing glycerin, but mounting in balsam after dehydration in absolute alcohol is perfectly suitable for showing the stained nerve-endings. The certainty of the results varies with

* Queen's Micr. Bulletin, v. (1888) p. 15.

† Zeitschr. f. Biol., xxiii. (1887) pp. 1–148 (pls. A–Q).

different animals, being most favourable in Reptilia, most unfavourable in the osseous fishes and in the Invertebrata.

Staining Nerve-endings with Gold Chloride.*—Dr. G. Boccardi recommends the following method for staining nerve-endings in muscle with gold.

The muscles are treated by Ranvier's method with lemon juice and gold chloride, or the mixture of gold chloride and formic acid; they are then washed in distilled water and the preparations laid for about 2 hours in a 0·1 or even 0·25–0·3 per cent. solution of oxalic acid. A still better mixture is, acid. formic. pur. 5 ccm.; acid. oxalic. 1 per cent. 1 ccm.; aq. destil. 25 ccm. Then wash in water, and mount in glycerin.

Weigert's Hæmatoxylin Method as applied to other than Nervous Tissues.†—Dr. P. Schiefferdecker states that Weigert's hæmatoxylin ferridcyanide method can be usefully employed on other tissues than nervous, for example it shows the nuclei of connective tissue well, but has little or no effect on lymph-corpuscles, hence its applicability to lymphatic glands for distinguishing between the framework of the gland and the corpuscles. It seems to have different actions on blood-corpuscles, but it is on the epithelium that its speciality is prominent, the sweat-glands, blood-vessels, and nerves standing out very clearly. Yet on the whole the method seems uncertain, and it is questionable how far the chemical, and how far the physical properties of the tissues are the important factors.

Staining Mitoses.‡—Dr. G. Bizzozero and Dr. G. Vassale found the following method gave the best results for fixing mitoses.

The sections made from pieces hardened in absolute alcohol were placed for 5–10 minutes in Ehrlich's fluid (gentian violet 1, alcohol 75, anilin oil 3, water 80), then rapidly washed in absolute alcohol, and then transferred to chromic acid solution 1:1000 for 30–40 seconds, whereupon they were replaced in absolute alcohol wherein they lost part of their colour. To better fix the mitoses it is well to put the sections back again in the chromic acid solution, and afterwards in absolute alcohol. After 30–40 seconds they are placed in oil of cloves; this process may be required to be repeated like the last stage. When no dye is any longer given off in the cloves, the sections may be mounted in dammar. This method gave good results with all tissues and organs. In many cases, however, a still better result was attained by treating the sections, previously to the chromic acid, with the Gram iodine solution (iodine 1, potassium iodide 2, water 300). The former method was found better for lymphatic glands, the latter for those organs in which the nucleus is easily decolorized, e. g. liver, salivary gland, kidney, &c. The foregoing staining method is also available for preparations stained in Flemming's chrom-osmium acetic acid mixture; the sections, however, must be well washed before they are placed in absolute alcohol. But whatever the hardening method, the cell-substance was uncoloured or slightly yellowish; in resting nuclei the nucleoli were slightly stained while the mitoses were violet or almost black.

* Lavori eseguiti nell' Ist. fisiol. di Napoli, 1886, p. 27.
† Anat. Anzeig., ii. (1887) pp. 680–4.
‡ Arch. f. Pathol. Anat., cx. (1887) pp. 165–244 (1 pl.).

Staining Leucoplasts, Protein-granules, Bordered Pit Membranes, and Woody Tissue.*—In his treatise on the morphology and physiology of the vegetable cell, Dr. A. Zimmerman recommends acid fuchsin for staining leucoplasts and chromatophores. After the objects have been placed in a concentrated solution of the dye for some minutes, they are shaken about in a solution of picric acid in 50 per cent. alcohol for one minute, and then washed in 50–70 per cent. spirit. The preparations are mounted in balsam. For the fixation of the protein-granules a saturated solution of picric acid in strong spirit is recommended. When fixed and stained the protein-granules can be mounted at once in balsam. In a mixture of hæmatoxylin and Bismarck brown, woody membranes are stained brown, the others violet. For showing the membrane of the bordered pits in material preserved in spirit, gentian-violet is recommended. The dye is picked up from a watery solution by this membrane, which becomes deeply stained, while others are almost colourless. Next to the bordered pit membrane the middle lamellæ stain best. The sections may be examined in oil of cloves and then mounted in balsam.

New Method for Staining Fibrin and Micro-organisms.†—Prof. C. Weigert has devised a modification of Gram's method in which the alcohol and oil of cloves are replaced by anilin oil. The procedure is as follows:—The section (hardening in spirit) is stained with the anilin-gentian violet solution. The staining may be done either on the slide or in a watch-glass. In the latter case the section must be washed with water or with NaCl solution to remove excess of dye before it is placed on the slide. The section is then mopped up with bibulous paper and the iodine solution dropped on; when the latter has acted sufficiently the section is again blotted and then covered with a drop of anilin oil, which must be removed several times as it quickly picks up the stain. The section becomes gradually transparent and the anilin oil is removed with xylol and then mounted in balsam.

If a double stain be desired the additional colour must be imparted before the violet. In this method there is no need to remove the celloidin. By this procedure fungi and pneumonia cocci are more easily demonstrated than by Gram's method, but its principal recommendation is the sharp stain it imparts to threads of fibrin. Bacteria and fungi appear quite dark, almost black, the fibrin threads a beautiful blue.

New Nuclear Stain and Note on Fixation.‡—Dr. G. Platner describes a new pigment to which he gives the name nucleus-black. It is imported from Russia as a black solution, and appears to be a metal base in combination with an organic acid. When used in weak solution it is specially adapted for staining nuclei, nucleoli, and axis cylinders, the protoplasm, connective tissue, and nerve-sheath remaining unstained. If used in concentrated solution the staining is more diffused, but may be reduced by alkalies. Thus five or six drops of liquor ammoniæ to a watch-glassful of water or a saturated solution of lithium carbonate diluted, if required, with distilled water, are convenient for limiting the stain to the nucleus and showing up the karyokinetic figures.

* Sep. Repr. from 'Encyklopædie der Naturwissenschaften,' Abtheilung: Handbuch d. Botanik, Schenk, 1887, 223 pp. Cf. Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 529–30.

† Fortschr. d. Med., v. (1887) p. 228.

‡ Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 349–52.

The time required for staining sections with this nuclear stain is as a rule only a few minutes, but if the material have been hardened in Flemming's mixture 24 hours are necessary. The duration of decolorizing must be judged by the desired effect and from the previous staining. The author notes that this black pigment seems to be very resisting, and the preparations are very suitable for photographic purposes.

The author then proceeds to advocate the use of heat for fixing and preserving material, especially for certain objects such as the ova of *Ascaris megalocephala* which are impenetrable to the action of ordinary reagents. The thin oviduct of the animal is placed in a test-tube and exposed to the action of water at a temperature which need not exceed 50° C., for Max Schulze has shown that the protoplasm is killed and stiffened at this degree. The test-tube must be continually shaken during the heating. The ova are afterwards hardened in spirit which must be increased in strength. Care must be taken not to overheat the preparation, as their form is thereby much altered.

By this method certain details in the ova of *Ascaris* can be brought out which have hitherto escaped notice. For example, certain elements of the equatorial plate, hitherto described as spherical, now appear as short thick rods which by a distinct fissure may be seen to separate into two dumbbell-shaped daughter elements; an important point, as it shows agreement with the ordinary type of nuclear fission.

Baumgarten's Method of Triple-staining.*—Dr. A. Lewin says that excellent results are obtainable by means of Baumgarten's triple-staining method, for which the procedure is as follows:—

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

(2) The sections are then passed twice successively into absolute alcohol for two minutes; to the spirit picric acid is added until the hue resembles that of hock.

(3) The sections are then soaked in a freshly prepared solution of Ehrlich's gentian-violet (100 parts anilin-oil water and 11 parts alcoholic solution of gentian-violet) for one minute.

(4) The sections are then immersed in Lugol's iodine solution (iodine 1, iodide of potash 2, water 300) for one minute, after which they are washed in absolute alcohol for thirty seconds.

(5) Excess of gentian-violet is removed with acidulated spirit (HCl 3, absolute alcohol 97).

(6) The preparations are then dehydrated in absolute alcohol to which picric acid has been added until the colour is pale yellow (about five minutes). Afterwards the sections are cleared up in oil of cloves and mounted in xylol balsam.

Anilin-oil Safranin Solution.†—Dr. V. Babes gives the following modification of his anilin-oil safranin, and which he states gives very superior results. It colours sections almost in a moment, is available for all kinds of tissues, and is especially good for showing up mitoses. To 100 parts of water are added 2 parts of anilin oil and excess of

* Bull. Soc. Belge de Micr., xiv. (1888) pp. 146-7.
† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 470-1.

safranin powder. The mixture is then heated to 60°–80° and filtered. Thus made the fluid is clear and deep red, and it will keep for one or two months.

Metanil-yellow.*—This is a yellow powder with sp. gr. 1·3102, soluble in water, 12 parts aq. destil. at 16° C. dissolving 0·031 grm. The watery solution is orange coloured and neutral on reaction. On evaporation, crystals are formed which belong to the rhombic system. Dr. H. Griesbach says that, for microscopical investigation it may be used for staining tissues, to which it imparts usually a yellow colour, the tone of which may vary from a bright to a dark hue. It may also be used as a double stain in conjunction with other dyes, such as Congo red, methyl-violet, acid fuchsin, so that a double or triple staining, according to the combination, is effected.

Simple Method for clearing Methylen Iodide.†—Herr R. Brauns found quite accidentally a method for clearing methylen iodide which has become brown. Some brownish methylen iodide happened to become frozen, only a small quantity, dark brown in colour, remaining fluid. When the latter was poured off, and the methylen iodide melted, the methylen iodide was found to be of a pale yellow colour and of excellent quality. At 15° C. the sp. gr. = 3·330.

As methylen iodide solidifies at 5° C., it is only necessary to expose it to comparatively slight cold to clarify it in the best and simplest manner.

Carmine Injections.‡—Trouble with carmine gelatin fluids when used for micro-injections, arises, says Dr. W. C. Borden, in two ways, either from an excess or deficiency in the amount of acid used to precipitate the carmine. In the first case the carmine precipitates in a too coarsely granular form, in the second, all the ammonia not being neutralized, the ammoniacal solution of carmine will diffuse through the walls of the blood-vessels. The difficulty is obviated by determining beforehand the exact amount of acid which it takes to neutralize a given quantity of ammonia—that quantity which is to be used in the fluid made. To this end take a drachm of aq. ammoniæ, and add gradually, with constant stirring, acetic acid, testing with blue litmus paper. The instant the paper changes to red stop adding the acid and note the amount which has been used. Suppose that it is $1\frac{5}{6}$ dr., then the proportion of acetic acid will be 11 to 6, and if the amount of ammonia used be 4 dr., then the amount of acid needed will be $7\frac{1}{3}$ dr. In this way the proper amount of acetic acid to ammonia may be found in any formula. The following formula is recommended as being the best of the gelatin-carmine warm flowing masses.

Carmine solution:—Carmine No. 40, 4 dr.; aq. ammoniæ fort., 4 dr.; water, 6 oz. Grind the carmine in a mortar, gradually adding the water, then add the ammonia, and heat gently until the carmine is dissolved.

Gelatin solution:—Gelatin, $1\frac{1}{8}$ oz.; water, $7\frac{7}{8}$ oz. Soak the gelatin in the water until soft, and then dissolve by heating. Take 5 oz. of the gelatin solution and add to it the solution of carmine. Add to the remainder of the gelatin solution sufficient acetic acid as found by previous trial to neutralize 4 dr. of ammonia contained in the carmine solution.

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 439-62 (4 figs.).
† Neues Jahrb. f. Mineral., Geol. u. Palæontol., 1888 (i.) pp. 213-4.
‡ Amer. Mon. Micr. Journ., ix. (1888) pp. 39-41 (1 fig.).

Heat the solution containing the carmine and that containing the acid to the same degree, by placing the bottles containing them in a pan of water kept hot on a stove or over a lamp. Add gradually with constant stirring the gelatin solution containing the acid to that containing the carmine. Filter while hot through two thicknesses of flannel. The fluid can be poured into the flannel shaped into a bag, when pressure on the sides of the bag will cause the contained fluid to pass through the cloth. Add four dr. of chloral hydrate and shake until dissolved. The chloral will preserve the mass for quite a long time, but if it is to be used within a day or two the chloral is not necessary. A mass made up by the formula given is sufficient in amount to inject a cat or rabbit. If needed for a single organ the ingredients can be reduced to the relative proportion.

A manometer should always be used for injecting and the apparatus suggested by the author consists of a wide-mouthed bottle fitted with a manometer made from a piece of bent glass tubing fastened to an upright board with a scale in inches or millimetres marked on it. The only other articles necessary are a tin box with a shelf inside on which to lay the animal to be injected; a sheet of glass large enough to cover the box, a thermometer, a few feet of rubber and glass tubing, and a couple of spring clamps for closing the tubing when it is necessary to stop the flow. Good atomizer bulbs are also required. There is no difficulty in maintaining a pressure of 100 mm. while injecting.

Before making an injection the apparatus should be tested by closing the exit tube and gradually raising the pressure to 100 mm., in order that any defects may be remedied. Before killing the animal the box is filled below the shelf with water at 40° C., and a lamp placed underneath to keep the temperature at that point. The melted injecting mass is then poured into the injecting bottle in order that it may attain the same temperature. About 12 oz. of a 3/4 per cent. salt solution is poured into another bottle also arranged with injection-tubes and placed in the box. The animal is chloroformed, and the apex of the heart having been snipped off, the salt solution is injected at a pressure of 50 mm. until it runs clear. The carmine mass is then injected, beginning with a pressure of 50 mm., and gradually increased to 100 mm. When the injection is finished the animal is cooled down in ice-water or a refrigerator, and the selected parts afterwards hardened in spirit.

Robin's, Lacaze-Duthiers', and Farabœuf's Injecting Syringes.*—Dr. Beale † prefers the syringe to any of the contrivances described in this Journal, 1884, pp. 643–51, for producing pressure by the fall of a liquid. The ordinary syringe has, however, several inconveniences which it is the object of the following modified forms to remedy.

Robin's syringe (fig. 113), has a rack-and-pinion movement to the piston so as to avoid the dangerous irregularities of pressure which are very liable to occur, especially after prolonged work. It also has a second tube and tap at the side for taking up the injecting fluid.

* Fol's Lehrbuch der Vergl. Mikr. Anatomie, 1884, pp. 21–4 (3 figs.).

† "After having tried many different methods of proceeding, I find that upon the whole the ordinary injecting syringe is the most successful as well as the cheapest, the most convenient, and the most simple instrument, and it is very easily kept in good order. It need scarcely be said that by no mechanical means can such varieties of pressure be obtained as by the aid of the muscles of the fingers and thumb, while the pressure can be instantly modified or removed at the pleasure of the operator."—'How to work with the Microscope,' 1880, p. 104.

Lacaze-Duthiers' (fig. 114), has also a rack-and-pinion arrangement and double tube but is designed to obviate the difficulties found to arise in many cases from movement of the syringe, as well as unequal pressure. It is attached to a heavy base, so that it will stand upright by itself, and a disc is placed on the top of the piston for weights, by which the piston can be made to descend automatically and at any given rate. The

Fig. 113.

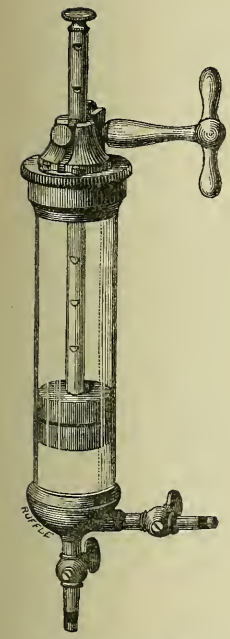
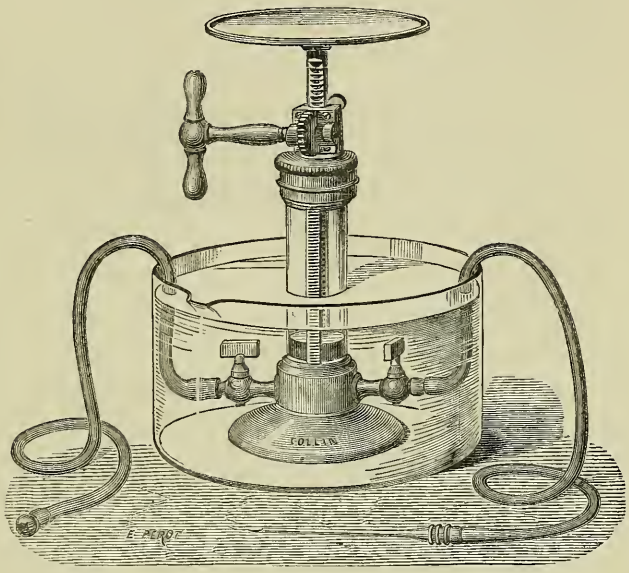


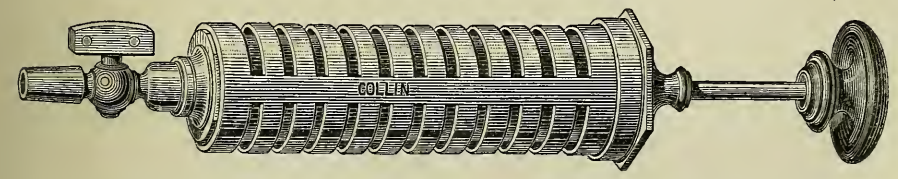
Fig. 114.



syringe can be placed in a vessel of warm water when it is necessary to keep the injecting fluid at a given temperature. M. Robin * preferred, instead of the disc, a stretched indiarubber band, which passes through a ring at the top of the piston, the ends being fastened to the cylinder. The two tubes can be used for injecting two orders of vessels simultaneously.

Farabœuf's (fig. 115) is covered with a non-conducting material so as

Fig. 115.



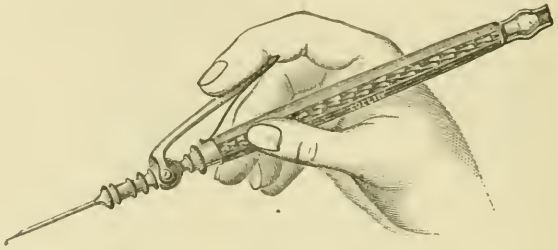
to protect the hand from the heat when fluids are used which must be kept very hot. The intervals allow the contents of the glass syringe to be seen.

* Robin's 'Traité du Microscope,' 1877, pp. 990–1 (1 fig.).

Collin's Automatic Cannula-holder.—On the other hand, Prof. H. Fol * prefers a pressure arrangement, on the ground that with all forms of syringe the leather dries up when it has not been used for some time, with the result that when the syringe is wanted it is not in a serviceable condition.

Whatever form of pressure-apparatus is used, it is very convenient, he points out, to have a cannula-holder with an automatic closing arrangement, such as that of MM. Collin shown in fig. 116.

Fig. 116.



The holder is hollow, and is connected with the tube from the pressure apparatus. Having been filled with the fluid, and some having been allowed to run out of the cannula, the cock is closed and the cannula is placed in the vessel to be injected, the holder being held in the hand like a pen. By pressing the lever the flow of the fluid can be regulated as desired. Prof. Fol says, "Whoever has worked with such an instrument will hardly again use the old syringe, especially where difficult injections of invertebrate animals have to be performed."

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

Half-clearing method of preparing Nerve Sections.†—Dr. Byrom Bramwell lays the section previously stained with carmine on a slide, and then pours on methylated spirit; the spirit is then mopped up, and a small quantity of oil of cloves poured on. While the preparation is still cloudy the oil of cloves is drained off quickly, and having been replaced by Canada balsam, the cover-glass is put on. The results attained, although in some cases extremely good, are eminently uncertain on the whole, the preparations being spotty, irregularly or too much cleared up.

Adaptation of Kaiser's gelatin for arranging microscopic preparations in rows.‡—Signor A. Poli commends to the notice of botanists, especially for the preservation of algæ, the mixture of gelatin and glycerin known as Kaiser's glycerinated gelatin, as first proposed by Nordstedt, and recommended in Strasburger's 'Botanisches Practicum.' He finds it especially convenient when it is desired to arrange a number of minute objects in rows under the same cover-glass. A fine streak of the fused gelatin, which melts at 45° or even lower, is first placed on the

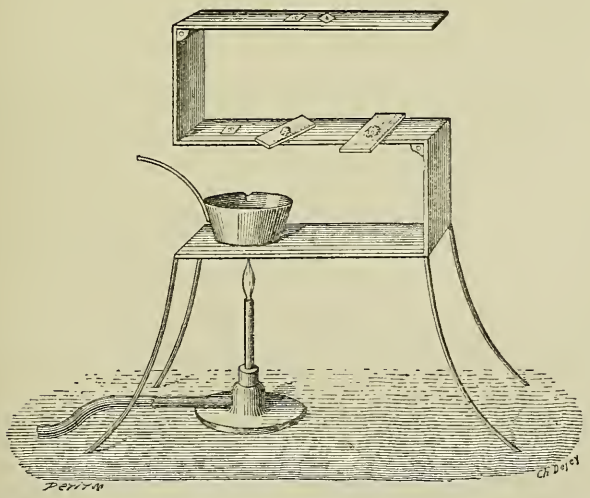
* Fol's Lehrbuch, p. 24 and pp. 25–6 (1 fig.).

† Edinburgh Med. Journ., Oct. 1886. ‡ Malpighia, ii. (1888) pp. 107–9.

slide by a very fine brush, at the spot intended to be occupied by the object, which is then deposited on the gelatin by a pencil, and adheres to it directly, and the cover-glass at once placed on. If they do not adhere immediately, the slide may be slightly warmed, and then allowed to cool.

Purification of Tolu Balsam for Microscopical Purposes.*—Herr C. C. Keller who has already advocated the use of tolu for mounting diatoms, gives the following method for purifying the balsam. 1 kilogramme of crude tolu balsam is heated in a water-bath until it is completely melted, when an equal quantity (up to 1200 grm.) of pure spirit of at least 95 per cent. is added. The solution is then filtered, and to it are added 500–600 grm. of petroleum ether in small portions. At first a clear solution results, the petroleum ether being taken up by the alcoholic balsam solution, but soon it separates into two layers. It is then shaken up vigorously, and allowed to stand for 24 hours. Two clear layers are then found, the upper yellowish one consisting principally of cinnamic and benzoic acids, the lower brown one being composed of the tolu resin plus much cinnamic and benzoic acids dissolved in alcohol and a little petroleum ether. The two layers are next separated by decantation. The following step consists in heating 4 litres of distilled water in a capacious vessel almost up to boiling point, and when the flame is put out the resinous solution is poured slowly in. As the petroleum ether boils at 65°–75° C. it disappears, the resin is precipitated, and when cold the cinnamic and benzoic acids crystallize out. The resinous mass is then stirred up several times with boiling water in order to get rid of the last traces of the acid. The resin is best dried over sulphuric acid or by the aid of gentle heat, and dissolved in benzol or chloroform. If, as may happen, when dried by heat, the balsam becomes red or brown-red, it should not be used.

Fig. 117.

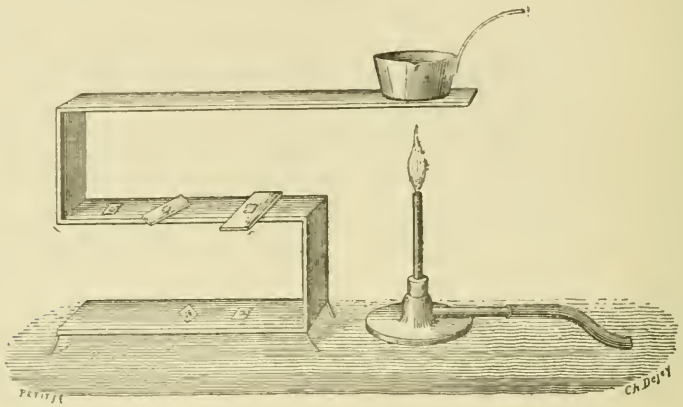


Hot Plate Apparatus.†—It is useful for microscopists to have at hand an apparatus capable of being heated to different temperatures in

* Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 471–4.
† Arch. de Physiol., viii. (1886) pp. 273–5 (2 figs.).

order to melt paraffin mixtures of wax and oil for imbedding, for heating specimens mounted in balsam, for drying and coagulating blood, sputum, &c. For this purpose M. L. Malassez has devised the apparatus (fig. 117) which consists of a metal plate bent into the shape of a capital S. The whole length of the plate is 50 cm., and it is 6 cm. broad and 2·5 mm. thick. The apparatus takes up very little room, as it is only 12 cm. long, 12 cm. high, and 6 cm. broad. It may be heated from below or

Fig. 118.



from above; if from below it must be supported on four legs, and the Bunsen burner placed underneath (fig. 117). If from above, then the topmost shelf must be made to project so that the burner can go underneath (fig. 118).

MacDonnell.—[Exhibition of Slides.]

["Three dozen slides (chiefly entomological, and sections of wood) mounted by Mr. H. Sharp in balsam in an ingenious manner, so as to obviate pressure and distortion of the object, by pasting a rim of paper on the slide, and thus leaving a space of any requisite thickness for the object. This process was invented by Mr. Sharp, of Adelong, and the results were excellent."]

Journ. and Proc. Roy. Soc. of N. S. Wales, XXI. (1887) p. 294.

Minot, C. S.—**The Mounting of Serial Sections.**

[Summary of existing state of knowledge on the subject.]

The Microscope, VIII. (1888) pp. 133-8.

(6) Miscellaneous.

Method of calculating the rapidity of Bacterial Increase.*—Drs. H. Buchner, T. Longard, and G. Riedlin, who have been investigating the rapidity with which certain micro-organisms increase, remark that the following six conditions must be fulfilled in any attempt to determine maximum rapidity of development:—(1) The nutrient medium must be as favourable as possible (they used cold meat infusion: peptone 5 per cent., sugar 1 per cent., salt 1/2 per cent.; solution alkaline; in some

* Centralbl. f. Bacteriol. u. Parasitenk., ii. (1887) pp. 1-7 (1 fig.).

cases the sugar was omitted). (2) The temperature must be the most favourable—37° C. (3) The cultivation must be not only pure, but strong. (4) The number of individuals in the nutrient medium must be accurately determined; this number must be small. (5) At the conclusion of the experiment the number of individuals must also be calculated. (6) The duration of the experiment must be known, and also short (2–5 hours).

The actual procedure was as follows:—From a pure cultivation of the bacillus in the meat-peptone solution a small quantity on a platinum wire is transferred to 50 ccm. of a sterile 0·6 per cent. salt solution. After having been well shaken up, 1 ccm. is taken up with a pipette and transferred to 50 ccm. of meat-peptone solution. With the last solution, which contains at most a couple of hundred individuals to the cubic centimetre, three plate cultivations are made with 1 ccm. each of the solution. In this way the bacterial contents of the solution are determined with sufficient accuracy. These quantities having been removed, the nutrient solution, which has previously to the inoculation been raised to 37° C., is kept at this temperature for 2–5 hours. At the expiration of this time three more (secondary) plate cultivations are inoculated with 1 ccm. each of the solution. This gives the number of individuals present at the conclusion of the experiment.

The enumeration of the colonies was made by numbering those visible under the field of the Microscope and striking an average from 10–30 such enumerations. The gelatin layer of the plate should be perfectly even, and not too thick. Having obtained the average number of colonies to the field of vision, and then having ascertained the size of the field, the number of colonies on the whole plate was calculated. As the size of the field for a given objective diminishes with the strength of the eye-piece, the size of the field for each individual eye-piece should be determined once for all. The higher eye-pieces with the smaller fields are more convenient for the more thickly crowded plates.

Fig. 119.

This method may be further developed by adapting to the diaphragm of a high eye-piece two pairs of crossed threads (fig. 119). The distance between the threads should amount to about 1/10–1/12 of the diameter of the diaphragm. The small square in the middle of the field is convenient for enumerating very thickly sown colonies. The number of colonies seen within the small square is ascertained at many different places of the cultivation plate. Colonies which happen to lie on the boundary of the square are only numbered if their larger half fall within the square. From many enumerations an average is obtained which serves as a basis for calculating the contents of the colonies of the whole plate. In this way a plate with 5–10 mlllions of colonies can be numbered.

In the eye-piece used by the authors the small square had the apparent size of 1·7 sq. cm., but the actual space with the objective used was 0·0156 sq. cm., that is, the 6410th part of a sq. cm. If, therefore, there were ten colonies to the square, in the gelatin layer of 80 sq. cm. superficies there would be a total of 5,128,800 colonies.

The method for calculating was as follows:—

Let a = number of primary colonies.
b = „ secondary colonies.
n = „ generations.
a cells or rods after 1 generation = $a \times 2$.
2 generations = $a \times 2 \times 2$.
n „ = $a \times 2^n$.
$\therefore a \times 2^n = b$.

$$2^n = \frac{b}{a}.$$

$$n = \frac{\log_b - \log_a}{\log_2}.$$

The cholera vibrio was chiefly experimented on, and the results of seven examinations are given. In number these are too few for any precise knowledge; in certain details of time they vary considerably, and the last experiment given was apparently the first made, and seems to have been thrown in to add length to a too short series.

The following are the numbers given:—

Experiment 1. (Feb. 1887.) Duration 3 hours.
Primary colonies = 18
Secondary „ = 7250
$n = 8 \cdot 7$
$\therefore$ each brood developed in 20·7 minutes.

Experiment 2. (Feb. 1887.) Duration 3 hours.
Primary colonies = 149
Secondary „ = 95,952
$n = 9 \cdot 3$
Period of development = 9·3 minutes.

Experiment 3. (Feb. 1887.) Duration 2 hours.
Primary colonies = 3,583
Secondary „ = 90,666
$n = 4 \cdot 7$
Period of development = 25·5 minutes.

Experiment 4. (March 1887.) Duration 2 hours.
Primary colonies = 15,345
Secondary „ = 133,545
$n = 3 \cdot 1$
Period of development = 38·7 minutes.

Experiment 5. (March 1887.) Duration 2 hours.
Primary colonies = 3,550
Secondary „ = 27,608
$n = 3$
Period of development = 40 minutes.

Experiment 6. (April 1887.) Duration 2 hours.
Primary colonies = 143
Secondary „ = 1291
$n = 3 \cdot 18$
Period of development = 37·7 minutes.

Experiment 7. (June 1886.) Duration 5 hours.
Primary colonies = 35
Secondary „ = 981,792
$n = 14 \cdot 8$
Period of development = 20·3 minutes.

It may be noted that either the period of development of each brood varied considerably, or the method of experimentation or of calculation was at fault.

Analysis of Water used for Brewing as regards Micro-organisms.* —The examination of drinking-water, remarks Dr. E. C. Hansen, is made by means of Koch's plate-cultivation method, by means of meat-peptone gelatin; and this method is also employed in zymotechnical laboratories. But for the analysis of water used in brewing another method must be adopted. The question at issue is not so much to find out what and how many micro-organisms exist in the water, nor what will develope in gelatin with or without the addition of meat and peptone, but rather how the water behaves towards the wort and the beer, to what degree it is rich in micro-organisms which can develope in these media, and if among them there be any kinds capable of exerting a detrimental action. The analysis, in short, must be carried out under conditions obtaining in the brewery itself.

The nutrient solutions, the beer and the wort, are placed in small flasks plugged with cotton-wool. Each flask, fifteen filled with beer and fifteen with wort, was inoculated with 0·02 cm. of cold tap-water. The water was inserted by means of a pipette, the upper end of which was fixed to a rubber tube, in order to prevent any germs entering from the air. The number of drops was regulated by means of a stopcock. It need hardly be remarked that the apparatus and the media were carefully sterilized. Also, the amount of water placed in each bulb was accurately measured, in order that the result could be calculated up to 1 ccm.

For the sake of comparison, an analysis was made by Koch's method from the same water, and also on another plate; but instead of meat-peptone gelatin, wort-gelatin (wort with about 5 per cent. gelatin) was used here. The cultivations were placed in a thermostat at 24°–25° C., and the experiment was suspended after fourteen days. None of the beer- or wort-flasks contained a trace of vegetation. In Koch's gelatin there were 111 spots of vegetation, that is 222 for 1 ccm. water; all contained bacteria, but only a few fluidified the gelatin. The wort gelatin showed fifteen vegetations, or thirty to 1 ccm. water. Other experiments gave analogous results, and on the whole showed that while the hygienic method put the total too high, the estimates from the wort-gelatin cultivations were too low, and that very few of the bacteria present in the water had any effect on the wort, and none at all on the beer. Yet, when both of these fluids were much diluted, they lost their original power of resistance, but then of course they were neither what is usually understood by beer and wort.

Some further experiments established the fact that bacteria from water, even though introduced in large quantity, were unable to develope in beer, but hyphomycetes of water occasionally did so.

Based on these observations, the author made an analysis of the

* Centralbl. f. Backteriol. u. Parasitenk, iii. (1888) pp. 377-9, from Zeitschr. f. d. Gesell. Brauwesen, 1888, No. 1.

properties of the Alt-Carlsberg water. Fifteen flasks of beer and fifteen flasks of wort were inoculated with one drop of water (0·04 ccm.) and ten flasks of each sort with 1/4 ccm. of water; they were then shaken up, and for fourteen days kept at a temperature of 24°–25° C. The result was that 1 ccm. water contained 1·3 wort-bacteria and 1·3 moulds, or 2·6 vegetations altogether. They were all in the wort; the beer was quite unaffected.

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The Microscope, VIII. (1888) pp. 145–7.

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352 pp., 8vo, Jena, 1888.

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600 pp., 162 figs. and 8 pls., 12mo, Paris, 1888.

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Zeitschr. f. Hygeine, IV. (1888) pp. 22–4.

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Anatom. Anzeiger, II. (1887), pp. 382–92, 392–4.

Kastschenko, N.—**Eine kurze Notiz in Bezug auf meine Methode.** (A short note in reference to my method.) *Zeitschr. f. Wiss. Mikr.*, IV. (1887) pp. 353–6.

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Monatschr. f. Anat., 1887, 10 pp. and figs.

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9 *Hefte* and 158 figs., 8vo, Prag, 1887.

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Arch. of Dent., 1887, May.

Nelson, S. N.—**Methods of examination of Bacteria for laboratory purposes.**
Journ. Amer. Med. Assoc., 1888, pp. 381–6.

Osborn, H. L.—**Studies for Beginners. II.**
Amer. Mon. Micr. Journ., IX. (1888) pp. 85–6.

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Rep. and Trans. Cardiff Naturalists' Soc., XIX. (1887) pp. 107–10.

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[Report of Lecture.] *Ann. Rep. Ealing Micr. and Nat. Hist. Soc. for* 1887–8, 4 pp.

Ranvier, L.—**Traité technique d'Histologie.** (Technical Treatise on Histology.)
Fasc. VII. (and last), pp. 977–1109, figs. 325–79, 8vo, Paris, 1888.

Sanderson, B., Foster, M., and Brunton.—**Manuel du Laboratoire de Physiologie.** (Manual of the Physiological Laboratory.) *Transl.* by G. Moquin-Tandon. ii. and 620 pp., 184 figs., 8vo, Paris, 1888.

Stöhr, P.—**Lehrbuch der Histologie und der mikroskopischen Anatomie des Menschen mit Einschluss der mikroskopischen Technik.** (Handbook of Histology and Human Microscopical Anatomy, including Microscopical Technique.)
2nd ed., 209 figs., 8vo, Jena, 1888.

Tiemann, F.—**Illustrirter Leitfaden für die praktische mikroskospische Untersuchung des Schweinefleisches auf Trichinen.** (Illustrated guide to the practical microscopical investigation of hog's flesh for Trichinæ.)
3rd ed., 8vo, Breslau, 1887, viii. and 139 pp., 29 figs.

Zune, A.—**Cours de Microscopie médicale et pharmaceutique.** (Course of medical and pharmaceutical microscopy.) *Contd.*
Moniteur du Praticien, III. (1887) pp. 190, 215, and 249.

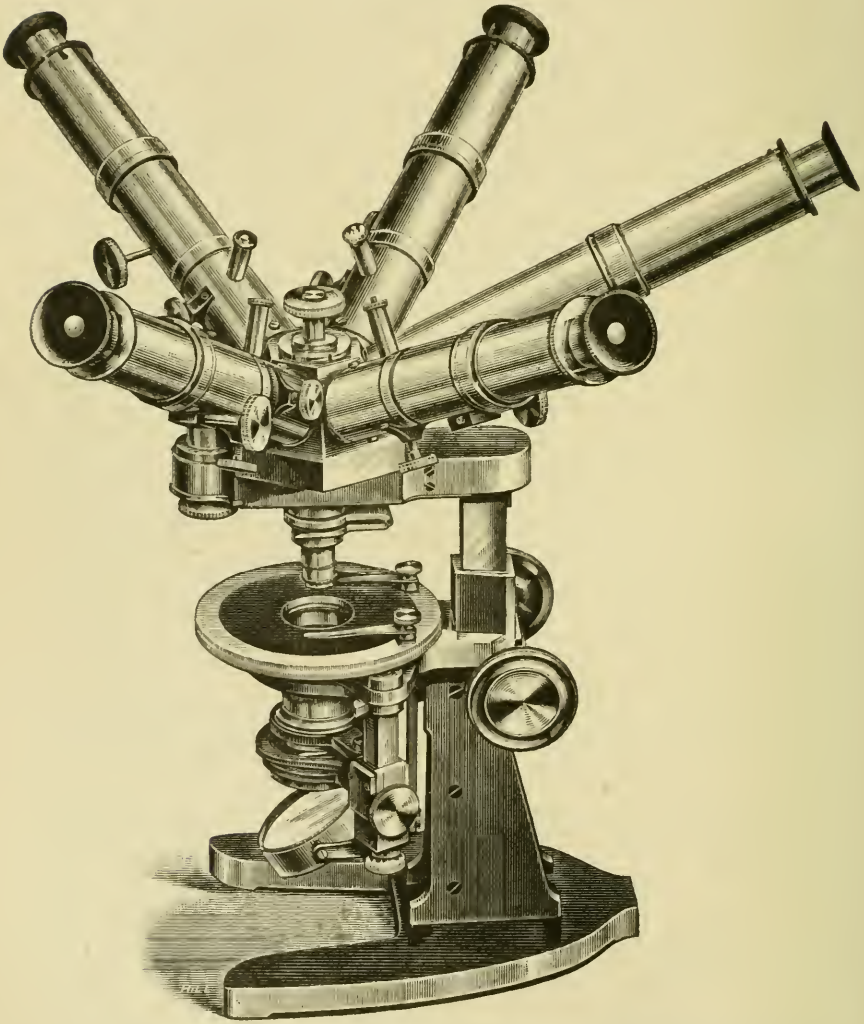
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Thury's Five-tube Microscope.—M. Thury has designed, and the Geneva Society for the Construction of Physical Instruments have constructed the Microscope with five body-tubes shown in fig. 120.

Fig. 120.



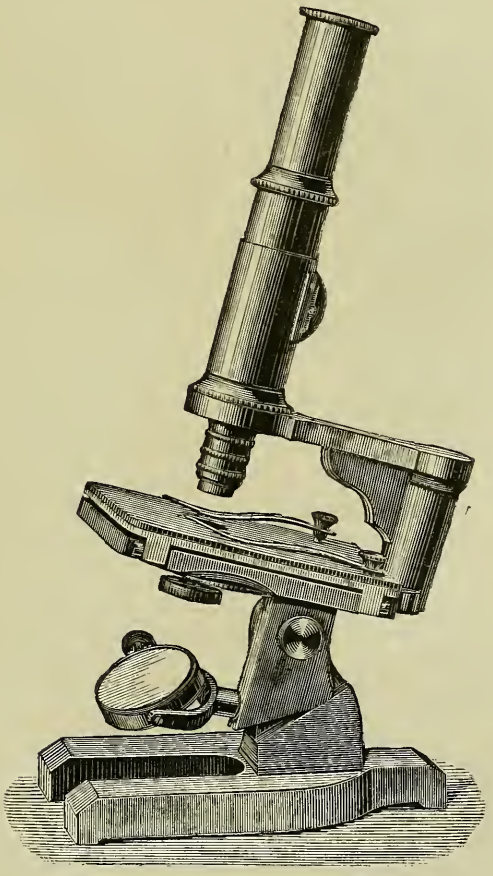
* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

The principle of the instrument is the same as was described in this Journal, 1887, p. 796, where a Microscope with four tubes was figured. A totally reflecting prism is placed over the objective, and as this is rotated by the milled-head at the top, the image is thrown into each of the tubes in succession, thus enabling a Professor to show the same object to various members of his class.

Four of the tubes have each two screws for centering in two rectangular directions. They also have each a rack and pinion for focusing. An unavoidable difficulty of the instrument is, that the object appears differently placed to the different observers, but a mark in the field of each of the four tubes shows which was the right-hand side of the object to the observer using the first tube.

Schieck's Meat-examining Microscope.—Herr F. W. Schieck has applied to this Microscope (fig. 121), an arrangement for inclination,

Fig. 121.

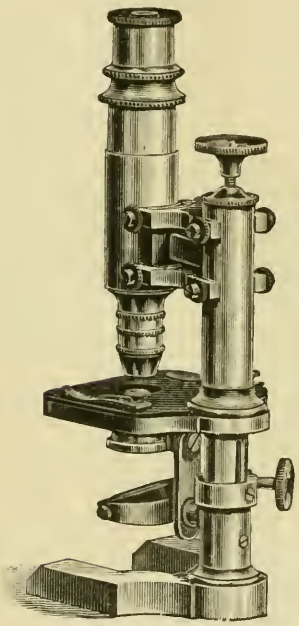


which, although adopted in the case of small instruments, has not been hitherto applied, so far as we know, to those of the size of his

Microscope, which is stated to be 12 in. high, stage 4 in. by 4 in., "weight $2\frac{3}{4}$ kilo." The tail-piece attached to the under side of the stage turns on an axis projecting laterally from the standard, the latter having a diagonal stop-piece at the bottom, against which the end of the tail-piece, which is sloped off as shown in the fig., abuts when the instrument is upright.

Schieck's Travelling Microscope. — We are reminded that Herr Schieck some years ago brought out the Microscope shown in fig. 122, which anticipates those of Dr. Zeiss described *ante*, p. 637, inasmuch as the prolongation of the stem beneath the stage slides in a socket on the base, and can be clamped at any point.

Fig. 122.



The object of this device was stated to be to enable the instrument to go into a case of reduced dimensions for travelling.

Zeiss's IIa Microscope—Babuchin's Microscope.—In the description of these Microscopes, *ante*, p. 637, we should have explained that by means of the screw at the back of the limb, the fine-adjustment can be thrown out of gear when travelling, thus preventing the point of the micrometer-screw from getting damaged.

Leitz's Demonstration Microscope—Old Demonstration Microscope. — The design of this Microscope sufficiently appears from fig. 123. The form of the frame in which the body-tube socket screws, is devised to enable it to be held in the hand and passed round for class demonstration (the object being viewed by transmitted light), and at the same time to allow of its being rested on the table when not in use.

We are forcibly reminded by this Microscope of the tendency to the repetition—with more or less modifications—of antique forms. On page 109 we reproduced a figure from the 'Acta Eruditorum' (1686), illustrating the employment of Campani's Compound Microscope on opaque and transparent objects, and it is evident that Leitz's Demonstration Microscope might be substituted for Campani's, the difference of form being only a simplification certainly not suggestive of an interval of upwards of two centuries in their construction.

Fig. 124 shows what appears to have been a Demonstration Microscope of the last century. It is constructed of wood and cardboard, and is apparently a modification of Culpeper and Scarlet's Microscope figured in Dr. Robert Smith's 'Opticks' (Cambridge, 1738, 2 vols. 4to.). The body-tube slides in a socket for focusing, and has a draw-tube in which the lenses of a Huyghenian eye-piece are applied respectively above and below, the draw-tube serving not only to increase the amplification, but also (probably) as a means of focusing the image more accurately, as in some of the modern "miniature" Microscopes. Mounted transparent

Fig. 123.

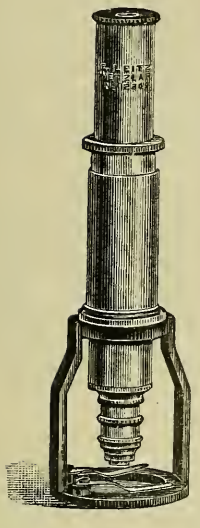
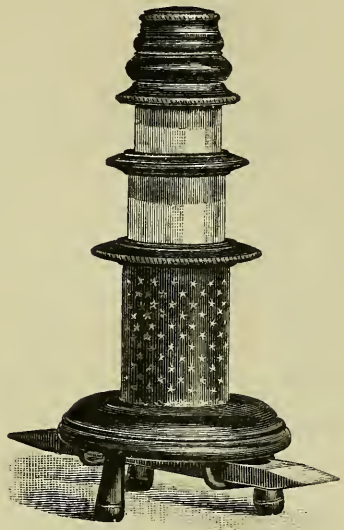
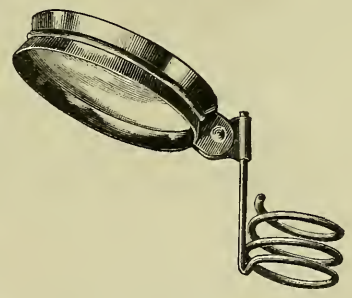


Fig. 124.



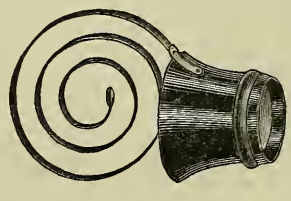
objects were viewed on "sliders" passing through a bent staple on either side of the under face of the base, the instrument being directed to the source of light. For viewing opaque objects, some such method as that shown with Campani's Microscope (above quoted), was probably employed.

Fig. 125.



Dentist's Examining Glass.—In Mr. S. S. White's Catalogue of Dental Materials,* we find an examining glass figured, consisting of a low-power lens (fig. 125), mounted in a metal ring, hinged on a socket that slides on a rod terminating in a spiral, by which it is carried on the finger in examining teeth, &c. In practice we should expect the difficulty of holding the lens steady a great drawback to its utility.

Fig. 126.

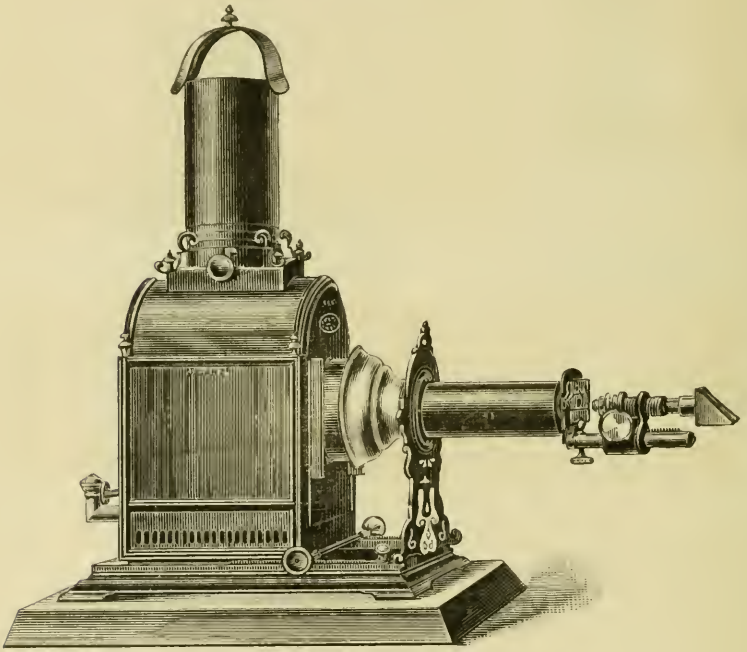


Bausch and Lomb Optical Co.'s "Watchmaker Glass."—The Bausch and Lomb Co. have obtained a patent for the application of a spiral spring to a watchmaker's glass to encircle the head and thus keep the lens in position. We are unable to say how far this arrangement has been found to be of practical utility, nor can we trace its origin with certainty. We have, however been informed that such a device was in use in the last century, if not earlier.

* Philadelphia, 1877, p. 227.

Ganz's Pinakoscope with Dreyfus's Reflector. — Herr J. Ganz's instrument, which was exhibited at the Wiesbaden Exhibition last year, is practically a Sciopticon,* but for microscopic purposes it is fitted with a stage and carrier for objectives. Mr. L. Dreyfus (now of Wiesbaden), has added a reflector fixed in a short tube which can be pushed over the end of the tube carrying the objective (fig. 127), so that the images in place of being shown on a screen, can be thrown on the table, an arrange-

Fig. 127.



ment which is very effective for drawing objects. Mr. Dreyfus writes, "By the aid of this apparatus we make all the drawings used in the lectures here with perfect ease, sitting at the table. The drawing can be left, and finished whenever we have time again."

The illumination being obtained from a mineral-oil lamp is not strong enough to show objects under powers higher than a 2/3 in. objective.

Tri-ocular, Quadri-ocular, &c., Prisms.—Figs. 128 to 132 show the various prisms belonging to the Microscopes described in this Journal, 1887, pp. 796–800. Fig. 128 is the prism over the objective of Nachet's double-bodied Microscope, fig. 129 that of Nachet's triple-bodied, and fig. 130 the small four-sided prism for which M. Nachet (pp. 1067–8)

* Cf. J. Scherrer, 'Das Pinakoskop und seine Anwendung,' &c., 61 pp. and 30 figs., 8vo, Speicher, 1886. Cf. also Boll. Accad. Med. Roma, 1886, pp. 178–92.

claimed priority over that of Prof. Harting (p. 799) shown in fig. 131. The prisms of Mr. Ahrens's Tri-ocular Microscope (p. 799) are shown in fig. 132.

Fig. 128.

Fig. 129. Fig. 130.

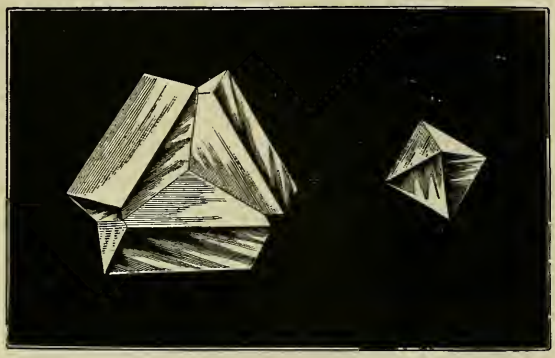


Fig. 131.

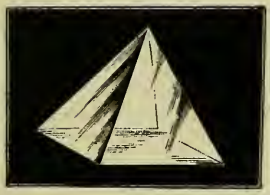
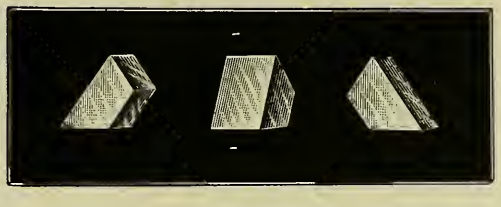


Fig. 132.



Heurck, H. van.—**Le Microscope Anglo-Continental ou Microscope d'Étudiant de M. Watson and Sons.** (Watson and Sons' Anglo-Continental or Student's Microscope.)

[Includes also a photomicrographic apparatus.]

Journ. de Micr., XI. (1888) pp. 314–8 (2 figs.).

Seaman, W. H.—**American and Foreign Microscopes.** *Science*, XI. (1888) p. 120.

(2) Eye-pieces and Objectives.

Zeiss's "Compensation Eye-piece 6 with 1/1 Micron-division." *—The graduation of the eye-piece micrometers hitherto made is arbitrary, and has no intimate connection with the magnifying power of the objectives used with them for micrometric measurement. For this reason it is necessary to have a table giving the value of an interval for each objective and eye-piece; for example, the interval may be—

With eye-piece 2, for objectives A, C, E, and 1/12 = 16, 6·7, 2·7, 1·82 μ.

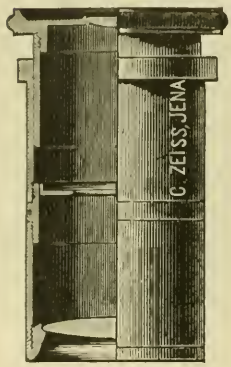
With eye-piece 3, for the same objectives = 14, 6·0, 2·4, 1·67 μ.

If, then, the image of an object observed with a 1/12-in. homogeneous-immersion objective covers 3·75 intervals of the micrometer eye-piece 2, the true dimension is $3{\cdot}75 \times 1{\cdot}82 = 6{\cdot}82$ μ.

* From the description issued by Dr. Zeiss. Cf. also K. Schliephacke in Flora, lxxi. (1888) pp. 33–44.

The rational gradation in the focal lengths of the apochromatic objectives has made it possible to essentially simplify both in calculation and tabulation the measurements to be made with them. The micrometer eye-piece (fig. 133) used is a compensation eye-piece, No. 6, of the usual form (new construction), and a graduation in which the intervals for an ideal objective of 1·0 mm. focal length (with normal tube-length) are 0·001 mm. = 1 μ.

Fig. 133.



The value of an interval rises in the same ratio as the focal lengths of the objectives, and is represented by the same numbers, it is therefore

2·0 μ	for apochromatic	2·0 mm.	(1·30 and 1·40 N.A.)
2·5 „	„	2·5 „	
3·0 „	„	3·0 „	(1·30 and 1·40 N.A.)
4·0 „	„	4·0 „	
8·0 „	„	8·0 „	
16·0 „	„	16·0 „	

so that the same number denotes the interval in terms of μ and the focal length in mm. The use of this eye-piece therefore renders a special table unnecessary.

Measurements made in this way will always be correct within a slight percentage, since individual variations of particular eye-pieces and objectives always lie within very small limits. If, however, it is necessary in special cases to find a very exact value of an interval for a particular objective, it must be tested in the ordinary way by a stage micrometer, and then the small deviation in the value of an interval from its true value for a given objective, as expressed by its number, can be corrected by a slight alteration of the tube-length. In such a case the objective in question is focused upon a stage micrometer, and if an interval of the micron-division does not cover exactly so many thousandths of a mm. as are given by the focal length of the objective, the correction is made by a small lengthening or shortening of the tube-length, and the exact tube-length shown by the graduations of the draw-tube noted for each objective.

American v. Foreign Microscopes; the Verdict of an Impartial Expert.
[Results of Dr. H. J. Detmers' examination of objectives by Leitz, Seibert, and Zeiss.] *St. Louis Med. and Surg. Journ.*, LV. (1888) pp. 160–3.

(3) Illuminating and other Apparatus.

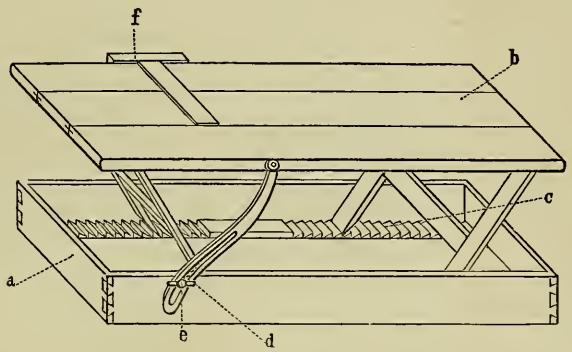
Eternod's Drawing-board.*—Prof. A. Eternod recommends the use of a drawing-board invented by him, and which he has found useful for microscopical drawing, as it is very stable and easy of management. It consists of a shallow box (fig. 134, *a*), the sides of which are strongly

* Internat. Monatschr. f. Anat. u. Histol., ii. (1885) pp. 269–70 (6 figs. of a plate).

morticed together; a drawing-board (fig. 134, *b*) made of poplar; a rackwork arrangement (fig. 134, *c*) by which the board can be fixed in or altered to any desired position with great rapidity; and a brass catch by which it can be fixed instantly with a turn of a screw (fig 134, *d*, *e*).

The advantages of this apparatus pointed out are: (1) it can be raised

Fig. 134.



or lowered to any level, and still kept in the horizontal position (figs. 134, 136, 138, 139); (2) it can be placed obliquely (figs. 135 and 137); (3) it

Fig. 135.

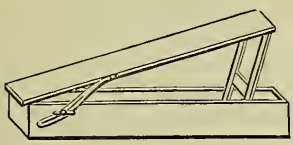


Fig. 136.

can be displaced laterally (fig. 138), and obliquely (fig. 137); (4) when folded up, the apparatus only takes up a very small space; the measurements given by the author are 70 cm. by 55 cm.

Fig. 137.

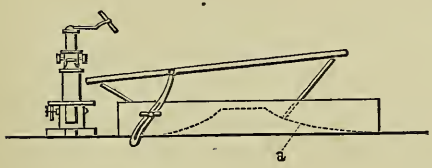


Fig. 138.

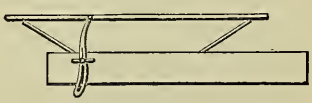
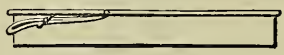


Fig. 139.



If the rackwork arrangement be made to a curve (fig. 137, *a*) the teeth will hold more firmly, but this is not necessary, as the apparatus is perfectly steady.

Babes' Hot Stage.*—In figs. 140 and 141 are shown different aspects of Dr. V. Babes' hot stage for constant temperatures. By means of the two screws *sch* it is fastened to the stage of the Microscope or to Reichert's movable stage. The hot stage consists of a gnomon-shaped box filled with water or glycerin. The preparation is slipped in through the aperture *o*, and it can be moved about. It is warmed both from above and below. The objective and the Abbe condenser are partly surrounded by the box. Heat is imparted by a thick copper wire *k* heated in a gas flame. The other end, which is within the box, is convoluted. The copper wire is insulated from the sides of the box by a layer of asbestos.

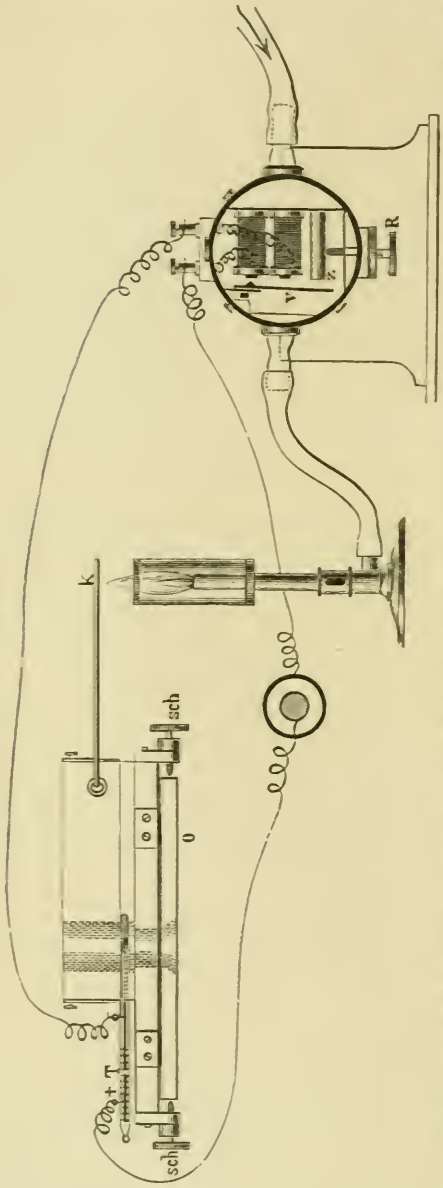


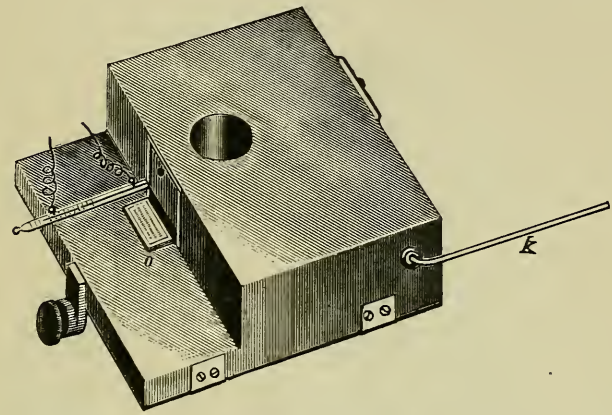
Fig. 140.

The regulation is effected by means of an electrical thermometer T inserted in the same orifice as that in which the preparation is placed, and consequently exposed to the same temperature. The wires of the electric thermometer pass to the apparatus shown in fig. 140, which is supplied by a small Leclanché battery. By the movement of the pole to a point previously settled upon, the current is closed, and the plate V attracted towards the electro-magnets. This reduces the stream of gas at Z, and the flame is consequently diminished. As the mercury sinks, the valve V is again opened, and the gas again flows through the pipe Z to the jet. To the thermostat there is also

* Centralbl. f. Bakteriol. u. Parasitenk., iv. (1888) pp. 23–5 (2 figs.).

attached a screw (R, fig. 140) for specially regulating the flame when it has been reduced by the regulation apparatus. As the regulation of the

Fig. 141.



temperature is instantaneous, the vital conditions of bacteria at definite temperatures can be studied exactly.

Capillary Slide and accessories for the examination of Ova.*— This apparatus, which was designed by M. L. Chabry for the examination of Ascidian ova, has now received several additions rendering it more serviceable than the original form (see this Journal, 1887, p. 319).

It consists of a thick glass plate *p* (fig. 142) placed on the stage of the Microscope, and upon which rests a capillary tube T bent at a right angle, the latter part projecting over the stage. The tube lies in a couple of glass sockets *d d* fixed to the plate with shellac. This allows the capillary tube to be pushed up and down from left to right, and also to turn on its axis. This axial revolution is effected by a special contrivance. P *o* is a metal plate bent at a right angle with a long and a short leg. The longer leg is clamped to the stage by a screw, so that the shorter leg is parallel to the side of the stage and about 5 cm. distant from it. Through the short leg passes the rod M B, bent twice at a right angle, and one end of which is fixed on a disc, about the size of a penny piece. K is a plate of shellac fastened to the short leg. By turning the disc the capillary tube is made to revolve. The tubes must be perfectly free from air-bubbles, and it is advised to keep a quantity of them on hand. They should be about 10 cm. long and arranged according to the breadth of their lumen, and that tube should be selected of which the diameter is about equal to that of the object to be examined, so that when the tube is made to revolve the ova may not be damaged.

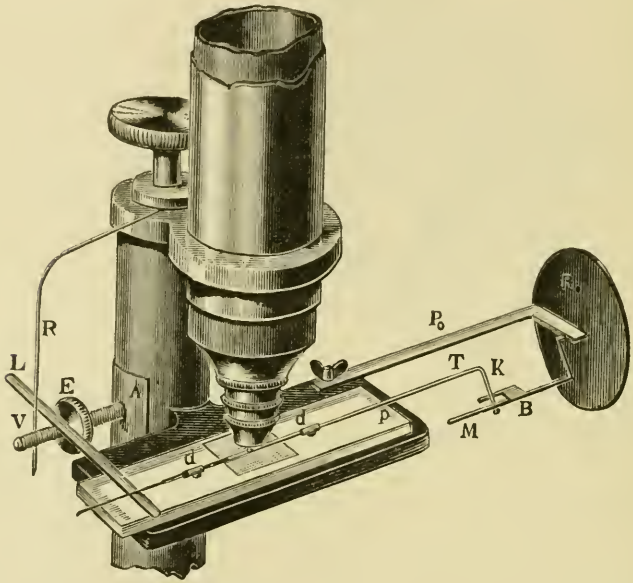
The ova are introduced into the capillary tube by a suction-pump made out of a piece of glass tubing fitted at both ends with a piece of rubber tube. On one piece of the rubber tube is fitted a self-acting clamp, between the clips of which is slipped the capillary tube. To the other piece is fitted a small syringe, by the use of which the ova are sucked

* Journ. de l'Anat. et de la Physiol., xxiii. (1887) pp. 167-320 (5 pls.). Cf. Zeitschr. f. Wiss. Mikr., v. (1888) pp. 60-5 (2 figs.).

into the tube. This operation may be performed under the Microscope if necessary.

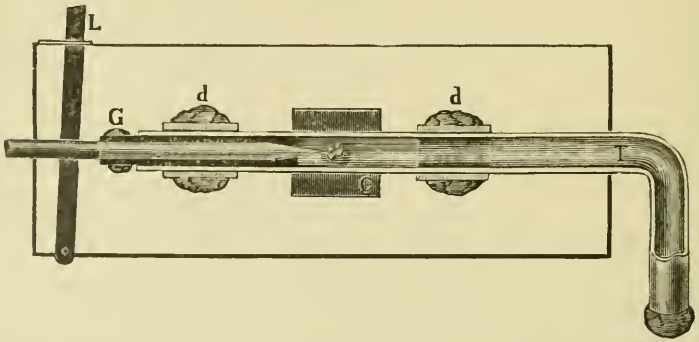
If any other movements are to be imparted to the ovum an additional apparatus is required. This is called the perforator, and consists of a

Fig. 142.



needle, its case, and motor apparatus—a lever controlling screw and spring. The needles are made out of glass by drawing out very fine threads from a glass rod over a lamp. A quantity of these about 10 cm.

Fig. 143.



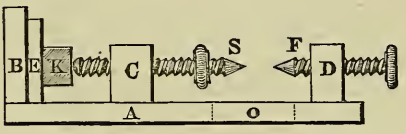
long should be made. Those which are quite regular in thickness are then to be arranged in packets, after inspecting them under the Microscope; the points are then fixed on to capillary tubes by means of a thermo-cautery. This piece of manipulation requires much practice and patience.

In order to introduce a needle into the capillary tube upon the slide, a special protector is necessary. This is shown in fig. 143 where it appears as a black tube fastened to the slide by shellac G. The difference between the parts sliding on one another must not amount to more than 10 μ. The lever L, figs. 142 and 143, is fixed to the capillary tube with a minute drop of marine glue. The other extremity lies upon the screw V fixed to the standard of the Microscope at A, and between the milled head E and the spring R, made of brass wire. The perforation of an ovum is effected by just flicking the spring after having turned the screw back to the required degree.

There are numerous minute details given by the author as to points of manipulation, but for these the original must be consulted.

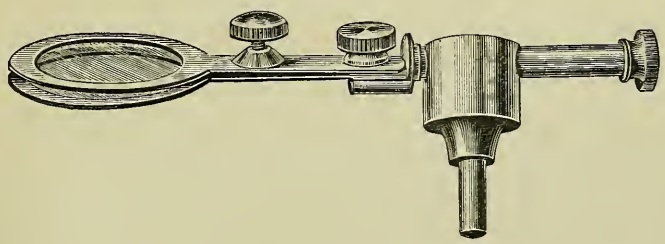
Measuring Corrosion Surfaces in Iron Pyrites.*—Herr F. Beeke, while examining iron pyrites, came to the conclusion that the primary corrosion surfaces were those of greatest resistance, and in order to prove this measured the difference between several parallel surfaces on the same crystal. For this purpose a screw micrometer by Zeiss was used in conjunction with an apparatus (shown half its natural size, fig. 144) for measuring the thickness of the crystal under the Microscope. To the metal plate A interrupted at O, the upright piece B is attached, and to this a piece of plate glass E is fixed. Upon A are also fixed two more uprights C D, through which the screws S and F work. The screw S is rounded off at one end, pointed at the other, and bears a milled head. The screw F is pointed at one extremity, and at its other terminates in a milled head. This screw during the experiments is fixed. The crystal K is placed between the glass plate and the screw S, which is made to fix it closely both before and after corrosion. Then the difference in distance between the points S and F shows the amount of substance lost.

Fig. 144.



Rowland's Reversible Compressorium.—This device of Mr. W. Rowland (fig. 145) consists of two thin German silver plates each with a

Fig. 145.



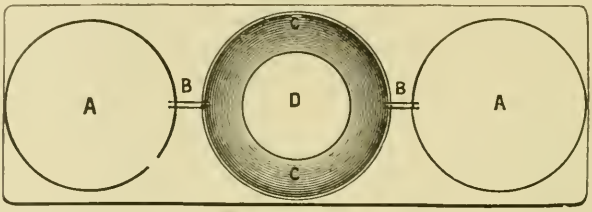
ring having a piece of cover-glass cemented to it. The lower plate is attached to a rod turning in a socket, while the upper pivots on a milled

* Tschermak's Mineral. u. Petrogr. Mittheil., viii. (1887) p. 318. Cf. Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 411–2 (1 fig.).

head which clamps it if required, or releases it when needed for more easy cleaning. Varying pressures of the cover-glasses are obtained by turning the milled head in the centre of the plate as in Wenham's compressorium. The socket fits in a hole in the stage, in the same way as stage forceps.

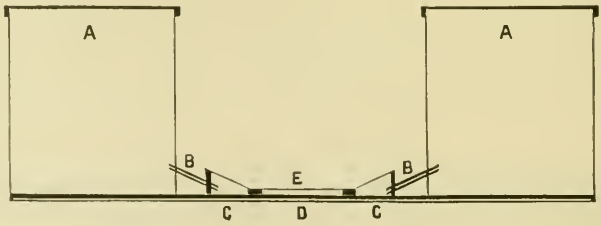
Beaumont's Reservoir Life-slide.—Mr. C. R. Beaumont describes this (figs. 146 and 147) as follows:—"Having long felt that if a cell were constructed in which minute organisms could be kept alive under as nearly as possible natural conditions, and at the same time allow of fairly high

Fig. 146.



powers being used for their examination, a much more accurate knowledge of the life-history of such organisms would be obtained, I at last conceived the idea of making a slide having reservoirs at each end, in which could be stored a supply of water; and so made that a small current could be continually kept flowing through the cell, from one reservoir to the other, either on or off the Microscope, thereby keeping the organisms in the cell constantly supplied with fresh water, in a manner as near as could be similar to the conditions obtained in their natural habitat.

Fig. 147.



The gentle percolation of water through the life-cell serves the treble purposes of keeping the organisms cool, and supplying them with food and aeration. It is not necessary to remind experienced microscopists that when small organisms are placed with a drop of water in a shallow cell and subjected to the concentrated light and heat from a condenser during protracted observations with the Microscope, very great changes are induced in the environment of the organisms, which very frequently lead to important physiological changes. Assuming these changes to be mainly caused by the concentrated heat from the condenser on so small a quantity of water, the immense advantage of using a slide wherein

fresh water is constantly percolating the cell, and regulating the temperature will be self-evident.

The slide consists of a slip of non-oxidizing metal $1\frac{3}{8}$ by $3\frac{1}{4}$ by 1/8 in., having a central opening of 1/2 in. D, with a disc of glass forming the bottom of the central cell, and fitting flush with the underside of the base, allowing of illumination with a paraboloid. Surrounding the glass on the upper surface is a slightly raised edge of metal forming a central flat cell, having a uniform depth about equal to the thickness of ordinary blotting-paper. Outside this central cell is a slight recess in the metallic base, which forms an annular cell C, surrounding the central one through which water percolates when in use. The central and annular cells are closed by means of a thin cover-glass, cemented to a rim of metal E, which fits watertight over the two cells; the under surface of the cover-glass being held close against the raised edge of metal forming the boundary of the inner cell, thus closing and preventing the escape of organisms placed therein. There is water communication between the central and annular cells, by a series of very fine capillary lines, ruled in the metallic edge between the cells.

On each end of the metallic base is fixed a reservoir A having a glass cover. These reservoirs are directly connected with the annular cell by fine tubes B, through which water flows when in use from one reservoir to the other.

The action is as follows:—Organisms are placed in the central cell and the cover-glass pressed tightly down; one of the reservoirs is then filled with water and the circulation established. If the slide be now placed on the stage of a Microscope provided with a revolving slide carrier so that the full reservoir is highest, the water will flow through the fine tube to the annular cell; a portion of which will percolate to the inner cell by capillary motion, and thence through the second tube into the other reservoir. When the upper reservoir is empty the motion may be reversed, thus enabling a constant circulation to be kept up during microscopic examination. Each reservoir is provided with a small air-vent, drilled coincidently through the upper edge of the reservoir and the rim of the cover. These vents may be entirely closed when desirable, by simply turning the covers slightly round so that the holes do not coincide. The flow of water may also be regulated, by placing bristles within the fine tubes leading from the reservoirs to the annular cell.

To continue the water circulation when off the Microscope several methods are available, two of which I will here mention. The method which recommends itself as the simplest, and perhaps gives the best results, consists of a stand or support for carrying the slide and large supply reservoir for containing enough water to last several days. The supply vessel is placed at a higher level than the slide, and a siphon may be used to convey water from this vessel into one of the reservoirs. A suitable siphon is easily made by bending a length of vaccine tube (to be had from most chemists) having a short piece of thread pushed inside the long end to regulate the drip. Another shorter siphon made from the same material is placed in the hole near the top of the other reservoir, to conduct the overflow into a vessel placed beneath. A better arrangement is obtained when the supply cistern is fitted with a miniature water-tap near the bottom, the water being allowed to fall in drops into the first reservoir of the slide, and flow out as before stated.

Another system of keeping up the circulation is by means of an automatic tilter. This apparatus consists of a small balanced table having an oscillating motion on a central axis, and made to carry one or more slides. The slides rest on the table with the reservoirs at right angles to its axis, so that each reservoir may be raised or depressed at intervals of about three hours; this being about the time occupied for the water to flow from one reservoir to the other when properly adjusted. The tilting is obtained from clockwork placed in a box underneath.

The first method has the advantage of simplicity and also of giving a complete change of water, and on that account is perhaps the best for most organisms. I may say that with a slide of this kind I have had the pleasure of watching three generations of *Floscularia* in succession. These organisms are probably amongst the most difficult objects to keep in a small slide on account of their voracious habits."

Mr. Beaumont also informs us that a friend who uses one of the slides without any tilting arrangement, finds that all that is necessary is to lay the slide on a flat surface and remove the cover from one of the reservoirs; this allows free evaporation to take place in the uncovered reservoir, thus setting up a current through the slide. Mr. Beaumont thinks that, on the whole, an arrangement without tilting is preferable, as the organisms are not precipitated against the sides of the cell so much.

Holman's Current Slide.*—Dr. Holman says that on his slide *Protococcus* may be kept alive many days; *Amœba* three weeks; and Bacteria for six months. In the minute canal, 1/100 in. wide, and 1/1000 in. deep, between the two concavities with shallow margins in his slide, blood-corpuscles may be caused to flow in either direction, to roll over, or to stand on edge by the warmth of the hands of the operator, brought towards the stage of the Microscope at a distance of about six inches.

Life Slides.†—Dr. A. C. Stokes in studying the morphology of minute animal organisms, uses only a shallow shellac cell, with about one-fourth of the ring scraped from both the upper and the lower margins, thus leaving two curved supports for the square cover, one on each side. This gives the inclosed drop with its animal life plenty of air, and facilitates the application of the wet brush at the point where the square cover projects beyond the lateral cell-wall. The secret of success consists in leaving enough of the cement ring to properly support the cover, and to lessen the force of the inflowing water supply, and also in having the cell shallow or deep according as the animals are microscopically small or large. Much depends on the depth of the cell in all cases. A comparatively large Infusorian, a Rotifer, or a *Chætonotus* can be injuriously hampered in its movements and in the proper performance of its functions by a cell of insufficient depth, and a good objective can be greatly hampered in its functions by a cell of too great depth.

The author also proposes the following form:—A small square, cut from glass of any desired thickness, is cemented with Canada balsam to a slip, and surrounded by a thick glass or zinc ring so as to leave a wide space between these parts. On the ring place a ring of wax, and,

* Journ. New York Micr. Soc., iv. (1888) p. 168.
† The Microscope, vii. (1887) pp. 129–33 (3 figs.).

after the object has been arranged on the central square, cover the whole with a thin circle and cement it fast by running a warm wire around the edge to melt the wax. A small drop of water may be placed in the annular space if desired. The thickness of the slip and square, and the depth of the cell must of course be determined by each worker according to his needs. The secret of success here is, to be sure that the joint between the ring and the slip is air-tight, and to firmly secure the cover, using an abundance of wax.

Lamps for Microscopical Work.*—The Editors of 'The Microscope' consider that in the efforts to put before the microscopical public attractive illuminating apparatus, writers seem to have lost sight of the excellencies of the humble hand-lamp. Beginners are thus led to purchase the expensive German student's lamp or some still more costly microscopical lamp. It can safely be asserted that for the general purposes of the working microscopist, a small hand-lamp giving a broad, flat flame (such a lamp as can be bought anywhere for 25 or 30 cents) is superior to any of the expensive lamps made especially for the purpose, and we are convinced from our observation of the methods of many microscopists that this is not realised by many except the experts.

By the size of the flame and the distance of the lamp from the Microscope, the intensity of the light can be readily adapted for any work, from the use of the lowest powers to the examination of histological and biological specimens with the highest immersion lenses. For bacteriological work with the 1/12 in. or 1/18 in. immersion lenses this light is unsurpassed. In the examination of opaque objects this lamp is not so convenient, as it is necessary then to have the source of light at quite an elevation. It is very easy, however, to improvise a stand.

Tubes for Microspectroscopic Analysis.†—For microspectroscopic analysis it is necessary to be able to alter the depth of the liquids examined and to know exactly what these depths are. Three forms of tubes answer these requirements. The first is a prismatic tube with the same proportions as that of the author's (M. L. Malassez) first hæmochromometer, so that the glass plates at the end of a length of 10 cm. are 10 mm. apart; consequently at distances, say, of 1, 2, or 3 cm. from the top the thickness of the liquid layer is 1, 2, or 3 mm. A millimetre scale placed along the side of the tube indicates the depths corresponding to different points in the length.

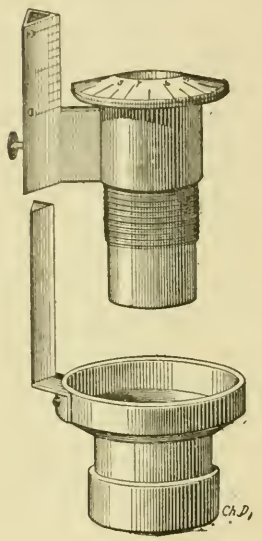
In the two other tubes there is an internal sliding tube ("tube plongeant"). The simpler form consists of a metal tube, 2 to 3 cm. long and 5 mm. in diameter; the lower extremity is closed by a piece of glass, and the upper expands like a basin. This is the tube into which the liquid to be examined is poured and it is placed in the aperture of the Microscope stage where it is held by the expansion at the upper end. The tube which slips into this is made of metal, and is a little longer and narrower than the outer one. Its lower end is closed by a glass, and its upper screws into the Microscope tube in place of the objective. By screwing down the Microscope tube the layer of liquid is thereby diminished. If on the Microscope tube there is a millimetre scale, and

* The Microscope, viii. (1888) p. 206–7.
† Arch. de Physiol., viii. (1886) pp. 268–71 (1 fig.).

if the milled head of the fine-adjustment be graduated, the thickness of the liquid layer is easily ascertained.

The third tube (fig. 148) is less simple than the foregoing, but it is constructed so that it gives the thickness of the liquid layer at once. It consists of (1) a metal tube, the lower end closed by glass, while the upper end is expanded; (2) of another tube to dip into the former and closed at the lower end by glass. But the latter tube, instead of being screwed to the Microscope, is screwed to an arm, the upright of which is fixed to the edge of the first or outer tube, so that by turning the inner tube round it sinks or rises, and thereby produces a thinner or thicker layer of fluid. The depth of the liquid is measured by means of a millimetre scale marked on one side of the upright. The head of the internal tube almost touches this scale, and hence it is easy to read off the number of millimetres the tube has risen or fallen. This procedure is facilitated for fractions of millimetres by dividing the upper surface of the disc into 10, and each of these divisions into two parts, by which a tenth or twentieth of a millimetre is given.

Fig. 148.



In order that the instrument may be more easily cleaned and fixed at zero, the upright is made in two pieces, the outer being fixed to the inner tube, and the inner one to the outer tube. The two pieces are kept tight by a binding-screw. When a liquid is to be examined, the outer piece is withdrawn, and the milled head of the other turned until the zeros of the two scales coincide; the tube is then slipped in so that the two glasses at the lower extremities are in apposition. The binding-screw is then tightened up. This position evidently corresponds to the thickness 0.

Weiss, D.—**Ueber das Fleischl'sche Hämometer.** (On the Fleischl Hæmometer.) *Prager Med. Wochenschr.*, XIII. (1888) p. 20.

(4) Photomicrography.

Burstert's Photomicrographic Apparatus.*—Dr. H. Burstert's apparatus is shown in fig. 149. The camera A is attached to the wooden stand L R S, the end of the expanding bellows being also fixed to the piece W which carries the Microscope, the stage *m*, and the illuminating apparatus *f c d*. W slides in a slot on R, and may be adjusted to any desired distance from the focusing plate. The various parts of the illuminating apparatus are made to slide upon an iron bar screwed to W, so that they may be adjusted independently.

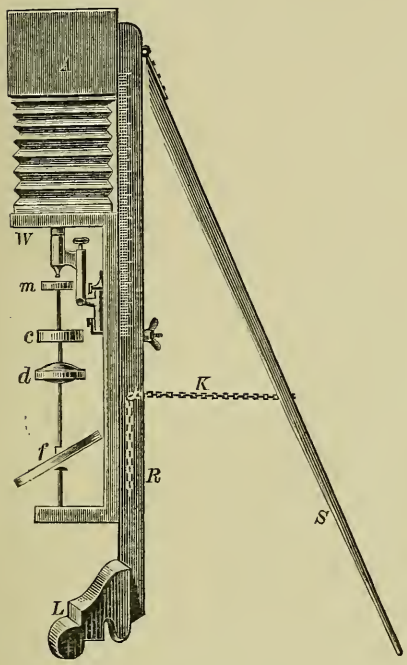
The whole apparatus is set at any desired inclination by means of the chain K and leg S, and it may be used vertically or horizontally. In the latter case the mirror *f* is removed, and replaced by the source of

* Jesserich, P., 'Die Mikrophotographie,' 8vo, Berlin, 1888, pp. 98–9 (1 fig.).

light. Upon R is a scale which gives the distance of the objective from the focusing plate.

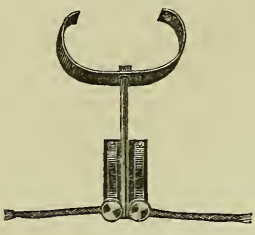
The advantages claimed for the instrument are "the firm stand resting on three points, and the attachment of the whole (illuminating apparatus and camera) to a common stand," "the Microscope, illuminating apparatus, and front part of the camera being capable of being brought to different distances from the focusing plate without the position of the separate parts to each other being in any way changed."

Fig. 149.



Neuhauss's Focusing Arrangement.—Dr. R. Neuhauss uses for the camera described *ante*, p. 294, the mechanism shown in fig. 150.

Fig. 150.



A piece of watch-spring is bent as shown in the figure, and is secured to a pin attached to a plate. The Microscope being horizontal, the plate is placed vertically with the ends of the watch-spring engaging in the milling of the micrometer-screw of the fine-adjustment. To the sides of the bottom of the plate cords are attached, which pass over horizontal pulleys on the right and left of the Microscope and are fastened to a wooden rod at the end of the camera. By pulling the one cord or the other the fine-adjustment screw is turned to the left or right.

"In this way" (see p. 294) "the fine-adjustment is made without any inconvenient connecting rods, and can be effected directly by one hand, while the other is engaged with the focusing lens." The motion obtained by the action of the clamp on the micrometer-screw is, it is claimed, quite fine enough to secure the complete sharpness of the image.

Drawings v. Photographs.—Screen for the Abbe Camera Lucida.* —At the present time, when to almost every Microscope a photographic camera is being attached, and when photomicrographs, of every degree of merit, are being produced on all sides, it may be well, Dr. G. A. Piersol considers, to weigh the respective values of the pencil and sunbeam as

* Amer. Mon. Micr. Journ., ix. (1888) pp. 103-4.

means of recording the observations of the investigator. The idea of reproducing, by photography, what is seen in the Microscope, is so captivating, that it is a matter for little surprise that so many undertake the work. These remarks do not apply to the photographing of preparations for the purpose of producing excellent pictures, but bear upon the merits of the two methods as auxiliaries to the work-table. That the pencil is being unwisely neglected, owing to a too implicit reliance on photography, is an unfortunate present tendency, especially for the young investigator, who loses the training to accurate observation which the conscientious use of the pencil brings. But both the photographic camera and the drawing-prism have their advantages, and the investigator can afford to dispense with neither, as, by their judicious employment —sometimes by their combination—more satisfactory and valuable results are obtained than are possible by any exclusive adherence to either.

An experience in photomicrography, which warrants a full appreciation of its value and capability, has taught that the most serviceable and satisfactory field of photography lies at the extremes of the table of amplification, with very low (20 to 70 diam.), and with very high powers (500 to 1500 diam.). What drawing can equal, in beauty of detail, a really good photograph of a suitable specimen taken with a fine low-power objective? who can draw fibrillæ of striated muscle, a group of bacteria, or a delicately marked diatom in competition with photographs? Excellent pictures are made under ordinary magnifications (200 to 350 diam)., but in the majority of cases there is much less cause for congratulation. Under these circumstances, the conscientiously and skilfully used pencil will produce a more valuable and satisfactory record for the investigator than the camera. The reason that *good* photographs, with very low or very high powers, are so satisfactory is, that under both conditions suitable lenses reproduce *all* the planes of tissue necessary for a serviceable representation of the object; nine times in ten this will not be the case with the pictures demanded of the 1/4 or 1/6. While it is unreasonable to expect the lens to reproduce more than the plane accurately in focus, it is nevertheless true that this physical limitation (reduced to a minimum by the thinnest possible sections) frequently renders photographs, under medium powers, unsatisfactory substitutes for more diagrammatic drawings. At the present time the investigator who depends upon photographs for his illustrations, finds himself confronted by the pertinent question as to the manner in which his pictures shall serve as journal illustrations. That photography, in its applications to book-making, is yet in its infancy, no one doubts; that really beautiful results are already accomplished by the best methods is equally certain; if, therefore, the liberality of the publisher places one of the unexceptional "processes" at his command, the investigator may feel confident. Let him, however, be cautious as to where he places his hopes when economy is consulted, for there is nothing more annoying to the worker himself, or more unfortunate for the cause of photomicrography, than the dissemination of those monstrosities whose harsh black and white masses, devoid of half-tone and detail, are supposed to "reproduce" a really fine negative.

Frequently, however, the use of the photograph is out of the question, and the investigator or the artist must make the necessary substitute; by all means let it be the microscopist himself, for he will then have the guarantee that the feature of the drawing, especially valuable, is

appreciated. Under such circumstances, a combination of the camera and pencil, which the writer has employed since the introduction of the Eastman "bromide paper," may often be found very satisfactory. Selecting the "B" grade, and marking out all undesired parts of the negative, a somewhat under-exposed print is made and developed until the cardinal parts of the picture are visible; this, when dried, yields a black and white sketch which, after being worked over with Indian ink and hard lead-pencil, presents the appearance of an elaborately finished drawing, and, as such, will be satisfactorily copied by the artist on the block or stone. Where details are very simple, the outlines of the photograph are easily transferred to the drawing-paper by means of the interposed sheet of "graphite" or "carbon" paper and the tracing point.

But, after all, for the busy worker the direct sketch on paper is frequently the most convenient and economical. It is to be regretted that the drawing-prisms in use on the Continent are not more generally used among our own microscopists. An experience embracing all the usual forms has resulted in a settling down to the Abbe apparatus as being the most satisfactory, and, due regard to the inclination of the mirror and the warranted size of the sketch being observed, as leaving little to be desired. After a long observation of struggles with the drawing-prisms usually furnished by American and English makers, it is truly refreshing to see with what ease and accuracy complicated contours are followed with this instrument even at the first attempt.

With any form of drawing attachment the nice balance between the illumination of the microscopical image and that of the paper is an all-important condition; having had occasion recently to use the Abbe prism to sketch some 1400 sections, the author found a simple device of great service. This consisted of a light stand supporting a small glass plate (10 × 15 cm.), two-thirds of which was "matt," being very finely ground, leaving the remaining third as a clear strip extending in the direction of the greatest length of the plate. The section being well lighted and focused, and the paper adjusted for the drawing, the screen should be interposed between the source of illumination and the mirror, when the object becomes illuminated by a soft diffuse light, very favourable for the rapid and accurate sketching of details. Slight lateral movements of the screen by the left hand soon determine its best position. When a doubt arises as to some detail, a movement of the wrist floods the field with light, enabling an exact observation to be made, while a second change restores the mellow illumination so favourable for drawing. All this can be done without moving the eye from the tube or taking the pencil from the paper. The position of the screen between the light and mirror is more effective than when the ground glass is mounted as part of the substage apparatus. Those who have never used this simple contrivance in drawing will find it a material aid in many cases. Its frequent usefulness on other occasions, as a light-moderator for low-power examinations, will insure it a permanent place on the work-table.

Instantaneous Photomicrography.*—Herr M. Stenglein, who has been trying to adapt the instantaneous method to photomicrography, recommends a mixture of magnesium, chlorate of potash, and sulphide of antimony, which gives a flash lasting for 1/50–1/30 of a second. The

* Centralbl. f. Bakteriol. u. Parasitenk., iii. (1888) pp. 670-4, 702–7 (1 fig.).

percentage composition is 60 parts (by weight) chlorate of potash, 30 parts magnesium in powder, 10 parts sulphide of antimony. The combustion of this powder is effected in a lantern L, the body of which is a metal tube, closed at one end and provided at the other with a glass plate and a diaphragm, the aperture of which corresponds accurately with the diameter of the illuminating lens. Within the lantern, and on a level with its central point, is a metal plate, upon which the powder and touch-paper are placed. On the left side of the lantern is a slit closed by a shutter; through the slit the touch-paper is lighted. The lantern is further provided with a chimney, bent at an angle and about 5 metres long. The chimney, which fits on the lantern, is not shown in the illustration. About 0·75–1 metre from its end the chimney is fitted with a special apparatus for absorbing the smoke.

The camera is placed vertically and the illuminating lens B horizontally. The preliminary focusing is made with a mineral-oil lamp, afterwards exchanged for the lantern.

For instantaneous photography the sensitiveness of the plate must be known, and to estimate it for this magnesium powder the author has devised a special sensitometer. This consists of a glass plate 12 × 15 cm., divided up into thirty rectangular spaces of 2 × 3 cm. and covered with tissue paper. The spaces are numbered according to the number of layers of paper. This sensitometer is fixed in a copying frame and then inside a pasteboard box open in front. The frame is then placed in a room lighted by a candle and exposed for a certain time. The ordinary developer is used, but *without* the addition of bromide. Then the number on the sensitometer gives the sensitiveness of the plate. The author's results were obtained from stearine candles (eight to the pound), distance 30 cm., exposure one minute, and developing five minutes with the pyrogallic developer; he found that plates 22 and 23 were quite distinct, and that No. 24 was almost as good.

As most objectives differ more or less in their focus, it is obviously advisable to obtain a filter which will permit sharp photographic pictures to be produced by their aid. A mixture of copper nitrate and chromic acid in water allows only 7 per cent. of all spectrum colours to pass through (or diluted 12–14 per cent.). By using this as a light filter in combination with erythrosin the focal differences are quite obviated. As dry plates are not usually obtainable in a condition suitable for the erythrosin emulsion, wet plates are recommended. All operations with these plates must be conducted in a very subdued red light. Mixtures of erythrosin and silver nitrate give precipitates of a silver compound which are very sensitive to yellow light, and act more powerfully in bromide-gelatin than the pure dye. For making this mixture the following formula is given:—25 ccm. erythrosin solution, 1 : 1000; 1 ccm. silver nitrate solution, 1 : 80; 1/2 ccm. ammonia; 75 ccm. water. The plates are bathed therein for one minute and dried in the dark.

Photographing moving Microscopic Objects.*—M. L. Errera proposes to apply to microscopic objects the process already employed for recording each phase of the movement of a horse, &c., more especially the plan adopted by Anschütz in his "Schnellseher," which is fixed in a dark chamber which that author describes as follows:†—"The succes-

* Bull. Soc. Belg. Micr., xiv. (1887) pp. 32–5.
† Catalogue of the Wiesbaden Exhibition, 1887.

sive images on the glass of the man or animal in movement are fixed on a circular plate turning on its centre, and they are made to pass one after another behind an opening in a large screen in front of the observer. Every time that one of the images reaches the middle of the aperture it is illuminated during the fraction of a second (about 1/10,000) by the discharge of an induction coil through a Geissler tube placed behind the movable disc." The effect is of course the same as that of the zoetrope or "wheel of life."

M. Errera's idea of applying this process to microscopic objects is thus expressed:—

"The details and the mechanism of the movements of microscopic beings are still very imperfectly known. The cells with vibratile cilia, the infusoria, and the zoospores still present a crowd of problems to be resolved. I can hardly think that photography, which has rendered such great services in analysing the leap of man, the flight of the seagull, and the gallop of the horse, could not also be employed with success in the case of fishes, insects, worms, protozoa, algæ, or isolated histological elements. I propose, in conjunction with a skilful photographer, to make some experiments in this direction. The aquarium Microscope of Klönne and Müller, and that of Nachet with several bodies, suitably modified, will probably allow of the instantaneous photography of microscopic movements."

Photographing Phosphorescent Bacilli by means of their own light.*—Dr. Fischer has taken good photographs from cultivations of three different phosphorescent bacteria. To do this successfully it is necessary that the cultivation should shed an intense light, the dry plates must be very sensitive, and the exposure long (24–36 hours). The best pictures were obtained from *B. phosphorescens*, the cultivations of which in a dark room at 5°–10° C. gave out their brightest light. In these photograms not only are the colonies seen distinctly and sharply formed, but the outlines of the test-tubes and other vessels are recognizable. A herring illuminated with *B. phosphorescens* took extremely well, the scales showing with perfect distinctness. The head and tail, which were not illuminated, did not appear in the photograph.

Dr. Fischer then went a step farther, and obtained photographs of external objects, e.g. a watch, by the illumination of these phosphorescent colonies in a dark room. Not only could the time be read, but the hands and second-hands were distinctly visible. The illuminant bacteria alluded to are those commented on before in this Journal (*ante*, p. 277)—the "West Indian" and the "endemic" phosphorescent bacilli, and *B. phosphorescens*.

GRAY, W. M.—**Photo-micrography.**
[Methods used by the author in photomicrography of sections of animal tissues.]
The Microscope, VIII. (1888) pp. 172–5.

NEUHAUSS, R.—**Die Entwickelung der Mikrophotographie in den letzten zwei Jahren mit besonderer Berücksichtigung ihrer Bedeutung für die Lehre von den Mikroorganismen.** (The development of Photomicrography in the last two years with special reference to its importance for the theory of micro-organisms.)
Centralbl. f. Bacteriol. u. Parasitenk., IV. (1888) pp. 81–4, 111–6, 283–4.
[Also reply by M. Stenglein, *ibid.*, pp. 282–3.]

RAFTER'S (G. W.) **Photomicrographs.**
[Commendatory notice of them.] *Amer. Mon. Micr. Journ.*, IX. (1888) p. 113.

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* Centralbl. f. Bakteriol. u. Parasitenk., iv. (1888) pp. 89–92.

(5) Microscopical Optics and Manipulation.

Variation in Micrometric Measurements due to different illumination.—Mr. C. Fasoldt sends us the following "Table showing the variation in measurements due to the different applications of light and illuminations."

"The image of 4/10 in. was the object on which these measurements were made, and was ruled on a glass disc of No. 2 covering glass, 7/1000 in. in thickness.

"All measurements were taken on one and the same ruling, with the same Microscope, objective, and eye-piece, under the same focus, and having the Microscope in the same position continually, and only changing the mirror and excluding the one light while the other was used.

Unmounted—Lamplight.

Lines downward.		Lines upward.	
Concave mirror	4/10 in. 10/100,000 −	Concave mirror	4/10 in. 10/100,000 +
Plane „	4/10 in. 5/100,000 +	Plane „	4/10 in. 14/100,000 +
Ill. through objective	4/10 in. 5/100,000 +	Ill. through objective	4/10 in. 15/100,000 +

Mounted on Glass.

Lamplight.		Daylight.	
Concave mirror	4/10 in. 0	Concave mirror	4/10 in. 30/100,000 +
Plane „	4/10 in. 15/100,000 +	Plane „	4/10 in. 20/100,000 +
Ill. through objective	4/10 in. 31/100,000 +		

"A number of comparisons were made at each position and in the same temperature.

"A Spencer objective was used for these measurements; but Bausch and Lomb and Gundlach objectives were also tried, obtaining the same results.

"The Microscope used is one constructed on my late patents, and has a micrometer for measuring similar to a cobweb micrometer. But instead of cobwebs, three movable steel pointers are used, which are worked as fine as this metal will permit. The stage is mechanical, and the main slide is moved with great precision by a fine screw 100 threads per inch."

Error was therefore eliminated in the case only of the lines mounted on glass when the concave mirror and lamplight was used.

Testing Screw-Micrometers of Reading-Microscopes.*—Prof. Reinhertz points out that every micrometer is liable to special errors and that these must be studied before the requisite corrections can be applied. The errors are due to (1) the screw itself; (2) the mounting of the screw; (3) the remaining parts of the micrometer.

(1) According as the screw produces unequal linear movements at different parts for a complete turn, or unequal linear movements for equal fractions of a single turn, the errors may be called "progressive" or "periodic"; the former are due to inequalities of pitch, the latter to irregularities of the thread.

(2) The position of the screw is fixed by its point or head being maintained in constant pressure against a plane surface; if this surface

* Central-Ztg. f. Optik u. Mech., ix. (1888) pp. 37–40.

has inequalities, or is not perpendicular to the screw, or if the screw-point is out of centre, the errors in the readings are functions of corresponding fractions of a single turn, or are "periodic."

(3) Imperfections in the other parts may introduce numerous irregular errors, capable of entirely destroying the advantantages of micrometric reading.

The errors may therefore be either progressive, periodic, or irregular; the first may practically be neglected since only one or two or at the most five turns are employed in theodolite readings; the irregular errors must be determined and eliminated by repeated readjustment to the same graduation mark, the vernier being clamped, and by observing the mean errors of adjustment and reading; if these are subject to occasional large variation they indicate imperfections in the mechanism, lubricant, &c.

It remains to determine the periodic errors; i.e. to compare the different values found for the same interval on the scale as measured at different parts of the drum. The most convenient interval to use is the distance on the scale between some graduation and a supplementary mark which corresponds to 1/10, 1/8, or 1/5 of a complete turn. The drum is set to 0, one end of the interval is brought on to the cross wires by the vernier screw, and then the other end by a movement of the drum; the first position is then recovered by a movement of the vernier-screw; and in this way a series of measurements are made by alternate use of the vernier-screw and drum until the zero-reading upon the latter is again reached; the readings are then reversed. A series of such double sets of observations will give a mean value of the interval which may be regarded as the true value, and the differences between this and the values obtained at different parts of the drum will be the corrections to be applied. An example quoted by Prof. Reinhertz shows how the periodic error was determined on a micrometer screw, so that by applying the correction the mean error of a single measurement could be reduced from 8·5 in. to 4·4 in.; and was finally removed altogether by correcting the eccentricity of the hollow cone in which the screw point was made to work.

If the periodic errors do not lie within the mean errors of adjustment and reading the screw should be rejected, and in any case the periodic errors should be eliminated by repeated readings at different parts of the drum.

Arachnoidiscus as a new Test for High-power Objectives.*—Mr. T. F. Smith says that there are two great objections to using the Podura scale as a test object for an oil-immersion. The first is that the conventional markings can only be seen when the scale is a little way off the cover-glass, and, consequently, the objective not working at its full aperture; and, secondly, it is impossible to tell the best point.

A dry glass, on the Podura scale, is exceeding sensitive, and a little turn of the correction-collar, or a little difference in the length of the draw-tube, will make all the difference between fine definition and no definition at all. With the oil-immersion, however, you can go through the whole range of the correction-collar without making any difference in the markings, beyond changing them from red to blue. Of course,

* Journ. Quek. Micr. Club, iii. (1888) pp. 247–53.

opticians will tell you that they know the best point, but his experience is as follows:—

Four object-glasses, with a correction-collar, were supposed to be set with best definition on the Podura scale at the point 0; the first was best on a balsam-mounted slide at point $2\frac{1}{2}$; No. 2 glass was at its best at point 5; No. 3 at point $7\frac{1}{2}$; and the last glass at its best on the same slide at point 10, or as far as it could go. It is no use blaming opticians, for the English microscopists have been brought up (and rightly, up to a certain point) to believe in the Podura scale, and makers cannot be expected to run the risk of producing a glass that is not at its best on that test. The only way then is to offer a substitute that shall stand for the oil-immersion in the same relation as the Podura scale does to the dry glass, and for that purpose Mr. Smith "offers the outer plate of the *Arachnoidiscus* (anything) mounted in balsam."

To him there is a particular appropriateness in choosing this as a test object, from the fact that although its main features for the last forty years have been as well known as the Podura scale itself, the discovery of the finer markings or structure is due entirely to the oil-immersion objective.

The advantages claimed for the new test-object for an oil-immersion are that the little projecting points or spines can only be clearly defined where the objective is perfectly corrected and set at its best point.

It is not every disc of the diatom that will act as a test, any more than will every scale of Podura. Some will show no projecting spines even with the widest-angled objective, and others are so coarse as to be no test at all; but a properly selected one will answer all the purpose, both for defining and resolving power.

Tests for Modern Objectives.*—Mr. E. M. Nelson considers that the advance of the Microscope in recent years is due to the *Podura* scale and the following diatoms:—1st, *Rhomboides;* 2ndly, *Grammatophora subtilissima;* 3rdly, and probably to a greater extent, *Amphipleura pellucida;* lastly, and at the present time, to *Pleurosigma angulatum, N. rhomboides,* and the secondary markings of diatoms in general with large angled cones of central light. It was the demand for glasses that would give classical images of the *Podura* scale which improved the central portions of the objectives, and it was the demand for diatom-resolving lenses which spurred on the opticians to make wide angles and to correct the margins.

But however much we may regret it, these old tests—the *Podura* and the *Amphipleura pellucida*—which have been of great service to the cause of microscopy, must be laid aside. The classical picture of *Podura* demands such a very small area of the centre of an objective that it tests too little of the glass.

The following are a few tests for modern objectives:—

1. *Pleurosigma angulatum*, showing dark perforations on a light ground, with a fracture passing *through* them. While the dioptric beam passes though the centre of the lens the diffraction spectra sweep the margin. Unless a lens be truly centered it will not stand this test.

2. A Cherryfield *Rhomboides* in balsam or styrax with the full aperture of Powell's latest condenser is a very severe test.

* Engl. Mech., xlviii. (1888) p. 51.

3. To these may be added the secondary marking on diatoms, e. g. *Coscinodiscus asteromphalus*, &c.

4. The fracture passing through the secondary markings, such as (*a*) *Triceratium*, (*b*) *Isthmia nervosa*.

5. The secondary markings in the areolations on the *hoop* of *Isthmia nervosa* in balsam.

All these tests are intended for solid cones of direct light of various apertures. Two classes of tests are comprised in this list. The first, and perhaps the best, is the way a fairly large test is presented. 1, 2, 4 (*a*), and some of 3 are in this class.

The other class consists in the possibility of making out the test at all. 4 (*b*), 5, and some of 3 are in this class.

Fasoldt's Test-plates.*—Mr. C. Fasoldt replies to Dr. R. H. Ward's report on the examination of one of his test-plates. He claims that Dr. T. F. C. Van Allen "resolved every band up to and including the 200,000 lines per inch in the presence of Dr. Ward." Also that "a number of gentlemen" have resolved all bands up to and including the 200,000, "seeing plainly lines and spaces."

"The successful resolution of the lines is not dependent on the mode of ruling, but on the *eyes*. And, considering the admitted inability in Dr. Ward's eyes, it would seem no more than an act of justice to all concerned had the Doctor delegated his position on the committee to some one whose eyes were more reliable, and who would have been equally unprejudiced as himself in making the investigations. Good eyesight is certainly an essential factor in such close tests as the resolution of even 120,000 lines per inch, and there may perhaps be a reasonable doubt whether the Doctor was able to resolve the 120,000 lines per inch, as he claimed he was able to do. His admissions are, however, very candid, and his report can, therefore, have no value as to the number or resolvability of the rulings under discussion."

Microscopical Optics and the Quekett Club Journal.—When an esteemed friend goes astray it is often very perplexing to know what course to take. Are we to leave him unadmonished out of fear of impairing the ties of friendship, or are we to openly recognize the evil of his ways and act accordingly? The friend who has more especially brought this difficulty to mind at the present moment is the Quekett Microscopical Club, for which we retain unimpaired all the regard of early days, and the evil in this case relates to some papers printed in its Journal.

We recently had occasion to comment upon some comical blunders occurring in a paper in which optical principles were turned upside down in a very naïve manner, but the last part of the Journal goes beyond even that extraordinary paper, and we find page after page containing the most terrible nonsense that has ever been published hitherto in a microscopical journal. The paper to which we more particularly refer is one entitled "On True and False Images in Microscopy,"† the writer of which, as he shows in paragraph after paragraph, has not taken the trouble to master even the rudiments of the subject about which he writes, although he starts with the ludicrous statement that, "to him the subject presents no difficulty whatever"! One of the more strik-

* The Microscope, viii. (1888) pp. 220–3.

† Journ. Quek. Micr. Club, iii. (1888) pp. 267–72.

ing instances of this will be found in the author's statement (p. 268) that a passage quoted from Prof. Abbe "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 writer therefore has avowedly not a glimmering of a notion of that most elementary point of the diffraction theory—the difference between "delineation" and "definition," or that perfect definition is quite consistent with imperfect delineation.

If the only result of publishing the paper were to raise a laugh at the expense of the author, the matter might be treated as not being of more than personal interest, but when we find the Quekett Club printing such rubbish, it is necessary to make a protest in the interest of microscopical science against so retrograde a proceeding, and this the more so as it was at the Quekett Club that one of the earliest demonstrations was given of the fact that microscopic images cannot be interpreted by simply "believing the evidence of one's own eyes," as it is now suggested is all that is necessary.

In another part of the same No. we have a bewildering mixture of conflicting statements.* As will be seen from the extracts we print below, the speaker declares as "absurd on the face of it, and Prof. Abbe did not believe anything of the kind," just what Prof. Abbe, as appears from another part of the same Journal, does believe, and which is nothing less than the cardinal fact of the diffraction theory, while the speaker himself later on, apparently quite unconscious of the discrepancy, states his belief in the very thing which he had before denounced as absurd.

Speaker's first Statement.

"There had no doubt "been some very objec- "tionable passages written "in connection with the "subject—not perhaps by "Prof. Abbe, but in such "a way as to appear to "put them into Prof. "Abbe's mouth; such for "instance, as the state- "ment that because the "whole of the diffraction "images were not taken "in, therefore the whole "structure of the object "could not be known. "That, of course, was "absurd on the face of it, "and Prof. Abbe did not "believe anything of the "kind."

Prof. Abbe's own Statement.

"Perfect similarity be- "tween the microscopical "image and the object "always depends on the "admission to and utiliza- "tion by the objective of "the whole of the dif- "fracted rays which the "structure is competent to "emit. When a portion "only of the total diffrac- "tion fan appertaining to "a given structure is lost, "the image is more or less "incomplete or dissimilar."

Speaker's second Statement.

"With these difficult "objects, however, though "they could get a fair "knowledge of them with- "in the limits of their "optical power, yet they "came at length to a point "where the largeness of "the angle required was "such that they could not "yet grasp the diffraction "spectra, and at that point "their entire knowledge "necessarily ended."

The mischief of all this is that it must necessarily have the effect of making a student believe that the subject is so confused and unsettled that it is of no use to try and understand it.

There is plenty of room for most interesting criticism on the subject of diffraction, but to be worth printing it must be founded on intelligent doubt, and must not consist of raw and undigested ideas arising from simple ignorance of the subject, which renders it necessary to win over

* Journ. Quek. Micr. Club, iii. (1888) p. 288.

again (for some minds) the ground formerly won and now so inconsiderately put in peril of being lost.

HARCHEK, A.—**Optometer und Apparat zum Messen der Brennweiten und zum Centriren optischer Linsen, System North Harchek.** (Optometer and apparatus for measuring the foci of and centering optical lenses,—North Harchek's system.)
Breslauer Aertztl. Zeitschr., XII. (1888) p. 139.

Highest Magnifying Power.

[Another specimen of the general ignorance on this subject. "What is the highest magnifying power that has been obtained? In 1864 an eminent microscopist expressed his opinion that in object-glasses with one twenty-fifth of an inch focus the Microscope had reached its utmost attainable limit of perfection. He added that it appeared impossible to separate or define lines more numerous than 90,000 in an inch on account of the decomposition of light. Yet within a few years after this opinion had been expressed, an object-glass with a one-fiftieth of an inch focus was made which magnified 1,575,000,000 times. This revealed the one four hundred thousandth part of an inch; but it again has been left far behind by a glass recently made in Sweden, which enables us to distinguish the one two hundred and four million seven hundred thousandth part of an inch."]
Tit-Bits, XIV. (1888) p. 310.

MERGIER, G. E.—**Traité pratique de Manipulations de Physique à l'usage des Etudiants en Médecine, précédé d'une Préface par M. le Prof. C. M. Gariel. Optique.** (Practical treatise on physical manipulations for students in medicine. With a preface by Prof. C. M. Gariel. Optics.)
iv. and 251 pp. and 90 figs., 8vo, Paris, 1888.

NELSON, E. M.—**On the Interpretation of a Photomicrographic Phenomenon by the Abbe Diffraction Theory.** *Journ. Quek. Micr. Club*, III. (1888) pp. 273–9.

" " **True and False Images in Microscopy.**
Journ. Quek. Micr. Club, III. (1888) p. 288.

" " **Amphipleura pellucida.**
[Report of resolution with Powell's 1/4 in. objective 1·17 N.A. with dry front, i. e. with 1·0 N.A.] *Engl. Mech.*, XLIII. (1888) p. 51.

SMITH, T. F.—**On True versus False Images in Microscopy.**
Journ. Quek. Micr. Club, III. (1888) pp. 267–72, 288–9.

TANAKADATE, A.—**Note on the Constants of a Lens.**
Journ. Coll. of Sci. Tokio, I. (1888) p. 333.

VEREKER, J. G. P.—**Numerical Aperture.**
Journ. of Micr., I. (1888) pp. 155–66 (4 figs.).

(6) Miscellaneous.

Simple method of Projecting upon the screen Microscopic Rock Sections, both by ordinary and by polarized light.*—Mr. E. P. Quinn "knowing the difficulty experienced in pointing out to students any particular crystal in a rock section when viewed with the Microscope direct, attempted to project the images on the screen, and by the aid of comparatively simple apparatus met with very gratifying success, both with ordinary and with polarized light.

The tube of the Microscope was screwed out and replaced with a cork, through which a hole had been cut to carry the ordinary 1 in. objective, and behind it the analyser of the Microscope. The polariscope and rock section occupied their usual position as when used with the Microscope in the ordinary way. The Microscope-stand being inclined into the horizontal position was placed in front of the object-lens of the limelight lantern. The object-lens of a lantern usually consists of a combination of two lenses. If so the back lens is taken out and the front lens only used, acting as an extra condenser, concentrating the light upon the rock section and causing it to pass through the polarizer and the analyser.

* Rep. Brit. Assoc. Adv. Sci., 1887, p. 725.

A little adjustment of the light was required to get it well through both polarizer and analyser, but this with a little care was soon done, and a bright picture, several feet in diameter, was projected upon the screen, showing the crystals well defined and exhibiting very strikingly the changes of colour, &c., characteristic of the crystals when viewed by polarized light, and in such a manner as to be well seen by a number of people at once and also allowing the lecturer to readily point out any particular crystal or crystals to which he desires to draw the attention of his audience. As the optical axis of the lantern and Microscope did not coincide, the lantern was placed on a board provided with four levelling screws, with which the necessary adjustments were readily made.

Much better effects may be got if the 'Prazmowski' form of prisms made by Zeiss are used instead of the usual Nicol's prism on account of their greater aperture and shorter length, and the most brilliant results with the 1 in. objective of fifty angular apertures (*sic*) by Wray of London."

Microscopy and the Study of Rocks.*—Prof. J. W. Judd thinks there is perhaps just now a danger of our exaggerating the importance of the microscopic method as applied to the study of rocks. That the method has already done much in enabling us to follow out and trace the effects of the slow processes of change within the earth's crust, and that it will do still more in the future no one can doubt. But when it is sought to make the Microscope a "court of final appeal" in geological questions, and in doing so to disregard the importance of field observation, we perceive the same source of danger as is now perhaps being experienced in connection with almost every branch of natural history research. It must be remembered that while the Microscope enables us to see a little more than the naked eye or the pocket lens, yet, nevertheless, between what is actually seen by the very highest powers of our Microscopes and the molecular groupings and reactions which give rise to the varied phenomena of the mineral kingdom, there is room f r almost infinite possibilities. We accept the teaching of the Microscope with all thankfulness, but we recognize the fact at the same time that it has enabled us to get only a very little nearer to the heart of those great physical problems which we aim at solving.

Microscope and Telescope.†—M. J. C. Houzeau, formerly Director of the Brussels Observatory, has a lengthy paper under this title, from which we extract the following:—

"The field of scientific research was immensely widened by the simultaneous invention of the Microscope and Telescope. In the whole course of history there is not another invention which has exerted a similar influence in the sphere of material facts. The circle of individual action was extended in an unexpected degree by gunpowder; it was this which enabled Cortez and his four hundred followers to put to flight armies which outnumbered his own in the proportion of 100 to 1. In the strictly material order of things, gunpowder is the first signal triumph of applied science—of modern science. But we must grant that it had an essentially destructive character; it belonged to the arts of war, which in our social childhood take precedence of the arts of peace.

The second invention which—still in the material world—produced a profound revolution, belonged to the useful arts. This was the steam engine, by which our industrial forces have been enlarged to an enor-

* Nature, xxxviii. (1888) p. 386.

† Bull. Soc. Belg. Micr., xiii. (1887) pp. 90-110.

mous extent; it constituted an addition of energy which was equivalent to the creation of millions of workmen. The steam engines at work in civilised countries represent the labour of ten or twelve times the total number of adult males in the population of the world. This was an acquisition of power, but not of intelligence.

But after these two inventions, the one warlike, the other industrial, there came one belonging to science, that of the Microscope and Telescope, which has had no parallel in history for the extent and the effects of its material results. Outside the world as perceptible by our senses, there was, above and below, a sort of immense envelope, which had for thousands of years escaped the eyes of man. Beyond the boundaries of the visible, both in the large and the little, there was, as it were, a second sphere, vaster than that in which so many generations had lived, which had remained up to that time an impenetrable domain. One day, thanks to what I shall call the new eyes with which man learnt to endow himself, the previously unknown world was revealed to us; and we know now whether it contained sufficient subjects of interest and wonder.

Viewed thus in its glory, the double invention of the Microscope and the Telescope appears a sudden thing. Yet this great and extraordinary extension of the sense of sight was not altogether new. Primitive man could not remain a stranger to certain facts of magnification which, so to speak, forced themselves upon his attention.

When I was living in the Antilles, I once saw a black, who had been brought from his native land of Africa before the suppression of slavery, and who was consequently a savage, looking through a drop of dew at a gnat upon a leaf. This was a temporary observation, unintentional and the effect of chance; still it was none the less an observation, and the chance would naturally recur in certain circumstances. Primitive man could not then be entirely ignorant of the magnifying power of drops of water. . . .

The two instruments, the Microscope and Telescope, thus appear to us as proceeding from the same germ. We see that they were produced at the same time, the beginning of that 17th century to which they were destined to reveal so many marvels, and in the same form, namely a convex lens associated with a concave lens. The first improvement was made contemporaneously in both, by the substitution in both cases of a convex for a concave eye-piece; for the Telescope in 1613 by Scheiner at the suggestion of Kepler, for the Microscope in 1618 by Francesco Fontana. Both profited, so to speak, by Huyghens' idea of using three lenses, and both were at the same time invested with a new power by the application of achromatism. There is a further resemblance; the names of the two instruments remained vague and to some extent confused; the Academy dei Lincei, at Rome, judged it necessary to have distinct names, and a Greek, named Remiscianus, settled in Italy, supplied the two words Microscope and Telescope; so that the two instruments born together received baptism at the same time, after having shared everything at their entrance into the world.

If they have subsequently separated, and if they tend to separate more widely in their construction, it is only in consequence of the different purposes to which they are applied. Practical convenience has led by degrees to distinct arrangements adapted on both sides to the conditions which they have to satisfy. But this diverging course should not make us forget the original similarity of the types. . . .

The invention of the Microscope and Telescope has not only contributed to open out a new sphere to us so vast that we cannot yet realize its extent, but it has also shown us the contrast which exists between our mental faculties and the fertility of nature; we have here an evident proof that the imagination, however potent it may at first appear, is only rich in combinations of known things; it forms combinations of great variety, often fantastic and unnatural; it can magnify or reduce images to any extent; but from its own source it extracts nothing that is really new; and however inventive it may imagine itself to be, it would discover nothing if nature did not supply examples."

Brain Markings.

["A well-known New York physician has just published the sort of discovery which Lord Lytton would have made a novel out of. An aged Polish count, formerly professor of languages and a famous oriental scholar, died in the hospital, and Dr. Rookwood had occasion, in conjunction with other experts, to make a microscopical examination of a certain part of the cerebrum. They noticed a peculiar set of markings, which took the form of Egyptian and Chinese hieroglyphics. These were amplified to a magnitude of 3000 diameters, and the results shown to another oriental scholar, who declared them to be true characters in the Ethiopic, Syriac, and Egyptian languages. Dr. Rookwood suggests that his discovery will lead to extracting from the dead their literary achievements as well as their suppressed opinions."]

Sci.-Gossip, 1888, p. 67.

Conservirung von Zeichnungen. (Preserving drawings.)

[Lay the drawing on a flat surface and pour over it collodion in which 2 per cent. of stearine has been dissolved. In twenty minutes it is dry and fixed.]

Neueste Erfind. u. Erfahr., 1887, p. 571.

DALLINGER, Rev. W. H.—**Memoir.** *Research*, I. (1888) pp. 40–1 (portrait).

Dallinger, Dr., Presentation to.

["'All Sheffield,' of any public note, took its leave of Dr. and Mrs. Dallinger in the Council Chamber of the cutlery metropolis on Tuesday. The Mayor, on behalf of numerous subscribers, presented Mrs. Dallinger with a silver tray, and the Dr. with a substantial sum of money, the value of the gifts being enhanced by the kindest expressions of regard for the recipients. The Mayor regarded Dr. Dallinger's removal from the town almost as a public calamity. The Doctor said that since he came to Sheffield he had been privileged with companionship and friendships and intercourse which had made his life, that was full of labour, equally full of sweetness. His labour during the past eight years had not been barren; some work had been accomplished. He had been enabled, by increasingly powerful instruments, to penetrate still further and further down, but so far as this portion of his life had been serviceable to science, it had been more powerful than it otherwise could have been because he was surrounded by such friends and such interests in this never-to-be-forgotten town. He thanked them for the present to his wife, without whose constant assistance he could never have performed the work that had been done at Wesley College. The gift to himself would be devoted to the purchase of any new instrument that he required, so long as it lasted. He had been working in a department of science that had been absolutely untouched, and he was constantly finding that something was wanting that was not existing in scientific instruments before. It was a source of joy to him that through its gift Sheffield would be permanently represented on the scientific side of his house."]

Christian World, Aug. 16, 1888.

FRITSCH, G.—See Neumayer, G., *infra*.

Gosse, P. H., Hon. F.R.M.S.—Obituary. *Athenæum*, 1888, Sept. 1, pp. 294–5.

Gray, Asa, Hon. F.R.M.S.—Obituary. *Nature*, XXXVII. (1888) pp. 375–7.

[MANTON W. P., and OTHERS.—**Use and Abuse of the Microscope.**]

["Dr. E. L. Nealey, of Bangor, read a paper on the 'Use and Abuse of the Microscope' before the recent meeting of the Maine Medical Society. Our experience leads us to think that most physicians abuse the instrument by not using it."] *The Microscope*, VIII. (1886) p. 217.

NEUMAYER, G.—**Anleitung zu wissenschaftlichen Beobachtungen auf Reisen.** (Guide to scientific observations in travelling.) Contains Fritsch, G., Praktische Gesichtspunkte für die Verwendung zweier dem Reisenden wichtigen technischen Hülfsmittel: Das Mikroskop und der photographische Apparat. (Practical suggestions for the use of two of the traveller's important technical aids: the Microscope and the photographic apparatus, pp. 512–612, 8 figs.)
2nd ed., 2 vols. 8vo, Berlin, 1888.

RUTLEY, F.—**Rock-forming Minerals.**
[Contains chapters on (1) Apparatus, Methods of Preparation, Examination, &c., (2) Propagation of Light, Reflection, Refraction, Double Refraction, Optic Axes, &c., (3) Polarization of Light, (4) Axes of Optical Elasticity, Examination in Polarized Light, (5) Wave Surfaces, (6) Bisectrices and Optic Normal, (7) Examination in Convergent Polarized Light, (8) Pleochroism.]
iv. and 252 pp., 126 figs., 8vo, London, 1888.

VEREKER, J. G. P.—**[On the Choice of a Microscope.]**
Scientif. Enquirer, III. (1888) pp. 152–4.

Wiesbaden, Katalog zur wissenschaftlichen Ausstellung der 60. Versammlung deutscher Naturforscher und Aerzte zu. (Catalogue of the Scientific Exhibition of the 60th Meeting of German Naturalists and Physicians at Wiesbaden.) Edited by L. Dreyfus.
ix. and 224 pp., 8vo, Wiesbaden, 1887.
Cf. also *Zeitschr. f. Instrumentenk.*, VII. (1887) pp. 428–9.
Zeitschr. f. Wiss. Mikr., IV. (1887) pp. 303–25 (1 fig.).

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Cultivation of Schizomycetes in Coloured Nutritive Media.†—Herr Birch-Hirschfeld found three years ago that the comma bacilli of cholera not only retained their lively movements in stained bouillon, but multiplied in a manner similar to what they do in unstained hanging drops. It was afterwards found that other kinds of bacteria, both mobile and immobile varieties, behaved in a similar manner, and this method of staining Schizomycetes was then used by the author for demonstration purposes. Besides fuchsin, other anilin pigments were employed (dahlia, Victoria blue, &c.) For the observation of fission fungi in hanging drops, this method offers decided advantages, as the small and motile forms are more easily found and focused, and the morphological characters of the bacteria are also rendered more evident by the staining of their protoplasm.

The author remarks that bacteriological literature scarcely notices the relation of living bacteria towards anilin pigments, and seems to think that such a method might afford information about the morphological changes bacteria undergo in their development and multiplication, and that inoculation experiments with living stained pathogenic bacteria might help to decide certain questions anent the localization and spread of germs imported into the organism. With regard to these points, it may be mentioned that anthrax bacilli deeply stained with diamond-fuchsin or victoria-blue, and grown on gelatin, retain their virulence quite unchanged.

For observing the morphological changes connected with growth

* 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. Hygeine, vii. pp. 341–53. Centralbl. f. Bakteriol. u. Parasitenk., iii. (1888) pp. 447–9.

and spore-formation, the dyes previously mentioned are of little value, but phloxin-red may be employed with advantage. It is extremely soluble in water, stains spores quite intensely, and cultivations on gelatin and bouillon stained with this dye throve luxuriantly. Experiments on typhoid bacillus made by this method confirmed the formation of spores as first stated by Gaffky. Benzo-purpurin was also found to be a useful dye, as it stained the spores alone, and left the rest of the protoplasm uncoloured.

Cultivation of Anaerobic Micro-organisms.*—Dr. C. Fränkel has invented an apparatus for the cultivation of anaerobic microbes, which he says combines the advantages of the methods of Liborius and Gruber. The nutrient media, bouillon, gelatin, agar, are placed in test-tubes somewhat wider than the ordinary ones. Sterilization, inoculation, &c., are then performed in the usual way. This done, the tube is closed with a caoutchouc plug, through which pass two glass tubes bent at a right angle. One of these reaches to the bottom of the test-tube, the shorter one goes no farther than the bottom of the caoutchouc plug. The exposed extremities are drawn out to fine points, and this arm of the longer tube, besides containing a plug of cotton-wool, is connected with a hydrogen apparatus by means of a piece of rubber tubing. The gas then passes through the nutrient medium and escapes through the shorter leg. When the air is thoroughly expelled, the pointed ends are melted up, and then the medium is spread over the surface of the test-tube in the manner proposed by Ehrlich.

In order to prevent certain sources of error, two points must be rigorously observed; first, the two pieces of glass tubing and the rubber plug must be thoroughly sterilized. This is best done by laying them for an hour in a 1 per cent. sublimate solution. The second source of error is the escape of the hydrogen and the entrance of air. This is avoided by covering the plug with paraffin which melts at about 80°.

When bouillon is the medium, the test-tube can be freed from every trace of air in 1½–2 minutes.

If gelatin be used, then the test-tube must be placed in water at 37° while the gas is passing through. This takes only 3–4 minutes. Agar must be used in 2 per cent. solution to which 1 per cent. grape sugar is added. As the agar solidifies rapidly below 40°, it is necessary to be quick in passing the gas through and wetting off the points. The tube must then be rolled round in lukewarm water or in the hand.

The advantages claimed for this method are cheapness, convenience, and suitability for its intended purpose.

Bacterial Growth between 50° and 70° C.†—Dr. Globig who has been experimenting with Bacteria found in garden mould, made his preliminary isolation in covered capsules of 5–7 cm. diameter, and grew the micro-organisms on pieces of potato. The colonies thus obtained were cultivated in test-tubes on blocks of potato cut obliquely. For the latter step, potatoes were boiled and disinfected with sublimate solution, and then cylindrical blocks punched out of them with a cork-borer, the diameter of which was just less than that of the test-tubes. The blocks were then cut obliquely, and jammed in the test-tubes so that they did not move, and closed with the usual precautions. By this

* Centralbl. f. Bakteriol. u. Parasitenk., iii. (1888) pp. 735-40, 763-8 (1 fig.).
† Zeitschr. f. Hygeine, iii. (1887) p. 295.

procedure 30 different kinds of bacteria were bred, which developed between 56° and 58°. With higher and lower temperatures different kinds of bacteria appeared. At 68°–70°, only a few colonies developed, while if the temperature were lowered to 50° or below, the potato bacillus appeared, and this overgrew all other colonies. The author notes that these bacilli are located on the superficial layers of the mould, and that the sun's warmth must be the most powerful factor in their genesis.

Alkali-Albuminate as a Nutrient Medium.*—Prof. J. Rosenthal and Dr. O. Schulz make alkali-albuminate in the following manner which is simpler than that of Tarchanoff.

The albumen taken from fresh hens' eggs is separated from the chalazæ, and clarified before it is mixed with the alkali solution. This is done in the most simple way by straining the albumen through a bag made of a double layer of muslin. It should be squeezed through slowly with the hand. The filtrate, quite clean and free from bubbles, is then poured into a graduated vessel closed with a ground-glass stopper and diluted with a 1 per cent. solution of caustic soda or potash and distilled water. The proportions are, to every 5 ccm. albumen, 3 ccm. alkali solution, and 2 ccm. water. The mixture is then shaken until it froths, after which it is allowed to stand for some hours, when the shaking is repeated in order that the three constituents may be intimately mixed. The alkali-albuminate is then poured into test-tubes, Erlenmayer's bulbs, or flat glass pans, and heated over water to a temperature of 95°–98° C. for a short time. In a few minutes a jelly is produced, which in thin layers is perfectly clear, in thick somewhat opalescent, but which always possesses the consistence and transparency requisite for a nutrient medium. Heating up to 100° C. should be avoided, as bubbles are produced owing to the vaporization of the water.

The alkali-albuminate may, if desired, be modified by the addition of certain inorganic salts (NaCl, KCl, Na_2CO_3, Na_2SO_4, $NaHPO_4$, &c.), or by diluting with other nutrient fluids; thus the authors have obtained very good results from the following mixture:—5 ccm. albumen and 2·2 ccm. 1 per cent. alkali solution mixed with meat infusion, diluted about one-half with distilled water so that the whole quantity amounted to 10 ccm.

Preparation of Nutrient Gelatin and Agar.†—The practical worker in bacteriology deplores, says Dr. T. L. Cheesman, jun., the loss of time usually attendant upon the preparation, and especially upon the filtration of nutrient gelatin and agar. The method formulated by Koch and closely followed by most workers, is very satisfactory in producing good, clear culture media, but a few modifications render the procedure a much less formidable one, and as the changes to be suggested are simply those of detail, it may be well to state in brief the method now in use in the Bacterial Laboratory of the College of Physicians and Surgeons, New York, which after considerable trial gives uniform and satisfactory results. One pound of finely chopped beef, as free as possible from fat and gristle, is mixed with 1000 ccm. of distilled water and kept in a cool place for 12 or 18 hours. It is then strained, cold, through a coarse cloth, into a wide-mouthed "agate ware" or "enamelled iron" vessel of sufficient size, and 5 gm. of C.P. sodium chloride, 10 gm. of

* Biol. Centralbl., viii. (1888) pp. 307–11.
† Amer. Naturalist, xxii. (1888) pp. 472–3.

pepton, and 100 gm. of gelatin (or 10 gm. of agar) are added. This is then placed in a water-bath (to which a large handful of rock salt has been added, if agar is to be prepared) and the gelatin (or agar) melted as rapidly as possible. The fluid is then neutralized by the careful addition of sodium bicarbonate in solution, and the boiling continued for a few minutes after, in order to precipitate the phosphates.

The fluid is now cooled by running water, to such a temperature as will not coagulate the white of egg, yet not enough to solidify it, when the whites of two eggs, thoroughly beaten up, are mixed with it, and the whole boiled for half an hour.

Filtration which has usually been effected by means of filter paper, can be much more rapidly performed by the use of *absorbent cotton in large quantity*. The pores of the paper become clogged by the fine precipitates and by the cooling of the medium, and even with the use of the "hot funnel" the filtration is sometimes very slow. Cotton, on the other hand, presents in its meshes a much larger surface for the entanglement of the fine precipitates, and when used in large quantity, allows the gelatin (or agar) even when not very hot, to flow through it rapidly. The preparation of the filter is as follows:—The absorbent cotton is unrolled and sterilized in bulk in the hot-air chamber, care being taken not to char it. A 6-in. (15 cem.) glass funnel is packed full with the dry sterilized cotton, placed in in layers, in such a way as to keep it well out of the neck, and having no folds nor ridges of cotton next the glass, through which the precipitates might pass into the receiving flask. The neutralized culture medium, after being boiled with the white of egg, as above described, is strained through coarse flannel into a flask, and poured slowly upon the centre of the filter until the cotton is thoroughly soaked, and the fluid begins to run into the flask below. This moistening causes the cotton to sink considerably, and packs it in the funnel, and when packed, the fluid filters through it almost as rapidly as it is poured into the funnel. The funnel is now filled and the fluid filtered as fast as it will run through. The first filtration seldom produces a clear medium, but through the same filter the fluid may be poured again and again, each time becoming clearer, and the moderate cooling which necessarily occurs, does not sensibly retard the rapidity of filtration. When filtration is completed, a considerable portion of the medium entangled in the filter can be saved, by pressing upon the cotton with a sterilized glass rod, gently at first and near the sides, then in the centre and with considerable force. The gelatin or agar pressed from the cotton is sometimes cloudy, for which reason it is well to catch it in a separate flask.

It not infrequently happens that gelatin which filters clear precipitates phosphates on boiling; and that agar, on cooling, forms a flocculent precipitate. To insure against filling tubes with such media, it is safest always to fill one tube with the medium, and by first cooling, then by boiling and again cooling, to test the permanence of the transparency obtained. Should these precipitates form, it will be necessary to boil the gelatin in the flask, and to refilter it through a small plug of dry cotton placed in a funnel; while agar should be allowed to completely solidify, when it is again melted and filtered through a small plug of cotton. The media are now ready for tubing and sterilizing in the usual way.

The large quantity of absorbent cotton used and the considerable amount of medium lost, by remaining entangled in the meshes of the

cotton (this may amount to 200 ccm. for each of the large cotton filters employed) are unquestionably objections to this method of filtration, but in its favour it may be stated that one filter, when properly packed, serves to clear a large quantity of medium, and the great saving of time in filtering enables one to prepare a large amount of these nutrients at one operation, which may be stored for future use. Furthermore, the "hot funnel" is dispened with.

The modifications here described may be best appreciated by the fact that they render it possible to prepare within three hours several litres of the above-mentioned culture media.

Eggs for Cultivation purposes.*—Dr. F. Hüppe has used eggs in the natural condition for the cultivation of micro-organisms for about twelve months. Fresh eggs are first cleaned and the shell is then sterilized with sublimate solution. They are next washed with sterilized water and wiped with sterilized cotton-wool. This done, an opening is made in the shell with an instrument (previously heat-sterilized) and then the contents are inoculated in the usual way. Before the opening is made the egg is well shaken in order to mix its contents. The opening is closed with a thin piece of sterilized paper, and then the paper coated over with collodion. By this procedure experiments have been made as to the reduction of sulphur compounds to sulphuretted hydrogen and on the cholera bacillus. For the latter purpose the procedure is very favourable, as the conditions resembling those of the intestine with regard to oxygenation are imitated very closely.

Cultivation on Potato.†—M. Roux has for more than a year used the following method of cultivating on potato. Without any disinfecting washing the potato is cut up into long slices and these put into test-tubes about $2\frac{1}{2}$ cm. in diameter. About the lower fourth of these tubes is a constriction which prevents the potato slice from slipping to the bottom. The tubes (not hitherto sterilized) are then plugged with cotton wool and heated in a steam sterilizer to 115° for about 15 minutes. The pieces of potato should be thick enough not to bend. When removed from the sterilizer the surface of the potato is damp, but after being placed in a vertical position in an incubator it dries in a few hours. The potato is then ready for use. The tubes are then covered with a rubber cap and kept till wanted.

This method, by a simple modification, is applicable to the cultivation of anaerobic micro-organisms. For this purpose a side-piece is added to the test-tube just below the constriction. After inoculation the top of the tube is melted up and then the air is evacuated through the side-piece. Another done, this tube is also melted up. The bacilli of malignant œdema, when cultivated in this way, thrive extremely well.

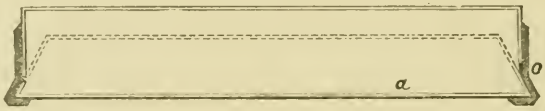
Simple Method for reproducing Koch's Cultivation Plates.‡—Prof. de Giaxa records a simple method for obtaining copies of the colonies on cultivation plates by a system of coarse photography. After the plate has been removed from the moist chamber, its under surface is wiped with blotting-paper moistened with ether, and it is then placed on a piece of albumen paper which has been sensitized with nitrate of silver. The plate and paper supported by a board are then covered with

* Centralbl. f. Bacteriol., u. Parasitenk., iv. (1888) pp. 80–1.
† Ann. Inst. Pasteur, 1888, p. 28 (2 figs.).
‡ Centralbl. f. Bakteriol. u. Parasitenk., iii. (1888) pp. 700–2 (1 fig.).

a bell-jar. These manipulations are carried out in a dark room, and having been finished the apparatus is placed in the sunlight about half a minute. The paper is next repeatedly washed in a dark room to remove the excess of silver, then placed in a gold chloride bath, and afterwards fixed in one of hyposulphite of soda. After this it is well washed and finally dried.

Babes' modified Cultivation Vessel.*—In fig. 151 is shown Dr. V. Babes' recent modification of his cultivation capsule. In this the edge of the lower pan is made oblique, *a*, so that the agar does not slip down when the capsule is turned about in microscopical examination.

Fig. 151.



The condensation water now no longer drops upon the cultivation, but runs away down a fissure between the upper and lower pans (at *c*). Vessels made with this shape are much less exposed to infection from without than those with parallel edges. The cultivation can be closed up by means of a rubber ring *c*.

Cooler for quickly setting Gelatin Plates.†—Dr. A. Pfeifer recommends instead of the glass apparatus usually employed, a box made of zinc plate (the sides = 25 cm. each, and the height = 1½-2 cm.) and supported at each corner on cast-iron feet. When filled with water the box may be made to acquire any temperature. Water from 8°–10° R. suffices to set gelatin in a very short time, and when manipulating agar plates, warm water may be used to prevent the agar from setting too quickly. This apparatus does away with ice, is very cheap, certain, and saves a lot of time.

Collecting and Preparing Characeæ.‡—Mr. T. F. Allen says that to gather Characeæ successfully a dredge must be used; for shallow water a small fine-toothed rake is preferred, but for deeper water (one rarely finds them at a greater depth than 10 feet) the dredge and line are essential. The best dredge for all purposes is the one recommended by Prof. Nordstedt, made as follows:—A disc of lead about 3 in. diam., and 3/4 in. thick has imbedded in its circumference a row of hooks, about 10 in number; through the centre of this disc is passed an iron rod, which projects about 3 in. below the disc, and about 9 in. above; to the ring in the upper end toward which the points of the hooks are directed, a cord is attached. The dredge weighs about 2½ lb., and catches all sorts of "weeds" growing on the bottom.

The dissection of these plants is perfectly simple. The delicate species are placed in water until their normal form is restored (if they have been dried), and a portion is put in a "cell" on a glass slide, and examined under a 2 in. objective; sometimes, but rarely, a higher power

* Centralbl. f. Bakteriol. u. Parasitenk., iv. (1888) p. 26 (1 fig.).
† Deutsche Med. Wochenschr., 1887, No. 42.
‡ 'The Characeæ of America.' Cf. Amer. Naturalist, xxii. (1888) pp. 455-7.

is needed for determining fine points, such as the structure of the cortex. Should these species be incrusted with lime, a piece should be placed in a little strong vinegar till the lime is completely dissolved, then washed in pure water and examined. Specimens foul with mud must be cleaned in water with a camel's hair brush, but this is liable to detach the globules of fruit, and is only occasionally to be resorted to. Should it be desirable to preserve bits for future reference, they are best mounted in glycerin-jelly, in cells deep enough to avoid crushing, and shallow enough to permit free examination (flattened brass curtain-rings make excellent cells). When the jelly has dried at the edges, turn on a ring of white zinc cement.

Cultivation of Lichen-forming Ascomycetes without Algæ.*—Dr. A. Möller has, in a number of lichens, especially crustaceous lichens, succeeded in cultivating on nutrient media the fungus from ascospores and spermatia to the exclusion of gonidia, considerable thalli being formed, and in two kinds even spermogonia. The cultivations were rendered difficult in one way by the extremely slow growth of the objects, and in another by the presence of bacteria and saccharomyces. To meet the latter inconvenience the author took the apothecia from places which were as free from dust as possible, and placed them under a stream of water for 10 minutes, and by so doing a few pure cultivations were obtained. When the cultivations on the slides had become visible to the naked eye they were placed in flasks of the same shape as Erlenmayer's bulbs, some in nutrient media, some on sawdust &c., and the flasks closed with filter paper.

Apparatus for Infecting.†—Herr N. W. Diakonow proposes the following plan for the culture of fungi. The advantages claimed for the process are:—(1) the absolute purity of the culture from admixture with any other species; (2) the possibility of carrying on the culture in several different vessels at the same time; and (3) the equal distribution of the spores over the whole surface of the nutrient fluid, and the consequent unimpeded growth of every separate mycelium. The author has cultivated *Penicillium glaucum* with great success in this way.

The apparatus (fig. 152) consists of a centre-vessel A, and a number of side-vessels C surrounding it in a circle. To the upper neck of A is fixed, by an india-rubber connection, a tube B, dipping deep down into the vessel; the upper broad half of this tube is loosely filled with cotton-wool; the whole tube is easily movable in all directions. A number of short glass tubes *a*, usually from 4 to 7, are fused into the vessel A in a horizontal plane, at equal distances from one another. To these glass tubes *a* are fixed, by india-rubber connections, the side vessels C of any desired form and size. Each of these vessels has a small glass tube *c* fused into it at the same level as the tubes *a;* the ends of these tubes, about 2 cm. in length, project into the vessels, and are curved at right angles downwards.

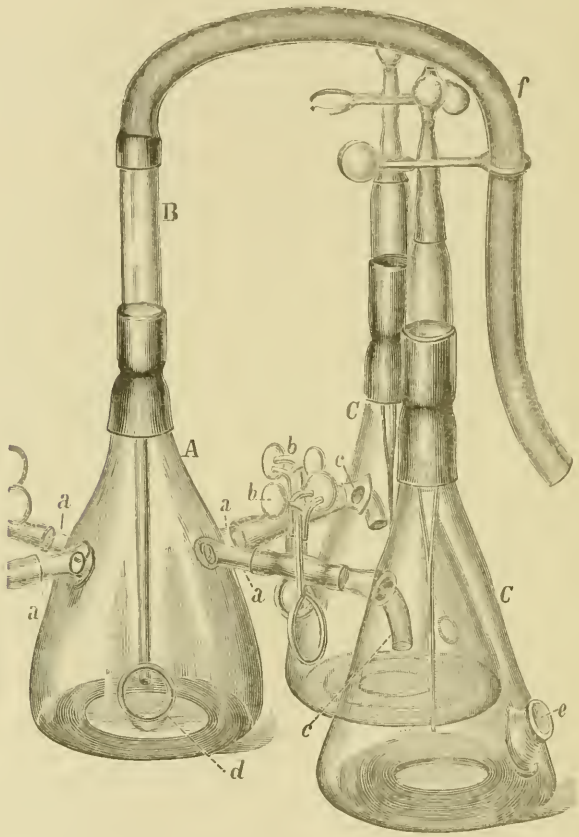
When the apparatus is about to be used, each of the side vessels is provided either with the same or with different nutrient fluids. In the centre vessel is also placed a nutrient mixture of glucose and peptone. The side-necks *d* and *e* are then stopped with wads, and all the vessels sterilized at the same time by boiling. During the boiling the cocks *b*

* Unters. Bot. Inst. Münster i. W., 1887, 52 pp.

† Ber. Deutsch. Bot. Gesell., vi. (1888) pp. 120–6 (1 fig.).

are left open, so that the steam may produce its sterilizing effect in all parts of the apparatus. When the sterilizing is completed, the cocks *b* are closed, and then, after cooling, the germs are introduced with all

Fig. 152.



needful precautions, into A through the side-neck *d*. As soon as the conidia in A have developed fertile mycelia, the infection of the side-vessels may be effected.

For this purpose the side-neck *d* is closed by an india-rubber cap or in some other way, and an india-rubber tube *f* fixed to the glass tube B. The cocks *b* are then opened, the tube B moved by the hand in all directions, and a current of air blown through *f* and B into the centre vessel A; and the conidia are thus blown through the connecting-tubes *a* and *c* into all the side-vessels C. The side-vessels can then be detached at pleasure.

Hansen.—La culture pure de la levure. (The pure culture of yeast.) *Mon. Scientif.*, XXIX. (1887) p. 1033.

Jackson, R. T.—Catching fixed forms of Animal life on transparent media for study. *Science*, XI. (1888) No. 275, 3 pp.

KLEMENSIEWICZ, R.—Ein Vegetationskasten für niedrige Temperatur. (A culture chamber for low temperatures.) *Wiener Klin. Wochenschr.*, 1888, p. 283.

NOEGGERATH, E.—Ueber eine neue Methode der Bacterienzüchtung auf gefärbten Nährmedien zu diagnostischen Zwecken. (On a new method of bacteria cultivation on coloured nutrient media for diagnostic purposes.) *Fortschr. d. Med.*, VI. (1888) pp. 1–3 (1 pl.).

UNNA, P. G.—Die Züchtung der Oberhautpilze. (The cultivation of skin fungi.) *Monatschrift für Prakt. Dermatol.*, 1888, pp. 465–76.

ZAGARI, G.—La Coltura dei Micro-organisme Anaerobi. (The culture of anaerobic micro-organisms.) *Giorn. Internaz. Sci. Med.*, 1888, p. 218.

(2) Preparing Objects.

Effect of Hardening Agents on the Ganglion-cells of the Spinal Cord.*—Dr. S. Trzebinski has experimented on a number of hardening media to ascertain whether and in what way they affect the ganglion-cells of the spinal cord in rabbits and dogs.

(1) Müller's fluid: hardening 4 to 5 weeks. The preparations were either washed before being placed in spirit, or were placed in spirit in the dark without being washed. The spirit was from the first of 96° or it was made weak (10°), and increased in 5 days to 96°.

(2) Hardening in spirit either of 96° at once or by increased strengths as in No. 1.

(3) Hardening in chromic acid. The preparations were placed for 6 hours in a 0·1 per cent. solution, then for 48 hours in a 0·25 per cent. solution, and were afterwards hardened in spirit or in a mixture of Müller's fluid and spirit.

(4) Hardening in 10 per cent. sublimate solution (8 days) with subsequent hardening in spirit which contained 0·5 per cent. iodine.

The stains used were, borax-carmine, alum-carmine, with or without previous staining in Weigert's hæmatoxylin solution, magenta-red, and Weigert's method. Fresh preparations were coloured with methyl-green. In fresh preparations stained with methyl-green the ganglion-cells were on the whole well stained, their finer structure recognizable, and there was no evidence of pericellular spaces. In all the preparations treated by the above hardening methods the ganglion-cells were altered, (1) pericellular spaces appeared; (2) vacuoles in the cell-substance; (3) the cell contents did not show the same structure as in the fresh cells; (4) the susceptibility of the cell contents for dyes had become inconstant. On the whole the most satisfactory method seemed to be the sublimate process which was followed by iodized alcohol.

Sublimate as a Hardening Medium for the Brain.†—Herr A. Diomidoff hardens brains and cords in 7 per cent. watery sublimate solution. The preparations, which should not be larger than 1 ccm., are left in the solution not longer than five to nine days, and then passed through successively 50°, 70°, and 90° spirit. In each spirit the preparation remains about twenty-four hours, so that the whole hardening occupies about eight days.

The chief point in the author's paper consists in his observation that all hardening fluids which contain mercury salts alone or in combination with silver solutions, or solutions of the latter in combination with chromic or copper salts, produce after long action on nerve prepara-

* Virchow's Archiv, cvii. (1887) pp. 1–17.

† Wratsch, 1887, pp. 472–4. Cf. Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 499–500.

tions, precipitates or albuminates which are indistinguishable from natural pigment, and for which they have been repeatedly mistaken.

Preparations hardened in the above manner can be made into very thin sections, and are easily stained with anilin colours, but are not susceptible of being treated by Weigert's hæmatoxylin method. Safranin stains the chromoleptic substance very beautifully. Over the freezing and alcohol hardening the sublimate alcohol method has the important advantage of not altering the contour of the cells.

With regard to the pigment produced along the vessels and in the nerve-cells, it was found that it disappeared entirely therefrom after long immersion in warm distilled water. Alcohol and ether had no effect except to change the black into brown. Caustic potash dissolved in spirit or 25 per cent. acetic acid had no action. 25 per cent. nitric acid destroyed it slowly, while a 30 per cent. solution of iodide of potassium converted it into a yellow-brown, and the strong Lugol solution quite effaced it in five minutes. Cold distilled water dissolves it after several weeks.

This artificial black pigment, according to the author, is either a compound of a metal and of albumen, or the result of a simple mechanical saturation of the tissue, probably the former.

Preparation of Criodrilus lacuum.*—In his investigation into the structure of *Criodrilus lacuum* Dr. A. Collin examined living specimens, and sections prepared with Jung's microtome. Hardening was generally effected by a mixture of one part of corrosive sublimate and one part 70 per cent. alcohol. The pieces were left in the mixture for from thirty minutes to one hour, according to their size. They were then placed in water or weak spirit for some time, dehydrated by alcohol and chloroform, and imbedded in paraffin. Neither chromic nor picric acids are adapted for hardening worms. Specimens were killed with chloroform, and died without any violent muscular contraction. The staining of the pieces was best effected by ammoniacal picrocarmine; the sections were successfully stained by methylen-blue or borax-carmine with acetic acid; the former coloured the ganglionic cells, and the latter the nuclei of the epithelia and of the connective tissue. Macerations were effected partly with Müller's solution and partly with potash.

Method of Preparing Tegumentary Filaments of Flagellata.†—M. J. Künstler refers to the well-known fact that flagellate Infusoria, when treated with certain reagents, become covered with a variable, though often very considerable quantity of filaments, which are sometimes very long, and that an analogous phenomenon may be observed in ciliate Infusoria. In the latter, however, each filament is derived from a small refractive capsule, placed in the peripheral layer of the body. Till their homology shall be disproved all these processes may be called trichocysts. The best way to prepare them is to treat perfectly fresh specimens with concentrated osmic acid, so as to fix them, and then to colour them very slowly by diffusion by means of picrocarminate of ammonia. A less delicate method, by which one can at least determine whether or no a given species has trichocysts, is to fix a specimen with concentrated

* Zeitschr. f. Wiss. Zool., xlvi. (1888) pp. 474–5.
† Comptes Rendus, cvii. (1888) pp. 138–9.

osmic acid, and colour it with Collin-black acidulated by chromic acid to which glycerin has been added.

New Method for making Microscopical Preparations from Test-tube Cultivations.*—Dr. R. Fischl recommends the following procedure for obtaining microscopical preparations from test-tube cultivations:—By means of a cork-borer the central track is removed from the gelatin. This gelatin cylinder containing the micro-organisms is then placed for 24–48 hours in 96 per cent. alcohol or in a mixture of equal parts of ether and alcohol, and then sectioned on a microtome between cork layers. The sections are then stained by Gram's method, the micro-organisms alone retaining the stain. The author has applied the foregoing to the examination of ferment-fungi with excellent results.

Chitin Solvents.†—Mr. T. H. Morgan reports the results of experiments which he has made with chitin solvents. He followed a prescription recommended by Dr. Loob,‡ namely, Labaraque solution (potassium hypochlorite) and Javelle solution (the corresponding sodium compound). Mr. Morgan used the solutions successfully in two forms, strong as in the commercial fluid, weak when diluted from five to six times with water. In most cases the strong solution acts too rapidly and powerfully. The preparations after removal of the chitin were hardened in picro-sulphuric acid, corrosive sublimate, or different strengths of alcohol. The method was also used for specimens already hardened and preserved. The experiments seem to show that something else in the compound besides free chlorine is brought into play.

Preparing Slides to show Brownian Movement.§—Prof. H. M. Whelpley says that permanent mounts to illustrate the phenomenon of pedesis are not difficult to make, "provided, however, that the motion does not cease after a few days, as claimed by some authorities." He has "no reason for doubting the statement of one writer, who says he has a mount six years old that shows the movement nicely and as well as it ever did." Place a well-cleaned slide on the turntable and run a ring of cement on it about 0·5 mm. high. In warm weather, or in a warm room during winter, the cement will become sufficiently dry in a half hour to permit of finishing the mount. This is accomplished by placing in the cell a large drop of a liquid made by mixing carmine or other powders ‖ with 100 times its volume of water, and placing in position a well-cleaned cover-glass. When the cover is pressed down, the superfluous liquid will be pressed out and the fresh cement will hold the cover firmly to the cell. The pressure reduces the depth of the cell to about 0·25 mm. The slides should be washed to remove any particles of the powder that may have run out with the liquid and been deposited on the cover-glass. When dried it is ready for use, and such a mount, at least as far as the mechanical part is concerned, will last a lifetime. Either white zinc cement or Brunswick black can be used.

* Fortschr. d. Med., v. (1887) p. 653.
† Stud. Biol. Lab. Johns-Hopkins Univ., iv. (1888) pp. 217–9.
‡ See this Journal, 1885, p. 896.
§ Amer. Mon. Micr. Journ., ix (1888) pp. 125–7.
‖ Vermilion, cobalt, wood charcoal, indigo, camboge, pumice stone, carbonate of lead, glass.

BENDA, C.—**Eine neue Härtungsmethode besonders für das Centralnervensystem.** (A new hardening method especially for the central nervous system.)
Centralbl. Med. Wiss., XXVI. (1888) p. 497.

GIESON, J. VAN.—**A Résumé of recent Technical Methods for the Nervous System.**
Journ. Nerv. and Mental Diseases, XIV. (1887) p. 310.

GIFFORD, J. W.—**Preparations for High Powers.**
[Beale's glycerin-carmine fluid—Gum and glycerin and glycerin jelly—Modification of Flemming's chromo-aceto-osmic acid.]
Journ. of Micr., I. (1888) pp. 152–4.

KLEIN, L.—**Beiträge zur Technik der mikroskopischen Dauerpräparate.** (Contributions to the technique of permanent microscopical preparations.)
MT. Bot. Vereins Freiburg, 1888, Nos. 49–50.

RUDANOWSKI.—**Making Microscopical Nerve Preparations by dividing the nerves into primitive bundles by chemical processes, and the latter into their component parts.** *Russkaja Medicina*, 1887, No. 38 (Russian)

WOODHEAD, G. S.—**Method of preparation of large sections of the Lung.**
Brit. Med. Journ., 1888, p. 737.

(3) Cutting, including Imbedding.

Photoxylin for Imbedding.—Dr. Krysinski * suggests the use as an imbedding substance of photoxylin, a kind of pyroxylin used by Russian photographers, and which he considers superior to celloidin on account of its keeping without deterioration, and remaining clear in solution or mass. Mr. G. M. Beringer,† who has experimented in the production of photoxylin, finds that the following formula gives the best results:—Nitrous acid, 43° R., 3½ lb. av.; sulphuric acid, 4½ lb.; potassium nitrate, granular, 8 oz.; wood pulp, 4 oz.

The nitrous and sulphuric acids are mixed in an earthenware crock and allowed to stand until the temperature has fallen to 90° F., when the potassium nitrate is added and thoroughly incorporated with the acid mixture. The wood pulp is then immediately immersed in the mixture and allowed to remain for twelve hours. It is then removed from the acid and thoroughly washed.

The material thus obtained is quite soluble in equal parts of ether and absolute alcohol. For general work Krysinski recommends two solutions; a thin solution (1/2 to 1 per cent.), and a 5 per cent. The specimen is placed from strong alcohol into the thin solution, to remain from twelve to twenty-four hours, when it is transferred to the thicker solution. To fix the specimen before cutting, it is only necessary to place it on a cork. A film soon spreads over the mass, which is then submerged in 70 per cent. alcohol, and after two or three hours is ready for sectioning.

Paraffin-imbedding Process in Botany.‡—Within a few months there have appeared two articles § on this subject, and as Mr. D. H. Campbell has been devoting some attention to it lately, he thinks it may be of interest to state briefly the results obtained. It was found convenient to combine to some extent the methods given in the articles referred to, as neither was found in all respects satisfactory, and some simplifications of the processes were made which were found advantageous.

* Virchow's Arch. f. Path. Anat. u. Hist., 1888. Cf. The Microscope, viii. (1888) p. 183. † Amer. Journ. Pharm., 1888. Cf. ibid.

‡ Bot. Gazette, xiii. (1888) pp. 158–60.

§ Schönland, S., Bot. Centralbl., xxx. (1887) pp. 283–5. See this Journal, 1887, p. 680. Moll, Bot. Gazette, xiii. (1888) pp. 5–14. See this Journal, *ante*, p. 315.

The experiments were made upon the germinating macrospores and the young embryos of *Pilularia globulifera*, and the results obtained warrant a very strong recommendation of the imbedding process where the sectioning of very delicate tissues is necessary; indeed, when the results thus obtained are compared with the imperfect and uncertain methods ordinarily used in such work, no one who has used both will hesitate as to their comparative merits. With the firmer plant tissues there is usually no necessity for any imbedding process, and owing to the time and care necessary to successfully apply this method, it is not to be recommended in such cases.

In regard to the best hardening agents, Schönland and Moll disagree, the former recommending alcohol, which Moll does not consider satisfactory, preferring chromic acid or the mixture of chromic, osmic, and acetic acids used by Flemming. There is no question that for many purposes absolute alcohol is to be preferred, owing to its convenience and the perfection with which it ordinarily preserves all plant tissues. With mixtures of chromic, picric, or osmic acid thorough washing is necessary after hardening; but as Moll rightly remarks, where cuticularized cell-walls are present it is extremely difficult to get the paraffin to penetrate such membranes, whereas it is much easier where fixing solutions containing chromic acid are employed. A practical illustration of this was found in the very thick-walled macrospores of *Pilularia*.

After the material is thoroughly hardened, and, in the case of alcoholic material, allowed to remain for twenty-four hours in borax-carmine, it is treated as described by Schönland. For the gradual transfer from 30 per cent. to absolute alcohol the Schultz apparatus * was found most serviceable.

The following method of imbedding was found practical and simple: —A small paper box is made by taking a strip of pretty firm paper and winding it tightly about an ordinary cylindrical cork, fastening the paper with a little gum arabic, and holding it in place with a pin until dry. On taking out the pin the paper cylinder can of course be slipped off the cork. The box is completed by cutting out a round piece of paper of exactly the size of the cylinder, and putting this into the cylinder as the bottom of the box. The object to be imbedded is placed horizontally upon the bottom, and the melted paraffin poured over it, after which the whole is placed in a shallow flat-bottomed vessel filled with melted paraffin. Thus there is no possibility of the paraffin's escaping, which otherwise it is almost impossible to prevent, and there is also no necessity of handling the objects after they are once in the paraffin, which in the case of small objects is a great advantage. In case the objects are displaced in pouring the paraffin over them, it is a simple matter to adjust them, using a heated needle for this purpose.

In order to insure thorough saturation, the objects were usually left overnight in the melted paraffin, and then, as in the articles mentioned, quickly cooled to avoid the formation of bubbles. The vessel containing the paper boxes may be exposed to the air for a few minutes until a thin film has formed over the surface of the paraffin in the latter, when these may be quickly lifted out and plunged into cold water. As soon as the paraffin is thoroughly hard, the pasted seam in the paper cylinder may be loosened with the blade of a knife or scalpel, when it will be found

* Strasburger, Bot. Prak., 2nd ed.

that the paper separates readily from the inclosed paraffin, and on removing the bottom of the box in the same way the result is a solid cylindrical block of paraffin, with the object to be cut lying horizontally close to the smooth lower face, so that the sectioning is easily regulated.

Schönland recommends paraffin with a melting-point of about 45° C., but the author found this much too soft to cut well, and prefers (as Moll recommends) a harder sort, melting at about 50° C. Schönland again says that a temperature above 50° C. is to be avoided, but in no case has the author found that a temperature of 50°–55° C. was in the least degree hurtful.

For sectioning the rocking microtome used by Schönland was employed, and found in every way satisfactory.

Moll describes fully the fixing processes, but the author's experience has been that it is not desirable to hasten the staining process. Safranin was mainly used, and the best results were had by allowing the sections to remain for about twenty-four hours in a very dilute watery solution. At the end of this time they should be deeply stained. The slide is then plunged in absolute alcohol until the excess of the colour is removed, and when this is accomplished, and most of the alcohol has been removed from the slide with a cloth or blotting-paper, taking care of course not to touch the sections, a few drops of xylol are applied, and allowed to remain until the sections look perfectly transparent, when a drop of Canada balsam dissolved in xylol or chloroform may be applied, and a cover-glass put over the preparation, which is now complete.

The employment of soft paraffin in order to make the sections adhere, as described by Schönland, is quite unnecessary, as the sections adhere perfectly without this; indeed, it is much easier to get a good ribbon of sections without the soft paraffin than with it, owing to the difficulty of perfectly removing the surplus soft paraffin.

Further Notes on Celloidin Technique.*—Dr. S. Apáthy communicates some further instructions for manipulating celloidin by way of supplement to his previous paper.†

(1) How to keep celloidin blocks.—If cork be used for sticking the celloidin blocks on, it must first be saturated with soft paraffin in order that the 70–80 per cent. spirit in which the object is to be preserved may not be spoilt by the tannic acid. But as celloidin will not adhere to paraffin, the latter must be shaved off from one end, and then this end, together with the celloidin block which has been stuck on, is plunged for a second in some paraffin heated above its boiling point. In this way a block of celloidin can be kept even without spirit without any danger of its becoming dry. Sectioning must, of course, be done with a dry knife. The thin casing of paraffin, even if it does not fall off of itself, can be dissolved at once in bergamot oil, and offers no difficulty. If it be desired to discontinue making sections, it is only necessary to cover the exposed surface with a drop of paraffin.

(2) Writing on celloidin.—Mark the bottom of the paper case in which the object is to be imbedded with a lead pencil. Then, when the paper case is stripped off from the block consolidated in 70–80 per cent. spirit, the writing will be found transferred to the celloidin, and in order to

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 45–9.

† See this Journal, *ante*, p. 670.

preserve it there it is only necessary to brush over the surface a layer of thin celloidin.

(3) Staining of the series.—The arrangement of unstained sections or of very small objects may be facilitated by adding to the bergamot oil a few drops of an alcoholic solution of safranin. The sections stained rose-colour are then easily visible. This staining of the celloidin disappears in a day or two, and in a few hours after exposure to sunlight. If now the series, which is placed on a slide, and from which the oil has been mopped up, is to be stained, the slide is placed in a capsule, on the bottom of which are a few drops of ether and absolute alcohol. The series clears up at once, and the celloidin is so far softened that it cleaves firmly to the slide. As soon as drops of ether and of absolute alcohol appear on the slide, it is at once removed to another capsule containing 90 per cent. spirit, whereby the celloidin is hardened, and all trace of the bergamot oil removed. After a quarter of an hour the slide may be placed in any stain which is free from water or contains at least 70 per cent. spirit. If aqueous staining solutions are to be used, care must be taken that when exposed to the alcohol-ether vapour the celloidin sections overlap, or at least touch, so that the series may be treated as one large section.

(4) Applying direction-lines to the celloidin block.—As a general rule, the sides of the block suffice as direction-lines, provided that the celloidin is distinguishable from the outline of the object. This distinction may be rendered more evident by adding to the fluid celloidin or to the bergamot oil a few drops of some pigment dissolved in 90 per cent. spirit, such as picric acid or carmine, dyes which stain celloidin much more quickly than the object.

If it be necessary that the position of an object should be very accurately determined, it is better to imbed in the celloidin a thin plate of gelatin and to arrange the object upon this. By this means there is in each section a fixed outline with fixed end-points, and for the purposes of plastic reconstruction leaves little to be desired as regards orientation.

(5) Modification of the method of staining with hæmatoxylin and the chromic acid salts.—The author finds that a modification of Haidenhain's method for staining celloidin series prevents the sections from becoming overstained and brittle. He now uses hæmatoxylin and the chromic salt in 1 per cent. solutions in 70–80 per cent. spirit. The bichromate solution is made by mixing 1 part of a 5 per cent. solution of bichromate of potash with 4 parts of 80–90 per cent. spirit. Not only must the solution be kept in the dark, but the object must be stained, treated with alcohol, and imbedded in the dark.

Bruce's Microtome for cutting whole sections of the Brain and other organs.—This instrument (fig. 153) was designed by Dr. A. Bruce to meet the requirements of those who wish to cut sections of 4 in. diameter and upwards. The construction was necessitated by the inconveniences which were found to attach to large microtomes made after the manner of Rutherford's microtome. The method of freezing adopted in Rutherford's instrument is well adapted for freezing tissues of moderate size, where the freezing mixture is at a small distance from the tissue, but is quite unsuited for a tissue of 4 or 5 in. diam., where some part of the object to be frozen would be at least $2\frac{1}{2}$ in. from the freezing mixture.

In the new instrument freezing is effected by laying the object to be

frozen upon a zinc plate A connected with metallic pillars, which are surrounded by a freezing mixture, as in the Williams microtome. In order that the plate may be quickly and effectively cooled to a temperature sufficient to freeze a tissue placed upon it, it is put in con-

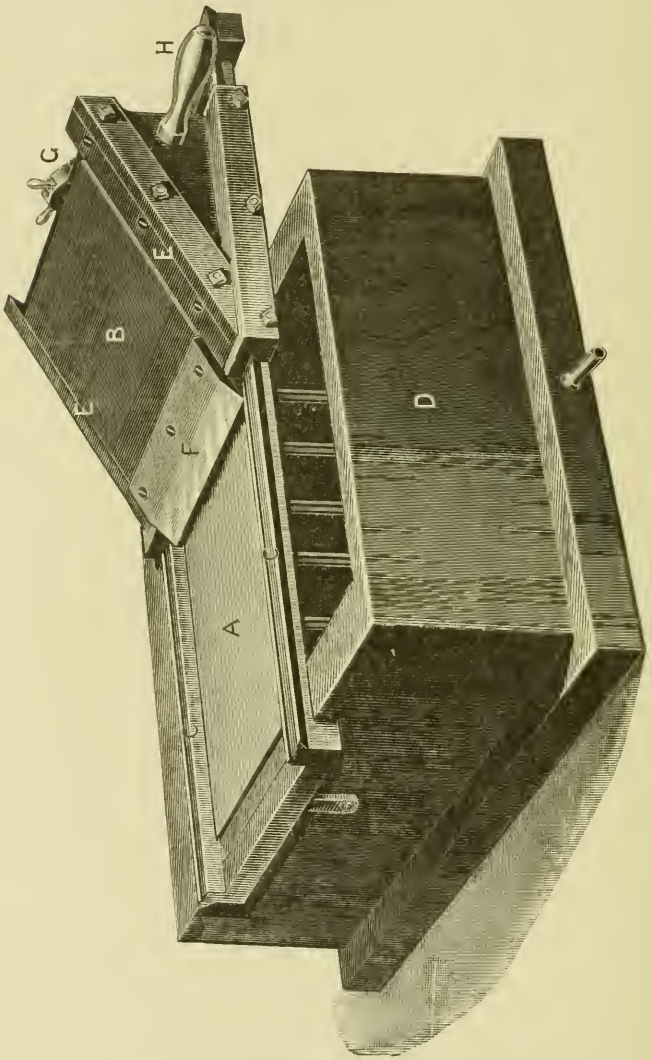


Fig. 153.

nection, not with one, but with twelve pillars, which rest upon the bottom of the freezing-box D, and are in close metallic contact with the plate. In order to further increase the effect of the freezing mixture, the pillars are made of a cruciform shape in their transverse section, as shown in fig. 154. The freezing mixture of ice and salt is passed between the

pillars and against their arms, and this process is found so effective that tissues of 6 in. diam. and upwards, and half an inch in thickness, are frozen through in twenty minutes. Dr. Woodhead has made a further improvement in the method of freezing by placing a shallow box filled with a freezing mixture upon the plate. This box, the under side of which is immediately over the tissue to be frozen, considerably accelerates the freezing process.

Fig. 154.

The knife F is attached to a plate B, which slides in grooves in the "plough" E E, and is moved forward or backward by a screw. The capstan head is shown at G. As the knife is placed obliquely, it moves but a small distance vertically for each forward movement of the screw, so that a comparatively coarse screw is as efficient as a fine one would be if acting vertically. The plough is moved backwards and forwards by two handles, one of which is shown at H, travelling in the rails at C C. All the parts are made with "fitting strips," as in a slide-rest, so that wear may be readily taken up.

The dimensions of the apparatus are as follows:—Freezing-box, length 22 in., breadth 12 in., depth 8 in.; rails upon which the plough slides, 34 in. long and 1½ in. wide; plough, 14 in. long and 8 in. high; knife, 9 in. on cutting face.

The microtome is made by Mr. A. Frazer, scientific instrument maker, of Edinburgh.

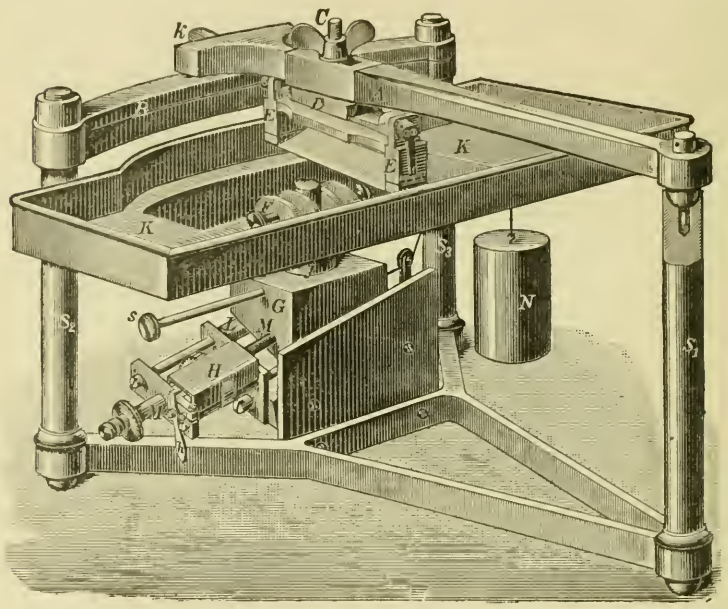
Thate's New Microtome.*—Herr P. Thate has invented an immersion microtome which possesses advantages in its arrangement of the knife-carrier and circumvents certain difficulties inherent in the sliding microtome. It is fully represented in fig. 155.

The three columns S_1 S_2 S_3 are connected near their base by a triangular cast-iron piece. The pillar S_1 is hollowed out at the top, so that the arm A, about 50 cm. long, may be worked through the ball-joint. The columns S_2 S_3 are joined by the arciform piece B, along the upper surface of which the end of the arm A, expanded at its extremity, works. The expanded end of A is supported on two hard steel knobs. The arm A is moved to and fro by the handle *k*. About 20 cm. from its free end the piece A is perforated by a slit through which the tap of the binding-screw C projects, and by means of which the knife-carrier is clamped to the arm A. For this purpose the lower end of C is swallow-tailed, so that it may be pushed into a corresponding opening in the double piece D, and that when the binding-screw is tightened it is fixed to the arm A. The ends of D are gripped by the block E E, joined together by a flat horizontal plate. To the under surface of E E the ends of the knife are screwed, while through their upper extremities pass the screws binding E E to D. Consequently, by altering the screws in E E and the screw C, the knife can be placed in any desired position. The amount of vertical movement of the edge of the knife, which, of course, moves through part of a circle, is shown by the indicator at E. F is the clamp for holding the specimen, and K the pan or well which contains the fluid, water, or spirit. The clamp and well are formed in one piece and fixed to the tube J, which in its turn passes through the block G, and is fixed in any position by the binding-screw S. The fine-adjustment of the block is effected by the micrometer-screw M,

* Zeitschr. f. Instrumentenk., viii. (1888) pp. 176–7 (1 fig.).

which passes through G, and the latter in its turn is supported on an inclined plane formed by the bars L. Every raising of the block G, 0·005 mm., is indicated by an audible click produced by the plate H. The last arrangement is ungeared by means of the handle *h* when the

Fig. 155.



coarse-adjustment of the preparation is necessary. The pressure of the block G on the micrometer-screw is obviated by the counterpoise N suspended by a cord running over two rollers.

Accessory for rapid Cutting with the Thoma Microtome.*—Herr J. Erdös has devised an arrangement for the Thoma microtome whereby the knife-carrier is set in motion by pedals, thus leaving both hands free to manipulate the sections, &c. This is claimed to be an improvement, as heretofore the right hand was employed in moving the knife along, &c., while the left was used merely for preventing the section from rolling up.

A plate about 1½ cm. in diameter, and perforated by a hole in its centre, is fixed to the knife-carrier by means of its binding-screw. Either end is terminated by a small hook. These hooks are connected with cords which run over pulleys (see fig. 156) to pedals. On the end of the microtome farthest from the pulleys, the cord runs over two pulleys, on the nearer side over one. Both cords then pass over another pair of pulleys which are fixed to the edge of the table, and then pass down to the pedals.

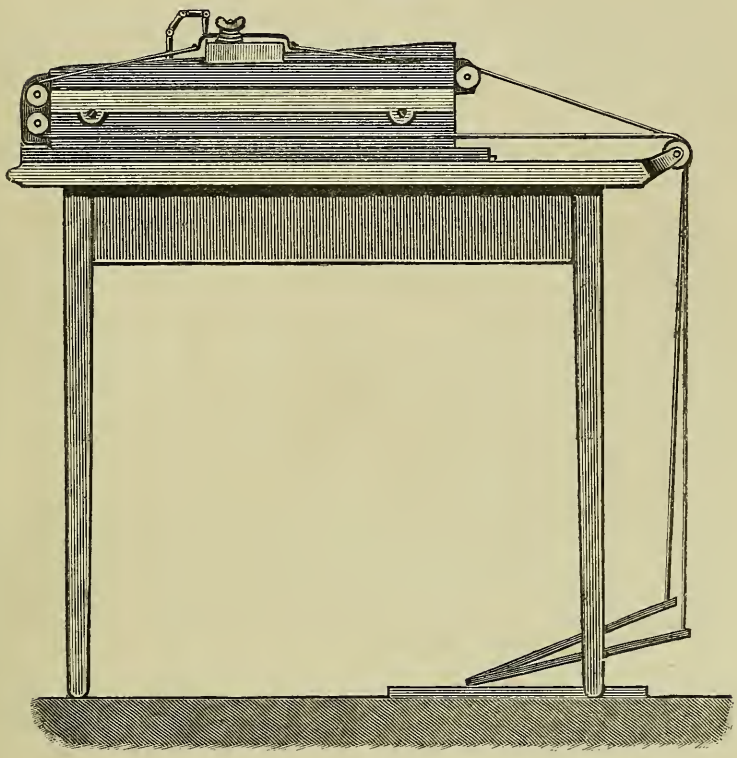
It is advised to fix the microtome to the table by means of strips of

* Internat Monatschr. f. Anat. u. Hist, ii. (1885) pp. 343-6 (1 fig.).

wood nailed to the table round the instrument, so that it cannot move while being worked.

The sections are prevented from rolling up by fixing in the joint of

Fig. 156.



the object-holder a camel's-hair brush, so that the latter just touches the surface of the section or the paraffin.

New Section-stretcher, with arrangements for removing the Section.*—Prof. H. Strasser describes a device invented by him for keeping sections straight and causing them at the same time to adhere to a paper band which is one of the principal parts of the apparatus. Over the object and the knife-blade a paper band is arranged parallel to the long axis of the microtome. One end is clamped to the object-holder, and the other kept taut by a weight connected with the band by a cord running over a roller. The band is made to just touch the surface of the object by means of a metal roller of 1 to $1\frac{1}{2}$ cm. in diameter. The roller can be placed in any position by means of a universal joint, and it is made to move up and down in the same groove as the knife-carrier, by means of a similar carrier. The roller is then adjusted parallel to the edge of the knife, and thus the section is kept from curling up by the superjacent

* Zeitschr f. Wiss. Mikr., iv. (1887) pp. 218-9.

pressure. The under surface of the paper band is rendered adhesive by means of gum and collodion, and thus by each action of the knife a new section is placed in position along the band, the front end of which must be snipped off to remove the piece carrying the section, and then reclamped.

BALTZAR, G., and E. ZIMMERMANN.—**Microtom mit festem Messer und selbstthätigem Vorschub des Objekts.** (Microtome with fixed knife and automatic movement of the object.) German Patent, Kl. 42, No. 1431, 1888.

[MANTON, W. P., and others.]—**Modern Methods of Imbedding.** *The Microscope*, VIII. (1888) pp. 181–4.

STOWELL, C. H.—**Thin Sections.** *The Microscope*, VIII. (1888) pp. 175.

(4) Staining and Injecting.

Double-staining of Nucleated Blood-corpuscles.*—Dr. W. M. Gray gives the following directions:—Spread a thin layer of blood on a clean slide and dry. Immerse the slide in a beaker of alum-carmine (Grenacher's formula) for five minutes; wash in clean water, and immerse in a beaker of a weak solution of sulph-indigotate of soda or potash (the solution should be of a dark-blue colour—not black-blue, as in a strong solution). After the slide has acquired a purplish hue, wash in water and dry. After drying, warm slightly and mount in balsam. The nuclei will be a beautiful red, and the protoplasm a greenish blue.

Vital Methylen-blue Reaction of Cell-granules.†—If the larvæ of the frog or triton, says Dr. O. Schultze, be placed in a watery solution of pure methylen-blue, of the strength of 1:100,000–1,000,000, after twenty-four hours, certain granules in the cells of the cutaneous epithelium become stained with the weakest solution; the staining is confined to a small spot close to the pylorus which to the naked eye resembles a small blue ring. When the strongest solution is used for eight days, all the parts become of a deep blue colour. The pigment is absorbed by certain granules within the cells and causes them to swell up. These are identical with Altmann's bioblasts. These granules are not stained, or at any rate very slightly, when the dye is introduced through the blood-current, while, on the other hand, in larvæ living in the blue solution, the nerves are not stained. If the larvæ be removed from the blue solution to pure water all trace of the pigment disappears in eight days.

Differential Staining of the Tissues of Living Animals.‡—M. A. Pilliet has found that, by a simple subcutaneous or intra-peritoneal injection of methyl-blue, in rats, guinea-pigs, and other small animals, the entire kidney and some other organs are stained a diffused blue. By mixing the same material (methyl-blue) with the food of rats and guinea-pigs, only the glomerules of the kidneys were stained. If, instead of blue, fuchsin be used, the entire kidney becomes stained a vinous red, which, under section, however, shows the glomerules and

* Queen's Micr. Bulletin, v. (1888) p. 15.

† Anat. Anzeig., ii. (1887) pp. 684–8.

‡ St. Louis Med. and Surg. Journ., lv. (1888) pp. 28–9 from 'Progrès Médical.' Cf. also Journ. de Microgr., xii. (1888) pp. 285–90.

epithelial nuclei to have taken a much deeper colour than the balance of the structures. So marked was this in the experiments of the author, that in perfectly fresh sections these were very sharply and neatly differentiated.

A very remarkable fact was brought out in the course of Pilliet's experiments, viz. that when methyl-blue is introduced intra-peritoneally into guinea-pigs, the glomerule is stained a rose-carmine. When frogs were placed in an aqueous solution of methyl-blue, so weak that they could live in it several days, it was found that while the balance of the tissues were stained a diffused blue the glomerules showed a colour varying from rose-carmine, or rose-red, to ochre-yellow, the nuclei being more strongly tinted than the balance of the cell. In rats in which the blue had been intraperitoneally introduced, the blue was changed to red only on the surface of the glomerule. From these experiments it follows that in certain cases the glomerule possesses a peculiar oxidizing property in a high degree, since methyl-blue is a substance relatively refractory to oxidation. The significance of this discovery is that, in the kidney, the capillary circulation of the glomerules contains a large quantity of oxygenated blood, a fact which demonstrates the organ to be a true reducing apparatus and not simply a filter. We know that in the Reptilia the dark-blood returning from the tail is collected by a voluminous vein and carried to the glomerulæ, from which it departs, viâ the renal vein, not as black but as *red* blood. The kidney in this becomes a true reducing apparatus, partaking in this respect in the functions of the lung. The experiment of Ehrlich in this direction, made some three years ago, demonstrated these facts in a beautifully exact manner. By introducing intravenously into the system two substances, the combination of which gave rise to a coloured produce (indo-phenol), and which combination could take place only where oxygen existed in exceedingly feeble quantity, he arrived at a very exact knowledge of the degree of oxidation existing in any organ or part. In a similar manner, conversely, by using substances easily reducible (alizarine-blue, for instance), a scale of oxygenation may be arrived at. He thus demonstrated the scale of reductive power of the lungs, the cortical substance of the kidney, the mucous membrane of the stomach, &c. Later he established the same functions in the muscles, the liver, glands, &c.

Staining-differences of Unstriped Muscle and Connective Tissue Fibres.*—For distinguishing between smooth muscle-fibres and spindle-shaped connective tissue-cells, M. E. Rotterer recommends the following procedure. The fresh preparation is placed for 24 hours in a mixture of 10 vols. 36° alcohol, and 1 vol. formic acid. The hardening fluid is then quite extracted in water, after which the piece is treated with gum and spirit and then sectioned. The sections are stained for 36 hours in Grenacher's alum-carmine, and having been thoroughly washed, mounted in glycerin or balsam. The protoplasm of the unstriped muscle-fibres then appears red, the nucleus having a darker tinge. The cell contour is quite sharp. Connective tissue is quite colourless or rose-coloured, the cells are swollen, and their boundaries ill-defined. From this the author concludes "that the contractile protoplasm of unstriped muscle is not the same as that of connective tissue."

* Comptes Rend. Soc. Biol., iv. (1887) p. 615.

Improvements in the Silver-nitrate Method for Staining Nervous Tissue.*—Dr. C. Martinotti obtains the silver-nitrate reaction in large pieces of tissue, e. g. pons Varolii, by altering Golgi's method as follows:—(1) The quantity of silver-nitrate is increased relatively to the size of the object. (2) The solution is allowed to act for 13–30 days. (3) The pieces are kept at a temperature of 25°, in order that the reaction may reach the ganglion cells, but in order that all the cells of the neuroglia should participate in the reaction, a temperature of 35°–40° is necessary.

If 5 per cent. of glycerin be added to the solution, the reaction in the ganglion cells and their ramifications is facilitated. In order to prevent precipitates forming at the periphery of the pieces, these were imbedded in a mass made out of filter paper and distilled water after the objects had been taken out of Müller's fluid. This artifice was found to increase the contraction of the silver nitrate solution.

Staining in the Study of Bone Development.†—Dr. J. Schaffer in a large and diffuse article recapitulates the various stains which have been recommended from time to time for staining cartilage in the transition stage to bone so as to differentiate the osseous and cartilaginous elements. The method upon which the author dilates most was invented by Bouma, who found that safranin imparted a yellow colour to the cartilage, while the connective and osseous tissues appeared red. This yellow stain was supposed by Bouma to be due to the fact that safranin is not a chemically pure substance, and starting from this observation, the author proceeded to examine the relative staining capacities of several kinds of safranin in watery solution (1 : 2000). (1) The commercial. (2) Pheno-safranin a chemically pure dye. (3) Tetraethyl-phenosafranin, a substance which contains NaCl. The commercial safranin gave the best differentiation, cartilage orange, bone colourless, medullary tissue red. The pheno-safranin gave similar but less marked results. The tetraethyl-phenosafranin stained the cartilage red-violet, the bone and medullary tissue blue. The author then gives his method for fixing the stain, a 1 : 2000 watery solution of safranin.

The unstained sections, decalcified in nitric acid or in hydrochloric acid and salt solution, are placed for half an hour in the safranin solution. They are then washed in water and transferred for 2 to 3 hours to 1/10 per cent. sublimate solution and mounted in glycerin. If, however, the preparations are to be fixed up permanently, the sections on being removed from the sublimate solution must be passed rapidly through alcohol, dried upon the slide with bibulous paper, and left for a long time in oil of cloves or bergamot. They are then mounted in xylol balsam.

Preparing and Staining Mammalian Testicle.‡ — For hardening the mammalian testicle, Dr. A. Prenant found that osmic acid and Flemming's fluid were the best media, Kleinenberg's picro-sulphuric acid, nitric acid, strong oxalic acid, absolute alcohol, 3 and 4 per cent. bichromate of potash being less effective. A 1 per cent. solution of osmic acid acting for one to two hours gave the best results. Of the

* Congresso Medico di Pavia, Seduta 6a, Riforma Med., 12 Ott., 1887. Cf. Zeitschr. f. Wiss. Mikr., v. (1888) p. 88.

† Zeitschr. f. Wiss. Mikr., v. (1888) pp. 1–19.

‡ Internat. Monatsschr. f. Anat. u. Physiol., iv. (1887) pp. 358–70.

various "Flemming" solutions tried, that which contained most osmic acid was the most successful. The preparations were then soaked in chloroform and imbedded in paraffin and then sectioned in a Dumaige microtome. The sections were fixed to the slide with a mixture of equal parts of albumen and glycerin. The stains used were safranin, hæmatoxylin, hæmatoxylin-eosin, acid carmine, picro-carmine, and gentian-violet. These dyes all acted very slowly on preparations treated with the Flemming solutions, but very quickly on those fixed in osmic acid.

Bizzozero's method was employed for staining the nucleus, safranin being found to be quite as good as gentian-violet for this purpose, provided that the iodine solution were allowed to act more effectually, and the spirit less powerfully.

Stain for the Morphological Elements in Urine.*—Dr. F. L. James has hitherto recommended for this purpose the ordinary aqueous solution of eosin. It acts rapidly, and but a small amount is needed to give all the elements so decided a tinge that the most delicate hyaline cast will rarely escape the practical eye. He recently made a solution of boro-eosin, and after a number of experiments with it, much prefers it for this purpose to the simple aqueous solution above referred to. The new stain acts more rapidly, and imparts a deeper and richer tinge to the elements. In nucleated elements the nuclei take the stain in a much more intense degree than does the balance of the structure, and as a consequence, are clearly and sharply differentially stained by it. As to its lasting properties, it is yet too early to speak, but it is reasonable to suppose that it will be quite as permanent as the stain made with the aqueous solution of eosin. This, however, is a secondary consideration, as the chief value of the stain is the rapidity and the ease with which it enables us to find otherwise difficult objects. The formula for boro-eosin is as follows:—Eosin, 10 parts; sodium biborate in powder, 15 parts; alcohol of 95°, 60 parts; distilled water, 415 parts. Dissolve the borax in half of the water. Add the alcohol to the remainder of the water, dissolve the eosin in the mixture, mix the two solutions and filter.

In using it allow the urine to stand in a conical glass until the suspended elements have in a great measure subsided. The clear supernatant fluid is siphoned, or otherwise drawn off and the stain added to the remainder. A few drops of perosmic acid solution is added at the same time. This gives the urine a dark or almost black appearance by direct light, but when examined with transmitted light, the colour is a deep rich ruby. A drop withdrawn and examined within a half hour after adding the stains will show all the elements well coloured, the epithelia and granular casts especially so. The hyaline casts will be sufficiently coloured to be very distinct, but require more time for thorough staining. Permanent mounts of urine thus prepared will last a long time without deterioration, but for preservation the author advises the use of glycerin.

Staining Spores.†—Dr. G. Hauser recommends the following method for staining spores. The cover-glass is passed thrice through the flame in the usual manner, and is then covered with a strongish watery solution of fuchsin. The cover-glass is then passed through the flame forty or fifty times until the stain evaporates or even simmers. If

* St. Louis Med. and Surg. Journ., lv. (1888) pp. 98–9.
† Münchener Med. Wochenschr., 1887, p. 654.

evaporation takes place too quickly, more stain must be dropped on. The preparation is then decolorized for a few seconds in 25 per cent. sulphuric acid. The acid is washed out with water, and the preparation after stained with a weak solution of methylen blue. The time required for the whole manipulation is not more than five minutes.

Staining Tubercle and Leprosy Bacilli.*—Prof. N. Lübimoff recommends the following solution for staining the bacilli of tubercle and leprosy. It is called borofuchsin, and consists of fuchsin, 0·5 gr.; boracic acid, 0·5 gr.; absolute alcohol, 15 cm.; distilled water, 20 cm. It is made by first mixing the boracic acid and water, then adding the spirit, and finally the fuchsin. The latter dissolves gradually on agitation.

Thus prepared, the staining fluid has a slightly acid reaction, is transparent, clear, and as it does not deteriorate by keeping, is always ready for use. Cover-glass preparations of phthisical sputum are stained in 1–2 minutes. Sulphuric acid in the proportion of 1–5 is used for decolorizing, the cover-glasses are then washed in spirit, and then immersed for 1½ minute in a saturated alcoholic solution of methylen blue. The superfluous stain is washed off with water, and the cover-glass dried. It is advised to examine the preparation in Ol. ligni cedri, or in xylol balsam. Sections are treated in exactly the same way, but it is preferable to stain twenty-four hours in the borofuchsin. The author notes that lepra bacilli are much more easily and rapidly decolorized than tubercle bacilli.

Alcoholic Solution of Hæmatoxylin.†—Dr. G. Cuccati gives the following formula for making a hæmatoxylin solution which possesses the advantages of never going bad, and of staining only the chromatic part of the nuclei, the colour being fixed most deeply in the karyokinetic figures.

Dissolve 25 grm. of pure iodide of potassium in 25 ccm. of distilled water, and pour the mixture into a glass-stoppered bottle containing 75 ccm. absolute alcohol, shaking the while repeatedly.

Then grind together in a mortar 75 cgrm. of hæmatoxylin crystals and 6 grm. of alum. When these are intimately mixed, add 3 ccm. of the iodide solution. Keeping the mixture well stirred, add little by little the rest of the solution, and then pour into a well-stoppered bottle, and leave for 10–15 days. At the end of this period shake up well again, and in an hour or two afterwards filter and preserve the filtrate very carefully to prevent evaporation and deposit of alum or iodide crystals.

This solution only stains up to a certain point, consequently the sections may be left in it almost indefinitely.

Osmic Acid and Gold chloride Methods.‡—Dr. A. Kolossow says that the penetrating power of osmic acid, which is intrinsically almost nil, may be increased by a mixture of the acid with uranium salts. The author prepares a 0·5 per cent. solution of osmic acid in a 2 to 3 per cent. solution of nitrate or acetate of uranium (the former is the better). Large pieces of an object, for example a frog's tongue cut into two or three pieces, are easily penetrated by this mixture, wherein they may

* Centralbl. f. Bakteriol. u. Parasitenk., iii. (1888) pp. 540–3.
† Zeitschr. f. Wiss. Mikr., v. (1888) pp. 55–6.
‡ Ibid., pp. 50–3.

remain for 16, 24, 48 hours without becoming brittle, and only being stained a yellowish-brown colour, except the myelin, which is almost black, the medullated fibres and their endings are clearly seen. The author says that he has had quite satisfactory results with Meissner's and Grandry's corpuscles. The objects fixed by the foregoing solution should be well soaked in water, and after-hardened in absolute alcohol.

The author also gives the following procedure for treating connective tissue formations with gold chloride. The objects are placed for two, three, or more hours in a 1 per cent. chloride solution, acidulated with hydrochloric acid (100 : 1). After having been washed they are placed in the dark in a 1/50–1/100 per cent. solution of chromic acid for reduction. Though reduction may not at this stage be perfect, it is completed later on in oil of cloves, and the preparation is then mounted in balsam. The more carefully the chromic acid is washed out the clearer the picture is. The non-medullated nerve-fibres and their ramifications are stained almost black. The connective tissue cells appear just as distinctly, while the intercellular substance of the connective tissue is unstained. Muscle-fibres, striped and unstriped, are stained a greenish-blue colour. The author states that this method is almost always certain.

Phenol in Microscopical Technique.*—When sections imbedded in paraffin curl up and are placed in turpentine oil it is found extremely difficult to flatten them without breaking them. This inconvenience, says Signor E. Aievoli, may be remedied in the following manner:—the sections are immersed for 15–30 minutes in benzin or turpentine oil, and are then transferred to pure fluid phenol, wherein the sections unroll themselves and come to the surface of the fluid. The carbolic acid does not damage the tissue structure, even if the sections be left in it for twenty-four hours. The sections are then treated in the usual manner.

The author found great advantage in staining tissues *en masse* with a carmine solution prepared in the following manner:—One grm. of carmine is dissolved in 100 ccm. of hot water, and then 7 grm. of powdered carbolate of soda are added. The solution is kept stirred for 30–40 minutes and filtered when cold. In this solution large pieces of tissue may be stained in twenty-four hours. They are then transferred to acidulated (1 per cent.) spirit for some hours. This method is stated to give stronger and clearer colouring to the nuclei than other carmine solutions. It is also especially suitable for tissues which have been fixed with sublimate or absolute alcohol.

Double Staining.†—Dr. J. H. List states that the double stains recommended by him for epithelia, glands, and cartilage have undergone the test of time, the preparations retaining the beauty of the stain after a lapse of four years. (For the original methods see this Journal, 1885, p. 902.) In his present note the author mentions again eosin-methyl-green for epithelium, glands, and cartilage, and hæmatoxylin-eosin for glands and retina. With this stain it is absolutely necessary that objects hardened in acids should be thoroughly washed to remove all traces of the acid, otherwise a precipitate may form on the preparation.

Bismarck brown (Weigert's formula) gave excellent results with Invertebrates (connective tissue of molluscs), and rosanilin nitrate was

* Rivista Internaz. Med. e Chirurg. Napoli, iv. pp. 101–4.
† Zeitschr. f. Wiss. Mikr., v. (1888) pp. 53–4.

very effective for differentiating, for the nuclei of wandering leucocytes and for the mitoses in epithelia.

Hardening and Staining Plate-cultivations.* — Dr. E. Jacobi hardens and stains plate-cultivations by putting the plates in flat vessels and pouring over them a 1 per cent. solution of bichromate of potash, which is allowed to act for three days in the light. If the thin gelatin layer does not detach itself it can be easily removed with a knife. Then follows twenty-four hours' soaking in water and afterwards hardening in 50 per cent. and 70 per cent. spirit. From this small pieces of the gelatin, which are treated just like sections, are stained with Löffler's alkaline methylen-blue and afterwards washed in very dilute acetic acid, then placed in absolute alcohol, removed to the slide, where they are cleared up in xylol or in turpentine oil, and then mounted in Canada balsam. A leaden weight placed over the cover-glass serves to keep the specimen flat. Anilin-water-safranin or Gram's method may be used for staining. Experiments with agar plates were unsuccessful. Photograms obtained from these specimens coloured red or blue, the latter from orthochromatic plates, were satisfactory.

Injection Mass for the Vessels of the Spleen.†—Dr. H. Hoyer prepares a mass for injecting the vessels of the spleen in the following manner:—5 grm. of Berlin blue made up with oil (obtained from artists' colourmen in zinc tubes) are rubbed up in a mortar with 5 grm. of inspissated linseed oil. To this are then gradually added about 30 grams of some essential oil which is easily soluble in alcohol and has little action on the tissues round about the vessels (e. g. oil of lavender, fennel, thyme, rosemary) until a syrupy fluid is produced. It is then poured into a well-stoppered glass vessel and allowed to stand for twenty-four hours, when the supernatant fluid is poured off from the sediment. This blue fluid may then be preserved for an indefinite time, but if it has stood for a few days it is necessary to shake it up before using it. This must also be done if other than blue pigments be used, for example, chrome yellow, with which very satisfactory results are obtainable, the splenic capillaries appearing greyish-yellow by transmitted, bright yellow with reflected light.

The cannula is best filled with the injection mass by pouring the latter in at the end. Injection of the spleen must be carried out very slowly and at a very low pressure, and should be suspended when the surface arteries become visibly coloured, and if the venous side be injected when the whole organ shows the stain and before any actual swelling is observable. The preparation is then placed for twenty-four hours in strong spirit or absolute alcohol in order to dissolve the essential oil and to precipitate the pigment on the inner surface of the walls of the vessels. The organ may then be sectioned, stained, and mounted in the usual way.

This mass may be used for any other organ or tissue difficult of injection, as, for example, the marrow of bone.

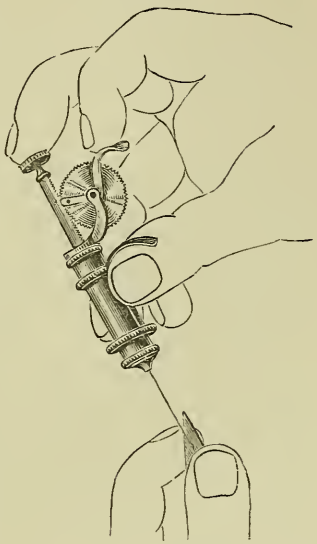
Injection with Indian Ink.‡—Prof. K. Taguchi recommends, from nine years' experience, the use of Indian or Chinese ink for cold injections. The colouring matter is not affected by light or chemical

* Centralbl. f. Bakteriol. u. Parasitenk., iii. (1888) pp. 536–8.
† Internat. Monatsschr. f. Anat. u. Physiol., iv. (1887) pp. 341–57.
‡ Arch. f. Mikr. Anat., xxxi. (1888) pp. 565–7 (1 pl.).

action, the carbon particles do not change the tissues outside the vessels, the material adheres so firmly to the walls of the vessels that it does not flow out on the surface of sections, the preparations may be hardened in alcohol, chromic acid, &c., without losing colour, and they may be examined fresh in glycerin. The sections may be afterwards stained with any colour.

A medium quality of black ink is chosen, Japanese rather than Chinese; it is rubbed down in water till the fluid is such that when dropped on thin blotting-paper it coheres, and forms no grey ring round the drops. The mode of using the fluid is in no way peculiar. Until the preparation is hardened there must be no contact of the section with water. Some sections are figured to show the success of this injection.

Fig. 157.



Beck's Microsyringe.* — Prof. M. Flesch recommends Dr. G. Beck's apparatus for minute injection. It is a small syringe, the piston-rod of which is worked by a cog-wheel arrangement, and can consequently be used for aspiration as well as injection without a change of hands being necessary. It is so made that the cannula needle fits on quite flush, thus preventing the inclosure of air-bubbles. In the original form the cannula screwed on, but this has been found to be quite unnecessary. The graduation, marked on the piston-rod, is accurate enough to allow about 10 ccm. of a fluid to be injected at one time. The piston washer is made of felt and not of leather. As this material does not become hard when heated the syringe can be disinfected in an oil-bath at 150° C. without damage.

The syringe itself and the method of working it are shown in the illustration (fig. 157).

Baránski, A.—**Zur Färbung des Actinomyces.** (On staining Actinomyces.)
Deutsch. Med. Wochenschr., 1887, p. 1065.

Durdufi, G. N.—**Beitrag zur physiologischen Methylenblaureaction.** (Contribution to the physiological reaction of methyl-blue.)
Deutsch. Med. Wochenschr., XXVI. (1888) p. 518.

Gieson, J. van.—**The Brain-cortex stained by Golgi's method.**
New York Med. Rec., XXXIII. (1887) p. 283.

Günther.—**Die schnellste Methode zur Färbung von Tuberkelbacillen.** (The quickest method for staining tubercle bacilli.)
Wiener Klin. Wochenschr., 1888, pp. 292–3.

Nickel, E.—**Die Farbenreactionen der Kohlenstoffverbindungen. 1. Farbenreactionen mit aromatischen Charakter.** (The colour reactions of carbon combinations. I. Colour reactions of an aromatic character.)
Inaugural diss., 42 pp. 8vo, Berlin, 1888.

Nott, T. E.—**Staining of Tubercle Bacilli.**
Atlanta Med. and Surg. Journ., 1888, pp. 200–2.

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 43–5 (1 fig.).

TÄNZER, P.—**Ueber die Unna'sche Färbungsmethode der elastischen Fasern der Haut.** (On Unna's staining method for the elastic fibres of the skin.) *Monatsschr. f. Prak. Dermatol.*, VI. (1887) No. 9.

UNGAR.—**Ueber Färbung von Spermatozoen.** (On staining spermatozoa.) *Verh. Naturhist. Vereins. Preuss. Rheinlande*, XLIII. (1887) SB. p. 303.

UPSON, H. S.—**Die Carminfärbung für Nervengewebe.** (Carmine staining for nerve-tissue.) *Neurol. Centralbl.*, VIII. (1888) pp. 319 and 320.

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

Continuous Centering of a Cover-glass.* — The Rev. J. L. Zabriskie finds that a very satisfactory method for the continuous centering of a cover-glass, for subsequent operations with the self-centering turntable, with either a glycerin or a balsam mount, when no cell is employed, is to run a very delicate ring of india-ink with a fine pen upon the upper, or clean side of the glass slip, while the slip is revolving upon the turntable, and 1/32 in. larger than the cover about to be used, as the first step in the operation of mounting.

He has heard of such rings being employed on the under side of the slip. But very few of the latter are such accurate parallelograms that a ring on the under side will be central for the upper side, because, when the slip is turned over, it is liable to be held on the turntable by the pair of diagonal corners, which were not employed in the first instance. And moreover, when the ring is run on the under side the thickness of even a thin slip renders difficult the subsequent centering of a cover by sight.

If the ring of ink is run on the clean side of the slip it is accurately centered for each subsequent operation; the cover can be centered within it accurately without returning to the turntable, and if the application of a spring-clip causes the cover to slide, the latter can still be immediately readjusted by sight.

The india-ink dries at once, and does not, as might be supposed, cause any practical difficulty by running in under the cover-glass. In case of a glycerin mount, if there is excess of glycerin around the cover, a small stream of cold water, used to wash away the excess glycerin, also instantly carries away the ring of ink. If there is no excess of glycerin the ring of ink may be left, and it will be entirely hidden by the sealing of the mount, if any dark-coloured cement is used. In case of a balsam mount the ring of ink will be scraped away when cleaning the slide, or if there is no excess of balsam, it may be quickly removed, when the mount has hardened, by the moisture of the breath and gentle rubbing with a handkerchief.

Steinach's Filter-capsule.†—Dr. E. Steinach has devised an apparatus for aiding certain manipulations in microscopical technique. It is a glass filter-capsule, and consists of a small round pan 4 cm. high and 6 cm. in diam. (figs. 158 and 159). Its floor is about 2 to 3 mm. thick, is slightly deepened towards the centre, and perforated by numerous funnel-shaped holes, the small ends of which are uppermost. The holes in the bottom of the sieve may vary in size as required, but as usually made are just capable of allowing a fine needle to pass through (about 1/2 to 1 mm.). The sieves are of two kinds, according as they are supported on feet or not. The sieve or filter-capsule is placed within

* Journ. New York Micr. Soc., iv. (1888) pp. 159-60.

† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 433-8 (2 figs.).

an outer pan which is supplied with a lid. This external glass capsule is of course somewhat larger than the inner or filter capsule, and its

Fig. 158.

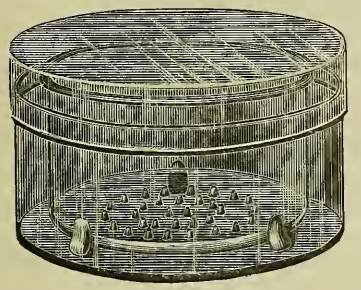
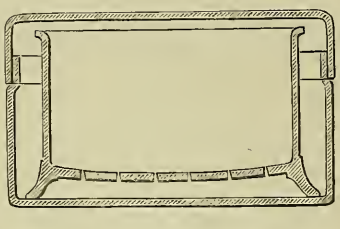


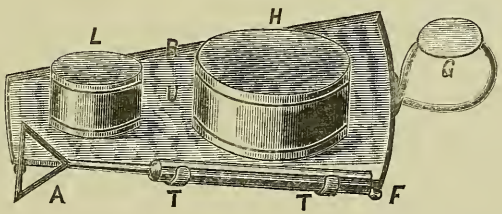
Fig. 159.



measurements are about 9 cm. in diam., and 6 cm. high. By means of this apparatus, preparations are washed, stained, decolorized or dehydrated, &c., by placing the section in the inner pan, and the fluid in the outer, and when the latter has acted sufficiently, the inner pan is merely lifted out, and having been allowed to drain is placed within another pan containing the next reagent and so on. When the reagent is expensive it is advisable to use the filter-capsule without legs. When required for removing all traces of acid from preparations, the apparatus is used as an irrigator.

Apparatus for inclosing microscopical preparations of botanical objects mounted in glycerin.*—Dr. M. Kronfeld has devised an apparatus for facilitating the inclosure of preparations with turpentine resin when these preparations are mounted in glycerin and a square cover-glass is used. The tool used for laying on the resin is a triangular

Fig. 160.



instrument made of wire. The resin is applied by heating the layer-on in the flame of a spirit-lamp or gas-jet, and it is to obviate the inconvenience of having the several apparatus required for this purpose in different places that he has brought them together.

U (fig. 160) is a tray resting on 4 feet F; its edges R are turned up and it is provided with a handle G. It carries two circular filletings in which the spirit-lamp L, and the resin-box H fit. On the side are two clips T T in which the laying-on tool A, with a wooden handle, rests.

* Bot. Centralbl., xxxiv. (1888) pp. 345–6 (1 fig.).

The spirit-lamp is a metal box filled with tow, and covered with wire gauze.

Preservation of Plants in Spirit and the Prevention of Browning.* —Dr. H. de Vries describes the following methods for preserving vegetable tissues in spirit and for the prevention of browning.

As the cause of the browning must be sought in certain uncoloured matters present in the cell-juices, and which by oxidation become brown, it follows that the first object is to remove these substances from the preparations before they become oxidized. It has long been known that many leaves become less darkly coloured, if, before the death of the cell, the air be removed (by means of the air-pump or boiling).

Boiling in water and then placing the preparation afterwards in cold spirit frequently gives satisfactory results, e.g. in *Viscus albus*. An excellent method is to boil the parts of the plants in spirit. Leaves of rhododendron, *Viscus*, *Aucuba*, which are only immersed for five minutes in boiling spirit, become quite decolorized afterwards, a result which, at any rate in *Aucuba*, can be attained in no other way.

Another method which, with the exception of *Aucuba*, gave excellent results, is to kill the plants in spirit to which about 2 per cent. hydrochloric, sulphuric, or acetic acid has been added. The preparations are kept in this fluid for several months and then transferred to spirit without acid. This is removed from time to time until all the colouring matter has been removed. The long stay in the acid fluid does not at all injure the plants as they are just as useful for microscopical purposes as fresh or otherwise preserved organs. Even the crystals of oxalate of lime are not dissolved by the mixture of spirit and hydrochloric acid, although they are when the acid is mixed with water. In this way completely decolorized preparations of *Monotropa* and *Orobanche* can be obtained, and this fluid will also prevent *Boletus* from becoming blue.

As the oxidation products are partly insoluble in acid alcohol, organs do not become thoroughly decolorized by the fluid; thus the bracts of *Plantago lanceolata* retain their colour, and in unripe fruits the places where the flowering parts were attached can still be recognized, because these parts were dead before they came into the acid spirit.

The decoloration of preparations which have already become brown can only be effected by oxidation. The most effective reagents for this purpose are chlorate of potash or soda with sulphuric acid. This completely or almost completely removes the browning. The preparations are placed in spirit to which 0·2–0·5 ccm. per cent. of strong sulphuric acid and a small quantity of chlorate of potash crystals are added. If the vessel be shaken from time to time, oxidation will be completed in 6 to 8 days; any trace of pigment left after this time will always be unaffected by the solution. The preparations are then transferred to spirit.

Another method of preservation consists in the use of a one per cent. solution of picric acid. The preparations, however, become stained yellow and always remain flabby, but as the chlorophyll is unaltered by the solution, it is very useful for preserving variegated flowers. Spirit through which sulphurous acid has been passed until a large quantity has been taken up gives satisfactory results. Pure glycerin is not

* Maandblad van Natuurwetenschappen, 1886, Nos. 1, 5, and 6, 1887, No. 4. Handelingen van het eerste Natuur- en Geneeskundig Congres te Amsterdam, 1887, p. 139. See this Journal, 1887, p. 675; 1886, p. 1075.

recommended for preserving the coloured parts of plants, as the dyes are given off after the lapse of a few months.

The author then discusses the brittleness which affects plants which have been long kept in strong spirit. This brittleness may be prevented by soaking the parts in water until they become quite flaccid and then placing them in spirit. As the results of his examination into the cause of this brittleness, the author finds that when the tinged parts of a plant are killed by immersion in spirit, their death is effected before the tension of different parts has had time to become equalized. Hence this tension is "fixed" by the spirit and becomes the cause of the brittleness. Water, however, equalizes the tension of the various parts, and hence removes the brittleness by rendering the tissue elastic.

Fixing Sections to the Slide. *—Mayer's albumen fixative, says Mr. J. Nelson, is absolutely reliable for fixing sections to the slide, and should be used whenever sections are loosely coherent in their parts. Neat results with this can only be obtained with a very thin and even film, to secure which proceed as follows:—A small drop of the fixative is spread on the slide with the ball of the index finger. Excess of fixative is removed by wiping the finger dry, and continuing the rubbing until no frothy streaks appear in the film. Then tap the moist surface lightly with the finger, so that by light reflected at a proper angle it appears finely stippled. Each section is pressed into the film with a brush, and when the slide is full, a piece of filter paper is placed over all, and pressed firmly with the finger until every part of each section is in even contact with the glass. Then heat the slide over steam until the paraffin melts, and then plunge into turpentine. The film is opaque in alcohol, but this is corrected in turpentine and mounting. Should the presence of the foreign albumen in the sections be undesirable, recourse should be had to Gaule's alcoholic fixative. It is a means whereby the albumen molecules of the section are brought into the same adhesive contact with the glass as those of ordinary fixatives. The slide is brushed over with 40–70 per cent. spirit, and when this film has evaporated, thin sections stick closely. Superfluous spirit is removed with bibulous paper, and the slide then evaporated to dryness; this is best done in a thermostat at 40° C. for 1–2 hours. The paraffin should never be allowed to melt. It is removed with turpentine as for other fixatives. Celloidin sections stick well with this method.

VOINOFF, R. G.—**On the different Cements for closing microscopical sections.** *Ejened. Klin. Gaz. St. Petersburg*, VII. (1887) p. 411 (Russian).

WOJNOFF, K.—**Einige Bemerkungen betreffend das Festkleben mikroskopischer Schnitte auf Objectträger.** (Some remarks on fixing microscopical sections to the slide.) *Klin. Wochenschr.*, 1887, 6 pp.

(6) Miscellaneous.

Methods of Plastic Reconstruction.†—Prof. H. Strasser writes at great length and in copious detail on methods of reconstructing the object. All he has to say is practically a recapitulation of Born's procedure for making wax plates upon which the image of the object is drawn. The outline is then cut out, and the various plates are united together in their proper order, and this done the edges are smoothed off so that an enlarged solid copy of the original object is obtained. For

* American Naturalist, xxii. (1888) p. 664.

† Zeitschr. f. Wiss. Mikr., iv. (1887) pp. 168–209, 330–9.

this purpose wax is melted and poured out on a piece of plate glass, and this sheet of wax is rolled level with an iron roller. The wax sheets may be simple, or laid on paper which has been previously saturated with wax, and the roller used may be hot or cold according as the wax is softer or harder. Instead of glass a lithographic stone is recommended.

Making Mounts Photographic.*—Mr. G. W. Rafter writes that there is a phase of mounting which could well be impressed upon the attention of microscopists. That is, to make all mounts with reference not merely to use under the tube, but with reference to good photographic results. He thinks he is justified by experience and study in saying what has been well said before, that whatever can be seen with an objective and eye-piece can be photographed as clearly as it can be seen, provided proper methods of preparation for photography are followed. He thinks it may be further stated that such methods of preparation will not diminish their value under the tube. "Go through a cabinet of ordinary mounts and see how few are photographable! The enormity of the thing appears when we consider that nearly all classes of mounts, including opaque, may be readily photographed if properly prepared. To this, however, there are a few exceptions. The additions to general knowledge of matters microscopic which could be made, if all working microscopists would prepare with reference to photography is simply enormous."

Improved method for Enumerating Blood-corpuscles.†—M. Mayet has made a further improvement in artificial serum used in the enumeration of blood-corpuscles. Blood to the volume of 4 mm. is first mixed with 500 mm. of a watery 1 per cent. solution of osmic acid by which the corpuscles are fixed and rendered colourable. At the end of three minutes 500 mm. of the following liquid is added:—Glycerin, 45 ccm.; distilled water, 55 ccm.; eosin in aqueous 1 per cent. solution, 17 ccm. The red corpuscles are brightly stained, the leucocytes being scarcely or not at all coloured, and this difference of tint allows the two kinds of corpuscles to be easily counted. The distribution of the corpuscles on the side is quite uniform, owing to the fact that the mean density of the two fluids used for dilution is equal to about 1084, and also to the viscosity of the glycerin. The further steps in the procedure are as heretofore.

Improved method for the Bacteriological Examination of Air.‡—The method adopted by MM. Straus and Wurtz for passing air through fluidified gelatin consists in transmitting the air through a tube contracted at the end, whereby fine bubbles are produced. Frothing is prevented by adding a drop of sterilized oil to the gelatin. The apparatus consists of a glass tube closed at the lower end and measuring 40 mm. broad by 20 cm. high. The diameter of the lower part is reduced to 15 mm., and herein 10 cm. of gelatin are placed. In the upper end, also contracted, is inserted a glass tube, the end of which reaches right to the bottom, and is there much reduced in size. Through this tube the air passes, and those germs which are not caught up by the gelatin are entangled in sterilized cotton-wool, a plug of which is placed

* Amer. Mon. Micr. Journ., ix. (1888) pp. 77-8.
† Comptes Rendus, cvi. (1888) pp. 1558-9.
‡ Ann. Instit. Pasteur, 1888, p. 171.

around the inner tube at the top of the outer one. The wool is then shaken up in the gelatin, which afterwards may be removed by the inner tube and spread out on plates, or it may be rolled out on the inside of the large tube. The entrance of air is very quick, 50 litres in 15 minutes.

Gelatin Culture Test for Micro-organisms of Water.* — Dr. C. Smart concludes an extensive consideration of the micro-organisms of water with the following remarks in reference to the gelatin culture test, which he believes to be valuable only in its doubtful promise for the future: "At present," he says, "in the hands of the sanitary inquirer, it gives but little information, and that little is surrounded on all sides by interrogation points. In the laboratory of the scientific investigator, new methods may be discovered by which pathogenetic germs may be isolated and identified; but until that time arrives the sanitary analyst must depend upon the chemical results as translated in each particular instance by the aid of the ascertained sanitary environment of the water, and however much he may cultivate the microbes, he should not forget to inspect that other field of microscopic life (*Nostoc*, *Kerona*, Algæ, &c.) to which reference was made at the beginning of this paper."

Illustrations of Pond Life.—The following paragraph appears in the 'Times' report of the 12th September of the soirée of the British Association at Bath:—

"At the soirée there were a large number of Microscopes and illustrations of the vegetable and animal kingdoms, and of histology, but the greatest novelty, which quite surprised most of the company, was a new method of illustrating pond life. Three sides of a long room were occupied with what are called transparencies. Brown paper is stretched on frames. Pieces are cut out of the brown paper corresponding with the size of the illustrations, which are painted on tissue paper. Behind the long row of these illustrations there are rows of gas-jets, and the strong light passing through the tissue paper made the objects distinctly visible at a long distance. The naturalists from other parts of the country quite envied the Bath and Bristol societies for the success they had attained in devising such a method of illustration, and carrying it out so efficiently."

Microscopists will recognize the method as that originally devised by Dr. Hudson, the President of this Society, to exhibit his drawings of Rotifers.†

Brown, F. W.—**A course in Animal Histology.** III. Blood. IV. The Connective Tissues—Endothelium.
The Microscope, VIII. (1888) pp. 177–80 (1 fig.), 201–3, 244–6.

Ewich.—**Ein Beitrag zur Fleischschau und Fleischkunde.** (A contribution to the examination and knowledge of meat.) 8vo, Osterwieck, 1888.

Freeborn, G. C.—**Notice of new Methods.** V.
Amer. Mon. Micr. Journ., IX. (1888) pp. 130–2.

Hensoldt, H.—**The Microscopical Investigation of Rocks.** A plea for the study of Petrology. *Journ. N. York Micr. Soc.*, IV. (1888) pp. 139–44.

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* The Microscope, viii. (1888) p. 215, from 'Philad. Med. News.'

† The 'Athenæum' of 15th September refers to them as "representing microscopic insect life from its lowest to its highest forms (!). They had been prepared by Dr. Hudson, of Clifton, who also described them verbally."

HESSE, W.—**Zur quantitativen Bestimmung der Keime in Flüssigkeiten.** (On the quantitative determination of germs in fluids).
Zeitschr. f. Hygiene, IV. (1888) p. 22.

KÜHNE, H.—**Praktische Anleitung zum mikroskopischen Nachweis der Bacterien im thierischen Gewebe.** (Practical guide to the microscopical demonstration of Bacteria in animal tissue.) vi. and 44 pp., 8vo, Leipzig, 1888.

MANTON, W. P.—**Rudiments of Practical Embryology.**
[Staining—Infiltrating the paper cell—Section-cutting—Preparation of slides—Mounting.] *The Microscope*, VIII. (1888) pp. 180–1, 203–6 (3 figs).

MIQUEL, P.—**De la valeur relative des procédés employés pour l'analyse micrographique des eaux.** (On the relative value of the processes employed for the microscopical analysis of water.) *Revue d'Hygiène*, 1888, pp. 391–406.

NIKIFOROFF, M.—**Kurze Studien in der mikroskopischen Technik.** (Short studies in microscopical technique.) 169 pp., 16mo, Moscow, 1888.

OSBORN, H. L.—**Studies for Beginners. III. The Vinegar Eel.**
Amer. Mon. Micr. Journ., IX. (1888) pp. 121–3.

STRENG, A.—**Ueber einige mikroskopisch-chemische Reaktionen.** (On some microchemical reactions.)
Neues Jahrb. f. Mineral., Geol., Palæontol., 1888, pp. 142–50 (3 figs.).

TINDALL, S. J.—**Scales on Red Currants.**
["A very beautiful object for the Polariscope."] *Sci.-Gossip*, 1888, p. 187.

TROUP, F.—**The Diagnosis of early Phthisis by the Microscope.**
Edinburgh Med. Journ., 1888, pp. 1–7.

WATERMAN, S.—**How to produce Hæmoglobin or Hæmatocrystallin.**
The Microscope, VIII. (1888) pp. 165–171 (1 pl.).

WENDE, E.—**[The Microscope in the Diagnosis of Skin Diseases.]**
The Microscope, VIII. (1888) p. 217, from *Med. Press of West. New York.*

WHELPLEY, H. M.—**Microscopy for Amateur Workers.**
[Recommendation of vegetable histology and morphology for amateurs.]
The Microscope, VIII. (1888) pp. 195–8.

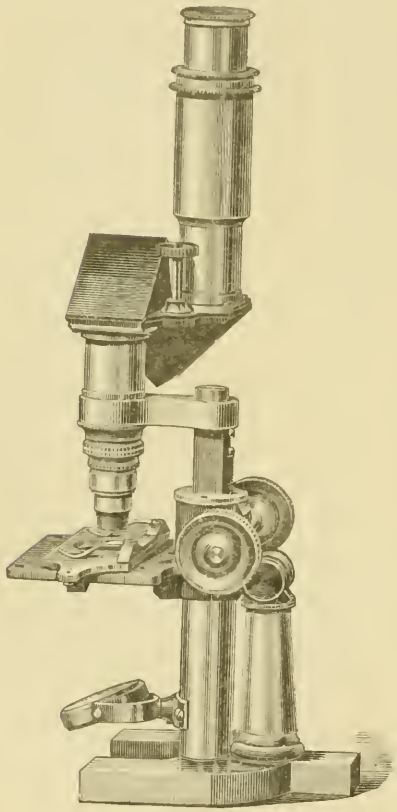
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Ahrens' New Erecting Microscope.*—In this instrument (fig. 161) the erection of the image is obtained by two right-angled prisms crossed in the way used in some of the binocular field-glasses. The form of the prisms will be gathered from the woodcut, which shows the boxes in which they are placed. The following is Mr. C. D. Ahrens' description of the instrument.

Fig. 161.



"The advantages of this over the one I made some years ago are that the rays are parallel with the stage, and better definition of the object is given. The prisms are not so troublesome to make, and by making them of quartz more light is obtained. The surfaces are also more perfect, and they are less liable to sweat or get injured. If properly cut they only show one image. As the rays travel across the prisms to the extent of about 3 in., only a short body is required. I believe such an erecting Microscope is the only way to see the objects in their right form, as I have found that lenses when used for inverting make some objects appear as in a pseudoscope with prisms."

Klein's Excursion Microscope.†—Dr. L. Klein writes that botanists and zoologists who are accustomed to make excursions to collect microscopical specimens only too often feel the want at the collecting place of a useful Microscope which would enable them to determine approximately what they have collected, and to recognize whether a locality offers them any advantage or not. By practice a rough separation of the larger specimens can be made with the naked eye, but of the smaller ones many a rare specimen is over-

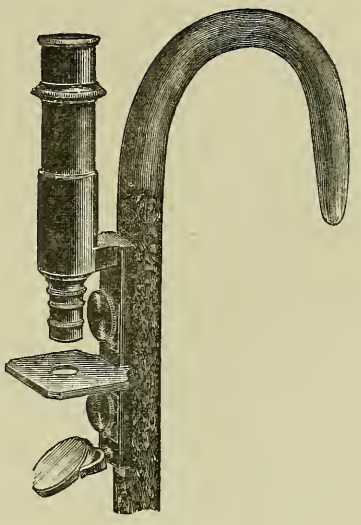
* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Zeitschr. f. Wiss. Mikr., v. (1888) pp. 196–9 (3 figs.)

looked which with the Microscope would have been easily recognized as such. Especially annoying is it when, with collecting-glasses full, fresh finds are made, and the question as to what has to be thrown aside has to be answered by macroscopical examination alone.

For excursion purposes the ordinary instruments are too heavy. The cheap school or "Salon" Microscopes are easy of transport, but not sufficiently good for the purpose. The only useful instrument, the so-called Algensucher of Zeiss, has the disadvantage that it only gives a very small field of view, so that small interesting objects may be easily overlooked, and much time is consumed in setting up the object.

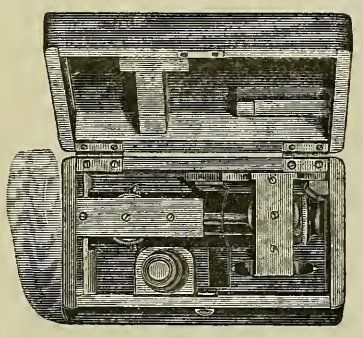
Fig. 162.



These considerations induced the author to attempt to combine the advantage of easy portability with the use of a good instrument. The instrument devised by him, and shown in fig. 162, was constructed by Herr R. Winkel of Göttingen, and has been proved by use to be admirably suitable for the purpose intended. The weight of an ordinary Microscope is centered chiefly in the stage, the pillar, and the foot. In the present instrument the stage is made as small as possible (52 mm. by 52 mm.) and the pillar and foot dispensed with altogether and replaced by an ordinary stout walking stick provided with a sharp ferule. The stick is fixed upright in the ground, and thus affords to the Microscope attached to it a most convenient position for observation. The

Fig. 163.

Fig. 164.



instrument, for convenience of transport, is made up of three parts :—the stick, near the handle of which is firmly screwed a metal plate (fig. 163)

for the reception of the two principal parts, the socket with the Microscope-tube and the stage with the mirror. These parts, with the objective and eye-piece, are contained in a box 12 cm. long and 6 cm. wide and deep (fig. 164), which can be carried in the pocket or slung across the shoulder by a strap.

The body-tube (115 mm. long) slides by hand in the socket for focusing, but the author suggests replacing this by the ordinary rack-and-pinion arrangement. The socket (46 mm. long) is attached by means of a short arm to a brass piece 19 mm. broad and 60 mm. long, which reaches down to the top of the stage. Through this piece passes a broad-headed screw, by which the socket is firmly screwed to the metal plate on the stick. A pin above and below the screw fitting into corresponding holes in the metal plate helps to keep the socket firmly in position. The stage with the mirror is fastened to the metal plate in a similar way. The mirror is only arranged for direct illumination, but is movable in all directions, so that the handle of the stick can never interfere with the observation. In the figure the stage-opening is represented by mistake as rather too large, so that a diaphragm would be necessary if it were desired to use somewhat high powers. A stage-opening of only 2 to 3 mm. is found to be most suitable for all purposes, and renders diaphragms unnecessary unless a specially low power is used.

Pritchard's Microscope with "Continental" Fine-adjustment.—An early form of achromatic Microscope is shown in fig. 165, which, from several points of its construction, we have ventured to assign to the late Andrew Pritchard, and which is interesting from the peculiarity of the fine-adjustment.

The spiral spring encircling the stem, in combination with the arrangement of the fine-adjustment screw below, would seem to indicate that what is generally known as one of the earliest forms of the "Continental" fine-adjustment was very soon adopted in England, if, indeed, its construction here did not precede G. Oberhäuser's, to whom the origination has been generally attributed. It is obvious that, if the spiral spring were sheathed by a tube, the fine-adjustment would be the "Continental" pure and simple.

The rectangular motions of the stage, actuated in diagonal directions on either side of the stem, are similar in design to those shown in one of A. Ross's earliest Microscopes figured in the 7th edition of the 'Encyclopædia Britannica,' and shown in fig. 166 from an extant example, a form which was also issued under Pritchard's name.

The condenser beneath the stage, with its long tube mounting, in the continuation of which the mirror is placed, reminds one of the tube with sliding condenser and mirror below, which formed an accessory to many of the earlier Pritchard and Ross Microscopes, and which was in fact a modification of Wollaston's doublet Microscope.

Griffith's Fine-adjustment.—Mr. E. H. Griffith sends us the following description of his new fine-adjustment. In fig. 167, 1, 2, 3 represent the milled head, pinion-axis, and pinion of the ordinary method of coarse-adjustment. The milled-head (1) is countersunk on its inner side, and the small wheel (4) is made to exactly fit the countersunk space, the inner surface of (1) and of the wheel (4) being perfectly smooth and flat. Attached to (4) is the socket and pinion (7), all of which are perfectly fitted over the pinion-axis (2) between the pinion (7) and milled

Fig. 165.

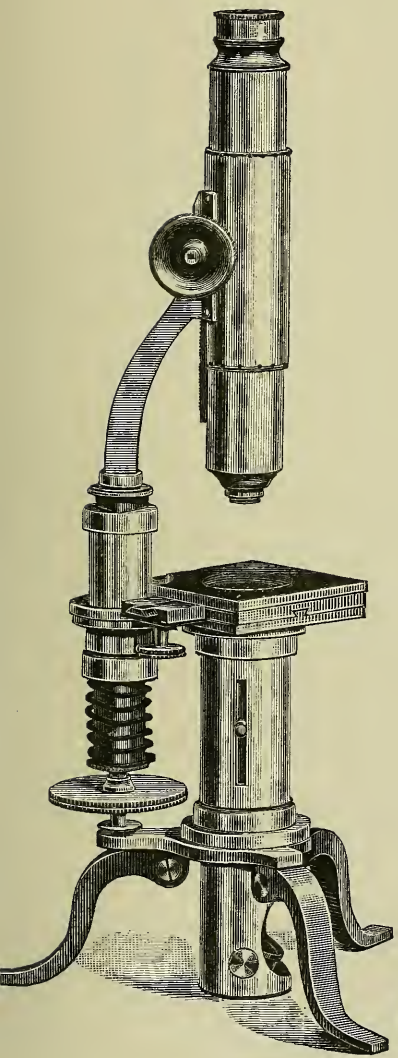
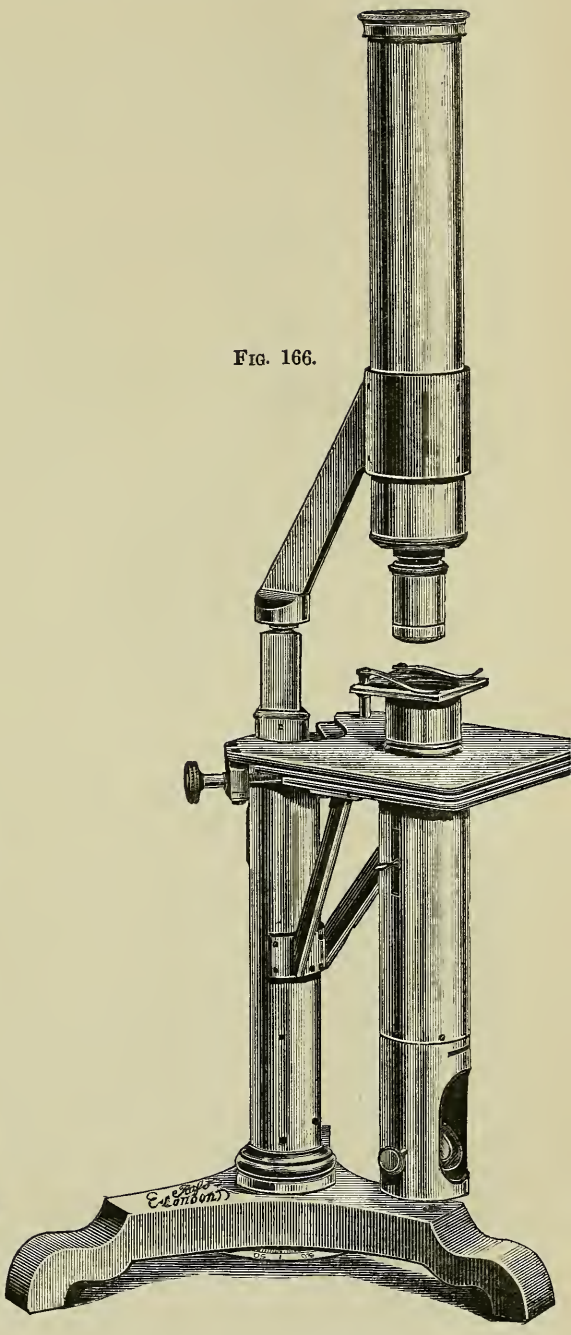


Fig. 166.



head (1). A leather washer (5) is made to rest closely against the inner surfaces of (1) and (4). It is held in position by another washer of metal (6) which, by means of two screws passing through it and (5), is made fast to the milled head. A small tension-wheel (10) has a screw passing through both washers, also binding them to (1), and when desired, locking the coarse-adjustment by making the whole combination prac-

Fig. 167.

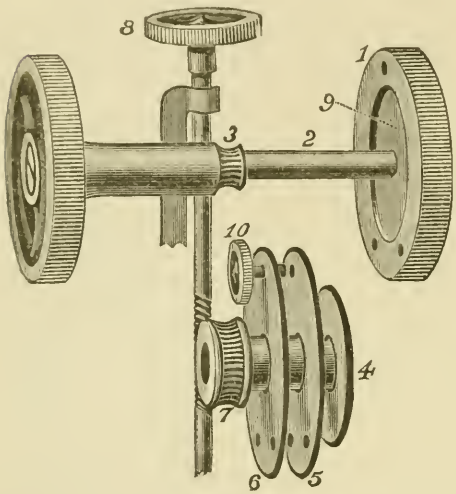
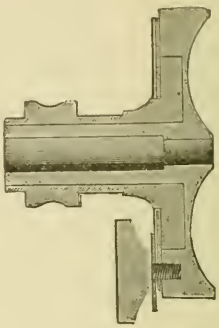


Fig. 168.



tically one wheel. When the coarse-adjustment is used the spindle (8) holds (7), (6), (5), (4), so that they cannot revolve with the pinion.

When the fine-adjustment is required the friction of the leather washer makes the whole combination practically one wheel, which is turned by means of the milled head (8), giving the entire range of the coarse-adjustment. Both adjustments are always ready for use except when the coarse one is purposely locked to prevent accidents. All wear is taken up by the spring as shown in the fig.

Fig. 168 shows the entire combination in proper position.

Necessity for a Sub-stage.*—Mr. J. Mayall, junr., in the second series of his Cantor Lectures on the Microscope at the Society of Arts, says that, in his opinion, every Microscope with which it is intended to do serious work should have a racking and centering sub-stage; and if the opticians would supply an adapter fitted with a pivoting diaphragm-carrier, or even a disc of apertures, so that objectives could be conveniently used as condensers, they would add much to the interest of popular microscopy.

As it is, it is to be feared that the great majority of possessors of Microscopes are not aware of the immense advantages attendant upon the use of condensers—achromatic condensers being, of course, far preferable, for it is with them alone that it is really practicable to observe

* Journ. Soc. Arts, xxxvi. (1888) p. 1169.

objects projected, as it were, in the image of the source of light focused by the condenser. It is, without doubt, highly desirable to have a series of achromatic condensers of different foci, to suit the field of view of objectives of different power. It appears not to be generally known that distancing the lamp from the Microscope will give a considerable range of size of luminous field, with one and the same condenser.

STRICKER, S.—**[Electric Microscope.]**

["By the use of his electric Microscope and of silver bromide plates, Prof. Stricker is enabled to get very fine photographs of living bacteria and other moving cells. He has taken photographs of living white blood-corpuscles with high-power lenses, which showed clearly and distinctly the network-like structure of those bodies."]

Engl. Mech., XLVI. (1888) p. 475.

(2) Eye-pieces and Objectives.

Defective Objectives and the Binocular Microscope.—It has been observed that badly corrected objectives appear worse with the Binocular Microscope than with the single tube. The reason of this is that with a badly corrected lens the different parts of the aperture will not work together exactly, the images formed by different parts disagreeing. In using the binocular different parts of the aperture are always made effective in forming the two images, so that the binocular is to this extent a test for good correction.

HEURCK, H. VAN.—**Les nouveaux objectifs apochromatiques de M. Reichert.** (The new apochromatic objectives of Herr Reichert.)

Bull. Soc. Belg. Micr., XIV. (1888) pp. 156–9.

SCHULZE, A.—**The new Apochromatic Micro-objectives and Compensating Oculars of Dr. Carl Zeiss.**

Proc. and Trans. Nat. Hist. Soc. Glasgow, II. (1888) pp. 154–62.

SCHULTZE, F. E.—**Eine von Herrn Westien in Rostock angefertigte Doppelloupe.** (A double lens made by Herr Westien of Rostock.)

SB. Gesell. Nat. Freunde Berlin, 1887, pp. 146–7.

„ „ **Ueber eine binoculäre Präparirloupe.** (On a binocular dissecting lens.)

Tagebl. 60. *Versamml. Deutsch. Naturf.*, 1887, p. 112

(3) Illuminating and other Apparatus.

Koch's and Max Wolz's Reflector.—Mr. T. Christy has recently exhibited a novel form of lamp. The lamp is shaded by a metal cover, near the bottom of which is inserted a solid curved rod of glass with a plane end. The light from the lamp passes into the rod, and after various internal total reflections, arrives at the end of the rod, where it may be directed upon the object.

The apparatus has been patented in Germany by Dr. W. Koch and Herr Max Wolz of Bonn, of whose specification the following is a translation :—*

"As is well known, rays proceeding from a source of light in a glass body on emergence are deflected from the normal. The more oblique the rays, the more are they deflected, the consequence of which is that finally they can no longer emerge, but are reflected back. This happens if the angle of incidence (for glass) amounts to $40\frac{2}{4}°$ and over. Use is

* Patentschrift No. 42,818, Klasse 4, 29th July, 1887.

made of this physical law in order to totally reflect all light-rays and cause them to pour out on any particular spot. The glass bodies used for this purpose are bent into the form of a parabola, and may consist of solid glass or of a glass bell, in which the source of light is at the vertex of the descending branch of the parabola.

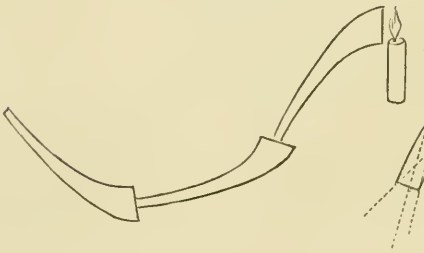
"In the drawings different forms of the instrument are represented: thus fig. 169 shows in elevation and plan a glass bell, which can be used as a lamp-glass. The outer as well as the inner surfaces of this bell are bent on both sides into a parabolic form. The rays from the source of light *l*, situated in an opening *o* in the middle of the bell, are on both sides thrown from one parabolic surface to the other until they

Fig. 169.

Fig. 170.

Fig. 172.

Fig. 171.



emerge and are dispersed from the lower end. All rays which enter the glass body are totally reflected with the greatest intensity, since each angle of incidence at least amounts to 40°. In the example chosen for the drawing, the side surfaces are not parallel but converge towards a point, in consequence of which the rays are rendered convergent before they emerge from the lower end, and thus the intensity of the emergent beam is heightened.

"This is also the case in the apparatus represented in fig. 170, which may replace the laryngeal, ophthalmoscopic, &c., mirrors hitherto used. By the use of this apparatus the light-rays are directed upon any desired spot and there uniformly distributed, so that no shadows can occur. The glass body in this case consists of a piece of solid glass bent into a parabolic form, to which a small prism can be attached in order better to see through the beam of light.

"By fitting into each other several of such parabolic glasses with sides running both parallel and also towards each other, it is possible to direct the light upon any particular spot which cannot be directly illuminated. Various examples of this are shown in figs. 171 and 172."

Nuttall's Warm Chamber.*—For experiments on Bacteria at the temperature of the blood Dr. G. Nuttall devised the apparatus shown in

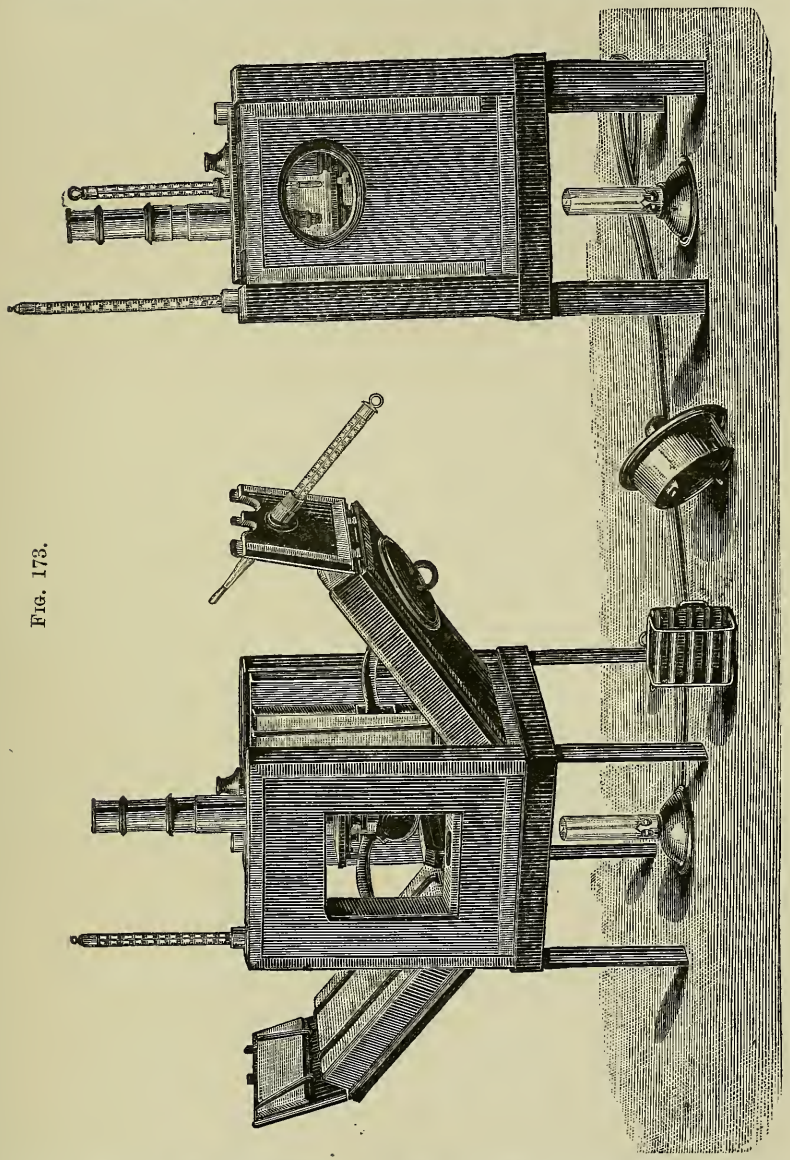


Fig. 173.

fig. 173, which is a modification of the warm chamber of Sachs, the figure on the left being a front view (open), and that on the right a side view (closed).

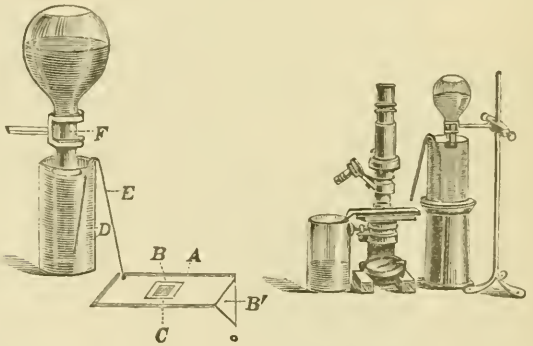
* Zeitschr. f. Hygiene, iv. (1888) pp. 353–94 (1 pl. and 1 fig.).

The whole of the lower part of the Microscope, with the object, is inclosed in a metal box, the four walls and bottom of which are double. The two sides are hinged on the bottom so that they can be turned down to facilitate the arrangement of the object in the first instance. These are filled with asbestos; the other two and the bottom being filled with water. The walls and top are covered with felt. A lamp beneath heats the water, which warms the air in the box. A thermometer passing into one of the walls shows the temperature of the water, and a second one passing through the top into the interior shows that of the inclosed air and the object. If it is desired to move the object during observation, an oval opening in one of the sides (closed by the cover shown on the ground between the two figs.) enables the hand to be introduced, and so saves the lowering of temperature which would be likely to arise if the whole side were let down. The inner surfaces of the walls are, in use, lined with several layers of wet blotting-paper.

Dr. Nuttall considers that the apparatus has great advantages over an ordinary warm stage, as the temperature can be maintained to fractions of a degree for a long time, and the thermometer shows accurately the temperature of the object.

Modification of Pagan's "Growing Slide."*—Mr. Selmar Schönland, referring to the arrangement designed by the Rev. A. Pagan for growing on microscopical slides small organisms, such as rotifers, algæ, &c., which live in water and require a frequent change of the medium, says that the results obtained with it were very remarkable. In the original design, however, the slide had always to be removed from the Microscope and kept on a specially constructed stage; and although in many cases this is of no importance, yet occasionally it is a very great drawback. The author has, therefore, devised an arrangement which

Fig. 174.



allows of the slide being kept constantly on the stage of the Microscope, and thus of the continuous observation of the same individual for weeks, and even, under certain conditions, for an indefinite period. The arrangement is represented in fig. 174.

The slide A has the ordinary form, but is made slightly longer than

* Ann. of Bot., ii. (1888) pp. 227-31 (2 figs.).

the stage of the Microscope so as to project a little at both ends. On it is placed a piece of ordinary blotting-paper which just leaves the margins of the slide free; a hole is cut out in the centre of this paper B C, and at one end is a triangular prolongation B′, which is bent downwards close to the slide. Water is drawn from a tumbler E by means of a capillary tube D, and drops on to the blotting-paper. The author usually makes the tube just wide enough to allow a small drop of water to escape about every 20 seconds. The water is drained off by the triangular prolongation of the blotting-paper already mentioned. An inverted flask F, filled with water, has its mouth just touching the surface of the water in the tumbler E, and keeps the level of the water in the tumbler constant, thus ensuring the regular escape of drops from the capillary tube D. The capillary tube has a thickened portion in the middle, which is convenient to keep the tube steady. To be quite sure that the tube will work properly, it is well to empty and refill it every 24 or 48 hours. On the right of the fig. the apparatus is represented in use.

Dixon, H. G.—**Sub-stage Condensers.** *Engl. Mech.*, XLVIII. (1888) p. 199.

Grosse, W.—**Ueber Polarisationsprismen.** (On polarizing prisms.) 72 pp., 2 pls., Kiel, 1888.

Krüss, A.—**Prismenkombination aus Kalkspath zwecks Mischung und Vergleichung von Lichtbündeln.** (Prism-combinations of calc-spar for mixing and comparing light-pencils.)
[German Patent, No. 43,569, 27th September, 1887. Could be used as a comparator such as Inostranseff's.]
Zeitschr. f. Instrumentenk., VIII. (1888) p. 371 (1 fig.).

[Manton, W. P., and others.]—**Sub-stage Condensers.**
[Principally a description of the Abbe Condenser.]
The Microscope, VIII. (1888) pp. 312-3.

Weiss, D.—**Ueber die Hämatoskopie des Dr. A. Hénocque.**
Prag. Med. Wochenschr., XIII. (1888) p. 117.

(4) Photomicrography.

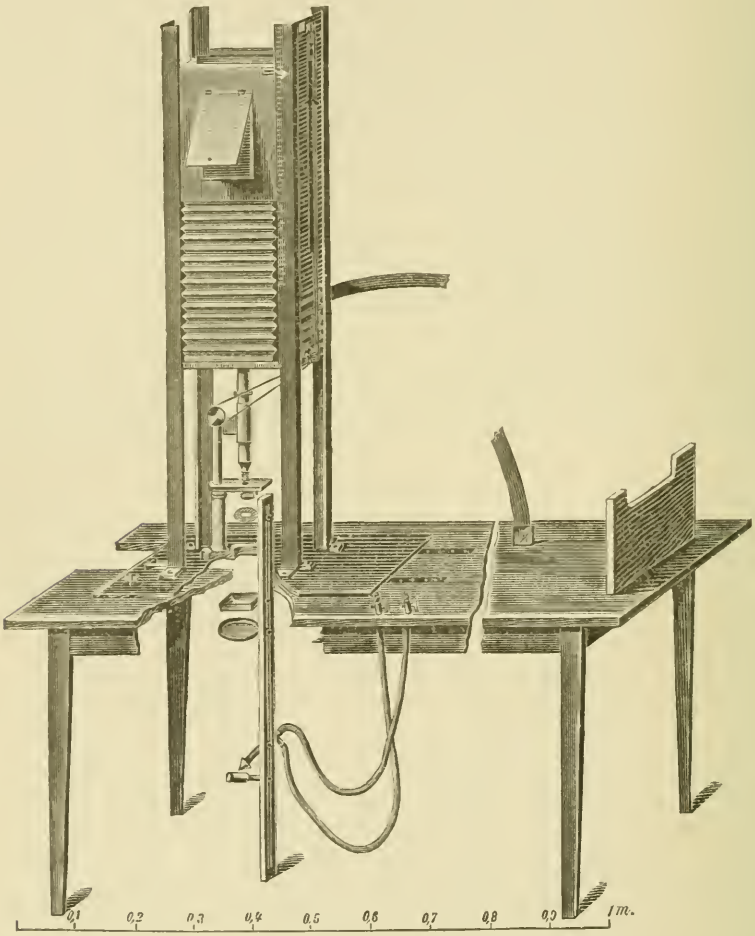
Jeserich's Photomicrographic Apparatus.*—Dr. P. Jeserich describes the apparatus shown in fig. 175, which can be used either with sunlight or artificial illumination and either vertical or horizontal, and an ordinary Microscope can be used, provided it has a horse-shoe base with sufficiently wide space to admit the light from the illuminating apparatus.

The instrument consists of a rectangular iron base, to which are screwed four vertical iron uprights of L shaped section, forming guides for the camera to slide in. The camera can be fixed at any height to a plate between two of the uprights by means of a nut and bolt passing through a slot in the plate. These two uprights are accurately graduated, so that an index on the camera gives the distance of the objective from the focusing plate. The index lies at a point a little below the focusing plate; consequently the zero point of the scale is placed at the same distance below the objective, and the true distance between the plate and the objective is then given by a direct reading. At the height of the body-tube is a very shallow box, or kind of camera, fixed in the same way by bolt and nut in the vertical slot, and united by a bellows connection to the first camera. The lower face of the smaller camera has in its centre a small opening provided with a screw-thread to receive a

* Jeserich, P., 'Die Mikrophotographie,' 8vo, Berlin, 1888, pp. 99–105 (2 figs.).

photographic objective. The objective may be replaced by an adapter, which acts as a light-proof connection with the Microscope when the latter is used. The light from the illuminating apparatus is transmitted through a circular opening in the base-plate; and the Microscope is screwed to the base by three adjustment-screws, so that the tube is vertically above this opening and vertically below the centre of the camera. The whole apparatus is placed on a strong wooden table. The illuminating apparatus is attached to the upright shown in the figure,

Fig. 175.

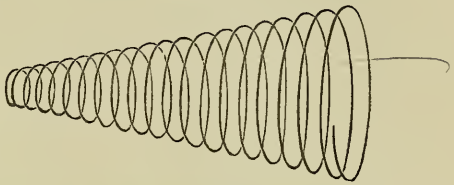


and can be adjusted as required. The mechanism for moving the fine-adjustment is described in the next note but one. The camera can be easily used in a horizontal position. For this purpose the base-plate is hinged to the table on the right-hand side, so that it can be inclined along a

semicircular guide until it finally rests in a horizontal position upon the support at the end of the table. In this position the apparatus is at a height of about 70 cm.

Griffith's Photomicrographic Camera.—Mr. E. H. Griffith suggests the use of a camera made of a wire spring cone in the place of the ordinary bellows (fig. 176).

Fig. 176.



The wire is properly tempered and of sufficient diameter to keep it in position. It is covered with black tape to prevent reflection, and a closely fitting piece of black cloth or other suitable material is placed over the entire frame. For transportation the camera may be put in a very small space, and it is less liable to accident than those with bellows made of leather.

Jeserich's Focusing Arrangement.*—Figs. 177 and 178 represent Dr. P. Jeserich's contrivance for working the micrometer screw from a distance where the upper part of the Microscope with the stage is made to revolve, as in the Hartnack model, the mechanism following all the changes of position and the micrometer screw not being loaded. S is a horizontal endless screw working in bearings at X X attached to the cross-piece of the Microscope; at one end this screw carries a grooved wheel R of about 5–6 cm. diameter, which serves as a pulley, any motion of which is communicated by means of S to the toothed wheel Z, which is attached to the micrometer screw. The endless cord passes from R over two freely-moving pulleys upon one axle attached by a clamp to the face of the camera, and from these over two similar pulleys at the other end of the camera; beyond these a weighted pulley G (5–10 grams) is suspended on the cord so as to keep it always taut. The

Fig. 177.

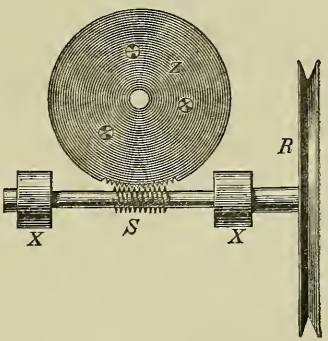
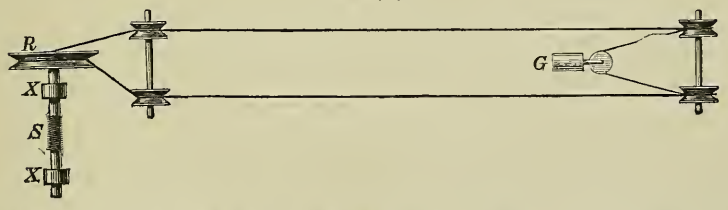


Fig. 178.



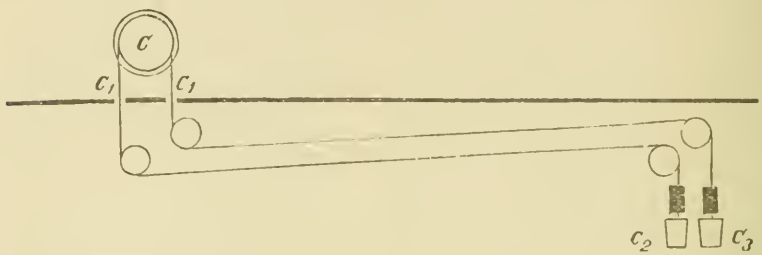
least movement of the string is thus communicated to the micrometer screw, while the whole apparatus is able to follow any movement of the

* Jeserich, P., 'Die Mikrophotographie,' 8vo, Berlin, 1888, pp. 132–4 (3 figs.).

Microscope. The most convenient arrangement for the cord is shown in fig. 178, in which position it can be used with a vertical, inclined, or horizontal camera.

Stenglein's Coarse and Fine Focusing Arrangements.*—After describing a form of horizontal camera which does not present any novel features, Herr M. Stenglein describes the method he adopts for moving the coarse-adjustment. C (fig. 179) is the milled head of the Microscope

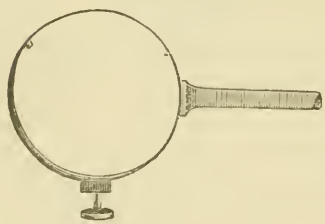
Fig. 179.



round which is a cord; C^1 C^1 are holes in the base-board for the cord to pass through, and C^2 C^3 weights attached to the cord at the focusing end of the camera. Each half of the cord passes over a couple of fixed pulleys.

The device employed for moving the fine-adjustment is shown in fig. 180, and is claimed to be better than any arrangement with toothed wheels. It consists of a brass ring, the circumference of which is a little larger than the head of the micrometer screw; on its inner side are two fixed points, while a third is supplied by a screw which serves to secure the ring to the milled head. To the outside of the ring is fixed a light and thin brass plate 45 mm. long, from the extremity of which the cords pass over two pulleys fixed to the board on each side of the camera. At the opposite end of the camera the cords again pass over a pair of pulleys, and are kept taut by a weight of 25–30 gr. By pulling one or other of the cords motion is imparted to the micrometer screw.

Fig. 180.



Adaptation of the ordinary Eye-piece for Photomicrography.†—Dr. R. Neuhauss has found that if the lenses in the eye-piece be separated for a little distance and an additional diaphragm fitted on, an image just as sharp as can be obtained with the expensive projection-ocular is thrown on the focusing screen.

The arrangement is extremely simple; a paper case or tube, $2\frac{1}{2}$ cm. long, is fitted on to the brass tube of the eye-piece. The internal diaphragm remains in its original place, while the new one is fixed over the eye-piece by means of a short movable tube.

* Centralbl. f. Bakteriol. u. Parasitenk., iii. (1888) pp. 442–5, 471–5 (3 figs.).
† Zeitschr. f. Wiss. Mikr., v. (1888) pp. 328–9.

The nearer the objects to be photographed are to the focusing disc, the greater distance must the lenses of the eye-piece be removed from one another. On the whole the lengthening varies from 1 to 2 cm.

Illumination of Objects in Photomicrography.*—Dr. M. Stenglein gives the results of his experiments on this subject. In photographing a microscopical preparation, the light is passed through a condensing lens on to the object, the image of which is thrown on some white screen. If now the object be removed, the image of the light will appear in its place. And the examination of this picture shows that its surface is not illuminated with perfect regularity, but that all the irregularities of the zirconium and calcium plates are reproduced in the zirconium and calcium lights. If a petroleum lamp with circular wick be used, the dark streak in the centre of the flame appears.

If now the image of the light be made to approach the objective, it will be noticed that the above-mentioned image gradually disappears and in its place there appears upon the white disc a circle which is more or less bright, according as the position of the image is in the objective or in front of it.

Now if the illuminating lens be covered with a screen behind which in a properly darkened room the cone of light can be observed, it will be rendered evident that when the greatest possible brightness of the light-circle is observed on the white screen, the cone of light is interrupted at the aperture of the objective.

If the cone be smaller than the objective's aperture, the image of the light shows more or less sharply on the white screen, and therefore all the shadow-lines of the source of light. If the cone be larger than the aperture, then the light and dark circles appear. If, having in the above described way obtained the greatest brightness and a regular illumination, the object to be photographed is inserted, it will be found that the sharpness of the image towards the margin is much increased.

The author's experiments were made with Klönne and Müller's 1, 2, 3, 4 objectives, and an apochromatic of Zeiss with 0·30 aperture and 30·0 mm. focal distance.

Zirconium Light for Photomicrography.†—Herren Schmidt and Haensch have recently brought out a new burner for photomicrographic purposes; in this zirconium replaces the calcium cylinder, which is found in practice to become partially consumed, and hence a rapid deterioration of the light. Zirconium is found to be very resistant, even in the hottest part of the flame, and a small plate thereof fixed in platinum and placed in the hottest part of the flame gives a splendid white light, the spectrum of which extends from A to H, and is perfectly continuous, being unbroken by any lines. The advantages of the light are that it gives a regular flame in any position, and when focused for the optical axis of an apparatus the illuminating point remains steady at the same spot.

ARSONVAL, — D'.—**Nouvelle lumière par incandescence du gaz d'éclairage. Application à l'examen microscopique, à l'analyse spectrale et la photographie.** (New incandescent gas-light; its application to microscopical examination, spectral analysis and photography.) *CR. Soc. Biol.*, V. (1888) No. 8.

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* Centralbl. f. Bakteriol. u. Parasitenk., iii. (1888) pp. 511–2.

† Zeitschr. f. Wiss. Mikr., v. (1888) p. 225.

Egbert, S.—**An Appliance for making Photo-micrographs with the Microscope in the upright position.**
[Simply a right-angled prism.]
The Microscope, VIII. (1888) pp. 310–2 (2 figs.).

Photomicrographic Apparatus, Some.
Scientific News, II. (1888) pp. 361–2 (1 fig.), 378–9 (2 figs.), 402–3 (2 figs.).

Schmidt & Haensch, Die neue verbesserte Vergrösserungscamera von. (The new improved enlarging camera of Schmidt and Haensch.)
Phot. Mittheil. v. Vogel, I. (1888) February, 4 pp.

Zeiss, C.—**Special-Katalog über Apparate für Mikrophotographie.** 4to, Jena, 1888.

(5) Microscopical Optics and Manipulation.

Microscopical Optics and the Quekett Club Journal.—Our remarks on this subject at p. 817 have produced letters from Mr. H. Morland and Mr. T. F. Smith,* the two authors whose papers were referred to, and also from "A Member of both Societies."† These letters illustrate in so marked a manner what we desired to enforce, that we deal with them further here.

One of Mr. Morland's original blunders was expressed in the following words :—"The only objection to my mind against this medium is that "its refractive index is *not sufficiently high for the new immersion* "*lenses*"! It is almost incomprehensible that notwithstanding the time that has elapsed he should not have appreciated the absurdity of what he thus propounded; but in the letter now published not the faintest glimmer is shown of any recognition on his part that his statement was as absurd as an assertion that the power of a telescope depends upon whether it is encased in wood or brass.

But if Mr. Morland's want of appreciation of the principles of the subject with which he was dealing is surprising, what are we to say to Mr. Smith's letter, which contains the most astounding microscopical mare's nest propounded since the days of the old aperture controversy.

It is hardly credible, but it is the fact, that Mr. Smith now justifies his original criticisms on the diffraction theory, and which we ventured to describe as "terrible nonsense," by the statement that that theory rested on objectives of low apertures, and that subsequently "the aperture of objectives has been increased by nearly one-half," so that adherence to the theory in the present day is "nothing better than superstition."

The first remark on this statement is that when the diffraction theory was propounded, we had not merely dry objectives with a theoretical maximum aperture of 1·0 N.A., but water-immersion objectives with 1·33 N.A., so that in the advance to 1·52 N.A. there is an increase not of nearly one-half or 50 per cent., but of 15 per cent. only. The second remark is that Mr. Smith is by his own admission wholly unaware that the theory was restated by Prof. Abbe *after* homogeneous-immersion objectives had come into use, and that in 1882 it was again developed by him in the fullest detail.‡

The letter of "A Member of both Societies" points the moral to

* Eng. Mech., xlviii. (1888) p. 178. † Ibid., p. 159.

‡ Mr. Smith's idea as to Prof. Abbe in 1875 "never having dreamt of the possibilities of the present objectives" is still more comical when it is considered what has been published in this Journal by Prof. Abbe on that very point, and the same remark applies to his views on "doubling the illuminating power," and "observing by direct light."

what at the best is a very humiliating chapter so far as microscopical optics is concerned. "A Member" insists that when Societies print rubbish in their Proceedings such comments as we made are beside the mark. Let us look at the matter by means of a parallel case.

Suppose a Fellow read a paper at the Astronomical Society refuting Newton's theory of gravitation on the ground that the premiss with which he started was wrong—that the apple fell to the ground simply because it got loose from the stalk, without which it would not have fallen. Can it be seriously suggested that the Society, as a Society, would not very properly incur serious discredit for printing such a paper in their Transactions? Is it conceivable that any astronomer would venture to write as "A Member" does, that "If no paper is to "appear in any journal because some one or other, and perhaps very "rightly, may consider it rubbish, most Societies had better give up "printing their proceedings altogether; and if the opinions of an author, "under his own signature, and controverted at the time of reading, are to "be fathered upon a whole Society, either some animus exists or editorial "craft must be in a poor way!"

It is especially to the Society who print nonsense that the complaint must be addressed, because it is they who are in reality the offenders. To the end of time there will be authors who will write with an air of transcendent knowledge on subjects of which they know nothing, and who will make similarly absurd mistakes to those of Mr. Morland and and Mr. Smith. If the matter rested there it would be of small consequence—an affair of only passing amusement. But when it comes to publication it is a very different question. Not only are the readers of the papers misled, but microscopical science itself is degraded and disgraced, and made a laughing-stock in other scientific circles.

There is no possible reason why a Microscopical Society should be less jealous of its good name and credit than any other learned Society; and so long as we have any share in the conduct of this Journal we shall spare no effort to prevent the publication by any recognized microscopical authority of views which whether by ignorance or only wrong-headedness, are what we have described as terrible nonsense. We are glad to note that the tone in which the authors write in their recent letters sufficiently shows that when they next write a microscopical paper they will take much more care than they did with the last, in order to avoid the comments it has been our duty to make, so that even in that quarter some good will have been accomplished; the similar feeling displayed in another direction by "A Member" leads us also to the hopeful conclusion that even if similar authors should hereafter be found, yet that we have seen the last of any reproduction in print of such lamentable papers as those on which we have commented.

Amphipleura pellucida.

[Criticism, by Delta, of Mr. Nelson's note, *ante*, p. 809, and remarks by T. F. S., E. M. Nelson, Delta, and Jack.]

Engl. Mech., XLVIII. (1888) pp. 117, 138, 159, 178, 199 (1 fig.), 219 and 260 (4 figs.).

D'AGEN, E.—**Initial Magnifying Power of Microscope Objectives.**

Engl. Mech., XLVIII. (1888) pp. 178-9.

HASSELBERG, B.—**Über eine Methode die Brennweite eines Linsensystems für verschiedene Strahlen mit grosser Genauigkeit zu bestimmen.** (On the method of determining with great accuracy the focal length of a system of lenses for different rays.) *Bull. Acad. Imp. Sci. St. Pétersbourg*, XXXII. (1888) pp. 412-34.

Kerber, A.—**Bestimmung der Hauptbildebene und Prüfung der Korrektionzustandes optischer Systeme.** (Determination of the principal image-plane and testing of the correction-condition of optical systems.)
Central-Ztg. f. Optik u. Mech., IX. (1888) pp. 205–8 (4 figs.).

Nelson, E. M.—**A simple Correction for Curvature of Image.**
Engl. Mech., XLVIII. (1888) pp. 259 (2 figs.).

(6) Miscellaneous.

B., J. E.—**Review of Tripp's 'British Mosses.'**
["The author wisely advises her readers to avoid as much as possible the use of lenses." (?)]
Journ. of Bot., XXVI. (1888) p. 351.

Dolbear, A. E.—**The Art of Projecting; a Manual of Experimentation in Physics, Chemistry, and Natural History, with the Porte-Lumière and Magic-Lantern.**
New ed., vi. and 178 pp., 119 figs., 8vo, Boston, 1888.

Fabre-Domergue.—**Premiers principes du Microscope et de la Technique Microscopique.** (First principles of the Microscope and microscopical technique.)
250 pp. and figs., 12mo, Paris, 1888.

Flesch, M.—**Über den Einfluss der neueren Verbesserungen auf die Anschaffung eines Mikroskopes seitens des Arztes.** (On the influence of modern improvements on Microscopes for medical men.)
Correspbl. f. Schweizer. Aerzte, XVII. (1888) p. 458.

Lehmann, O.—**Molekularphysik mit besonderer Berücksichtigung mikroskopischer Untersuchungen und Anleitung zu solchen, sowie einem Anhang über mikroskopische Analyse.** (Molecular physics, with special reference to microscopical investigations, and a guide thereto, as well as an appendix on microscopical analysis.)
Vol. I., x. and 852 pp., 5 pls. and 375 figs., 8vo, Leipzig, 1888.

Mayall, J., Jun.—**The Modern Microscope. I., II.**
[Cantor Lectures at the Society of Arts, 1888.]
Journ. Soc. Arts, XXXVI. (1888) pp. 1149–59 (19 figs.), 1164–72 (7 figs.).

Royston-Pigott, G. W.—**Microscopical Advances. XXXIX., XL.**
[Attenuated lines, circles, and dots.]
Engl. Mech., XLVIII. (1888) pp. 209 and 249 (1 fig.).

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Agar-agar for Cultivation.†—Dr. Richter gives a method for making agar which avoids to a great extent the difficulty of dissolving this medium in water. While the meat (250 grm.) for the infusion is macerating in water, into a flask holding about 250 ccm. are poured 10 grm. of agar finely chopped up and 150 ccm. of Moselle wine. Having been allowed to soak for a couple of hours, they are heated up to boiling-point in a water-bath. When the pieces are dissolved the agar-wine is set aside to cool. Next morning it is again liquefied in a water-bath and neutralized with carbonate of soda. The gelatin-meat-infusion, 2 per cent. gelatin, is then prepared in the usual way. When ready the agar wine is added to it, the mixture boiled for a quarter of an hour, and the whole filtered while hot.

The fluid (20–30 ccm.) which flows through at first is somewhat cloudy, but afterwards becomes quite clear. If cloudy the filtrate must

* 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.

† Berlin Klin. Wochenschr., 1887, p. 600.

be re-filtered. In order that the mass may have the proper degree of consistence it is necessary to use only 350 c.cm. of water in making the meat infusion instead of 500, in view of the addition of the 150 ccm. wine.

All kinds of microbes thrive excellently on this medium.

Albumen of Plovers' Eggs as Nutrient Medium for Micro-organisms.*—Dr. D. Dal Pozzo prepares the albumen of plovers' eggs in the following way. The egg is first carefully cleaned externally, and then, having been opened, the thin albumen which runs out is received into a sterilized vessel. To this one-fourth of water is added, and then the medium is poured into test-tubes, &c., where it is discontinuously sterilized, and allowed to set obliquely. From one egg four or five tubes may be filled. If necessary the medium may be modified with glycerin, dextrin, paste, &c. The thicker portion of the albumen surrounding the yolk may also be made use of by diluting it with water, and even with glycerin; it is then filtered and treated as before. Discontinuous sterilization is not absolutely necessary, as the albumen is always free from micro-organisms.

Fig. 181.

The albumen mass may also be used for the production of plates. The inoculating matter is finely disseminated throughout the albumen, and the plate is then dried over sulphuric acid, and the micro-organisms developed in a moist chamber at ordinary temperatures.

New Method for Cultivating Anaerobic Micro-organisms.†—Dr. H. Buchner's method consists in absorbing the oxygen by means of pyrogallic acid. There results an atmosphere of nitrogen and a little carbonic acid mixed with a trace of carbonic oxide.

The apparatus is shown on a reduced scale in fig. 181. The outer tube is usually made 22–24 cm. long and 3 cm. wide, the inner tube having corresponding proportions. In the bottom of the outer tube is placed 1 grm. of dry commercial pyrogallic acid, and on this by means of a pipette are poured 10 ccm. of a 10 per cent. solution of caustic potash. The smaller tube containing the previously inoculated gelatin, &c., is then placed within the larger one, and prevented from reaching the bottom by means of a wire stand. The smaller tube is plugged with cotton wool, and the outer one with a caoutchouc bung.

If the air space in the outer tube amount to 100 ccm., the quantity of pyrogallic acid to 1 grm., and that of the potash solution to 10 ccm., then the absorption of oxygen is completed in an incubator at a temperature of 37° in 24 hours. If the temperature be only 20° C., then it takes about two days to remove the oxygen entirely, while at 0° C. the absorption is very slow.

Frequent shaking of the pyrogallic acid produces of course a quicker absorption, and the addition of the alkali boiling hot accelerates the action. This method is said to save much time and labour in the laboratory.

* Med. Jahrb., 1887, pp. 523–9.

† Centralbl. f. Bakteriol. u. Parasitenk., iv. (1888) pp. 149–51 (1 fig.).

Milk as a Medium.* — Frl. M. Raskin has made an elaborate series of experiments on the culture of pathogenic micro-organisms on a firm and transparent basis prepared from milk. From milk three kinds of culture-media may be obtained, (1) where casein is retained, (2) where it is replaced by peptone, or (3) by sodium albuminate. The investigator describes the preparation of milk-peptone-gelatin, milk-peptone-agar, milk-casein-gelatin, milk-casein-agar, milk-albumen-gelatin, and milk-albumen-agar. The media proved to be very suitable. Eight species of Bacteria were found to flourish, *Bacillus malleï*, *B. typh. abdominalis*, *Komma bacillus choleræ asiaticæ*, *B. tussis convuls.*, *Staphylococcus pyogenes albus*, *Steph. pyog. aureus*, *Bacillus anthracis*, *Pneumococcus friedländeri*.

Cultivation of Bacillus Tuberculosis on Potato.†—Dr. A. D. Pawlowsky cultivates the bacillus of tubercle on potato as follows. Into narrow test-tubes, of the shape devised by Roux, are placed slips of potato. These are then sterilized for half an hour at 115°. When withdrawn from the steamer, the tubes are placed at an angle of 30°, in order to get cool, and also to drain. The potato is then inoculated, the tubes plugged and kept at a temperature of 39°.

After a dozen days' incubation the culture appears. It is whitish and glossy, and shows up distinctly against the yellow colour of the potato. In 5 to 6 weeks the surface is covered with greyish-white granulations. If glycerinated potato be used, the bacillus seems to develope with greater rapidity. The pathogenic properties of the bacillus are quite maintained, rabbits inoculated therewith die in 18 days.

The author is of opinion that the reason why other experimenters have failed to propagate the bacillus on potato, is that they have failed to recognize that humidity is an essential condition of the life of this microbe.

Cultivation of Anaerobic Microbes.‡—M. E. Roux describes some apparatus for cultivating anaerobic microbes. For cultivating in liquid media, in carbonic acid, or other gases the author uses Pasteur's double tubes, the open ends of which unite in a common narrow glass tube, besides which there is an additional tube at the side for filling purposes. The apparatus having been sterilized, the one test-tube is filled through the side tube with the inoculated nutrient solution, the other with sterile solution, after which the side tubes are melted up. Through the common exit tube the flask is evacuated with an air-pump and then filled with the gas desired. The connecting tube is now melted up. The nutrient tube is for control purposes, but afterwards may be used for another inoculation.

The simple plan for cultivating anaerobic microbes in solid media is to fill completely pipette-like vessels with gelatin nearly boiling, and then to melt up the ends. The gelatin is freed from air by the boiling. The tubes are inoculated by breaking off an end and then inserting the platinum needle, after which the end is melted up again. Another method employed is to have test-tubes with a narrow neck and then introduce the gas by means of a capillary tube passing through the cotton-wool plug into the gelatin. This done, the neck is melted up.

* Biol. Centralbl., viii. (1888) pp. 462–70.
† Ann. Instit. Pasteur, ii. (1888) p. 315.
‡ Ibid., 1887, No. 2.

The author also uses test-tubes 25 cm. long and 3 cm. broad, ending in a narrow tube 10–15 cm. long, which serves to connect with the air-pump and gasometer. When the tubes are filled with a small quantity of agar or gelatin they are inoculated, evacuated of air, and then filled with the selected gas. This done, the tube is melted up and the tube laid in the horizontal position.

An original experiment of the author's in anaerobic cultivation was to use *Bacillus subtilis* as an agent to use up the oxygen. The gelatin was boiled up in a tube with a narrow neck, then set by immersing in ice-water, and at once inoculated. The inoculated gelatin was then covered with a layer of agar inoculated with the *B. subtilis*, whereupon the tube was melted up. When the aerobic *B. subtilis* began to develope it absorbed the free oxygen present in the tube, and thereby created, for the germs of the anaerobic microbes lying below, the proper condition for their development.

Cultivation of the "Typhus" Bacillus in coloured nutrient media.*—Herr Birch-Hirschfeld has applied the method of staining Bacteria in the living condition to the study of the morphology and development of the typhoid Bacillus. The staining of the living Bacteria was effected partly in drop-cultivations and partly in test-tubes. For making the bouillon drop-cultures the author used the ordinary hollow-ground slides. The cover-glass was fixed on a rim made out of 5 parts vaselin and 1 part paraffin. This rim was run on the slide with a turn-table while the mixture was hot. This kind of rim allows the cover-glass to be easily lifted up, and an incubation does not run into the drop. Instead of the dyes usually adopted the author employed phloxin-red, a pigment which does not cause, like fuchsin, methyl-violet, &c., a granular precipitate to be deposited in the bouillon. Of a sterilized watery 1 per cent. solution of phloxin-red 1 ccm. is added to 6 ccm. of sterilized slightly alkaline bouillon. Of this the drops are made, and in it the typhoid Bacillus grows up coloured a bright red. The spores, too, which remain unstained in cover-glass preparations, are here (typhus and anthrax) brightly stained, and often more strongly than the rest of the protoplasm. If the bouillon solution be less stained than in the foregoing the spores only are stained.

Benzo-purpurin in similar quantities is still more suitable for the purpose than phloxin-red. This dye stains the spores brown.

One of the positive results, according to the author, of this method is to set at rest the disputed question of endogenous spores in typhoid Bacillus.

The author furthermore showed from the example of anthrax Bacillus that Bacteria bred in this way are unaffected both in development and virulence.

New Method of cultivating Bacteria in Coloured Media for Diagnostic Purposes.†—Dr. Noeggerath constructed a mixture of anilin dyes to correspond as nearly as possible with the spectrum colours. Of these dyes strong watery solutions were made, and then mixed in the following proportions:—Methylen-blue, 2 ccm.; gentian-violet, 4 ccm.; methyl-green, 1 ccm.; chrysoidin, 4 ccm.; fuchsin, 3 ccm. This mixture was then diluted with 200 ccm. water and added unfiltered to the gelatin in the proportion of 7–10 drops to about 10 ccm. of the latter. The whole

* Arch. f. Hygiene, vii. (1887) p. 341. † Fortschr. d. Med., vi. (1888) p. 1.

having been boiled twice or thrice in a test-tube was poured out on a plate, and when it had set, inoculated with the microbes to be examined. With the development of the microbes certain colours may appear; for example, *Streptococcus pyogenes* forms an orange-red streak in the midst of the dark-grey gelatinous mass. As this colour was not in the original mixture, the author regards it as a product of the vital activity of the Bacteria.

Improvement in Plaut's Flasks for sterilizing water.*—Dr. H. Plaut finds that his sterilizing bottles are subject to the inconvenience of an escape of the water when the closure of the stopper and neck is quite air-tight. This is obviated by using a cork stopper, and by drawing out the glass tube as far as the level of the water. When sterilization is completed the glass tube is pushed back again.

Fire-proof Cotton-wool Plug for Test-tubes.†—Dr. S. Bartoschewitsch has invented a modification of the cotton-wool stopper which consists in moistening it, before sterilization, with silicate of potash. Any shape can then be given to the plug with the fingers. The mass dries during sterilization, and in this way is produced a fire-proof casing which is difficult to remove from the plug, and can be used again a thousand times. This modification has the further advantage of preventing the nutrient medium from drying, and is much more convenient than the caoutchouc capsule in vogue.

Bordoni-Uffreduzzi, G.—**La Coltivazione del bacillo della lebbra.** (The culture of the leprosy bacillus.) *Arch. Sci. Med.*, XII. (1888) p. 53.

Mangeri, C.—**Sulla preparazione della gelatine all' agar-agar.** (On the preparation of gelatin from agar-agar.) *Gazz. degli Ospitali*, 1888, pp. 179–80.

Rousselet, C.—**On some methods of Collecting and Keeping Pond-life for the Microscope.** *Trans. Middlesex Nat. Hist. and Sci. Soc.*, 1888, pp. 64–71.

Schimmelbusch, C.—**Eine Modification des Koch'schen Plattenverfahrens.** (A modification of Koch's plate process.) *Fortschr. der Medizin*, 1888, pp. 616–9.

Soyka, J.—**Bakteriologische Untersuchungs-methoden mit besonderer Berücksichtigung quantitativer bakteriologischer Untersuchungen.** (Bacteriological investigation methods, with special reference to quantitative bacteriological investigations.) *Prag. Med. Wochenschr.*, 1888, pp. 429–30.

(2) Preparing Objects.

Methods of Examining Blood-corpuscles.‡—According to Prof. A. Mosso there are three principal reagents suitable for the examination of blood. The first of these is sodium chloride 0·75 per cent. solution, and this is unsatisfactory, as it alters and decolorizes many corpuscles. This negatives the advantages which this salt possesses in allowing the examination of blood in the fresh condition. Against the use of serum and iodized serum there are also weighty objections.

The other two reagents are perchloride of mercury, and osmic acid. These fix and solidify the blood, but the former suffers from the inconvenience of coagulating the serum. Perchloride of mercury is used chiefly according to the formulæ of Pacini and Hayem. The solution of the former is mercury perchloride 1 gr.; sodium chloride 4 gr.; distilled water 200 gr.

Hayem modified Pacini's formula as follows:—Distilled water

* Centralbl. f. Bakteriol. u. Parasitenk., iv. (1888) pp. 152–3. † Ibid., p. 212.
‡ Arch. Ital. Biol., x. (1888) pp. 40–8.

200 gr.; sodium chloride 1 gr.; sulphate of soda 5 gr.; perchloride of mercury 0·5 gr.; glycerin 28°.

The chief objections to mercurial solutions are, according to the author, that they do not prevent all the corpuscles from becoming altered, and that they always produce a decoloration of the red corpuscles.

Osmic acid used in 1 per cent. solution preserves blood-corpuscles better than any other known reagent, and does not precipitate the albumen like sublimate. It fixes the leucocytes in their natural condition, and though they become granular, they remain transparent, and preserve their proper and characteristic outlines.

Preserving Blood-corpuscles for Microscopical Examination.*—The following method of preparing permanent microscopical specimens of blood-corpuscles is extremely simple, and in Mr. R. Leigh's hands has yielded very satisfactory results.

A thin film of blood on a cover-glass is gently dried, and inverted, for half an hour or more, into a covered capsule containing a half-saturated solution of safranin in absolute alcohol. The loosely adhering stain is then washed off by a stream of distilled water, after which the specimen is again thoroughly dried, and mounted either in Canada balsam, liquefied by heat, or thinned by turpentine.

With human blood the corpuscles are stained a beautiful clear pink colour, and in non-mammalian blood the nuclei are stained dark pink, while the rest of the red corpuscles are lightly tinged. The specimens which were made three months before have retained their colour perfectly.

Methods for Investigating the Structure of the Central Nervous Organs in health and disease.†—In his 'Introduction to the Study of the Structure of the Central Nervous Organs in health and disease,' Dr. H. Oberstein recommends the dissociation method of Stilling. Harden in Müller's fluid, and then place in absolute alcohol. Then immerse in artificial wood vinegar for several weeks (glacial acetic acid 200 gr., water 800 gr., kreosote 29 drops). The preparations can, after being treated with oil of cloves, be mounted in balsam. If continuous series of sections be required, the tissue should be hardened in bichromate of potash. Begin with a 1 per cent. solution, change very often, gradually strengthening to 2 or 3 per cent. (time 6–8 weeks). In an incubator at from 35°–45° hardening is effected in 8–14 days. Special care is necessary for hardening spinal cord. If the preparations are to be kept in the bichromate solution after having been hardened, the strength should be 0·1 per cent. Hardening may be hastened by the addition of 20 to 30 drops of a 1 per cent. solution of chromic acid to the solution of the salt. When hardened the preparations are to be washed and then transferred to 50 per cent., and finally to 95 per cent. spirit. Müller's and Erlitzki's fluids and bichromate of ammonia are condemned. The best fixative for the delicate structures is a modification of Flemming's solution (Fol):—osmic acid 1 per cent., 2 vols.; chromic acid 1 per cent., 25 vols.; acetic acid 2 per cent., 8 vols.; water 68 vols. After being in this fluid for 24 hours, the pieces are thoroughly washed and then placed in 80 per cent. spirit.

* Journ. Anat. and Physiol., xxii. (1888) p. 497.

† 8vo, Leipzig u. Wien, 1888, 406 pp. 178 figs. Cf. Zeitschr. f. Wiss. Mikr., v. (1888) pp. 203–7.

For staining, Gerlach's ammonia-carmine is most recommended. The sections may be stained in 3 to 5 minutes, if placed over a water-bath filled with boiling water. Löwenthal's picrocarmine, Czokor's cochineal-alum solution, Bismarck brown, nigrosin, and Grenacher's alum-carmine are also mentioned favourably. For staining the nerve-sheaths, osmic acid (osmic acid 1 per cent. + glycerin + ammonia), and Golgi's sublimate and silver methods are also alluded to. Palladium and gold and Weigert's method are mentioned.

Methods for Examining the Structure of the Cerebrospinal Nerves.*—M. L. Petrone found that the two following methods were the best for investigating the structure of the intracranial and spinal nerves:—

(1) Bichromate of potash, or Müller's fluid, and nitrate of silver. The pieces of nerve were kept in a 2 per cent. solution of the bichromate, or in Müller's fluid, frequently changed, for at least two months. The hardening was accelerated by keeping the fluids at a temperature of about 25° C. After this the pieces are placed for 24 to 48 hours in 0·75 per cent. solution of nitrate of silver and kept in a warm place. The sections are washed several times, to free them of excess of nitrate of silver, with ordinary spirit, and finally with absolute alcohol. They are then passed through creosote and turpentine oil successively, and having been placed on a slide, are covered over with dammar merely (no cover-glass). The disadvantages of this method are the copious precipitate on the surface of the sections and the inconstancy of the staining.

(2) Bichromate of potash, or Müller's fluid, and sublimate. The pieces are first hardened as before, and then are placed by degrees in 0·35–0·5 per cent. sublimate solutions, which must for the first 10 days be renewed daily, and afterwards every third or fifth day. In this solution the pieces must remain for at least two months. The further treatment is as before, except that the copious use of water is required before the sections are placed in spirit in order to prevent the precipitate on their surface.

The foregoing methods may also be used for isolation of the elements:—(1) The pieces hardened in bichromate are thoroughly stained with ammonia-carmine, picrocarmine, chinolein, or methylen-blue, and then dissociated in glycerin or some other suitable medium. (2) The preparations are macerated in Ranvier's one-third spirit. Small pieces are then shaken up in a test-tube with a little water, to which picrocarmine and afterwards osmic acid are added.

Making Preparations of Bone and Teeth and retaining their soft parts.†—Dr. L. A. Weil takes only fresh, or nearly fresh, teeth, and in order to allow reagents and stains to penetrate into the pulp cavity, divides the tooth immediately after extraction with a sharp fret-saw, below the neck, into two or three pieces, "allowing water to trickle over it the while." The pieces are then laid in concentrated sublimate solution for some hours to fix the soft parts. After this they are washed in running water for about one hour, then placed in 30 per cent. spirit, which in 12 hours is changed to 50 per cent., and again after a similar period for 70 per cent. Then, in order to remove the black sublimate precipitate, the teeth are laid for twelve hours in 90 per

* Internat. Monatschr. f. Anat. u. Physiol., v. (1888) Heft. i.
† Zeitschr. f. Wiss. Mikr., v. (1888) pp. 200–2.

cent. spirit, to which 1·5–2·0 per cent. tincture of iodine has been added. The iodine is afterwards removed by immersion in absolute alcohol, until the teeth become white.

For staining, alcohol or aqueous solutions of borax-carmine gave the best results. From the absolute alcohol the teeth are removed to running water from 15 to 30 minutes, and then placed in the stain. In the watery solution of borax-carmine they remain one or two, in the spirituous two or three, days. They are then transferred to acidulated 70 per cent. spirit (70 per cent. spirit 100 ccm., acid. muriat. 1·0) in which they remain, the watery ones stained at least 12, the alcohol-stained ones 24 to 36 hours. This done, they are immersed for about 15 minutes in 90 per cent. spirit, and then for half an hour in absolute alcohol, after which they are transferred to some ethereal oil for twelve or more hours.

The ethereal oil is then quickly washed off the objects with pure xylol, and then they are placed for at least 24 hours in pure chloroform. After this they are passed into a solution of balsam in chloroform. The balsam is prepared by drying, in a water-bath heated gradually up to 90°, for eight hours or more, until when cold the mass will crack like glass on being punctured. Of this balsam so much is added to the chloroform as to make a thin solution, in which, as before mentioned, the teeth lie for 24 hours. After this time as much balsam is added to the solution as will dissolve. When no more balsam will dissolve, the teeth and a sufficiency of the balsam are poured into a vessel and heated up to 90° in a water-bath until the mass when cold shall be hard as glass. When the balsam is sufficiently set the teeth are carefully picked out, placed in a vice, and thin discs are cut from them with a fret-saw, water being allowed to trickle over them the while, and then they are ground in the usual way. The preparations are mounted in chloroform-balsam.

Preparing large Sections of Lung.*—Dr. G. S. Woodhead makes large sections of lung for demonstrating morbid appearances as follows:—Make the first incision through the lung in the direction in which you wish to have your sections. The second incision is made parallel to the first and not more than half an inch from the first. The section should then be placed in a flat dish on a layer of lint, and covered with several layers of lint, and over this a piece of plate-glass to keep the section flat and submerged. After being five or six weeks in the Müller, the sections are washed for about 24 hours in water. The slice is then placed in a mixture of 5 parts mucilage (B.P.) and 4 parts of syrup made by boiling 20 oz. of sugar in a pint of water. In winter 3 parts of syrup will suffice. Two drops of carbolic acid to the ounce prevent formation of fungi. After soaking in this for 48 hours or more, the slice is taken out for sectioning, dried with a soft cloth, then placed in B.P. mucilage for a few minutes, and then transferred to the freezing plate of the microtome. The microtome used is a modification by Dr. A. Bruce of the best features of the Hamilton and Williams microtomes. From time to time the slice must be banked up with gum, and when nearly frozen pare down the tissue to the level of the rails with a long thin knife. In front of the microtome place a flat white dish filled with warm distilled water, and in which is also placed a flat glass, larger than the slice, and which will eventually serve as

* The Microscope, viii. (1888) pp. 272–5.

cover-glass. The first complete section which finds its way into the white pan placed at a level of about one inch below that of the sections, is removed on the cover-glass to a dish of distilled water, wherein it remains for some hours. The sections are then stained with alum-carmine, picrocarmine, or ammonia-carmine. With picrocarmine rapid staining on the slide is best. In alum-carmine the section on the cover-glass may be left all night. Then transfer to distilled water to remove alum crystals.

Some of the unstained sections may be cleared up by Hamilton's liquor potassæ method. Having been thoroughly washed, pour over the surface of the sections with a pipette a solution of liquor potassæ 1 : 4 water. To imbed and mount take a quantity of gelatin, wash and cover with a saturated solution of salicylic acid. Soak all night, then pour off superfluous water and heat over a water-bath until the whole is thoroughly melted. To every one part of this add two parts of glycerin. Heat over water-bath, keeping it stirred until the whole is thoroughly mixed, strain through a piece of close flannel into a flask in which it may be reheated as required. Having allowed most of the water to drain away, the slide is placed on a level stand, and a thin layer of warm glycerin jelly run slowly and gently over the surface by means of a pipette ; then set aside to cool. To finish off the preparation, the slide on which the section is to be mounted is placed on three or four pieces of cork over a water-bath until it is warmed through. It is then transferred to the tripod, and a quantity of jelly is passed on to the centre and gradually on to the end nearer the manipulator. The cover-glass is then gently lowered down, the near end first. The jelly on the cover-glass keeps the section in position long enough to allow of the cover-glass coming into its place. The slide usually retains sufficient heat to melt away all superfluous jelly. Should this not be the case, the whole slide may be again heated and the extra mounting medium gently squeezed out. If there be any surplus at the margin of the cover the slide may be left for some time without further treatment. To preserve the specimen, remove the extra jelly with a knife, wipe carefully first with a moist, and afterwards with a dry cloth. Then paint round the margin several layers of benzol balsam. This must be done at once after the superfluous jelly has been scraped away, otherwise air-bubbles get in owing to the jelly becoming dry. It is convenient to mount these slides in common wooden frames.

Cleansing the Intestine of many animals of sand.*—Dr. Kükenthal remarks that the grit present in the gut of many animals, and which is due to their way of life, prevents the preparation of thin sections. Such is the case with the earthworm. The author advises that the animal be first washed clean and then be placed for some time in a tall glass vessel which has been filled up with bits of moistened blotting-paper. The worm gradually evacuates the earthy particles from the gut and fills it instead with paper.

Killing contractile Animals in a state of extension.†—M. L. Roule divides the contractile animals into those which contract rapidly, like Actiniæ, Hydroids, Bryozoa, and Ascidians, and those which contract more slowly, like *Alcyonium* and *Veretillum*. The latter

* Tagebl. 60. Versamml. Deutscher Naturf. u. Aerzte: Wiesbaden, 1887, p. 259.
† Arch. Zool. Expér. et Gén., vi. (1888) pp. v.–vii.

may be best killed by being plunged in a quantity of E. van Beneden's fluid, which consists of a saturated solution of corrosive sublimate in distilled water 3 parts, and crystallizable acetic acid 1 part. Specimens should be left in this fluid for from five to twenty-five minutes according to their size, and then washed in pure water. They should then be placed in alcohol of 45°, then 60°, 70°, and finally 80°. For histological purposes 90° and absolute alcohol should also be used. If necessary the quantity of acetic acid may be diminished.

For animals which contract rapidly it is best to use ordinary alum. Specimens are put in glass dishes with sufficient water to enable them to expand; when expanded some crystals of alum are quietly put near them; as these dissolve slowly the animals are killed gradually. Several hours are necessary for this reagent. They are then washed clean of alum, fixed with dilute solutions of Van Beneden's fluid; then washed with water and treated with a series of various strengths of alcohol.

Preparation of Embryos of Asterias.*—Mr. J. W. Fewkes, in his investigations into the development of *Asterias*, killed the young forms in 35 per cent. alcohol; they were then rapidly passed through various grades (50, 70, 90 per cent.) to absolute alcohol. They were then clarified in clove-oil, and mounted in balsam. Those which were stained were carried from 70 per cent. alcohol into Grenacher's alcoholic borax-carmine, washed, afterwards placed in from 90 per cent. to 100 per cent. alcohol, then removed to clove-oil or balsam. The preparations mounted without staining show very well the relation of the plates to each other, but it is necessary to use a staining fluid to bring out the tissues of the organs in the immediate vicinity of the calcareous skeleton. Mr. Fewkes, who used chloroform for clarifying purposes in his study of *Amphiura*, finds that clove-oil is to be preferred.

Investigation of Generative Products of Spongilla.†—Herr K. Fiedler has fixed and preserved the pieces of *Spongilla*, which he examined, with absolute alcohol and a mixture of alcohol and sublimate; the latter consisted of one part of cold saturated sublimate solution, one part of 70 per cent. alcohol, and one part of distilled water. Kleinenberg's picric sulphuric acid and Flemming's chrom-osmium-acetic acid mixture were also used with satisfactory results. Pieces were stained with Grenacher's borax-carmine and Schweigger-Seidel's hydrochloric acid and carmine. Smaller pieces were well stained with Böhmer's hæmatoxylin and with picrocarmine. Imbedding was generally effected in paraffin, rarely in celloidin. The thickness of the sections varied between 1/50 and 1/160 mm. Lyons blue was found to be especially useful in staining sections, for on being washed with ammoniacal alcohol the blue coloration was limited to the yolk-granules of the egg, and this showed up the red-stained nuclear structures. Sections of tissues preserved in picro-sulphuric acid showed, when stained with hæmatoxylin, a double coloration, the nuclei being of a bluish-violet and the vitelline constituents of a yellowish or feebly red tone.

New Method for Marking Root-hairs and for Hardening and Staining Plant-cells.‡—In his work on 'The Relations between Func-

* Bull. Mus. Comp. Zool. Camb. U.S.A., xvii. (1888) pp. 3–4.

† Zeitschr. f. Wiss. Zool., xlvii. (1888) pp. 86–8.

‡ 'Ueber die Beziehungen zwischen Function und Lage des Zellkerns bei den Pflanzen,' 8vo, Jena, 1887, 135 pp. (2 pls.).

tion and Position of the Cell-nucleus in Plants' Dr. G. Haberlandt gives the following new methods.

In order to control the growth of the root-hairs and to be able to measure their increase (it not being possible to mark these forms artificially), the germling was placed in the moist chamber on a slide, and then fine dry rice-starch was blown against the root-hairs and thereupon the cover-glass imposed. The starch-granules adhere to the sticky surface of the hairs and form marks placed at irregular intervals. The measurements were made under a low power by means of an ocular micrometer. The experiments frequently fail because the tender sensitive hairs very frequently stop growing after they have been marked. Successes, however, were scored with *Cucurbita Pepo*, *Pisum sativum*, *Polygonum Fagopyrum*, *Helianthus annuus*.

For studying the cell-nucleus, *Vaucheria* filaments were cut in two, and 20–30 minutes afterwards placed in a 1 per cent. chromic acid solution and the nuclei eventually stained with picrocarmine. For examining the plasma-balls ejected by the wounded *Vaucheria* the plants were not cut up in water, but in a 5–10 per cent. sugar solution, and cultivated for three to seven days either in porcelain capsules or in hanging drops.

It may also be mentioned that the author repeatedly obtained good results with picrocarmine, dilute methyl-green and acetic acid, and with borax-carmine. Excellent preparations showing the lacteal vessels were obtained by laying pieces of the epidermis in borax-carmine for several to twenty-four hours, and after treating with hydrochloric acid-alcohol examining in glycerin. The nuclei of *Saprolegnia* were brought out by hardening in 1 per cent. chromic acid, carefully washing, and staining with hæmatoxylin. Spores of *Pertusaria* were first treated with alcohol and ether to remove the oil in the nuclei, then stained with picrocarmine or logwood.

Preparation of Fresh-water Algæ.* — Dr. L. Klein proposes a modification of the ordinary method of preparing fresh-water algæ for microscopic examination. The use of any fluids, such as glycerin or potassium acetate, he has almost entirely abandoned, because of the time required in their preparation to secure their permanency, and the danger of injury to the cover-glasses in cleaning them. In those cases where a fluid is necessary, as when a single minute object lies in water beneath the cover-glass, he places a drop of 1 per cent. superosmic acid on the margin of the cover-glasses, and, after ten or twelve minutes, potassium acetate; this is blown under the cover-glass by means of a very fine glass tube. The hardening is effected by superosmic acid, and the closing by Canada balsam.

The solid substance preferred by Dr. Klein is Kaiser's glycerin-jelly,† viz. 1 part of very fine gelatin diluted with six parts of distilled water for two hours, and 7 parts by weight of chemically pure glycerin then added. To 100 gr. of this mixture 1 gr. of concentrated carbolic acid is added, and the whole warmed for ten minutes. In order to prevent shrivelling up the algæ must be hardened in superosmic acid before placing in the glycerin-gelatin.

For minute, and especially for unicellular algæ, Dr. Klein uses not

* Hedwigia, xxvii. (1888) pp. 121–6. † See this Journal, 1887, p. 694.

the fluid but vapour of superosmic acid, the alga to be hardened being placed in a hanging drop on a glass slide over the mouth of the flask containing the osmic acid. But this plan answers only when the object to be preserved occurs in the drop in considerable quantities. When it is solitary, or present only in very small numbers, the water in which it is contained must be partially evaporated in a watch-glass, a watch-glass containing from 5–10 drops of osmic acid being also placed in the evaporating-chamber; after the drops of the fluid have been partially evaporated dilute glycerin is added.

Glycerin-jelly is especially valuable as an imbedding material for such objects as are difficult to inclose in glycerin in consequence of their slipperiness.

Simple Method for Fixing Cover-glass Preparations.*—Dr. M. Nikiforow fixes fluids, e. g. blood, on cover-glasses by immersing them for one or two hours in a mixture of ether and absolute alcohol. The cover-glass is then taken out, and having been dried in the air, is stained by Ehrlich's method.

The process may also be used when micro-organisms are to be stained.

KLEIN, L.—**Beiträge zur Technik der Mikroskopischen Dauerpräparate.** (Contributions to the technique of microscopical permanent preparations.) *MT. Bot. Vereins Freiburg*, 1888, Nos. 49 and 50, 7 pp.

LAMB, D. S.—**Notes on the Technique of Frozen Anatomical Sections.** *Amer. Mon. Micr. Journ.*, IX. (1888) p. 205.

(3) Cutting, including Imbedding.

Cathcart Improved Microtome.—This instrument (fig. 182) differs from the original Cathcart Microtome in the following points:—(1) The principal screw is of larger diameter than in the old form, and has a head of considerably greater size; (2) The wooden frame is made with a projecting part, by means of which the instrument may be clamped on *both* sides, and two clamps are supplied; (3) The freezing-plate is made of circular shape, is supported on three pillars, and is provided with a ledge to prevent the ether getting to the upper side of the plate; (4) The construction of the instrument has been so modified that it may be used both for specimens frozen in gum and those imbedded in paraffin or celloidin.

The increased size of the screw gives a more steady movement than was possessed by the older and smaller microtome, while the greater circumference of the screw-head enables the operator to impart a finer movement to the screw. The relation between the pitch of the screw and the circumference of its head is such, that if the edge be moved forward a quarter of an inch, an object will be raised one-thousandth of an inch; and if it be moved an eighth of an inch, the object will be raised the two-thousandth of an inch.

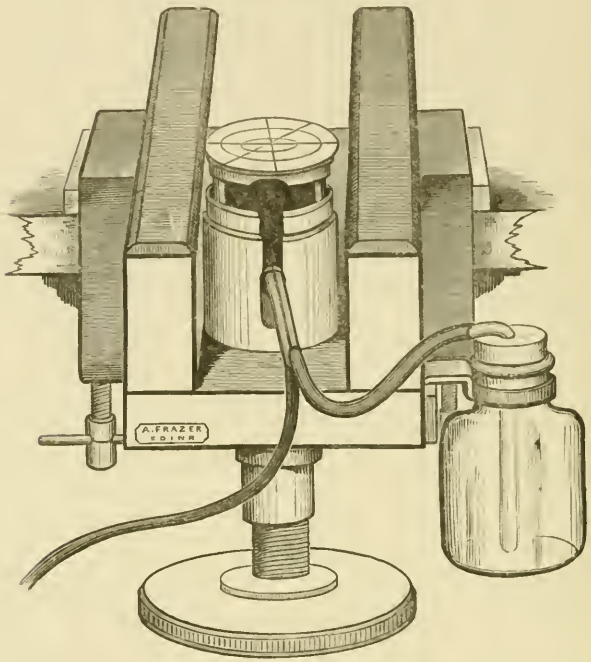
It is found that, when the instrument is clamped at both sides, less pressure need be applied at either side; and the tendency which the instrument had to turn upon the point of clamping, as on a pivot, is quite done away with.

In the original instrument, the plate was supported on two pillars, in order that as little heat as possible might be conveyed to the freezing-

* Zeitschr. f. Wiss. Mikr., v. (1888) p. 340.

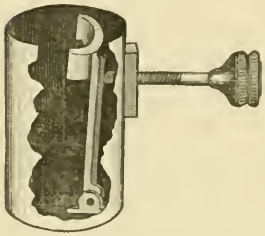
plate from the body of the instrument. In the new instrument, the size of the three supporting pillars and screws is so much reduced that

Fig. 182.



the conducting surface is not greater than in the old microtome. The arrangement for cutting imbedded sections consists of a tube (fig. 183) which fits the principal well of the microtome, and within which fits a hinged part similar to an ordinary vice. With the instrument are provided the means of preparing paraffin blocks for imbedding sections.

Fig. 183.



When it is intended to use the microtome for imbedding, the ether-spray, spray-bellows, and ether-bottle should be removed, and the freezing-tube, having been raised as far as possible by means of the principal screw, should then be withdrawn from the well. The imbedding-tube is now placed in the well, and, having been pushed down until it rests upon the point of the large screw, it may be lowered to a convenient height by working the large screw backwards.

The instrument is made by Mr. A. Frazer, of Edinburgh.

Thin Sections.—In opposition to the note of the Editors of the 'Microscope' (*ante*, p. 671), Dr. J. E. Reeves contends* that "the proper

* The Microscope, viii. (1888) pp. 252-5.

thickness of the section is a matter to be wholly determined by the particular character of the tissue or object to be examined and studied. Of course, no one having any correct knowledge of tissue structure would think of attempting to cut a section of bone, or of the skin of the heel, to the same measure of thinness that would be necessary to demonstrate bacilli in a section of tuberculous lung."

"If coarse details only are required, then a thick section properly cleared, and a low-power objective, will answer the purpose in view; but when the finest possible details of a histological or pathological specimen are sought by the aid of a high-power objective, a section just thin enough to hold the tissue elements together will not be too thin—the thinner the better—provided the section has been handled from beginning to end in the highest style of the beautiful art. In other words, a very thin, evenly-cut section—the 1/3000 in.—is of no more use or value than a section the 1/50 in. thick, if it—the thinner section—has not been perfectly cleared up and well mounted."

In reply * to Dr. Reeves's criticism, the editors "still insist that our sections must have a thickness that will include as many layers as can be *clearly* studied; for the details of a specimen cannot be observed unless it is thick enough to show the arrangement of its parts. As for studying the finest possible details, such as the structure of or changes in individual cells, no section, however thin, will serve the purpose. Other methods must then be employed."

Baltzar, G., and E. Zimmermann.—**Mikrotom mit festem Messer und selbstthätigen Vorschub des Objekts.** (Microtome with fixed knife and automatic movement of the object.)

German Patent, 12th March, 1888, No. 45,504.

Campbell, D. H.—**Paraffin-Einbettungmethode für pflanzliche Objecte.** (Paraffin imbedding methods for vegetable objects.)

Naturwiss. Wochenschr., II. (1888) p. 61.

(4) Staining and Injecting.

Methyl-green for observing the Chemical Reaction and Death of Cells.†—Prof. A. Mosso used for his researches on the reaction between methyl-green and blood- or pus-corpuscles, a watery 1 per cent. solution of sodium chloride in which 0·2 per cent of methyl-green was dissolved. To observe the action of this solution on the red corpuscles it is only necessary to prick the finger, and touch a drop of the solution placed on a slide with the blood. This preliminary examination, made with an apochromatic 20 mm., aperture 1·30, oculars 4 and 12, was supplemented by observations in the moist chamber at periods of 6 and 24 hours. The result of these experiments showed that if cells were quite healthy or in their proper working condition they did not become stained, but if this condition became weakened they stained violet, then bluish-green, and finally green. Dead cells became coloured green at once.

The solution was also noted to have a toxic action indicated by the death of the cells, and their consequent staining, as their enfeeblement began and death took place. The cells used for the examination were red and white corpuscles of the blood of fishes, frogs, &c., cilia

* The Microscope, viii. (1888) p. 248.

† Arch. Ital. Biol., x. (1888) pp. 29–39.

from the branchiæ of *Unio* and *Anodonta*, and spermatozoa. To the contractile protoplasm of vegetable cells methyl-green is also toxic (hairs from *Tradescantia virginica*, and spores of *Ulva lactuca*, a marine alga).

The author further found that methyl-green prevents the coagulation of blood. A solution of 0·5 per cent. methyl-green in 0·75 per cent. sodium chloride retards coagulation even in the proportion of 2 ccm. to 40 ccm. of blood, and if the amount be increased to 3 or 4 ccm. to 40 ccm. coagulation does not take place.

With regard to the chemical explanation of some of the foregoing facts, it was found that if the alkalinity of the cells be considerable, the methyl-green is destroyed, and consequently the violet staining of the cells is an index of diminished alkalinity.

Nuclear Carmine Stain.*—Dr. M. Nikiforow recommends the following method for making a carmine solution, which he says will keep for years, and while giving excellent results with nuclei in sections, may also be used for staining tissue *en masse*. Three parts of carmine, five parts of borax, and 100 parts of water are boiled together in a porcelain vessel. Ammonia is then added until the carmine has dissolved, the solution assuming a cherry-red colour. To this solution dilute acetic acid is added very carefully until the cherry-red colour has disappeared. Prepared in this way carmine is a thick, deeply stained (*sic*), odourless fluid, which will keep for a long time if a little carbolic acid be added to prevent the formation of fungi. Sections are stained in about 15 minutes, but may be left in the solution for 24 hours without over staining. If required for staining *en masse* the pieces must be left in the solution for several days, and when removed carefully washed. This carmine solution is especially suitable for preparations fixed in alcohol or osmic acid, or the chromic acid salts if not used for longer than two weeks.

Staining Karyokinetic Figures.†—Dr. L. Resegotti who, in conjunction with Prof. Martinotti, had previously shown that the mitoses of the nucleus may be demonstrated very well by means of safranin and chromic acid (see this Journal, 1888, p. 516), has recently extended his experiments to other anilin pigments and also to certain trade varieties of safranin. These varieties of safranin not only differ in colour and in specific weight, but also in solubility; for example, they are divided by the author into three classes, those which are soluble in spirit, those which are soluble in water, and those which are best dissolved by a mixture of spirit and water. In all 14 samples of safranin were examined, and all these gave positive results, but some varieties were better for the end in view than others.

Another difference noted is the resistance to decoloration by the chromic acid. This also varied with the different samples, but there is no note as to relation between the decoloration and solubility in water or spirit. Other anilin dyes which gave positive results were the hydrochlorate and acetate of fuchsin, dahlia, methyl-violet, gentian-violet, rubin, victoria blue, magenta red.

The author also made some experiments to see if the karyokinetic figures would not stain by substitution, but the only favourable results

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 337–8. † Ibid., pp. 320–4.

he seems to have had came from a combination of methyl-violet or dahlia, with eosin or acid fuchsin. The sections hardened in absolute alcohol are stained with an aqueous or weak spirituous solution of methyl-violet for five minutes, they are then transferred to a very dilute solution of eosin in spirit, wherein they remain for one or two minutes. After this they are again treated with spirit and mounted in the usual way.

Safranin as a Stain for the Central Nervous System.*—It has already been pointed out, says Dr. M. Nikiforow, that safranin stains certain parts of the central nervous system in a characteristic way when the tissue has been hardened in chromic acid salts. Thus the medullary sheath of the fibre (erythrophilous substance) stains rose, while the nuclei of the nerves, glia cells, and blood-vessels assume a violet hue. This property of safranin is all the more important, because in disease, and even in the earlier stages thereof, the characteristic coloration is lost. The method of the author for manipulating the tissue in order to obtain a satisfactory result, as far as differentiation is concerned, is as follows:—The brain or cord is hardened in chromic acid salts (Müller's fluid or bichromate of ammonium). The chromic acid salts are not to be washed off with water, and the sections are to be transferred directly from spirit to the concentrated aqueous solution of safranin. The anilin water solution or a 5 per cent. carbolic acid solution of this dye may be used. It is advised to over-stain the sections or to leave them in the staining solution for 24 hours. After this the sections are removed to spirit, where the excess of stain is washed off. As soon as the grey substance begins to appear, and can be distinguished from the white matter, the section is lifted out and placed in a solution of a metallic salt, chloride of gold, or chloride of platinum, the strength of which is 1 : 500 and 1 : 1000. When a trace of violet begins to show in the grey substance the section is at once placed in water and thoroughly washed. After this it is placed in alcohol until the rose-violet of the grey substance is clearly distinguishable from the red of the rest of the tissue. It is next cleared up in oil of cloves, and the latter replaced by xylol, and finally the specimens mounted in balsam.

Combining Weigert's Hæmatoxylin-copper Stain for Nerve-fibre with the use of the freezing Microtome.†—Prof. D. J. Hamilton states that sections of brain of any size can be cut with the freezing microtome and stained to perfection with the copper and hæmatoxylin if the following method be adopted.

The brain should be hardened in Müller's fluid, the longer the better, those which have lain years in the fluid being best to work on. Human brain requires three to four months, and that of a small animal three to four weeks. When thoroughly hardened it is cut into perpendicular transverse slices, about half an inch thick, and these are allowed to lie in Müller's fluid two or three weeks longer, and may be kept in this indefinitely. They are then cut into pieces required to fit the microtome, and these are placed in ordinary methylated or absolute alcohol for three days, the spirit being changed each day. From this they are transferred to a mixture of equal parts pure alcohol and ether, in which

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 338–40.
† Journ. of Anat. and Physiol., xxi. (1887) pp. 444–9.

they are allowed to lie for forty-eight hours. They are then transferred to a thin solution of celloidin in equal parts of ether and absolute alcohol. Collodion being cheaper than celloidin, and answering the same purpose, is preferable. In this solution the piece of tissue remains for at least three days, and is afterwards removed to a paper capsule filled with celloidin solution, and allowed to stand until a film forms on the surface. The mass is then consolidated by immersion for twenty-four hours in weak spirit, and the latter removed, in order that it may be sectioned in a freezing microtome, by immersion for 24 to 48 hours in Erlicki's fluid (bichromate of potash 5; copper sulphate 1; water 200).

The next step is to impregnate it with the last of the three following mixtures (C.):—

A. Syrup (crystallized sugar 28·5 grm. to 31 ccm. water), 3 ccm.; mucilage (gum acacia, 57 grm. to 310 ccm. water), 5 ccm.; water, 9 ccm.

B. Solution A., 2 parts; syrup as above, 1 part.

C. Cupric sulphate, 1 grm.; potassii bichrom., 5 grm.; solution B, 200 ccm.

It is kept in an air-tight bottle filled with this mixture for at least three days at a temperature of 100° F. The microtome used by the author is a Rutherford's freezer of large size, and the knife an ordinary planing iron, such as is used by carpenters, and set in a wooden handle. Before placing the piece of tissue in the well it should be wiped, in order to remove the liquid in which it has been soaked. A quantity of mucilage, only sufficient to cause the piece to adhere, is then poured into the well, and in this the piece of tissue itself. The ice and salt in the box must be frequently renewed in order to keep the temperature as low as possible, and if the sections should adhere to the knife the mass is not sufficiently frozen or the knife has become too warm. To keep the planing iron cool it must be plunged in the freezing mixture after every four or five sections. When cut, the sections are removed at once to a dish filled with Erlicki's fluid, in order to dissolve any mucilage that may be adhering to it. No harm results if left herein for several days. The section is next transferred to a dish filled with weak spirit to remove the Erlicki's fluid. The spirit is to be changed once. A slide is now covered with a thin film of collodion, in which the section is placed, in the position it is intended to occupy, and when it has partially dried the upper surface is covered with collodion. When thus fixed to the slide it is transferred to absolute alcohol. If absolute or very strong alcohol be not used the collodion may strip off the slide. After it has lain for a few minutes in spirit it is ready for staining with Weigert's hæmatoxylin (hæmatoxylin 1, absolute alcohol 10, carbonate of lithia 1, distilled water 90 parts). The staining may be effected by leaving the preparation in a warm chamber at a body temperature for twelve hours or longer, but a quarter of an hour suffices to stain the fibres, even without the aid of the warm chamber, if the brain has been hardened long enough and the solution of hæmatoxylin of proper quality.

When the section and surrounding collodion are thoroughly blackened, the slide is washed in a running stream of tap water. The slide is then transferred to the ferridcyanide and borax decolorizer (borax 2, ferridcyanide of potassium 2½, water 100 parts), wherein it remains until all superfluous stain has been removed from the grey matter. When thoroughly decolorized, the slide, with the collodion still adhering, is transferred to running water for twenty-four hours, in order to thoroughly

remove all trace of the decolorizer, the incomplete removal of which causes the stain to fade sooner or later.

The edges of the collodion are next clipped off close to the preparation and the slide dehydrated in strong spirit. It is then immersed in oil of cloves, wherein it is almost instantaneously clarified. This done, the surface is washed with xylol, and finally mounted in a mixture of gum-dammar and gum mastic dissolved in xylol, and placed in a warm chamber for twenty-four hours.

Staining of Elastic Fibres with Chromic Acid and Safranin.*—Dr. L. Ferria, who has been examining various examples of safranin, 18 in all, found that these differed in colour, specific gravity, in their solubility in water and spirit, and in their behaviour with chromic acid.

When an aqueous solution of chromic acid is added to an aqueous solution of safranin a precipitate is thrown down. This precipitate may vary from an abundant red, almost black, to a scanty red or yellowish red, and it is the samples of the latter which are least satisfactory in staining the elastic fibres. These latter were certified by their makers to be the purer varieties, and the author notes also that those varieties which stained elastic tissues well were less suitable for staining nuclei or showing the nuclear mitosis.

The author also found that preparations which had been hardened in spirit were stained very well if the sections were left for about five hours in a watery solution of safranin (1 : 1000) at a temperature of about 37°, and then, having been washed, were placed in the safranin solution. If the specimen should be overstained so that the section is of a diffuse red colour, it should be treated for a short time with a very dilute alcoholic solution of caustic potash and then left for 24 hours in absolute alcohol. Only the nuclei of the tissue are then stained red, and contrast well with the blackness of the elastic fibres.

Clarifying in bergamot oil and mounting in dammar is said to aid the clearness of the picture.

Congo-red as a Reagent for Cellulose.†—Dr. E. Heinricher in examining the behaviour of Congo-red towards the thickenings in cell-walls which occur as reserve matter in the cotyledons of *Impatiens Balsamina* and other varieties of *Impatiens*, found that these thickenings were stained red. As another series of reactions negatived the cellulose nature of these thickenings, the author proceeded to examine the behaviour of this pigment towards the mucous element of plants. The general result was that Congo-red stains not only cellulose and amyloid matter, but also mucus of most of the plants examined.

Hence, the author concludes that Congo-red is not to be considered as a specific reagent for cellulose, and, if used for distinguishing it, great care must be taken to guard against errors.

Simple and rapid Staining of the Tubercle Bacillus.‡—Mr. H. P. Loomis recommends Ziehl's solution for staining the tubercle bacillus, and Fraenkel's methylen-blue solution as a contrast stain. This method has the merit of being simple and rapid and dispensing with the use of acids.

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 341-3.
† Ibid., pp. 343-6.
‡ Medical Record, xxxiii. (1888) p. 631.

Staining the Spirochæte of Relapsing Fever.*—M. N. Nikiforow gives the following modification of his method of staining this micro-organism.

Instead of placing the drop of blood between two cover-glasses and then drawing them asunder, the author now takes a cover-glass between two fingers and touches the summit of a drop of blood with it, and then with the edge of a second cover-glass, held at an angle of 45° to the first, touches the blood, so that a thin layer becomes spread out on the first cover-glass. When dry the cover-glass is placed in a capsule of absolute alcohol, to which ether has been added. Herein the cover-glass remains from several hours to one day. When taken out, the preparations are stained with the ordinary watery anilin solution.

If the red corpuscles are not to be stained as well, the preparation must, before staining, be placed in 1 per cent. acetic acid.

Pyridin in Histological Technique.†—M. A. de Souza finds that, as pyridin coagulates albuminates with a neutral reaction, it can be used as a hardening agent. From the fact that it is miscible with oils and fats as with water, it possesses certain advantages where tissues are rich in such substances.

Hardening is effected in an incubator in about eight days, and with small animals in even a shorter time. The tissues are at once hardened, dehydrated, and cleared up, and can be easily sectioned and stained, as pyridin easily dissolves anilin dyes. The sections may be mounted in balsam, or, after four days' hardening, transferred to water without cockling. In the latter case they take up hæmatoxylin and picro-carmine very well.

The author obtained fair results by hardening skin in pyridin; he was less successful with liver, but the reagent seems suitable for pursuing the appearances in karyokinesis. The brain, however, gave the best results, the hardening being rapid and the cells of the grey matter staining deeply.

The author also employed this reagent for staining tubercle bacilli in sputum. The bacilli were rapidly stained without warming in the following way. A saturated solution of the dye (methyl-violet, fuchsin, or rubin) is made in pure pyridin. With this solution the preparation is moistened for 40–60 seconds; it is then decolorized in 30 per cent. nitric acid, and after being contrast-stained with vesuvin, eosin, or methylen-blue, also dissolved in pyridin, mounted in balsam. The method is more suitable for cover-glass preparations than for sections, although decent preparations can be obtained from the latter by soaking them in a dilute solution of ammonia.

If the advantages of pyridin are as stated by the author, there is no doubt it will be extensively employed.

Modification of Garbini's Double Stain with Anilin-blue and Safranin.‡—Dr. A. Garbini now uses carbonate of lithium as a decolorizer and his method is now modified and improved as follows:—Immerse the sections in 1 per cent. solution of anilin-blue for 2 to 4 minutes. Wash in distilled water; decolorize in a 1 per cent. solution of lithium carbonate. Then bring back the colour in a 0·5 per cent.

* Wratsch, 1887, p. 183 (Russian). Cf. Zeitschr. f. Wiss. Mikr., v. (1888) pp. 107–8.

† Comptes Rendus Soc. Biol., iv. (1887) pp. 622–3.

‡ Zeitschr. f. Wiss. Mikr., v. (1888) p. 170–1.

hydrochloric acid. Wash carefully; immerse in safranin for 10 to 20 minutes, and if possible in the warm. Dehydrate in *methylated* spirit, and then decolorize in a mixture of oil of cloves (2 parts) and cedar oil 1 part. Then immerse in xylol until the right hue is attained. (See this Journal, 1886, p. 899.)

Congo-red as a Reagent for Free Acid.*—Herr C. Wurster has shown by experiment that Congo-red, when used for organic substances, is not a certain test of free acid. In the presence of ammonia it forms with this a compound which is not decomposed by organic acids at all and not readily by inorganic acids (carbonic, acetic, hydrochloric, sulphuric, &c.). The blue-violet colour which shows the presence of free acids, does not occur in the presence of ammonia, when organic acids are added, or on addition of inorganic acids when all the ammonia has been combined with the free organic acid.

Since in animal chemistry, ammonia in many cases can scarcely be excluded, the yellow-red coloration of Congo-red may remain persistent in spite of the presence of relatively large quantities of acid.

Absorption of Anilin Pigments by living Animal Cells.†—The results of the experiments made by Dr. G. Martinotti on the absorption of anilin dyes by animal cells differ in some particulars from those of Pfeffer, &c., who experimented in the same direction. It is found that living animal or vegetable cells, if made to live in a medium coloured with these pigments, are variously affected; that is, that certain of these dyes are more poisonous than others, a result which is reckoned by the more or less rapid staining of the nucleus; for when the nucleus becomes visible by being stained, this indicates that the cell is dying or dead. If, however, a quantity of pigment short of being poisonous be used, the protoplasm of the cell becomes stained. But according to the author, this quantity is, certainly for certain dyes such as methyl-violet, methyl-green, &c., infinitesimal, and he only found two, Bismarck-brown and methylen-blue, to give satisfactory results.

If tadpoles be placed in a very dilute solution of Bismarck-brown they take on a brownish-yellow colour in 24 hours, while the water has lost all its colour. And if the solution be renewed from day to day, they may finally be made to assume a yellowish-black hue characteristic of the dye. Again, if they be placed in pure water, all the absorbed dye may be gradually removed.

Microscopical examination showed that certain kinds of cells only possessed the power of selecting the pigment. These were the pigmented cells of the skin within which the dye collected in such a way as to completely conceal their shape. Other cells which were red stained were the branched connective tissue cells lying in the subcutaneous stratum. Certain other polygonal epithelioid cells were found to contain large well-stained granules in their protoplasm. In muscular fibre cells, in the walls of blood-vessels, its coloured granules were occasionally seen.

The action of methylen-blue was similar, but less active and less pronounced. While the animal was alive the author did not find that the axis-cylinder was stained, as Ehrlich did. With methylen-blue certain granules normally found in the red corpuscles assumed a deep blue colour.

With regard to the absorption of these dyes during cell-prolifera-

* Centralbl. f. Physiol., 1887, p. 240.

† Zeitschr. f. Wiss. Mikr., v. (1888) pp. 305–13.

tion and its bearing on karyokinesis, the author found that it did not seem to have any direct relation to the nuclear mitosis. In order to fix the methylen-blue in the tissues an iodized solution of iodide of potash, or picrocarmine, or picrocarminate of ammonia, was used, the preparations being afterwards mounted in glycerin. This method was found to be inconvenient.

If Bismarck-brown be used, the tadpoles were immersed alive in a 0·2 per cent. solution of chromic acid. This fixed the tissues without affecting the Bismarck-brown. The tissues were then washed, and afterwards stained with safranin. In using spirit it is necessary to be cautious, as it rapidly absorbs the dye.

Theory of Microscopical Staining.*—Dr. H. Griesbach says that the more he considers the subject of microscopical staining the more he is convinced that it is based on chemical combinations taking place between the tissues and the pigments, both of which must, for various reasons, have very different chemical compositions at different times. This is easily obvious from certain examples, say, the composition of the infantile and adult brain. This difference in chemical composition is further augmented by the various reagents used for fixing the tissues, and also complicated by the reaction and composition of the dye itself. And so on.

Starch Injection-mass.†—Prof. S. H. Gage prepares a cold-flowing coarse injection-mass, the principle of which was first introduced by Ad. Pansch, from starch. This mass may be forced up nearly to the capillaries, rapidly hardens after injection, leaves the vessels flexible, and is suitable for permanent dry or alcoholic preparations.

Mass for ordinary injection : dry (laundry) starch, 100 ccm. ; water or 2½ per cent. aqueous solution of chloral hydrate, 100 ccm. ; 95 per cent. alcohol, 25 ccm. ; colour mixture, 25 ccm. When thoroughly mixed filter through two or three thicknesses of cambric. To prevent the starch from settling, the cloth should be tilted from side to side or the mass stirred during filtration.

The colour mixture : dry colour (e.g. Berlin blue), 100 ccm. ; glycerin, 100 ccm. ; 95 per cent. alcohol, 100 ccm. Mix well in a mortar and keep in stoppered bottle. If permanent preparations are not desired, anilin dyes may be used.

Special injection-mass for brains, &c. : corn starch, 100 ccm. ; 5 per cent. aqueous solution of chloral hydrate, 50 ccm. ; 95 per cent. alcohol, 75 ccm. ; colour mixture, 25 ccm. Either of the masses may be kept in large quantities in wide-mouthed bottles, but must be well stirred before using. If it be desired to inject very fine vessels, a preliminary injection should be made by using the stock mass diluted with an equal volume of water or of chloral solution. In any case it is advisable to make the injection as quickly as is possible.

Achard, C.—**Sur l'emploi de la teinture d'orcanette dans la technique histologique.** (On the employment of a tincture of orcanet in histological technique.) *Arch. de Physiol.*, IX. (1887) pp. 164–8.

Erdös, J.—**Eine Methode zur Injection der Blutgefässe mit kaltflüssiger Masse.** (A method for the injection of the blood-vessels with a cold fluid mass.) *Anat. Anzeig.*, III. (1888) p. 261.

Kertesz, A.—**Die Anilinfarbstoffe. Eigenschaften, Anwendung, Reactionen.** (The Anilin stains. Properties, use, reactions.) 8vo, Braunschweig, 1888.

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 314–19.

† Amer. Mon. Micr. Journ., ix. (1888) pp. 195–6.

KOWALEWSKY, N.—**Ueber die Wirkung von Methylenblau auf die Säugethiere.** (On the action of methyl-blue on mammals.) *Centralbl. Med. Wiss.*, 1888, p. 209.

LETULLE.—**Note sur un procédé de coloration stable de la matière amyloïde au moyen de l'éosine et de la potasse caustique.** (Note on a process of stable staining of the amyloid matter by means of eosin and caustic potash.) *Bull. Soc. Anat. Paris*, II. (1888) p. 85.

REDFERN, J. J.—**The Pal-Exner Method of Staining Sections of the Central Nervous System.** *Brit. Med. Journ.*, 1888, p. 642.

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

Mounting of specimens to be examined with homogeneous-immersion lenses.*—Dr. A. Garbini adopts the following device for preventing any damage to the specimen from the resin or balsam being acted on by cedar oil or other solvents after the examination under homogeneous immersion or during the clearing of the cover-glass. The slide when mounted is baked for some hours at a temperature of 30° C., until the solvent of the resinous medium has been, as far as possible, evaporated. When cool the edge of the cover-glass is ringed round with a thinnish coating of gum. The material best suited for this purpose is sold under the name of Senegaline (Adrien Maurin, Paris). It may be made to take any colour if desired. By this device a cover-glass can be cleaned with xylol or benzol with the greatest ease.

Preparing Styrax Balsam.†—Dr. Th. Marsson, who recommends styrax for mounting microscopical specimens, prepares it in the following way:—The grey commercial styrax is shaken up every day several times for eight days with an equal quantity of chloroform until two layers have separated out, the lower one of which contains the styrax. The contents of the bottle are then filtered, the filter being moistened with chloroform, and the clear brown styrax solution evaporated to the consistence of a thin syrup. This syrupy mass is then placed in a bottle, of which it occupies not more than 1/6 of the space, and petroleum-ether is added little by little. A first a clear brown fluid is formed, but after a time a milky clouding shows that the styrax is beginning to separate out. The petroleum-ether may now be added in larger quantity in order to hasten the precipitation of the balsam, When all the balsam is thrown down the clear fluid is poured away, and then the styrax balsam is purified from all trace of chloroform or petroleum-ether by evaporation in a water-bath, after which the residue forms a thick, clear brown, stringy mass, and after exposure to the air dries quite hard and can be scratched with a needle. As the styrax balsam in this condition is too stiff for manipulation, it is thinned down with a solvent. The solvent used by the author is monobromnaphthalin, which has a higher refractive index than styrax, and diluted with this a perfectly clear solution is formed. It flows very easily under the cover-glass, but dries somewhat slowly.

Herstellung von flüssigem Kitt oder Gummi. (Preparation of fluid Cement or Gum.) [For every 500 cc. of the cement or gum dissolve 150 gr. of glue or gelatin, 12·5 gr. borax, and 6·25 gr. soda, in 750 cc. of water, and keep it for some hours below the boiling-point. Let it stand, decant and concentrate the fluid by evaporation. The solution is fluid at ordinary temperatures.]
Chem. Ztg., 1888, p. 287; *Engl. Patent*, 1886, Nr. 13,168.

SMILEY, C. W.—**Rinnbock's Slide of Arranged Diatoms, Chirodota wheels, Synapta plates, Synapta anchors, &c.**
Amer. Mon. Micr. Journ., IX. (1888) pp. 199–200 (1 pl.).

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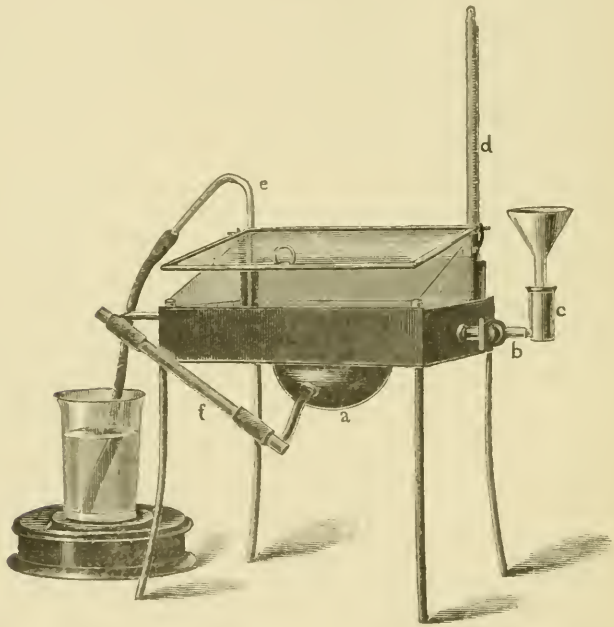
* Zeitschr f. Wiss. Mikr., v. (1888) pp. 171–2. † Ibid., pp. 346–50.

(6) Miscellaneous.

Garbini's Closed Water-bath.*—Dr. A. Garbini uses a modification of the water-bath described in his 'Manuale per la tecnica del microscopio,' for the purpose of heating slides on which sections are to be stuck by Giesbrecht's or Mayer's methods.

The apparatus (fig. 184) consists of a rectangular box 20 cm. long, 15 cm. broad, and 4 cm. high, closed hermetically. From the middle of the bottom projects the copper bulb *a*, having a diameter of 8 cm. On one side is a small tube *b*, with a stop-cock. It connects with a wider tube *c*, into which may be fitted a cork bung, and a glass funnel, for the purpose of filling the box. Upon the top of the box, by means of four fluted pillars

Fig. 184.



(the two front ones 0·5 cm. high, the two hind ones 4 cm. high) and three plates of glass fitting into the flutings a compartment is formed. This is closed above by a glass lid moving on hinges fixed to the posterior columns. From the figure it will be evident that this compartment is not quite closed when the lid is down, as there is a narrow aperture in front, and a wider one behind.

Behind the box are two glass tubes 3 cm. high, and with a diameter of 1·5 cm. Into one of these *d* fits a thermometer, and into the other a bent glass tube *e*, to carry off the steam.

Loss of water may be prevented by using, instead of the tube *e*, a

* Zeitschr. f. Wiss. Mikr., v. (1888) pp. 166–8 (1 fig.).

glass tube 60 cm. high, with a diameter of 2 cm., in which the steam can condense, and flow back into the water-bath.

The quantity of water in the bath is shown by the gauge *f*. Two of the special advantages of this form of water-bath are the prevention of dust, and the current of air which carries off the various vapours so that the lid always remains bright, and the progress of the preparation may be watched.

New Application of the Plasmolytic Method.*—Herr H. de Vries suggests an application of the method of plasmolysis for the determination of the molecular weight of a given substance. The calculation of the isotonic coefficient of any compound soluble in water, by means of the law implied in De Vries's † method for the analysis of the force of turgidity, presupposes a knowledge of the molecular weight or equivalent of the substance in question. If, therefore, the isotonic coefficient is known, it follows from the law that the molecular weight can be ascertained. If two substances have the same isotonic coefficients, this must result from their solutions containing the same number of molecules in a given quantity of water. Application of this law was made in the case of raffinose, a sugar of considerable importance in the manufacture of beet-root sugar, with a much higher power of rotation than cane-sugar, and affecting the estimation of the latter in molasses.

Three formulæ have been proposed for raffinose, agreeing in their percentage composition, viz. $C_{12}H_{22}O_{11} + 3H_2O$, $C_{18}H_{32}O_{16} + 5H_2O$, and $C_{36}H_{64}O_{32} + 10\,H_2O$. By the application of the proposed method, De Vries found the degree of concentration of raffinose isotonic with 0·1 molecule of cane-sugar to be 5·957 per cent. It follows that the molecular equivalent of raffinose must be approximately 595·7, which agrees very nearly with the second of the above formulæ.

New Method for Demonstrating and Counting Bacteria and Fungi Spores in the air.‡—Dr. R. J. Petri's method consists in drawing air by means of an air-pump through a sand filter. The sand consists of particles 0·25–0·5 mm. and must be thoroughly heated. It is then made up into the shape of corks with wire gauze. Two of these filters, each 3 cm. long and 1·5–1·8 cm. broad, are inserted in a glass tube 8–9 cm. long. The two filters touch in the middle of the tube. The second filter serves to control the efficiency of the first, and should remain quite free from germs, all of which should have been picked up by the first. After the filters are fitted in, the ends of the tube are plugged with cotton-wool. During an experiment the plugs are removed and one end of the tube connected with an aspirator. The air should be removed at the rate of about 10 litres in 1 to 2 minutes. The rapidity of the air stream in the filter should never exceed 0·7 m. a second. The germ-laden sand is then strewn in flat double capsules about 9 cm. broad, and then liquid gelatin poured over it so as to form a layer, care being taken that the sand is uniformly distributed. As the colonies grow they can be counted and examined microscopically. For the purposes of examination the author has constructed a special enumerator, for information about which the original must be consulted. For the purposes for which it is intended, namely, the examination of

* Bot. Ztg., xlvi. (1888) pp. 393–7.

† See this Journal, 1885, p. 84.

‡ Zeitschr. f. Hygiene, iii. (1887) p. 1.

bacteria, &c., contained in air, both as to kind and number, the author maintains that his method gives better results than any other.

Investigating the Effect of Remedies by the Microscope.*—A new method of research, says Dr. Schneidemühl, has been proposed by Prof. Ellenberger and Dr. Baum, who by means of the Microscope study the effect of drugs on organs. The remedies or drugs were administered to animals, and these having been killed, their livers were sectioned in order to find out if the liver cells showed the regular dark granulation of rest, or if on account of increased activity, they showed only faint granulation at their periphery. The hepatic activity was found to be stimulated by pilocarpin, muscarin, aloes, salicylate of soda, benzoate of soda, while atropin, sulphate of magnesia, acetate of lead, hydrochlorate of ammonia, and calomel were inhibitory.

'Annales de Micrographie.'—This new monthly journal seems likely to prove a useful addition to microscopical literature. It is edited by Dr. Miquel, Chief of the Micrographical Service of the Municipal Observatory of Montsouris, Paris, assisted by Dr. Fabre-Domergue and M. E. de Freudenreich. It is intended to be devoted to Bacteriology, Protophyta, and Protozoa, and it will contain both original articles and abstracts of French and foreign papers.

Bower, F. O.—**A Course of Practical Instruction in Botany.** Part I.
[Chap. I. deals with the making of preparations and the adjustment of the Microscope; Chap. II., practical exercises; Chap. III., Micro-chemical reactions, &c.] 2nd ed., 8vo, London, 1888.

Jaksch, R. V.—**Manuel de diagnostic des maladies internes par les méthodes bactériologiques, chimiques et microscopiques.** Trad. par L. Moulé. (Manual of the diagnosis of internal diseases by bacteriological, chemical, and microscopical methods. Translated by L. Moulé.)
xix. and 355 pp., 108 figs., 8vo, Paris, 1888.

Kellicott, D. S.—**Presidential Address** to the American Society of Microscopists, Columbus, O., 1888.
[The nature of Protozoa and lessons of these simplest animals.]
The Microscope, VIII. (1888) pp. 289–309.

Kühne, H.—**Praktische Anleitung zum mikroskopischen Nachweis der Bakterien im thierischen Gewebe.** (Practical Guide to the microscopical demonstration of Bacteria in animal tissues.) vi. and 44 pp., 8vo, Leipzig, 1888.

Latham, V. A.—**The Microscope and how to use it.**
[XV. Practical hints on histology. Special methods for examination of the spinal cord, brain, &c. *Continued.*]
Journ. of Microscopy, I. (1888) pp. 249–54.

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